Florida International University

Miami, FL

REANALYSIS OF THE 1954-1963 ATLANTIC HURRICANE SEASONS

A thesis submitted in partial fulfillment of the

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by

Sandy Delgado

2014

To: Interim Dean, Michael R. Heithaus
College of Arts and Sciences

This thesis, written by Sandy Delgado, and entitled Reanalysis of the 1954-1963 Atlantic Hurricane Seasons, having been approved in respect to style and intellectual content, is referred to you for judgment.

We have read this thesis and recommend that it be approved.

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DEDICATION

I dedicate this thesis to my family. Their love, understanding and support have been pivotal to the fruition of this research.

ACKNOWLEDGMENTS

The completion of these nine years of reanalysis was not a sole effort. I was fortunate to have the support, encouragement and help from several people. I was very lucky to have started working on the reanalysis about four years ago before I had finished my bachelors' degree. I will always be grateful to Dr. Hugh Willoughby, professor and advisor at FIU, for noticing my love and enthusiasm for hurricanes and understanding that working on past hurricanes would be a perfect place for me. Almost four years ago, Dr. Chris Landsea, advisor and mentor, provided the setting for me to use my love and understanding of hurricanes to travel back in time and improve on the work done by great scientists in the 1950s and 1960s with the advancements in the understanding of hurricanes and technology we have today. Dr. Landsea and I worked countless hours to make sure that my assessments on the tracks and intensities of all the tropical cyclones analyzed and added were as accurate as possible. I also had an instrumental person in this effort, Astryd Rodriguez spent countless of hours helping me with the plotting of many of the storms that were reanalyzed. Without her help, this reanalysis would have taken many more months. We also had a great partnership and it was a pleasure working together. I would also like to thank the NHC for allowing me to use the library where I spent most of my time working on the reanalysis. I would also like to thank all the hurricane specialists at the NHC for their encouragement and help, it has been a real pleasure all these years to be able to talk to everyone and gain some of their knowledge and experience. Special thanks to Dr. Lixion Avila for allowing me to borrow the United States Weather Bureau tropical cyclone advisories from 1954-1963. Thanks to Gloria Aversano, Librarian at the

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ABSTRACT OF THE THESIS

REANALYSIS OF THE 1954-1963 ATLANTIC HURRICANE SEASONS

by

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Professor Hugh E. Willoughby, Major Professor

HURDAT is the main historical archive of all tropical storms and hurricanes in the North Atlantic Basin, which includes the Caribbean Sea and Gulf of Mexico, from 1851 to the present. HURDAT is maintained and updated annually by the National Hurricane Center at Miami, Florida. Today, HURDAT is widely used by research scientists, operational hurricane forecasters, insurance companies, emergency managers and others. HURDAT contains both systematic biases and random errors. Thus, the reanalysis of HURDAT is vital. For this thesis, HURDAT is reanalyzed for the period of 1954-1963. The track and intensity of each existing tropical cyclone in HURDAT is assessed in the light of 21st century understanding and previously unrecognized tropical cyclones are detected and analyzed. The resulting changes will be recommended to the National Hurricane Center Best Track Change Committee for inclusion in HURDAT.

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ABBREVIATIONS AND ACRONYMS

Atlantic Hurricane Reanalysis Project	AHRP
Atlantic Multidecadal Oscillation	AMO
Atlantic Tropical Storm Report	ATSR
Automated Tropical Cyclone Forecast	ATCF
Central Texas	BTX
Comprehensive Ocean-Atmosphere Dataset	COADS
East	E
East-northeast	ENE
El Niño Southern Oscillation	ENSO
East-southeast	ESE
Extratropical	ET
Hour	hr
Hurricane Database	HURDAT
Hurricane Weather Maps	HWM
Knot	kt
Latitude	Lat
Longitude	Lon
Louisiana	LA
Maine	ME
Mariners Weather Logs	MWL
Maryland	MD
Massachusetts	MA

Miles per hour	mph
Millibar	mb
Mississippi	MS
National Aeronautics and Space Administration	NASA
National Climatic Data Center	NCDC
National Hurricane Center Best Track Change Committee	NHCBTCC
National Hurricane Research Project	NHRP
Nautical mile	nm
New Hampshire	NH
New York	NY
NHC Microfilm Maps	MICRO
NHC Storm Wallets	WALLETS
North Carolina	NC
North Texas	CTX
North	N
Northeast Florida	DFL
Northeast	NE
North-northeast	NNE
North-northwest	NNW
Northwest Florida	AFL
Northwest	NW
Radius of Maximum Winds	RMW
Rhode Island	RI

Saffir-Simpson Hurricane Wind Scale	SSHWS
South Carolina	SC
South Texas	ATX
South	S
Southeast Florida	CFL
Southeast	SE
South-southeast	SSE
South-southwest	WSW
Southwest Florida	BFL
Southwest	SW
Television Infrared Observation Satellite	TIROS
Tropical Storm	TS
Virginia	VA
West	W
West-northwest	WNW
West-southwest	SSW
Zulu time	Z

CHAPTER 1

PROBLEM AND OBJECTIVES

The objective here is the reanalysis of the North Atlantic hurricane database for the period of 1954-1963. Since the database was initially developed in the 1960s, HURDAT has been utilized for such purposes as "setting appropriate building codes for coastal zones, risk assessment for emergency managers, analysis of potential losses for insurance and business interests, intensity forecasting techniques, verification of official and model projections of track and intensity, seasonal forecasting, and climatic change studies" (Landsea et al. 2008a,b). The challenge is that HURDAT was not developed with these purposes in mind. Therefore, the focus of the Atlantic Hurricane Reanalysis Project is to improve the accuracy and completeness of HURDAT through the correction of random errors and biases. Some of the random errors include errors to the tracks and positions that are the consequence of a lack of sufficient observations near the storm. Sparse observations also introduce biases in estimated intensity. For example, the intensity may have been underestimated until a ship passed close or through the center of a storm or a reconnaissance airplane reached the tropical cyclone. Also, in the early 1960s, the first satellite images produced by TIROS showed cloud masses that the forecasters were able to identify as tropical cyclones. But without a technique to estimate intensity, the forecasters had to still wait for the reconnaissance aircraft or ship to investigate the storm intensity.

New data sources have become available that were not available in real-time when the tropical cyclone was active. Another objective is correction of US hurricanes landfall characteristics, because many landfall intensities are inaccurate. Moreover, some

tropical cyclones that existed were not included in the original HURDAT possibly because of the lack of data over the open Atlantic or because they were considered to have been extratropical. Also, advancements in understanding of tropical cyclones and better analysis techniques support a more accurate archive.

Systematic biases in the original HURDAT database are typically easier to detect and quantify than are random errors. For example, when the original HURDAT was developed, the position and intensity of the tropical cyclones was estimated only once daily and then interpolated to 6-hourly intervals (Landsea et al. 2008). This caused many errors, including artificial apparent weakening before landfall. Another problem was that many tropical cyclones showed unrealistic accelerations or decelerations at the beginnings and/or the ends of their tracks. In other cases, the analysis did not follow storms until dissipation or extratropical transition. Many intensities obtained by the reconnaissance aircraft were overestimates (Stearns, personal communication). In the 1950s and 1960s, reconnaissance aircraft were not able to measure surface winds directly. The onboard aerologists made estimates of the surface winds visually based upon sea state. They were able to measure the minimum sea-surface pressure by extrapolation or dropsonde, and often estimated the size of the eye from radar. Modern pressure-wind relationships allow us to improve estimates of the actual maximum surface winds. Sometimes the central pressures yield maximum wind speeds of 20 to even 50 kt less (according to the Brown et al. 2006 pressure-wind relationships) than the estimated maximum wind speed provided by the flight aerologist. This happens because modern pressure-wind relationships take into account factors, such as size, latitude and

translational velocity, that affect the direct relationship between central pressure and maximum wind.

A thorough search of the records reveals tropical cyclones that existed but were not originally listed in HURDAT. A tropical cyclone is defined by the National Hurricane Center as a “warm-core non-frontal synoptic-scale cyclone, originating over tropical or subtropical waters, with organized deep convection and a closed surface wind circulation about a well-defined center” (Glossary of NHC Terms). For inclusion in HURDAT, these tropical cyclones must have produced winds of gale-force (34 kt) or greater. Normally a dozen or more potential cyclones (called “suspects”) are found for each historical year. The search extends beyond the boundaries of the official Atlantic hurricane season, which lasts from June to November. Usually most of the suspects were tropical waves/troughs or occluded baroclinic cyclones but never became tropical cyclones. But we find a few previously unknown systems that qualify as tropical cyclones each year. Their tracks, positions and intensities are catalogued every 6 hours and presented to the NHCBTCC for potential inclusion to HURDAT. For the suspects in the early 1960s, the first satellite images are very helpful in our search and in the understanding of the structure of potential tropical cyclones.

CHAPTER 2

BACKGROUND INFORMATION

Prior to the reanalysis of the 1954-1963 Atlantic hurricane seasons, the AHRP had been completed and approved by the NHCBTCC for the years 1851-1950 and the new changes were made available to the community (Landsea et al. 2004a, 2008a, 2008b, 2012, 2013). The NHCBTCC is currently reviewing the hurricane seasons of 1951-1953. It should be noted that the reanalysis of the hurricanes Carol, Edna and Hazel of 1954 was conducted by Donna Strahan prior to the present study (Landsea et al. 2008b). Also the reanalysis of Hurricanes Donna (1960) and Carla (1961) was conducted by Chris Landsea, Jason Dunion and Cristina Carrasco, but not yet published. These hurricanes impacted the United States severely, and for this reason the reanalysis was done in advance. For completeness, the metadata from these studies have been included in the appendix. The tables in the results section include the information from these cyclones. The results of the present study will be submitted to the NHCBTCC together with the five hurricanes reanalyzed by others.

Pressure-Wind Relationship

The relationship between lower pressure and the increase in the winds around the center of tropical cyclones was well known during the decade of the 1950s and early 1960s, but the process was poorly understood. The first paper to tackle the problem was Fletcher (1955) using data collected from 10 significant hurricanes that affected the southern United States between 1909 and 1949. Fletcher (1955) provides a simple equation, $\mathrm{vm} = 16(pn - po)^{\frac{1}{2}}$ that can be used to estimate the intensity of the

hurricane. In the equation, v is the maximum surface wind in knots, p_n is the barometric pressure of the outermost closed isobar and p_o is the central pressure of the hurricane. Fletcher (1955) even indicates that when the outermost closed isobar is unknown; using 1010 mb would likely provide a reliable result. He acknowledges that if the tropical cyclone is embedded within usually low or high environmental pressures, using 1010 mb would result on estimated winds that are too high or too low. Nevertheless, the simple formula was step in the right direction. Later, Kraft (1961) published a paper that presented data from 13 Atlantic hurricanes and one Northwest Pacific typhoon. These systems made landfall around the time of their greatest intensity and relatively reliable measurements were made of the maximum winds and central pressures. Kraft (1961) provides a formula to estimate maximum surface winds is similar to Fletcher (1955), $\mathrm{V}max = 14(1013 - Pcenter)^{\frac{1}{2}}$.

The pressure-wind relationship used for the present reanalysis (Brown et al. 2006), which was derived using a large sample of reconnaissance aircraft data between 1998 and 2005. Aside from the difference in the number of observations, Brown et al. (2006) differs from Fletcher (1955) and Kraft (1961) in that it takes into account the latitude of the tropical cyclone and adjusts as the system moves poleward. The formulas provided by Fletcher (1955) and Kraft (1961) would indicate the same intensity for a hurricane located at 10N or 30N for the same given pressure. But today we know that the shape of the profiles of hurricanes in the lower latitudes (10-25N) is smaller than for storms in the higher latitudes or in a weakening state (Willoughby and Rahn, 2004). Thus, for example, a hurricane with a central pressure of 970 mb tends to have stronger maximum winds in the lower latitudes than when it approaches the mid latitudes (25-

45N). Brown et al. (2006) also takes into account whether the system is intensifying, weakening or steady-state, providing a slightly different intensity for these situations at the same central pressure values. The reanalysis does not use the exact value provided by Brown et al. (2006), it also takes into consideration forward speed, the RMW, as well as environmental pressures and then rounds the value to the nearest 5 kt. Since Brown et al. (2006) was published, more recent physically-based pressure-wind relationships have become available. Knaff and Zehr (2007) and Courtney and Knaff (2009) incorporate many aspects of the hurricanes which may possibly translate into a better assessment of the intensity. Nonetheless, Brown et al. (2006) has been used since the reanalysis effort began more than a decade ago, and more than 100 years have been reanalyzed using this method. Furthermore, some of the factors included in the Knaff and Zehr (2007) and Courtney and Knaff (2009) are unavailable for many of the historical tropical cyclones.

Finally, the original six-hourly assessment of the intensity in HURDAT are changed only if evidence is sufficient to justify the change. During the nine years of reanalysis it was evident that in the mid-1950s, the intensities in HURDAT had a high degree of correlation with the estimated surface or flight level winds from the reconnaissance aircraft no matter what central pressure was reported. This slowly shifted in the late 1950s and early 1960s as the forecasters had a better grasp on the pressure-wind relationship. For an example of how the reanalysis used the pressure-wind information, if a central pressure of 970 mb south of 25N would suggest maximum surface winds of 90 kt from the Brown et al. (2006) pressure-wind relationship at steady state, and the original intensity in HURDAT was 85 kt, the original intensity would likely be retained, as making a 5 kt change may not be justifiable given the somewhat crude

methodology employed. But if the hurricane were moving with a faster than typical forward speed and/or the RMW were smaller than the climatological value, then the intensity may be increased to 95 kt.

Saffir-Simpson Hurricane Wind Scale

The Saffir-Simpson Hurricane Wind Scale (Saffir and Simpson, 1974) is a 1 to 5 rating system that uses the maximum hurricane surface winds. Hurricanes in categories 1 and 2 will cause between minor to extensive damage, especially to trees and roofs. Hurricanes in categories 3, 4 and 5 are considered major hurricanes and the damage potential ranges from devastating to catastrophic. The hurricane scale was devised in 1974 by Herbert Saffir, an engineer, and Robert Simpson, a meteorologist. Originally it also included the storm surge for at each category but this aspect was removed in 2010 since the direct correlation between the maximum wind and storm surge is weak. In addition, a minor adjustment was made in 2012 to correct the boundaries between category 3 and 4, and 4 and 5. The inconsistency arose from the conversion between knots and miles per hour. For example, 115 kt is equivalent to 132.3 mph, which to the nearest 5 mph is 130 mph. In the old version, 130 mph was category 3 but 115 kt was category 4. The new version solves this problem.

SSHWS Category	Winds (kt)
1	64-82
2	83-95
3	96-113
4	114-135
5	>136

Table 1. Saffir-Simpson Hurricane Wind Scale. (Source: http://www.nhc.noaa.gov/sshws.shtml)

CHAPTER 3

DATA SOURCES

A gamut of data sources supports the reanalysis. As shown in Landsea (2007) and McAdie et al. (2009) (Figure 1), technological advances have allowed us to re-examine past tropical cyclones and make their histories more accurate and detailed.

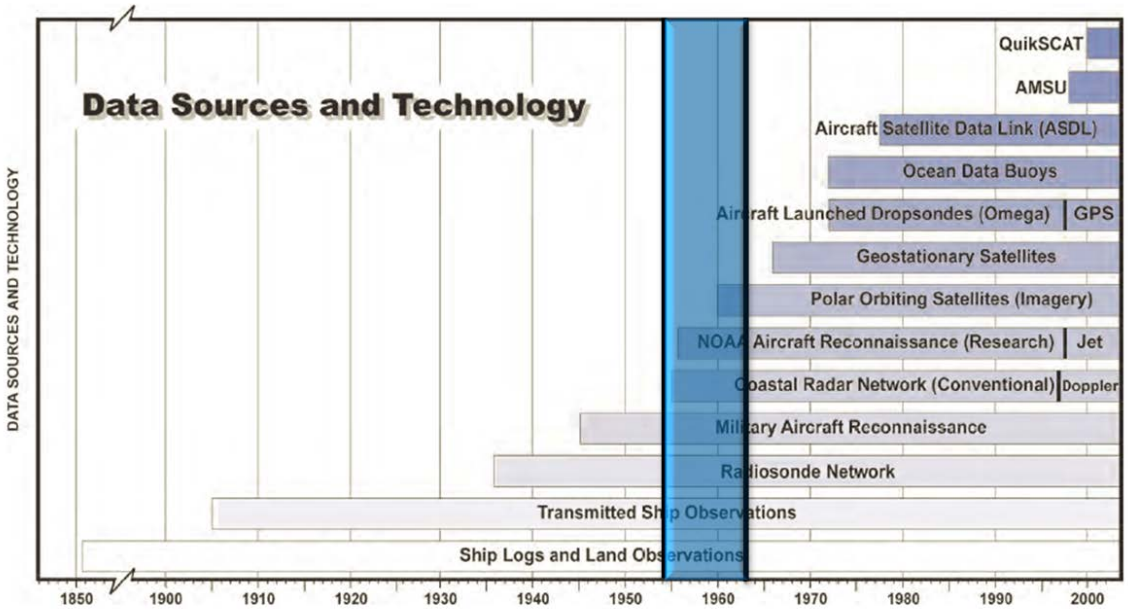

Figure 1. This graphic was obtained from McAdie et al. (2009) and shows the advancements in technology between 1850 and early 2000. The blue shaded strip includes the years covered in this reanalysis, 1954-1963.

Two different types of synoptic maps are keys to the process, the NHC microfilms of synoptic weather maps and the Historical Weather Maps (HWM) series. The Historical Weather Maps (Figure 2) provides surface analyses of the entire northern hemisphere once daily at 12Z and once daily 500 mb maps. The microfilm maps (Figure 3) are available every six hours for the entire Atlantic basin, except during the months of November and December. Microfilm maps of hurricanes making landfall in the United

States are available every hour for most storms. The HWM and microfilm show the observations from ships and land stations,

including the direction and strength of winds, sea level pressure, temperature, and dewpoint observed at the time of the measurement. The temperature and dewpoint are key in determining when a tropical cyclone has acquired non-tropical characteristics, or in the case of suspects, when a non-tropical cyclone has acquired tropical characteristics. The Comprehensive Ocean-Atmospheric Dataset (COADS), first introduced by Woodruff (1987), is a global database containing millions of ship observations. Many, but not all, of the ships in COADS are already plotted in the microfilm. Once all the

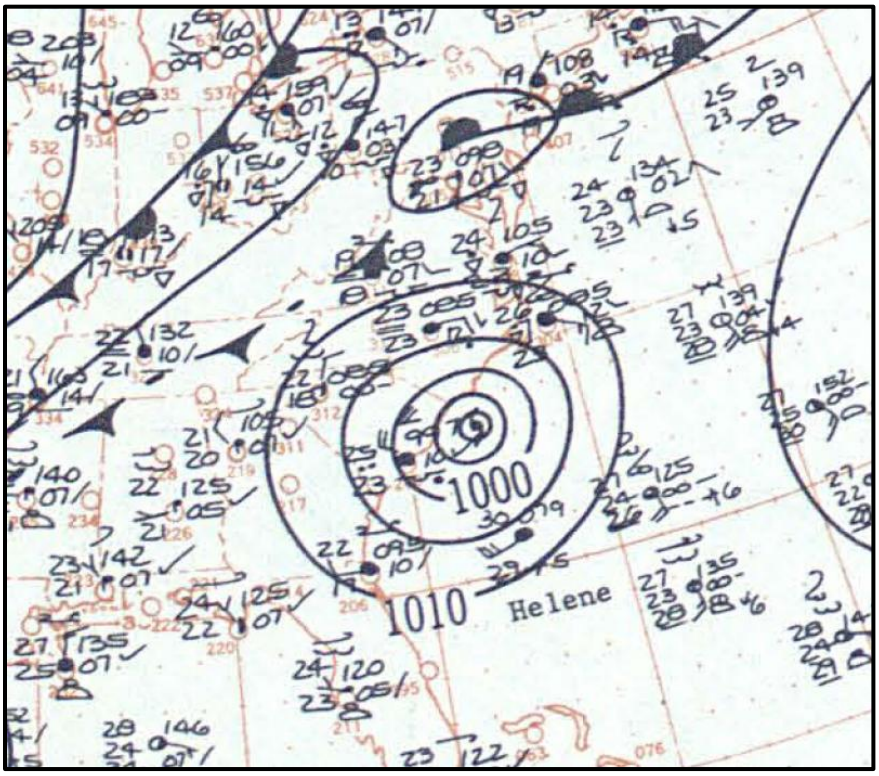

Figure 2. Historical Weather Map for September 27, 1958, zoomed-in, showing Hurricane Helene close to the eastern coast of the United States as a frontal boundary approaches from the northwest.

synoptic data is plotted in a single map, it usually provides for a better assessment of tropical cyclone intensity and position. Another source for ship data is the Mariners Weather Log (MWL), available starting in 1957. Data in the MWL sometimes reveal important observations that were not available from other sources. The Monthly Weather Review (MWR) contains monthly charts of cyclone tracks and annual post-season hurricane summaries and track maps. Monthly summaries in MWR also provide detailed information on significant hurricane that affected the United States. Other sources include the Local and State Monthly Climatologically Data Summaries from the National

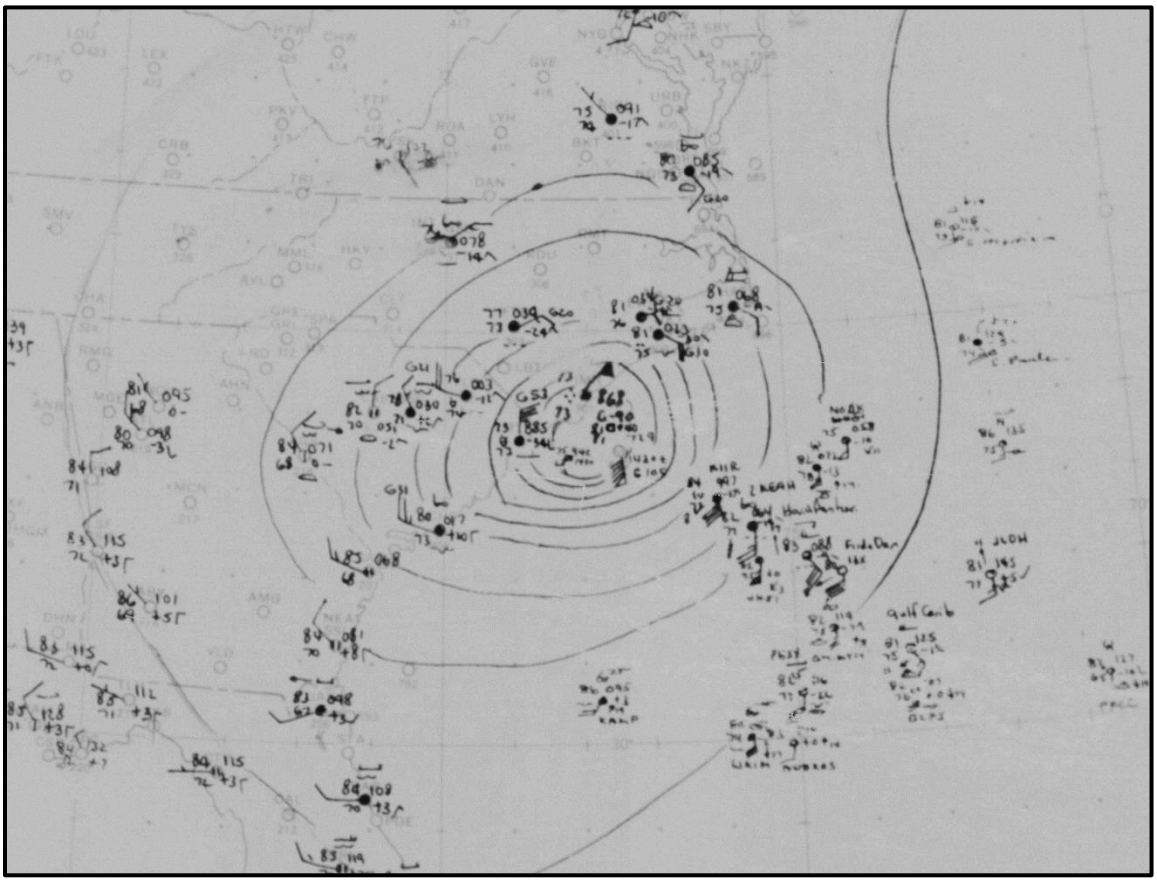

Figure 3. Microfilm image on September 27, 1958, at 15Z showing Hurricane Helene impacting parts of the Carolinas.

Climatic Data Center. These data are essential for tropical cyclones that make landfall or pass close to the United States.

The Annual Tropical Storm Report provides reconnaissance center fixes, including latitude, longitude, and the Storm Report provides reconnaissance center fixes, including latitude, longitude, and intensity. Furthermore, it includes a summary of the tropical cyclone's lifetime and observations from every mission. These data are crucial for the current project because they come directly from the centers of the tropical cyclones, even when the tropical cyclone misses ships and major population centers. The NHC Storm Wallets, an online site of all NHC archives for a particular system available starting in 1958, were very helpful they because they contain most of the available data on the tropical cyclones in one place. They provide the Weather Bureau advisories, radar center fixes, reconnaissance aircraft center fixes, tracks, storm summaries, and more. The current analysis also incorporates meteorological observations obtained from the meteorological offices of Caribbean countries and Mexico. We also use raw U.S. station data and previous analysis by Ho et al. (1987) and Jarrell et al. (1992)

Satellite Images

The time interval analyzed here encompasses the first use of satellite data to track tropical cyclones. The TIROS Program was engineered by NASA to understand the possibility of satellites' usefulness to study the Earth. Since the satellite technology was new in the late 1950s, TIROS was used to test designs and instruments. The first weather satellite, TIROS I, was launched on April 1, 1960. It lasted 78 days in orbit. The satellite sent thousands of pictures of cloud-covered areas and proved that satellites could provide

useful weather information from space. The TIROS cameras captured tropical cyclones (Figure 4) in various stages of development, from tropical waves to hurricanes, and at different stages of organization, from well-organized to poorly-organized systems. Nonetheless, satellite images were not available for all tropical cyclones and for most systems, only a single satellite image is available. Moreover, the quality of most photographs do not allow use of the Dvorak technique (Velden et al. 2006) provide an estimate of the storm intensity. Still, it is a tool with potential to enhance the completeness of HURDAT.

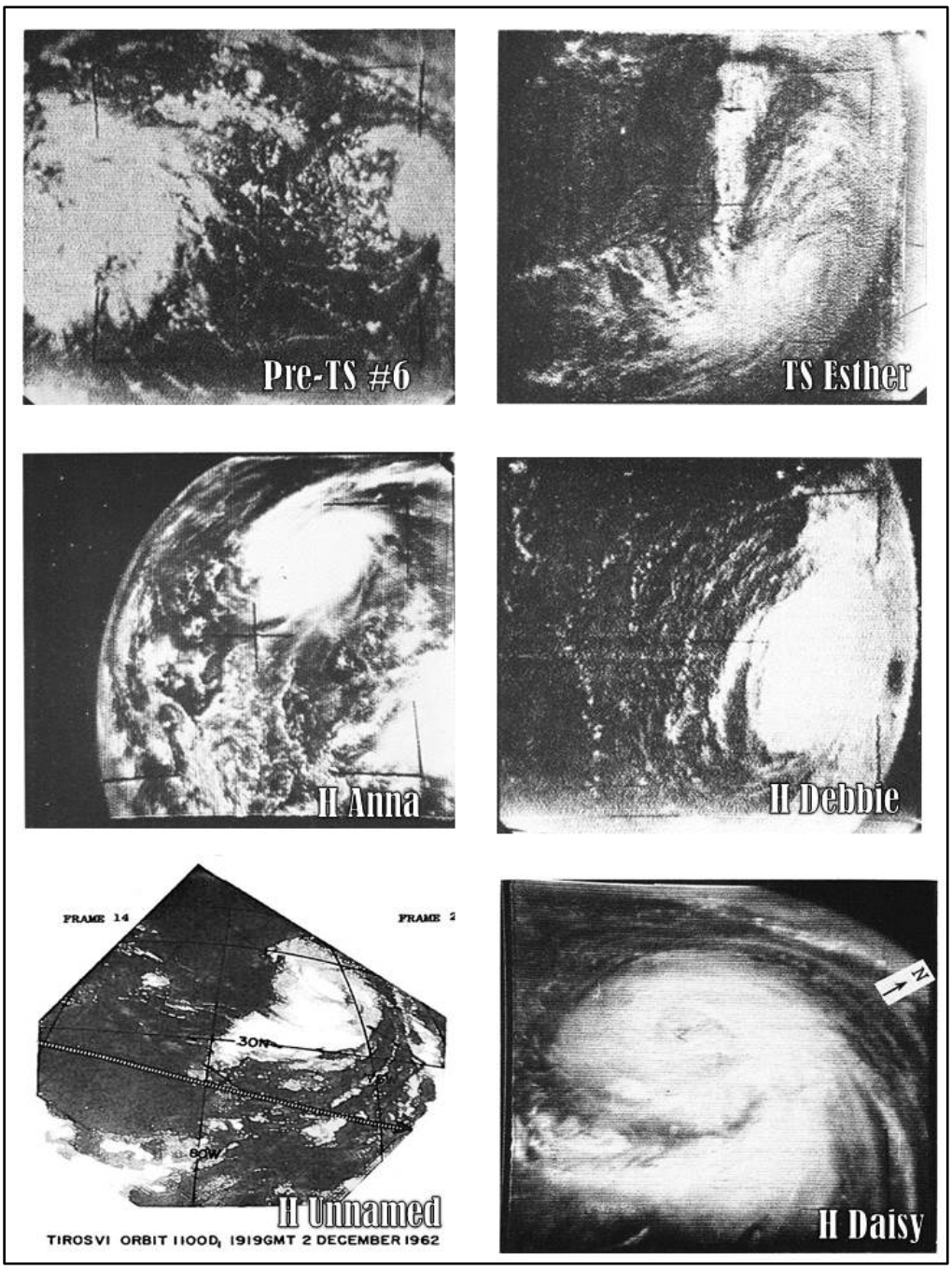

Figure 4. Satellite images captured by TIROS in 1961 and 1962 showing several tropical systems at different stages of development.

CHAPTER 4

METHODOLOGY

The reanalysis entails several steps. The first is to obtain all the meteorological data available from all sources and compile them into a single database for each cyclone. The microfilm maps are scanned using a scanner in NHC Library. The HWM is available online and the desired area is blown up and used for the reanalysis. The images are later printed to plot all the observations from all the sources onto synoptic maps for every 6-hr interval. Key pieces of information that are important for the track and intensity of a hurricane are the data collected by the reconnaissance aircraft. The center fixes positions, pressures, estimated surface or flight level winds and estimates of the eye diameter are recorded in an excel file containing all information about each tropical cyclone. Later, after obtaining a map of the original track in HURDAT from the ATCF, the reconnaissance aircraft data are plotted and compared to the original track (Figure 5). After all the data have been plotted, a daily metadata paragraph is written for each tropical cyclone. The metadata includes a summary of the synoptic analysis shown on the HWM and microfilm maps, the center positions and intensities at 12Z according to HURDAT, highlighted observations of gale-force winds (35 kts or more), low pressures (usually 1005 mb or lower), and the center fixes from the reconnaissance aircraft. When available, the center fixes from the satellites images are included. Important observations or accounts of visual observations, storm damage, etc. contribute to the daily metadata paragraph. For example, below is the daily summary of Hurricane Helene, 1958, on September 27:

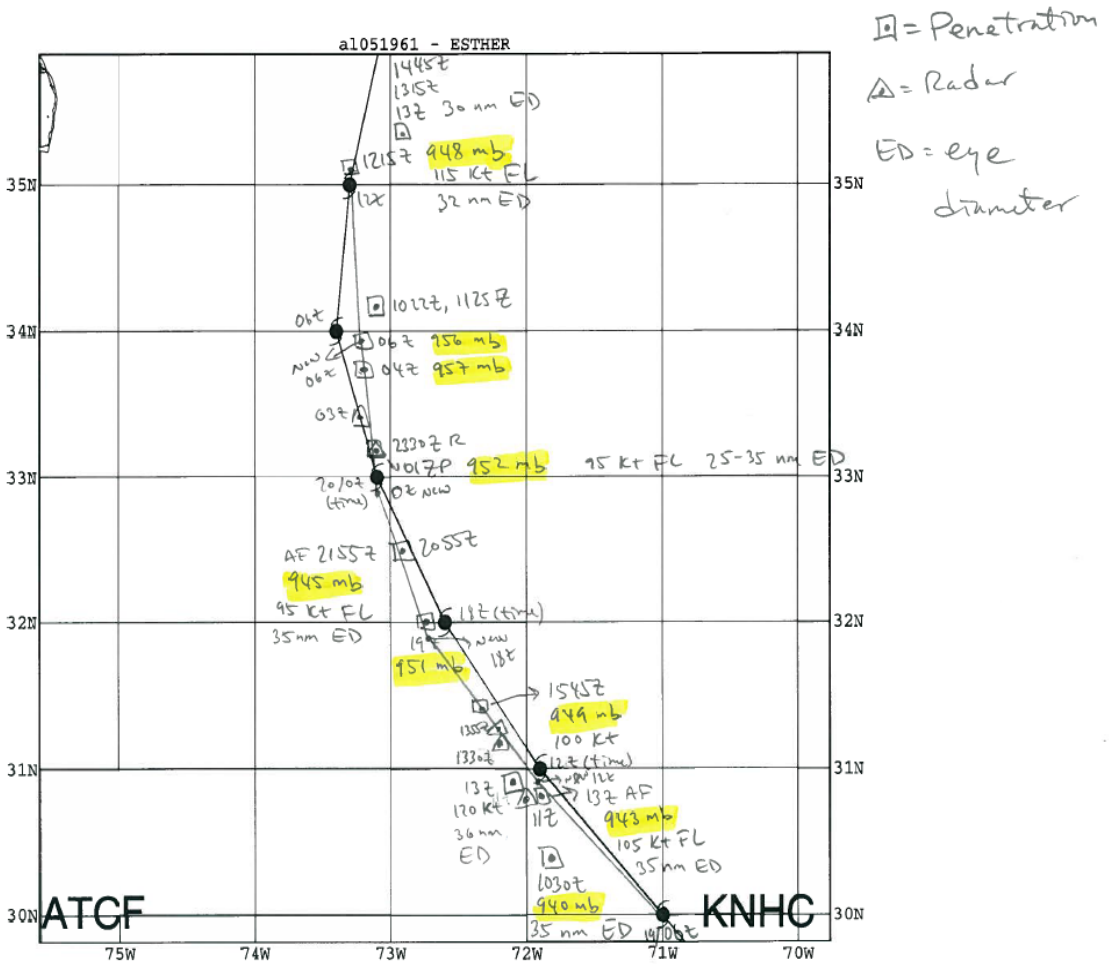

Figure 5. Part of the original track in HURDAT of Hurricane Esther, 1961, with the plotted reconnaissance aircraft data.

HWM analyzes a hurricane of at most 990 mb at 33.4N, 78.0W and a frontal boundary to the northwest at 12Z. HURDAT lists a 115 knot hurricane at 33.1N, 78.2W at 12Z. Microfilm shows a closed low pressure of at most 993 mb at 33.5N, 78.5W with a frontal boundary to the northwest at 12Z. Ship highlights: 50 kt W and 1006 mb at 29.3N, 78.6W at 00Z (COADS). 40 kt SE and 1011 mb at 33.7N, 74.7W at 03Z (micro). 35 kt SW and 1006 mb at 30.8N, 77.3W at 06Z (COADS). 40 kt SE and 1006 mb at 32.0N, 75.5W at 12Z (micro). 55 kt S at 32.1N, 75.6W at 15Z (micro). 55 kt SSW and 996 mb at 36.6N, 76.5W at 18Z (COADS). 65 kt S and 994 mb at 34.1N, 74.9W at 20Z (MWL). 70 kt SSW and 1000 mb at 32.4N, 75.7W at 21Z (MWL). Land highlights: 40 kt E and 1004 mb at Frying Pan, NC at 06Z (micro). 994 mb at Sullivan's Islands, SC at 0920Z (WALLET). 60 kt E and 992 mb at Frying Pan, NC at 12Z (micro). 90 kt S (gusts to 105 kt) and 973 mb at Frying Pan, NC at 1430Z (micro). 50 kt NNE (gusts to 90 kt) and 987 mb at Wilmington, NC at 15Z (micro). 74 kt N (gusts to 117 kt) and 977 mb at Wilmington, NC at 18Z (micro). 60 kt NW (gusts to 108 kt) and 983 mb at Wilmington, NC at 20Z (SWO). Gusts estimated to 125 kt, 948 mb at Cape Lookout, NC at 2230Z (WALLET). 971 mb at Oriental, NC at 2330Z (WALLET). 56 kt NNW (gusts to 84 kt) and 983 mb at Cherry Point, NC at 2359Z (SWO). Aircraft highlights: Penetration center fix estimated surface winds of 100 kt and an eye diameter of 25 nm at 31.5N, 78.3W at 0130Z (ATSR). Penetration center fix measured a central pressure of 943 mb at 31.7N, 78.5W at 0230Z (ATSR). Penetration center fix measured a central pressure of 933 mb and an eye diameter of 25 nm at 32.4N, 78.6W at 0630Z (ATSR). Penetration center fix measured a central pressure of 932 mb, estimated surface winds of 100 kt and an eye diameter of 25 nm at 32.7N, 78.7W at 08Z (ATSR). Penetration center fix measured a central pressure of 938 mb, estimated surface winds of 75 kt and an eye diameter of 25 nm at 33.1N, 78.5W at 11Z (ATSR). Radar center fix measured a peripheral pressure of 940 mb at 1730Z (ATSR). Penetration center fix measured a central pressure of 938 mb and estimated surface winds of 75 kt at 34.4N, 76.3W at 2230Z (ATSR).

MWR: "Helene moved on a northwestward course at 8 to 10 mph during the 26th as it continued to deepen, finally attaining a minimum pressure of 933 mb around midnight (local time) at a position some 80 miles east of Charleston, S.C. Hurricane-force winds, accompanied by high tides and torrential rains, pounded the coastal areas from Cape Fear to Cape Lookout. The Weather Bureau at Wilmington, N.C. recorded a maximum wind (one mile) of 88 mph and a peak gust of 135 mph. Both of these speeds greatly exceeded all previous records there. Total rainfall at Wilmington during the hurricane was 8.29 inches. At Cape Fear, winds were estimated at 125 mph with gusts to 150 to 160 mph. According to Sumner, the wind speeds and wind damage associated with Helene indicate a more intense hurricane than Hazel of 1954, but the fact that the center of Helene passed about 20 miles off the coast prevented the extremely high tides and wave damage associated with the 1954 hurricane. Reconnaissance and other types of observational data from hurricane Helene provided a wealth of material for research and some interesting experimental work was accomplished. Two balloon-borne radio tracking beacons were dropped into the eye of Helene by aircraft of the National Hurricane Research Project and remained in the eye for a significant period. A Navy plane also dropped a metallicized inflated plastic ball on the ocean surface in the eye for radar tracking. It was observed on radar for 12 hours or more."

Later, the reanalyzed positions and intensities for each storm at six hour intervals are prepared. Changes are made to HURDAT only when the available data suggest that a change is needed. In general, tiny (0.1 degrees latitude/longitude for position and 5 kt for intensity) alterations are not made to the HURDAT database given the sizable uncertainties inherent in the observations. On the basis of available data, the status of a tropical cyclone may be changed from the original HURDAT. Genesis can be indicated to have occurred earlier or later than originally shown, same with the transition to an extratropical cyclone or dissipation. Furthermore, a couple of the tropical cyclones reanalyzed weakened below tropical depression intensity and later regenerated, and a tropical wave stage is now shown.

After the positions, intensities and statuses are determined, opening and closing paragraphs are added to each tropical cyclone. The opening paragraph begins by describing minor, major or no proposed changes to HURDAT. Track changes larger than two degrees latitude/longitude are considered major changes, and intensity changes of 20 knots or greater (approximately one Saffir-Simpson category) are considered major intensity changes. The opening paragraph of the metadata also lists all sources. Below is an example of the opening paragraph from Hurricane Helene, 1958:

Major changes to the track and intensity shown in McAdie et al. (2009). Evidence for these alterations comes from the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Monthly Weather Review, Surface Weather Observations, Navy reconnaissance book, Mariners Weather Log and NHC Storm Wallets.

The closing paragraphs of the metadata for each storm contain a summary highlighting the changes and explain the reasoning behind them. Below is an example of the closing paragraphs from Hurricane Helene, 1958:

Hurricane Helene developed from a tropical wave that left the African coast around mid-September. Microfilm indicates that the wave showed little signs of development as it tracked westward across the eastern and central Atlantic, although the ship data over this area of the basin are sparse. Minor track changes are analyzed during the lifetime of Helene as a tropical cyclone; major track changes were analyzed at 12Z and 18Z on October 2nd when the system was an extratropical cyclone. The first position is at 06Z on September 21st as a 25 kt tropical depression, same as the original HURDAT. The actual genesis of this tropical cyclone is highly uncertain due to the low ship traffic east of the Lesser Antilles, but the data available suggests that the center was about 90 nm south than originally shown in HURDAT. It is also possible that the tropical cyclone did not develop a well-defined low-level circulation until September 22nd based on aircraft reconnaissance reports and ship observations. A ship reported 40 kt SE on September 21st at 18Z but this was about 300 nm east of the center and appears to have a high wind bias. The first reconnaissance aircraft penetration center fix measured a central pressure of 1013 mb and estimated surface winds of 20 kt at 1930Z on September 22nd. (Central pressures values for each 6 hour period were present in the original HURDAT between September 22nd at 12Z and September 30th at 00Z. Some of these were obviously analyses that were added in, not based upon actual observations. Thus, based on actual observations, some were retained and others removed. Detailed information on these changes can be found in the table at the end.) Intensification to a tropical storm is analyzed at 00Z on September 23rd, same as the original HURDAT. The next reconnaissance aircraft reached Helene at 1330Z and measured a central pressure of 1003 mb and estimated surface winds of 45 kt. A central pressure of 1003 mb suggests maximum sustained winds of 41 kt intensifying south of 25N from the Brown et al. pressure-wind relationship. An intensity of 40 kt is selected for 12Z on the 23rd, 5 kt less than originally shown in HURDAT, a minor intensity change. A few ships late on September 23rd reported low-end tropical storm force winds near the tropical cyclone.

On September 24th, Helene continued to intensify while moving to the northwest. A reconnaissance aircraft reached the tropical cyclone at 1330Z and measured a central pressure of 997 mb, estimated surface winds of 55 kt and an eye diameter of 9 nm. A central pressure of 997 mb suggests maximum surface winds of 51 kt north of 25N from the pressure-wind relationship. An eye diameter of 9 nm suggests an RMW of about 7 nm and the climatological value is 20 nm. Based on an RMW smaller than the climatology value and a forward speed of about 14 kt, an intensity of 60 kt is selected at 12Z on the

24th, down from 65 kt originally in HURDAT, a minor intensity change. Intensification to a hurricane is analyzed at 18Z on the 24th, six hours later than originally shown in HURDAT. A ship reported 65 kt S at 09Z on the 24th, but it was located about 150 nm southeast of the center and it is likely to have a high wind bias, compared to other ships nearby. Late on September 25th, the Navy and NHRP were investigating Helene and measured a central pressure of 982 mb around 18Z. The Navy aircraft also estimated surface winds of 75 kt and an eye diameter of 30 nm, while the NHRP aircraft estimated surface winds of 76 kt and an RMW of 28 nm. A central pressure of 982 mb suggests maximum sustained winds of 73 kt north of 25N intensifying. Since the forward speed of the hurricane had decreased to about 5 kt and the RMW is somewhat larger than climatology (28 nm vs 22 nm), an intensity of 70 kt is selected for 18Z on the 25th, down from 80 kt originally in HURDAT, a minor intensity change. Another penetration center fix at 0230Z on September 26th measured a central pressure of 986 mb, indicating that Helene may have temporarily weakened. A central pressure of 986 mb suggests maximum sustained winds of 65 kt north of 25N from the pressure-wind relationship. An intensity of 65 kt is selected for 00Z on the 26th, down from 85 kt originally in HURDAT, a major intensity change. It is possible that Helene may have weakened to a high-end tropical storm early on the 26th. Soon thereafter, Helene started to rapidly intensify. A reconnaissance aircraft measured a central pressure of 974 mb, estimated surface winds of 50 kt and an eye diameter of 20 nm at 08Z on the 26th. A central pressure of 974 mb suggests maximum surface winds of 83 kt north of 25N intensifying from the pressure wind-relationship. An eye diameter of 20 nm suggests an RMW of about 15 nm and the climatological value is 23 nm. Based on the RMW being smaller than the climatological value and a forward speed of about 8 kt, an intensity of 80 kt is selected for 06Z on the 26th, down from 85 kt originally in HURDAT, a minor intensity change. Another reconnaissance aircraft measured a central pressure of 963 mb, estimated surface winds of 55 kt and an eye diameter of 32 nm at 14Z on the 26th. A central pressure of 963 mb suggests maximum surface winds of 96 kt north of 25N intensifying from the pressure wind-relationship. An eye diameter of 32 nm suggests an RMW of about 24 nm and the climatological value is 22 nm. Because the RMW is similar to climatology and the forward speed was about 10 kt, an intensity of 95 kt is selected for 12Z on the 26th, up from 90 kt originally in HURDAT, a minor intensity change. Finally, a NHRP reconnaissance aircraft measured a central pressure of 948 mb, estimated surface winds of 99 kt and an RMW of 25 nm around 1830Z on the 26th. Later at 20Z, a Navy aircraft measured a central pressure of 948 mb, estimated surface winds of 110 kt and an eye diameter of 32 nm. A central pressure of 948 mb suggests maximum surface winds of 112 kt north of 25N intensifying from the pressure wind-relationship. Based on an RMW slightly larger than climatology (25 nm versus 20 nm) and a forward speed of about 13 kt, an intensity of 110 kt is selected for 18Z on the 26th, up from 105 kt originally in

HURDAT, a minor intensity change. Intensification to a major hurricane is analyzed at 18Z on the 26th, same as shown in the original HURDAT.

On September 27th, Helene continued to intensify as it approached the United States and started to turn to the north and later to the northeast. A reconnaissance aircraft measured a central pressure of 943 mb at 0230Z on the 27th. A central pressure of 943 mb suggests maximum surface winds of 117 kt north of 25N intensifying from the pressure wind-relationship. An eye diameter of 25 nm measured at 0630Z at the 27th suggests an RMW of about 19 nm and the climatological value is 21 nm. Since the RMW is close to the climatological value and the forward speed was about 10 kt, an intensity of 115 kt is selected for 00Z on the 27th, up from 110 kt originally in HURDAT, a minor intensity change. Another reconnaissance aircraft measured a central pressure of 933 mb at 06Z on the 27th. The aircraft also estimated surface winds of 100 kt and an eye diameter of 25 nm at 08Z. A central pressure of 933 mb suggests maximum surface winds of 127 kt north of 25N intensifying from the pressure wind-relationship. An eye diameter of 25 nm suggests an RMW of about 19 nm and the climatological value is 21 nm. An intensity of 125 kt is selected for 06Z on the 27th, up from 110 kt originally in HURDAT, a minor intensity change. The next reconnaissance aircraft measured a central pressure of 938 mb, estimated surface winds of 75 kt and an eye diameter of 25 nm at 11Z on the 27th. A central pressure of 938 mb suggests maximum surface winds of 116 kt north of 25N and 111 kt north of 25N weakening from the pressure wind-relationship. An eye diameter of 25 nm suggests an RMW of about 19 nm and the climatological value is 23 nm. An intensity of 120 kt is selected for 12Z on the 27th, up from 115 kt originally in HURDAT, a minor intensity change. Late on the 27th, the eye of Helene passed very close to North Carolina, about 10 nm south of Cape Fear and Cape Lookout. The strongest winds likely affected southeast North Carolina. The strongest winds reported in North Carolina were 74 kt at Wilmington and 110 kt estimated at Cape Fear. The Schwerdt et al. parametric hurricane wind model suggests that the highest sustained winds that impacted North Carolina reached 110 kt. The same wind model suggests that South Carolina was impacted by 92 kt winds, but since the winds that affected the state were coming from the north and northeast moving over land, a 15% wind reduction was implemented, suggesting maximum winds of 80 kt. Therefore, Helene is analyzed as a category 3 hurricane impact for North Carolina and category 1 hurricane impact for South Carolina. The strongest winds likely affected eastern South Carolina. The strongest winds reported in South Carolina were 35 kt at Myrtle Beach on the 27th at 15Z. Moreover, tropical storm force winds impacted southern Virginia and both, the hurricane wind model and surface observations at Norfolk and Langley, indicate that the highest winds were around 40 kt. Early on September 28th, Helene started to move away from the United States ahead of a frontal boundary. A reconnaissance aircraft measured a central pressure of 938 mb and estimated surface winds of 75 kt at 2230Z on the 27th. A central

pressure of 938 mb suggests maximum surface winds of 116 kt north of 25N from the Brown et al. pressure wind-relationship and 104 kt north of 35N from the Landsea et al. pressure-wind relationship. Based on a forward speed of about 10 kt, an intensity of 115 kt is selected for 00Z on the 28th, up from 110 kt originally in HURDAT, a minor intensity change. Two more penetration center fixes reported a central pressure of 945 mb at 03Z and 955 mb at 08Z on the 28th. A blend of these two measurements suggests a central pressure of about 950 mb around 06Z on the 27th, same as the original HURDAT. The aircraft also reported an eye diameter of 24 nm at 08Z on the 28th. A central pressure of 950 mb suggests sustained maximum winds of 101 kt north of 25N weakening and 97 kt north of 35kt, according to the corresponding pressure-wind relationships. An eye diameter of 24 nm suggests an RMW of about 18 nm and the climatological value is 25 nm. At this time, Helene was increasing in forward speed as it moved northeastward. Based on a forward speed of about 25 kt and an RMW smaller than climatology, an intensity of 110 kt is selected at 06Z on the 28th, same as originally shown in HURDAT.

On the 28th, Helene started to interact with a frontal boundary off the Mid-Atlantic of the United States and began to acquire extratropical characteristics. A reconnaissance aircraft at 14Z estimated surface winds of 90 kt and measured a pressure of 966 mb. Based on central pressure reports earlier and later on the day, it is likely that this pressure report was not a central pressure and has not been added to HURDAT. The last reconnaissance aircraft to reach Helene measured a central pressure of 943 mb and estimated surface winds of 105 kt at 2130Z and 951 mb at 2230Z on the 28th. A central pressure of 943 mb suggests maximum surface winds of 101 kt north of 35N from the pressure-wind relationship. Since the hurricane was becoming extratropical and also moving very rapidly (~39 kt) towards the east-northeast, an intensity of 100 kt is selected at 18Z on the 28th, up from 90 kt originally in HURDAT, a minor intensity change. Early on September 29th, coastal and ship observations indicate that Helene had become an extratropical cyclone. A temperature gradient had developed E-W across the circulation, along with frontal features. Extratropical transition is analyzed eighteen hours earlier than originally shown in HURDAT. Later on the 29th, Helene moved over the Atlantic provinces of Canada before moving northeast into the North Atlantic. It is analyzed that Helene reached Canada as a powerful extratropical cyclone and not as a hurricane as originally shown in HURDAT. Weakening below hurricane force occurred at 06Z on September 30th, six hours later than originally shown in HURDAT. Late on October 1st, ship observations indicate that the extratropical cyclone regained winds of hurricane force, but the strengthening was short-lived as the system started to weaken again on October 2nd. Major intensity changes are analyzed at 18Z on the 1st, and 00Z and 06Z on the 2nd. The analyzed intensity for these times is 70 kt, 70 kt and 65 kt, and HURDAT originally showed 50 kt, 50 kt and 45 kt, respectively. Late on the 2nd, the extratropical cyclone weakened again below hurricane force and kept a general eastward track. Early

on October 4th, the weakened extratropical cyclone merged with another extratropical cyclone to the north. The last position is analyzed at 00Z on the 4th, same as originally shown in HURDAT.

CHAPTER 5

RESULTS

The decade reanalyzed here contained several devastating events for many countries that border the Atlantic Ocean, Caribbean Sea and Gulf of Mexico. In 1954, three hurricanes impacted the eastern coast of the United States and three more the next year. In 1955, category 5 Hurricane Janet caused catastrophic damage in Swan Island and parts of the Yucatan Peninsula and a reconnaissance aircraft was lost flying into the powerful tropical cyclone. In 1956, Hurricane Betsy struck Puerto Rico, and Hurricane Greta became one of the largest tropical cyclones ever observed in the Atlantic, with a radius of tropical storm force winds comparable to Hurricane Sandy. In 1957, Hurricane Audrey surprised many in the northern Gulf Coast by evolving into a potent hurricane in late June and driving a deadly storm surge as it made landfall near the Texas and Louisiana border. In 1958, Hurricane Helene did not make landfall but passed only a few miles off the North Carolina coast as a high end category 4 hurricane while it recurved toward the Atlantic. Still, it was able to produce winds of major hurricane intensity over parts of the coastline. In 1959, Hurricane Gracie made landfall in South Carolina as a powerful category 4 hurricane. In 1960, Hurricane Donna affected the entire eastern seaboard after making landfall in South Florida and turning to the northeast. In 1961, Hurricane Carla hit Texas as a category 4 hurricane causing devastating damage. In 1962, the Atlantic experienced a quiet year with no hurricane landfalls. In 1963, two tropical storms affected the United States and Hurricane Flora caused over 8,000 deaths in Cuba and Haiti, making it one of the deadliest hurricane in the history of the Atlantic.

The reanalysis process is a time-consuming endeavor. Each season took a few months to complete because each day of each tropical cyclone to be reanalyzed as well as searching for new systems. The metadata files containing the detailed changes to HURDAT are included in Appendix (URL for supplementary data). The Appendix illustrates most of the work of this thesis, but this Results Section will summarize the most important changes to the original HURDAT.

1954 Hurricane Season

The 1954 hurricane season was very active for the United States with the landfalls of hurricanes Carol, Edna and Hazel. These hurricanes were reanalyzed by Donna Strahan. La Niña was active in the equatorial waters of the Pacific Ocean. The original HURDAT lists 11 tropical cyclones that reached tropical storm intensity, 8 reached hurricane intensity, and 2 became major hurricanes. The reanalysis adds three new tropical cyclones to the season, and none of the original systems were removed, increasing the season total to 14 tropical cyclones. The number of hurricanes decreased to 7 but the number of major hurricanes increased to 3. Hurricane Carol is shown in the original HURDAT with a peak intensity of 85 kt but as a major hurricane (Category 3 on the SSHWS) at landfall in New York and New England. This is an example of the original errors in HURDAT for many hurricanes that made U.S. landfall. This hurricane season also contained hurricane Alice that formed in late December and lasted into 1955. It was analyzed operationally as a tropical storm in early January of 1955, took the first name of the 1955 hurricane season, moved across the Leeward Islands, and dissipated over the eastern Caribbean Sea. Alice was the first known tropical cyclone to exist in two

calendar years. Of the new tropical cyclones, two occurred early in the season and moved northeastward, parallel to the eastern seaboard, while the third new system formed over the north Atlantic and was not a threat to land. Overall, there were minor changes to the intensities and tracks of the tropical cyclones originally in HURDAT. Figure 6 shows the original tracks and Figure 7 illustrates the revised tracks. The changes to the season are shown in Table 2.

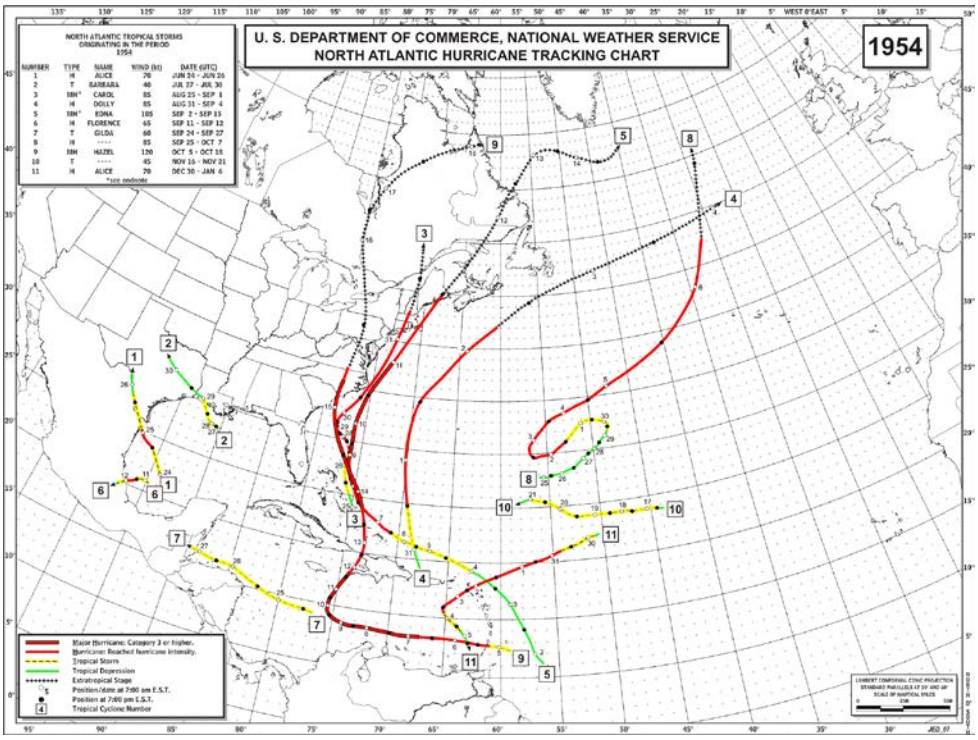

Figure 6. 1954 original track map.

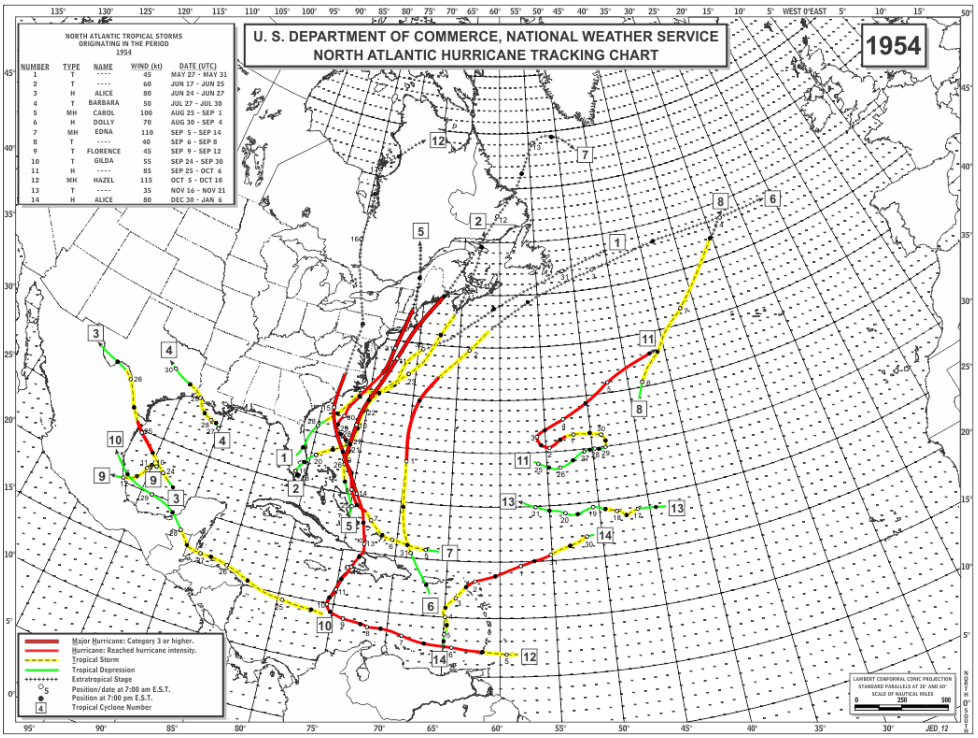

Figure 7. 1954 revised track map.

Revision for the 1954 Atlantic Hurricane Season

Name	Date	Original Peak Intensity (kt)	Revised Peak Intensity (kt)	Track Change	Intensity Change	Genesis/ Decay Change
Unnamed	05/27 - 05/31	-	45	-	-	-
Unnamed	06/17 - 06/25	-	60	-	-	-
Alice	06/24 - 06/27	70	80	Minor	Minor	Genesis 12 hr earlier, Decay 12 hr later
Barbara	07/27 - 07/30	40	50	Minor	Major	Genesis 6 hr later, Decay 6 hr earlier
Carol	08/25 - 09/01	85	100	Minor	Minor	Genesis 6 hr earlier
Dolly	08/31 - 09/04	85	70	Minor	Major	Genesis 6 hr earlier, Decay 6 hr later
Edna	09/05 - 09/14	105	110	Major	Major	Genesis 60 hr later, Decay 24 hr earlier
Unnamed	09/06 - 09/08	-	40	-	-	-
Florence	09/10 - 09/12	65	45	Minor	Major	Genesis 12 hr earlier
Gilda	09/24 - 09/30	60	55	Major	Minor	Decay 60 hr later
Unnamed	09/25 - 10/07	85	85	Minor	Minor	Decay 24 hr earlier
Hazel	10/05 - 10/18	120	115	Minor	Major	Decay 6 hr earlier
Unnamed	11/16 - 11/21	45	35	Minor	Minor	No change
Alice	12/30 - 01/06	70	80	Major	Major	Decay 6 hr later

Table 2. 1954 revisions.

1955 Hurricane Season

The 1955 hurricane season was also very active for the United States with the landfalls by hurricanes Connie, Diane and Ione. La Niña was present in the equatorial waters of the Pacific. The original HURDAT lists 12 tropical cyclones that reached tropical storm intensity, 9 reached hurricane intensity and 6 became major hurricanes. The reanalysis adds two new tropical cyclones to the season and none of the original systems were removed, increasing the total to 14 tropical cyclones. The number of hurricanes is decreased to 7 and the number of major hurricanes is decreased to 4. Hurricane Janet was the strongest hurricane in the season, reaching a peak intensity of 150 kt before passing over the Yucatan peninsula. Both of the newly added tropical storms developed over the eastern Atlantic and originally the names “Katie” and “Linda” were associated with these systems, as it appears in the microfilm images (Figure 8), but in 1955 neither was upgraded officially and the name “Katie” was used later in the season. This reanalysis suggests that the name “Linda” be used for the other proposed tropical storm. Overall, there were major changes to the intensities and minor alterations to the tracks of the tropical cyclones originally in HURDAT. Figure 9 shows the original tracks and Figure 10 illustrates the revised tracks. The changes to the season are shown in Table 3.

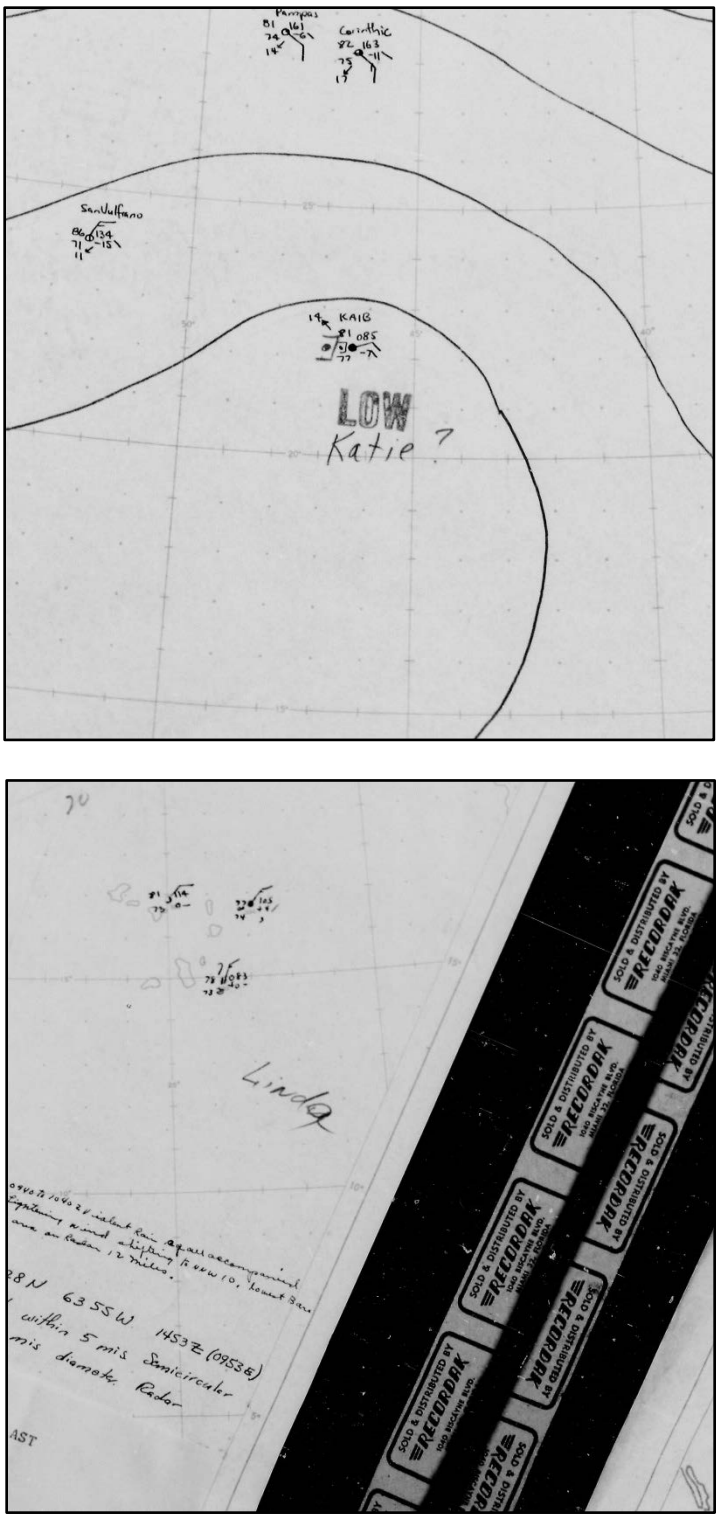

Figure 8. Top image is the microfilm on September 23rd, 1955 at 18Z showing a tropical disturbance listed as “Katie” and the bottom image is the microfilm on September 23rd, 1955 at 12Z showing another disturbance listed as “Linda”.

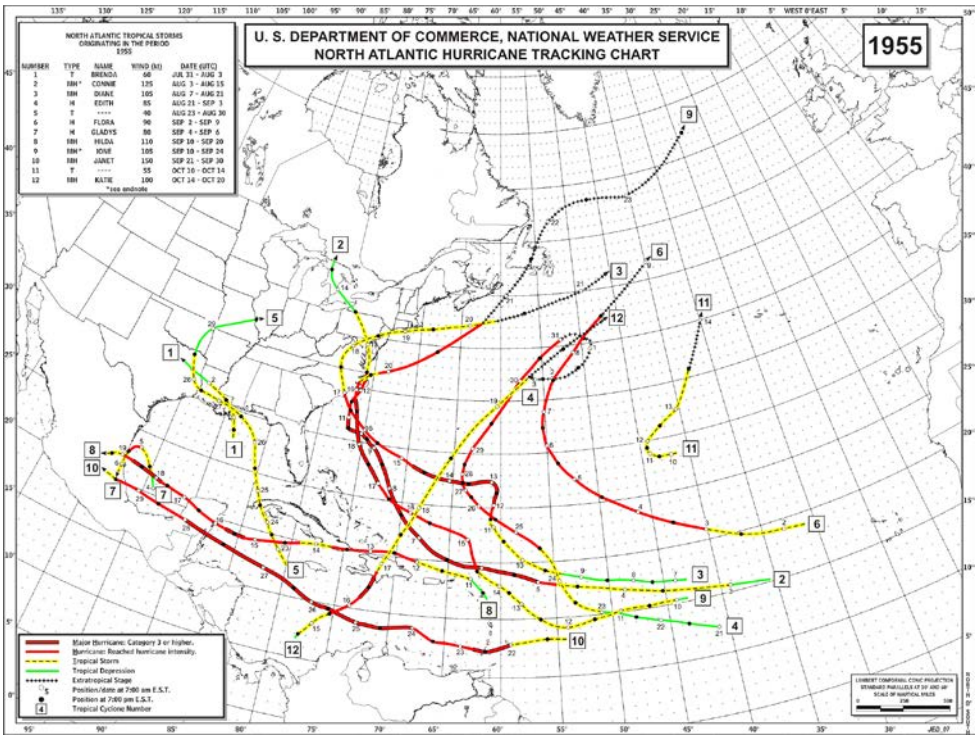

Figure 9. 1955 original track map.

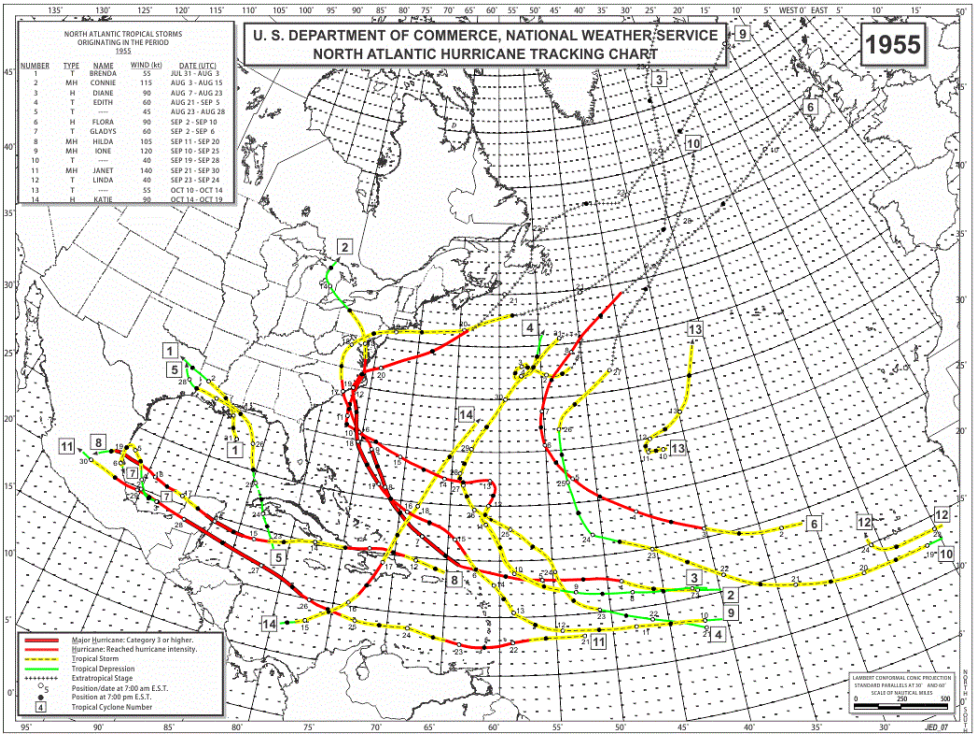

Figure 10. 1955 revised track map.

Revision for the 1955 Atlantic Hurricane Season

Name	Date	Original Peak Intensity (kt)	Revised Peak Intensity (kt)	Track Change	Intensity Change	Genesis/Decay Change
Brenda	07/31 - 08/03	60	55	Minor	Minor	Genesis 6 hr earlier
Connie	08/03 - 08/15	125	115	Major	Major	Decay 6 hr earlier
Diane	08/07 - 08/22	105	90	Major	Major	Decay 48 hr later
Edith	08/21 - 09/05	80	60	Major	Major	Decay 36 hr later
Unnamed	08/23 - 08/28	40	45	Minor	Minor	Decay 30 hr earlier
Flora	09/02 - 09/10	90	90	Minor	Major	Decay 24 hr later
Gladys	09/02 - 09/06	80	60	Minor	Major	Genesis 48 hr earlier
Ione	09/10 - 09/25	110	120	Major	Major	Decay 42 hr later
Hilda	09/11 - 09/20	110	105	Major	Major	Genesis 18 hr later
Unnamed	09/19 - 09/28	-	40	-	-	-
Janet	09/21 - 09/30	150	150	Minor	Major	Genesis 6 hr earlier, Decay 6 hr later
"Linda"	09/23 - 09/24	-	40	-	-	-
Unnamed	10/10 - 10/14	50	50	Minor	Major	-
Katie	10/14 - 10/19	100	90	Minor	Major	Decay 24 hr earlier

Table 3. 1955 revisions.

1956 Hurricane Season

The 1956 hurricane season was relatively quiet for the Atlantic in terms of landfalls. La Niña was present in the equatorial waters of the Pacific, but was weaker than in 1954 or 1955. The original HURDAT lists 8 tropical cyclones that reached tropical storm intensity, 4 reached hurricane intensity and 2 became major hurricanes. The reanalysis adds four new tropical cyclones to the season and none of the original systems were removed, increasing the total to 12 tropical cyclones. The number of hurricanes is retained at 4 and the number of major hurricanes is decreased to 1. Hurricane Betsy was the only major hurricane this season. Betsy marked a milestone in the communication of hurricane warnings in Puerto Rico, because hurricane warnings were issued on television for the first time. It was also the first hurricane observed by the San Juan Weather Radar (Pérez, 1971). Betsy later passed closed to the Bahamas producing hurricane conditions. Hurricane Flossy was the only hurricane to strike the United States. It affected the northern and northeastern Gulf of Mexico. Hurricane Greta was a large tropical cyclone late in the season. It's intensity was decreased from 120 kt to 85 kt, a major intensity change. Overall, there were major changes to the intensities and minor alterations to the tracks of the tropical cyclones originally in HURDAT. Figure 11 shows the original tracks and Figure 12 illustrates the revised tracks. The changes to the season are shown in Table 4.

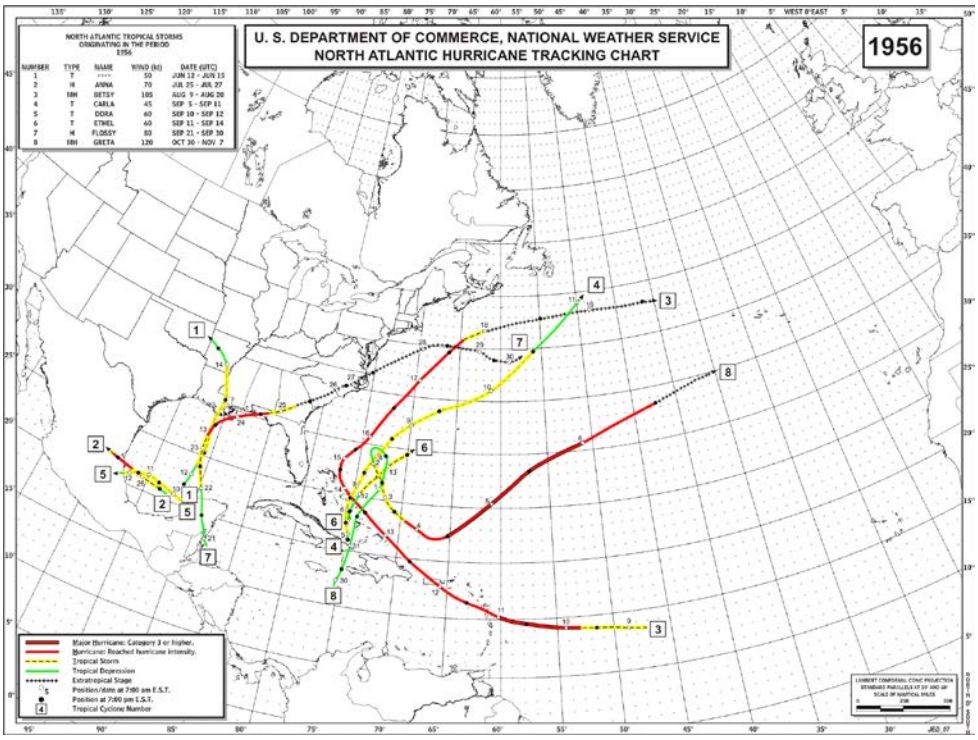

Figure 11. 1956 original track map.

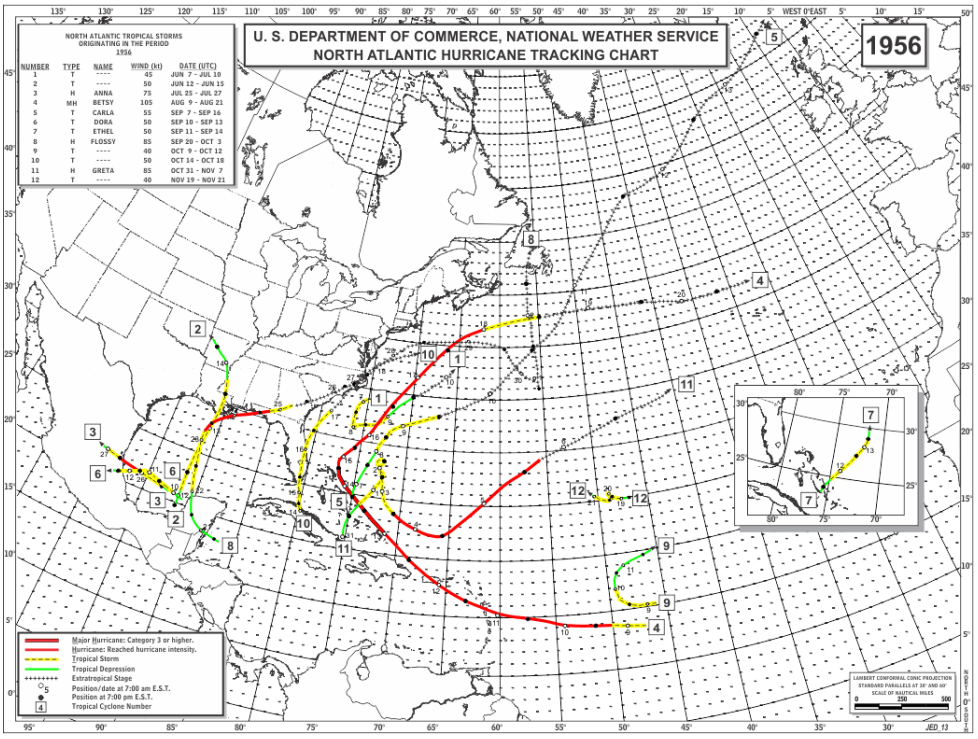

Figure 12. 1956 revised track map.

Revision for the 1956 Atlantic Hurricane Season

Name	Date	Original Peak Intensity (kt)	Revised Peak Intensity (kt)	Track Change	Intensity Change	Genesis/Decay Change
Unnamed	06/07 - 06/10	-	45	-	-	-
Unnamed	06/12 - 06/15	50	50	Major	Minor	No change
Anna	07/25 - 07/27	70	75	Minor	Major	Decay 6 hr later
Betsy	08/09 - 08/21	105	105	Minor	Major	Decay 30 hr later
Carla	09/05 - 09/16	45	55	Minor	Major	Genesis 42 hr later, Decay 114 hr later
Dora	09/10 - 09/13	60	50	Minor	Major	Decay 6 hr later
Ethel	09/11 - 09/14	60	50	Minor	Minor	Decay 6 hr later
Flossy	09/20 - 10/03	80	85	Major	Major	Genesis 6 hr earlier, Decay 60 hr later
Unnamed	10/09 - 10/12	-	40	-	-	-
Unnamed	10/14 - 10/18	-	50	-	-	-
Greta	10/31 - 11/07	120	85	-	-	Genesis 30 hr later

Table 4. 1956 revisions.

1957 Hurricane Season

The 1957 hurricane season experienced near normal levels of tropical cyclone activity and El Niño was active in the equatorial waters of the Pacific Ocean. The original HURDAT lists 8 tropical cyclones that reached tropical storm intensity, 3 that reached hurricane intensity and 2 that became major hurricanes. The reanalysis adds two new tropical cyclones to the season and none of the original systems were removed, increasing the total to 10 tropical cyclones. The number of hurricanes is retained at 3 and the number of major hurricanes is also retained to 2. Hurricane Audrey made landfall in the United States causing significant damage and hundreds of deaths in Cameron Parrish, Louisiana. The peak intensity, that at landfall was decreased from 125 kt originally, to 105 kt, a major intensity change. Hurricane Carrie was a long-lived tropical cyclone, that initially formed near the western coast of Africa and dissipated near the United Kingdom. The system lasted about 24 days. Two near tropical cyclones were added to the season, including a tropical storm forming in late April in the northern Gulf of Mexico (Figure 13). Overall, there were minor changes to the intensities and tracks original in HURDAT. The changes to the season are shown in Table 5. Figure 14 shows the original tracks and Figure 15 illustrates the revised tracks.

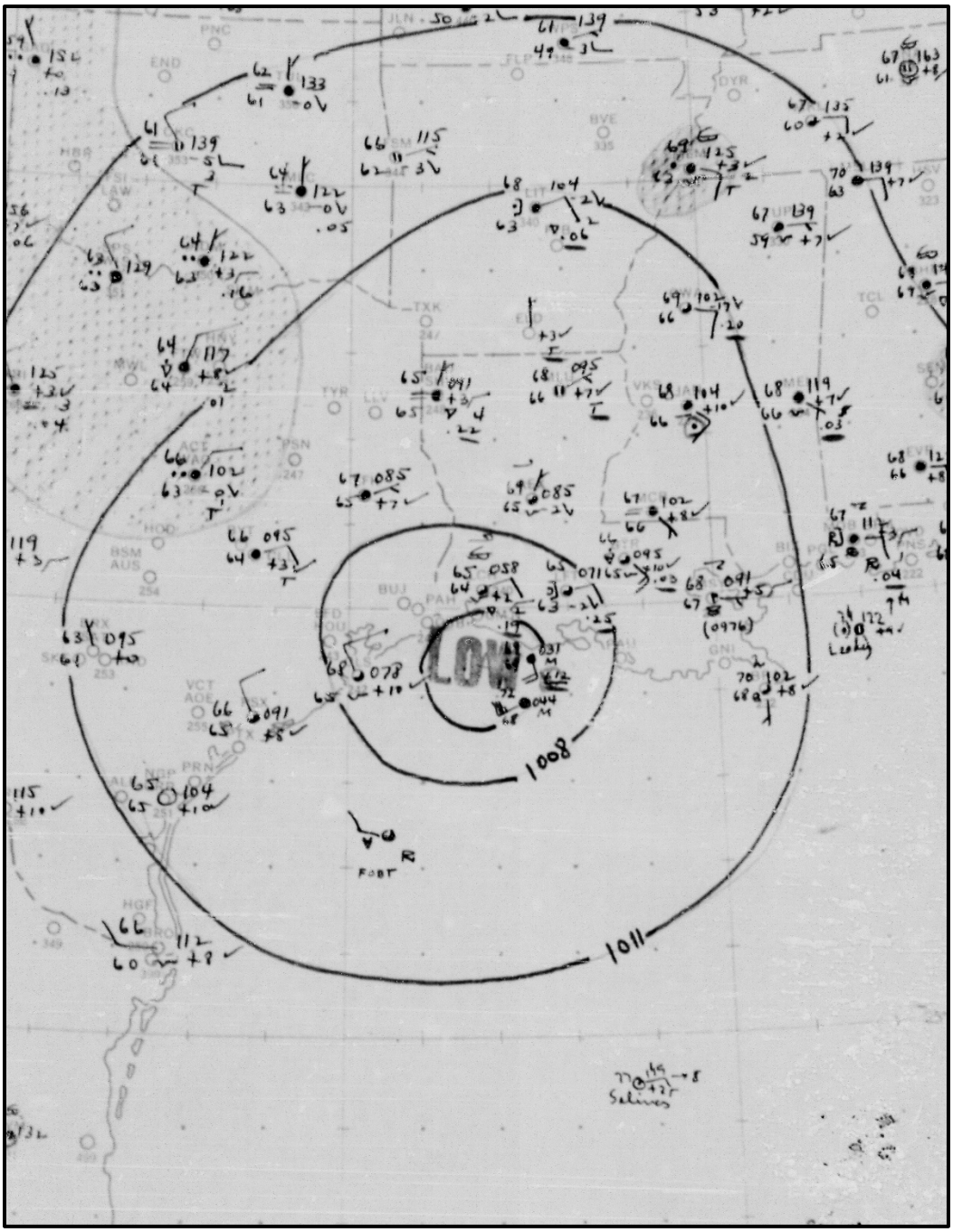

Figure 13. Microfilm image of the new tropical storm off the Louisiana coast on May 1st, 1957 at 12Z.

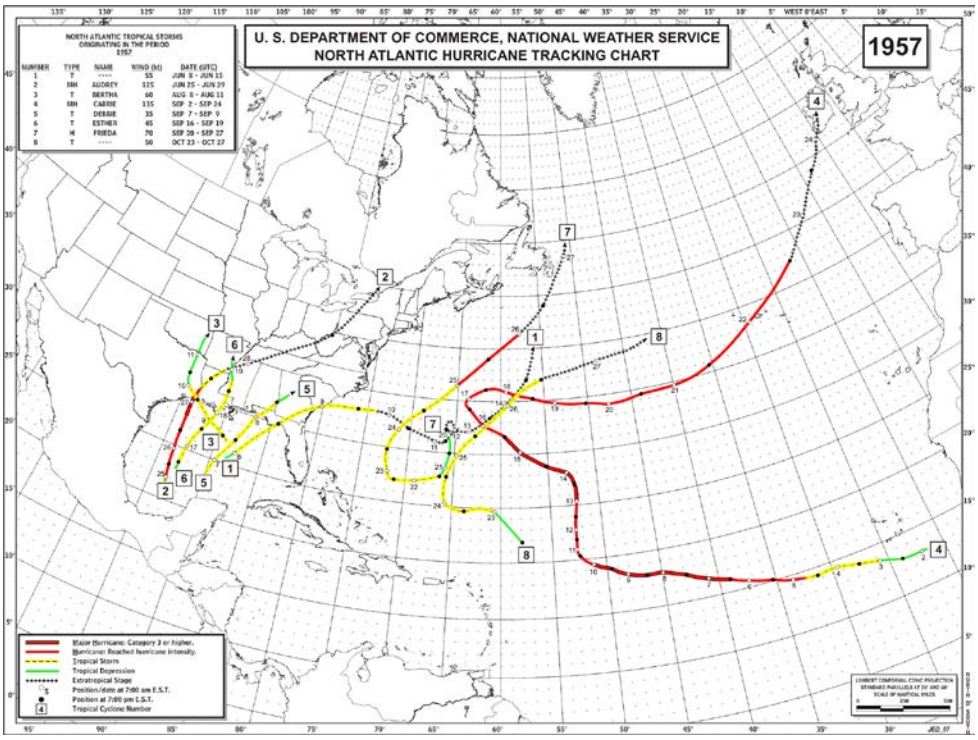

Figure 14. 1957 original track map.

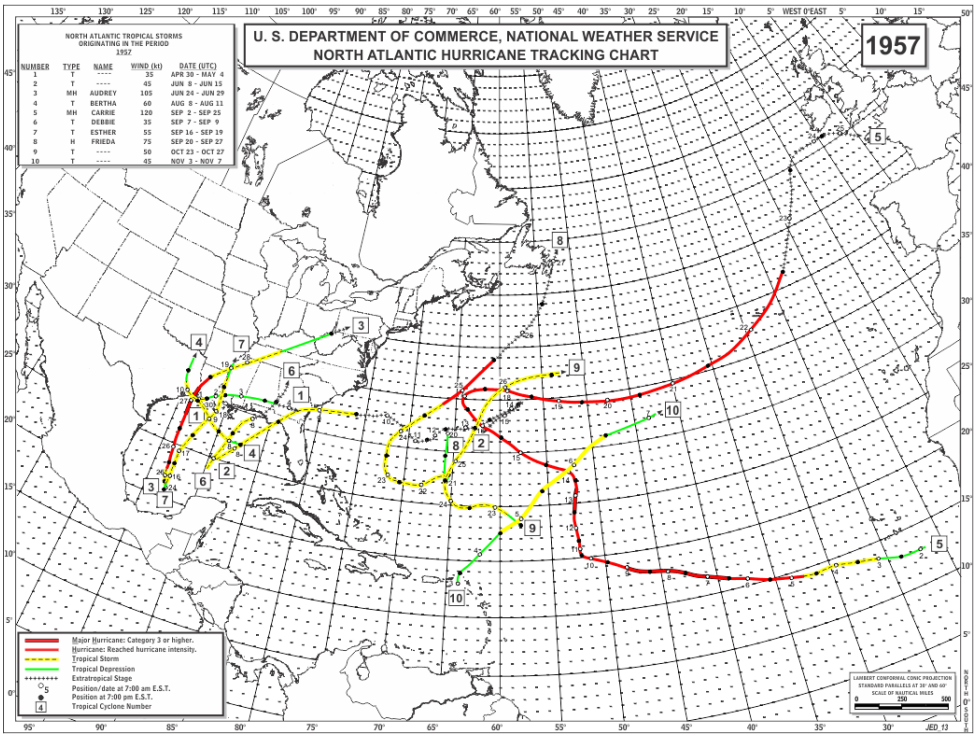

Figure 15. 1957 revised track map.

Revision for the 1957 Atlantic Hurricane Season

Name	Date	Original Peak Intensity (kt)	Revised Peak Intensity (kt)	Track Change	Intensity Change	Genesis/Decay Change
Unnamed	04/30 - 05/04	-	35	-	-	-
Unnamed	06/08 - 06/15	55	45	Minor	Minor	Decay 12 hr later
Audrey	06/24 - 06/29	125	105	Minor	Major	Genesis 12 hr earlier, Decay 6 hr earlier
Bertha	08/08 - 08/11	60	60	Minor	Minor	Genesis 12 hr earlier, Decay 12 hr earlier
Carrie	09/02 - 09/25	135	120	Major	Major	Decay 24 hr later
Debbie	09/07 - 09/09	35	35	Minor	Minor	No change
Esther	09/16 - 09/19	45	55	Minor	Minor	Genesis 18 hr earlier
Frieda	09/20 - 09/27	70	75	Minor	Minor	No change
Unnamed	10/23 - 10/27	50	50	Major	Minor	Decay 18 hr earlier
Unnamed	11/03 - 11/07	-	45	-	-	-

Table 5. 1957 revisions.

1958 Hurricane Season

The 1958 hurricane season was active with several long-lived tropical cyclones, that stayed away from land for the most part and neither El Niño nor La Niña was present in the equatorial waters of the Pacific. The original HURDAT lists 10 tropical cyclones that reached tropical storm intensity, 7 reached hurricane intensity and 5 became major hurricanes. The reanalysis adds one new tropical cyclone and none of the original systems were removed, increasing the total to 11 tropical cyclones. The number of hurricanes decreased to 6 and the number of major hurricanes remains the same. No hurricanes made landfall in the United States but Hurricane Helene passed a couple of miles off the North Carolina coastline producing damaging winds. Hurricane Ella struck Haiti and Cuba and continued west-northwest into the Gulf of Mexico. Fortunately, it was not able to regain its former intensity and made landfall in Texas as a tropical storm. The new tropical storm formed in late May over the central Caribbean Sea. It moved into the southeast Gulf of Mexico, then parallel to the east coast of the United States where it intensified into a tropical cyclone. Overall, there were major changes to the intensities and tracks originally in HURDAT. The changes to the season are shown in Table 6. Figure 16 shows the original tracks and Figure 17 illustrates the revised tracks.

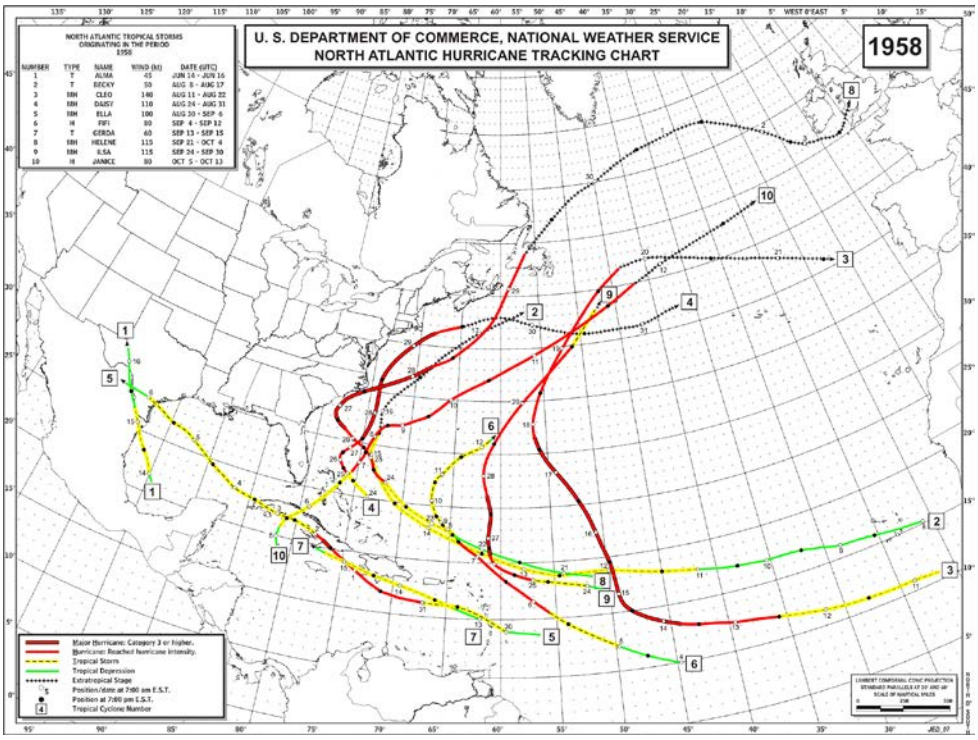

Figure 16. 1958 original track map.

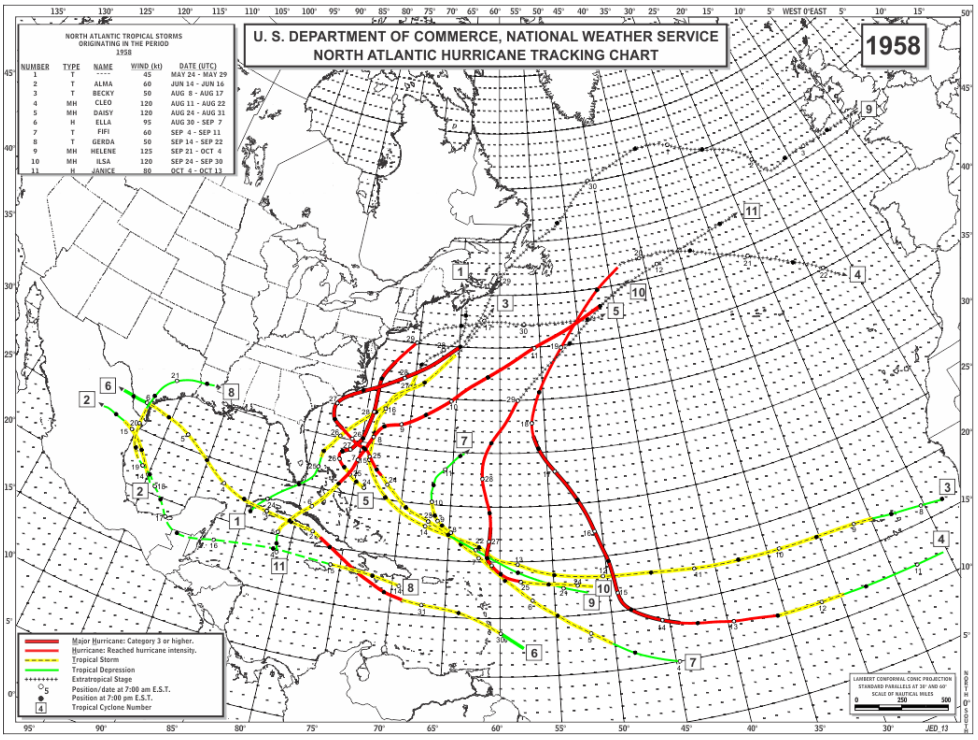

Figure 17. 1958 revised track map.

Revision for the 1958 Atlantic Hurricane Season

Name	Date	Original Peak Intensity (kt)	Revised Peak Intensity (kt)	Track Change	Intensity Change	Genesis/Decay Change
Unnamed	05/24 - 05/29	-	50	-	-	-
Alma	06/14 - 06/16	45	60	Major	Major	Decay 12 hr earlier
Becky	08/08 - 08/17	50	50	Major	Major	Genesis 12 hr earlier, Decay 6 hr earlier
Cleo	08/11 - 08/22	140	120	Major	Major	Decay 18 hr later
Daisy	08/24 - 08/31	110	120	Minor	Major	Decay 18 hr earlier
Ella	08/30 - 09/07	110	120	Major	Minor	Decay 6 hr later
Fifi	09/04 - 09/11	80	60	Major	Major	Decay 24 hr earlier
Gerda	09/14 - 09/12	60	50	Minor	Minor	Genesis 24 hr earlier, Decay 150 hr later
Helene	09/21 - 10/04	115	125	Major	Major	No change
Ilsa	09/24 - 09/30	115	120	Minor	Major	No change
Janice	10/04 - 10/13	80	80	Minor	Minor	Genesis 18 hr earlier, Decay 6 hr earlier

Table 6. 1958 revisions.

1959 Hurricane Season

The 1959 hurricane season was active for the basin with many tropical cyclones developing over the western Atlantic while ENSO was neutral. The original HURDAT lists 11 tropical cyclones that reached tropical storm intensity, 7 reached hurricane intensity and 2 became major hurricanes. The reanalysis adds three new tropical cyclones and none of the original systems were removed, increasing the total to 14 tropical cyclones. The number of hurricanes is decreased to 5 and the number of major hurricanes remains 2. Two hurricanes, Debra and Gracie, made landfall in the United States, in Texas and South Carolina, respectively. Both were small hurricanes, but Gracie reached major hurricane intensity and made landfall at peak intensity of 115 kt. A third system – Cindy – was initially indicated to have reached hurricane intensity and no stroke to the South Carolina as a Category 1 hurricane. The reanalysis, instead, indicates the cyclone only reached high end tropical storm status at both its peak and U.S. landfall. Unnamed tropical cyclone #3 was found to have been extratropical at the time it reached hurricane intensity, thus it peaked below hurricane intensity as a tropical cyclone. The three new tropical cyclones formed in the mid-latitudes from initially baroclinic systems and were threats only to marine interests. Overall, there were minor changes to original HURDAT. Figure 18 shows the original tracks and Figure 19 illustrates the revised tracks. The changes to the season are shown in Table 7.

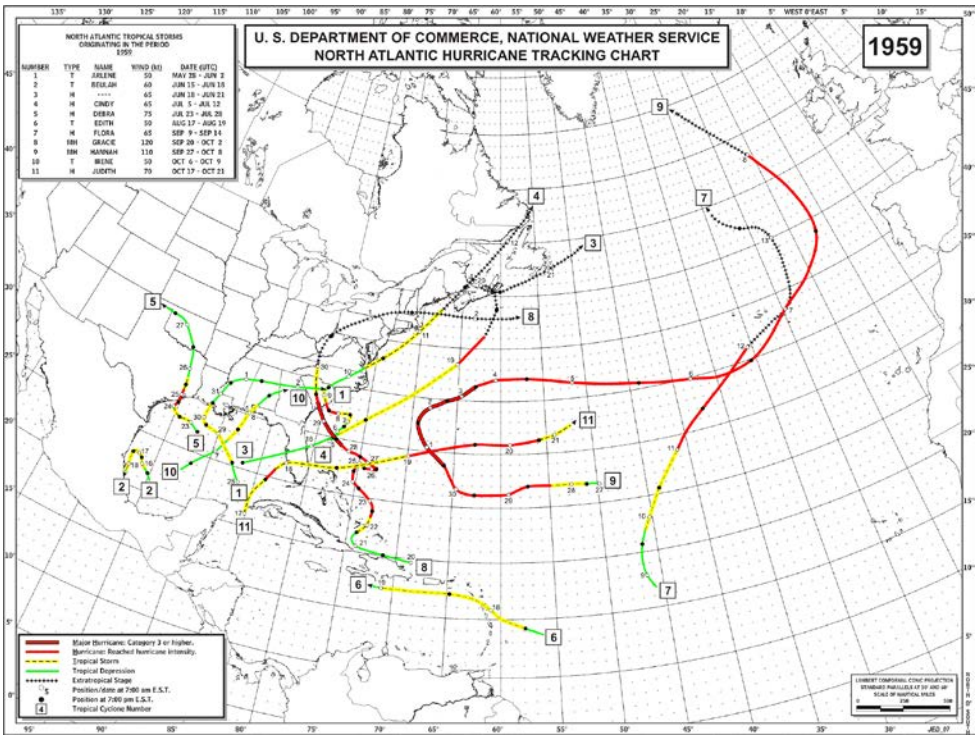

Figure 18. 1959 original track map.

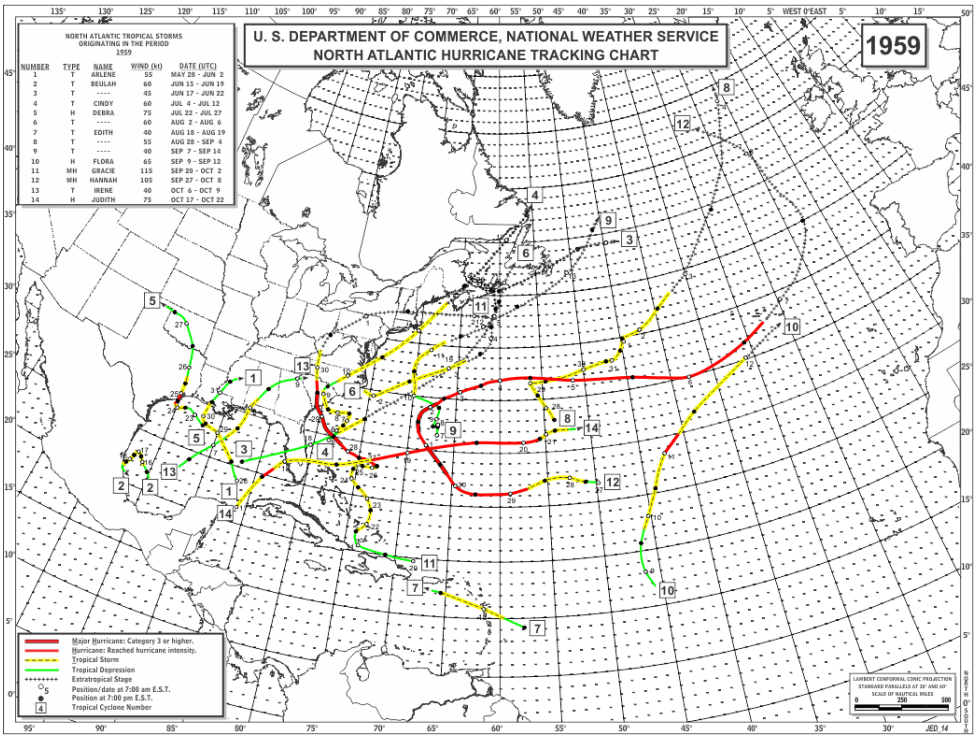

Figure 19. 1959 revised track map.

Revision for the 1959 Atlantic Hurricane Season

Name	Date	Original Peak Intensity (kt)	Revised Peak Intensity (kt)	Track Change	Intensity Change	Genesis/Decay Change
Arlene	05/28 - 06/02	50	55	Minor	Major	Decay 42 hr earlier
Beulah	06/15 - 06/19	60	60	Minor	Minor	Decay 12 hr later
Unnamed	06/17 - 06/22	65	45	Minor	Minor	Genesis 6 hr earlier, Decay 18 hr later
Cindy	07/04 - 07/12	65	60	Minor	Minor	Genesis 24 hr earlier
Debra	07/22 - 07/27	75	75	Minor	Minor	Genesis 6 hr earlier, Decay 12 hr earlier
Unnamed	08/02 - 08/06	-	60	-	-	-
Edith	08/18 - 08/19	50	40	Minor	Minor	Genesis 6 hr later, Decay 12 hr earlier
Unnamed	09/07 - 09/14	-	40	-	-	-
Flora	09/09 - 09/12	65	65	Minor	Minor	Decay 12 hr earlier
Gracie	09/20 - 10/02	120	115	Minor	Major	Decay 6 hr earlier
Hannah	09/27 - 10/08	110	105	Minor	Major	No change
Irene	10/06 - 10/09	50	40	Minor	Minor	Decay 6 hr later
Judith	10/17 - 10/22	70	75	Major	Minor	Decay 12 hr later

Table 7. 1959 revisions.

1960 Hurricane Season

The 1960 hurricane season was quiet in terms of the number of tropical cyclones that formed in the basin while the ENSO was neutral. The original HURDAT lists 7 tropical cyclones that reached tropical storm intensity, 4 reached hurricane intensity and 2 became major hurricanes. The reanalysis did not find any missing tropical cyclones and none of the original systems were removed. The number of hurricanes remained 4 and the number of major hurricanes remained 2. Two hurricanes made landfall in the United States. Hurricane Donna was the more significant hurricane, affecting the US East Coast from the Florida Keys to Maine. Donna was reanalyzed by Chris Landsea, Cristina Carrasco and Jason Dunion (unpublished work). Hurricane Ethel struck Louisiana and Mississippi and rapidly weakened as it moved inland. The peak intensity of both Donna and Ethel was 140 kt, category 5, in the original HURDAT. The reanalysis suggests a peak intensity of 125 kt, category 4, for Donna and only 100 kt, category 3, for Ethel. Overall, there were major changes to the intensities and minor alterations to the tracks of the tropical cyclones in the original HURDAT. Figure 20 shows the original tracks and Figure 21 illustrates the revised tracks. The changes to the season are shown in Table 8.

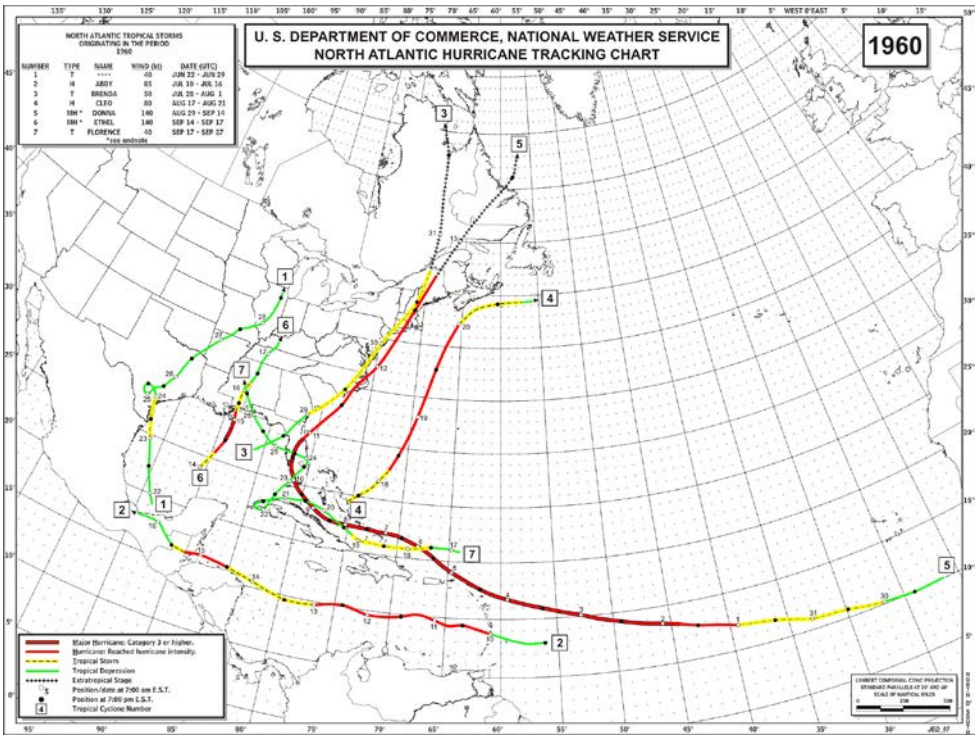

Figure 20. 1960 original track map.

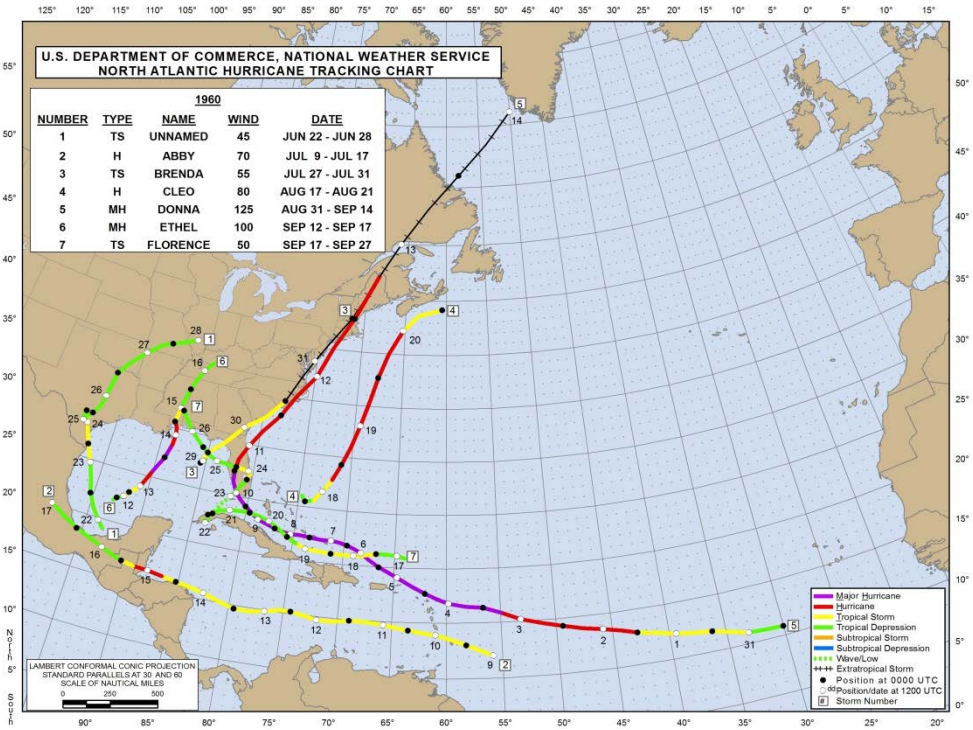

Figure 21. 1960 revised track map.

Revision for the 1960 Atlantic Hurricane Season

Name	Date	Original Peak Intensity (kt)	Revised Peak Intensity (kt)	Track Change	Intensity Change	Genesis/Decay Change
Unnamed	06/22 - 06/28	40	45	Minor	Minor	Decay 12 hr earlier
Abby	07/09 - 07/16	70	70	Major	Major	Genesis 12 hr earlier, Decay 18 hr later
Brenda	07/27 - 07/31	50	55	Minor	Minor	Genesis 24 hr earlier, Decay 18 hr earlier
Cleo	08/17 - 08/21	80	80	Minor	Minor	Decay 6 hr earlier
Donna	08/31 - 09/14	140	125	Major	Major	Genesis 30 hr later, Decay 12 hr later
Ethel	09/12 - 09/17	140	100	Minor	Major	Genesis 18 hr earlier
Florence	09/17 - 09/27	40	50	Minor	Major	Decay 6 hr earlier

Table 8. 1960 revisions.

1961 Hurricane Season

The 1961 hurricane season was very active with two devastating hurricanes while the ENSO was neutral. The original HURDAT listed 11 tropical cyclones that reached tropical storm intensity, 8 reached hurricane intensity and 7 became major hurricanes. The reanalysis adds one new tropical cyclone and none of the original systems were removed, increasing the season total to 12. The number of hurricanes is retained at 8 and the number of major hurricanes is decreased to 5. It is interesting to note that 11 of the 12 tropical cyclones formed between September and November. Hurricane Carla was the only hurricane to make landfall in the United States, striking Texas as a powerful category 4. Carla was reanalyzed by Chris Landsea and Cristina Carrasco (unpublished work). Hurricane Hattie formed late in the season in the Caribbean Sea and devastated Belize, also at category 4. The peak intensity of Hattie was 140 kt originally in HURDAT, making it a category 5 hurricane. The reanalysis suggests a peak intensity of 135 kt, high-end category 4. The new tropical storm formed from a disturbed area associated with a tropical wave over the eastern Caribbean Sea. The system gradually moved northeastward becoming better organized. It was not a threat to land as a tropical cyclone. Overall, there were major changes to the intensities and minor alterations to the tracks of the tropical cyclones originally in HURDAT. Figure 22 shows the original tracks and Figure 23 illustrates the revised tracks. The changes to the season are shown in Table 9.

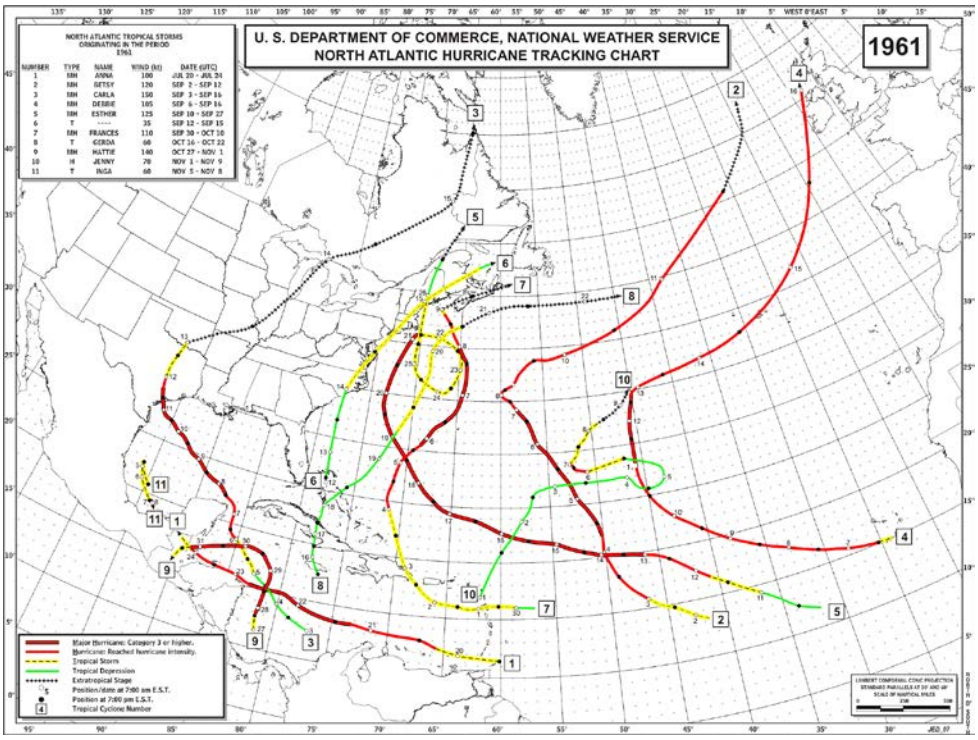

Figure 22. 1961 original track map.

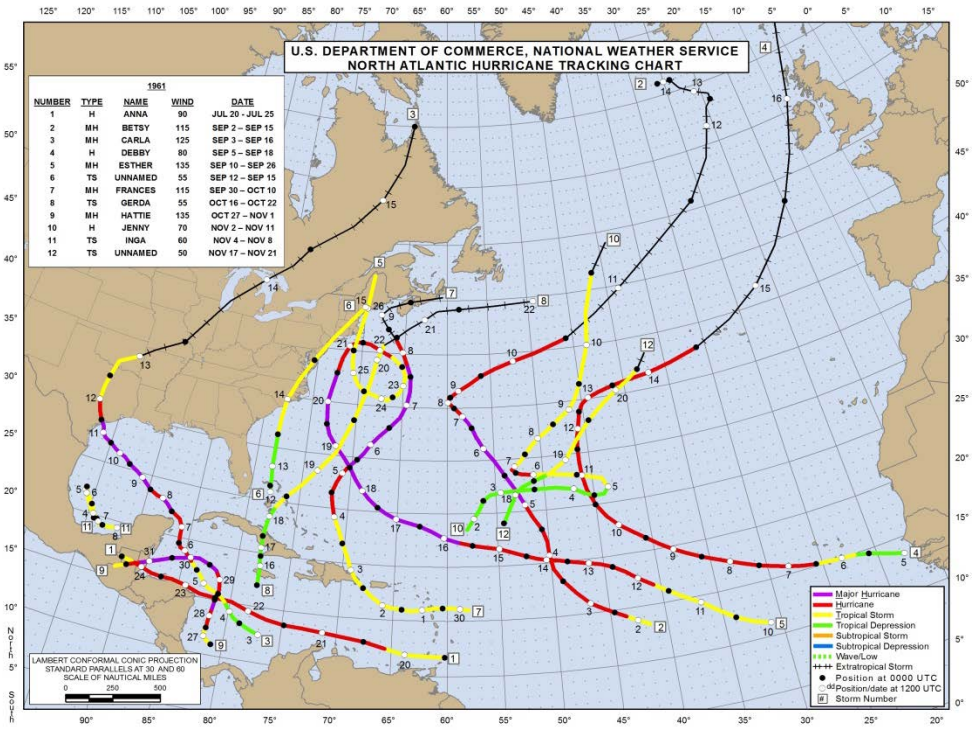

Figure 23. 1961 revised track map.

Revision for the 1961 Atlantic Hurricane Season

Name	Date	Original Peak Intensity (kt)	Revised Peak Intensity (kt)	Track Change	Intensity Change	Genesis/Decay Change
Anna	07/20 - 07/24	100	90	Minor	Major	Decay 6 hr later
Betsy	09/02 - 09/12	120	115	Minor	Major	Decay 66 hr later
Carla	09/03 - 09/16	150	125	Minor	Minor	No changes
Debbie	09/05 - 09/18	105	75	Minor	Major	Genesis 30 hr earlier, Decay 54 hr later
Esther	09/10 - 09/26	125	135	Minor	Major	Decay 12 hr earlier
Unnamed	09/12 - 09/15	35	55	Minor	Major	Decay 6 hr earlier
Frances	09/30 - 10/10	110	115	Minor	Minor	Decay 6 hr earlier
Gerda	10/16 - 10/22	60	55	Major	Major	Decay 6 hr earlier
Hattie	10/27 - 11/01	140	135	Minor	Minor	Genesis 12 hr earlier
Inga	11/04 - 11/08	60	60	Minor	Minor	Genesis 24 hr earlier
Jenny	11/02 - 11/10	70	70	Minor	Major	Genesis 18 hr earlier, Decay 24 hr later
Unnamed	11/17 - 11/21	-	50	-	-	-

Table 9. 1961 revisions.

1962 Hurricane Season

The 1962 hurricane season was relatively quiet in the Atlantic while ENSO was neutral. The original HURDAT listed 5 tropical cyclones that reached tropical storm intensity, 3 reached hurricane intensity and 1 became a major hurricane. The reanalysis adds three new tropical cyclones and none of the original systems were removed, increasing the season total to 8. The number of hurricanes is increased to 4 and the intensity of Hurricane Ella is decreased from 100 kt originally in HURDAT to 90 kt, thus the analysis shows no major hurricanes. It is interesting to note that no tropical cyclones formed in the Gulf of Mexico and Caribbean Sea. The previous occurrence was in 1914 when only one tropical cyclone was recorded in the entire basin. Most of the tropical cyclone activity was concentrated over the western Atlantic but no hurricane made landfall in the United States. All of the new tropical cyclones formed in the mid-latitudes from initially baroclinic origins. The last tropical cyclone (Figure 24) of the season was a long-lived, late-season system with an erratic track over the waters off the southeast coast of the United States. Overall, there were major changes to the intensities and minor alterations to the tracks of the tropical cyclones originally in HURDAT. Figure 25 shows the original tracks and Figure 26 illustrates the revised tracks. The changes to the season appear in Table 10.

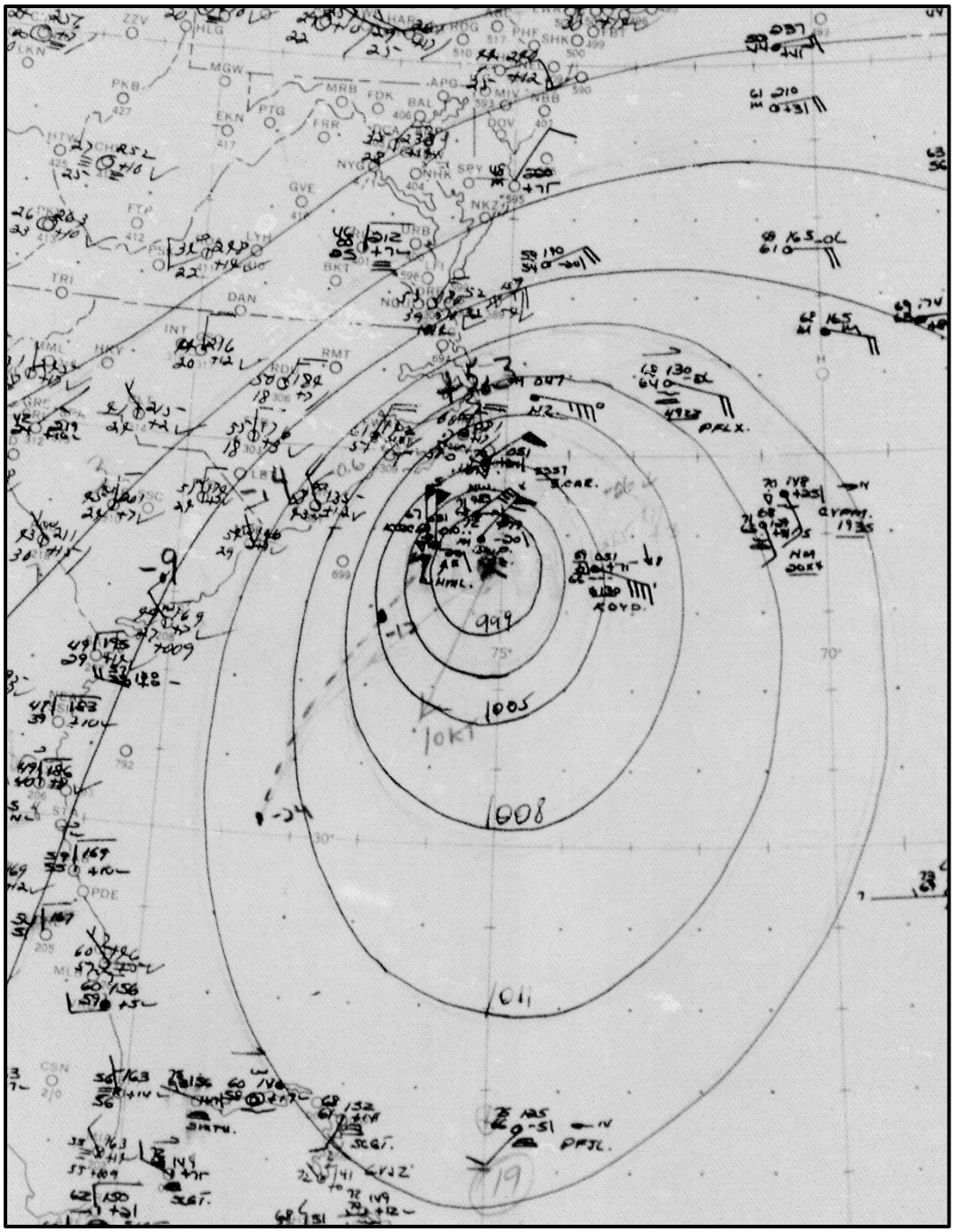

Figure 24. Microfilm image of the Unnamed Hurricane #7 on December 2nd at 12Z off the North Carolina coast.

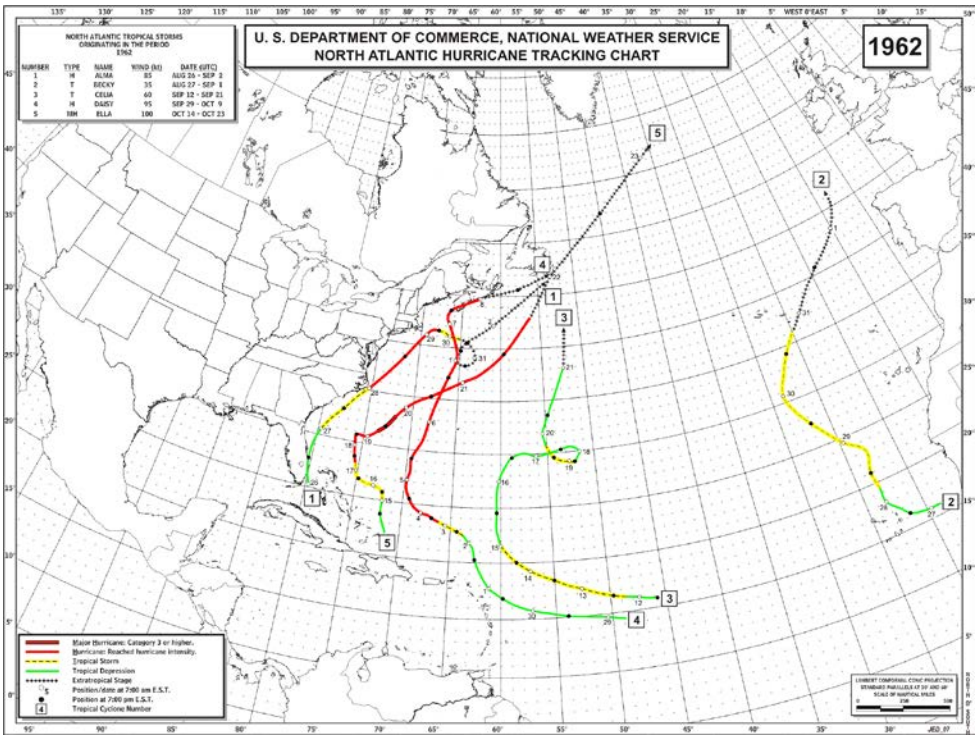

Figure 25. 1962 original track map.

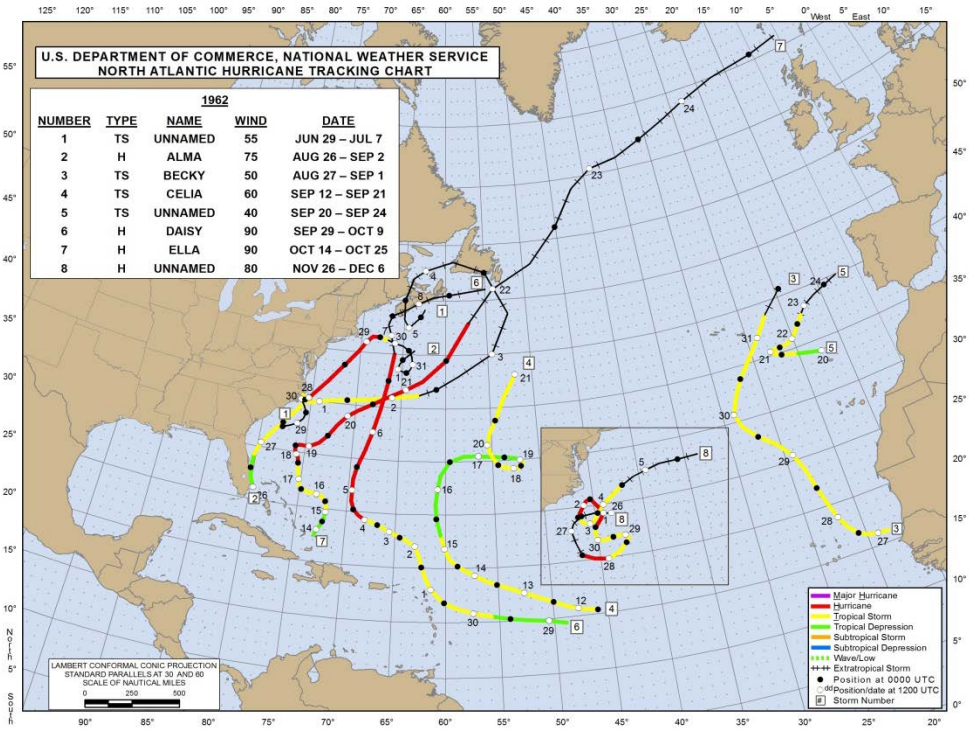

Figure 26. 1962 revised track map.

Revision for the 1962 Atlantic Hurricane Season

Name	Date	Original Peak Intensity (kt)	Revised Peak Intensity (kt)	Track Change	Intensity Change	Genesis/ Decay Change
Unnamed	06/29 - 07/06	-	55	-	-	-
Alma	08/26 - 09/02	85	75	Minor	Minor	Decay 12 hr earlier
Becky	08/27 - 09/01	35	50	Minor	Major	Decay 18 hr earlier
Celia	09/12 - 09/21	60	60	Minor	Major	Decay 6 hr earlier
Unnamed	09/20 - 09/24	-	40	-	-	-
Daisy	09/29 - 10/09	95	90	Minor	Minor	No changes
Ella	10/14 - 10/23	100	90	Minor	Major	Decay 6 hr earlier
Unnamed	11/26 - 12/06	-	70	-	-	-

Table 10. 1962 revisions.

1963 Hurricane Season

The 1963 hurricane season was an active season for the Atlantic while ENSO was neutral. The original HURDAT listed 9 tropical cyclones that reached tropical storm intensity, 7 reached hurricane intensity and 2 became a major hurricane. The reanalysis adds 1 new tropical cyclone and none of the original systems were removed, increasing the season total to 10. The number of hurricanes is decreased to 6 and the number of major hurricanes is increased to 3. Most of the tropical cyclone activity was located over the western Atlantic. Hurricanes Edith and Flora affected the Lesser and Greater Antilles causing significant damages. Flora produced over 100 inches of rain over eastern Cuba. The new tropical storm began as a disturbance over the Caribbean Sea and moved northward becoming a tropical storm off the Southeast coast of the United States and later impacting North Carolina. Overall, there were minor changes to the intensities and tracks of the tropical cyclones originally in HURDAT. Figure 27 shows the original tracks and Figure 28 illustrates the revised tracks. The changes to the season appear in Table 11.

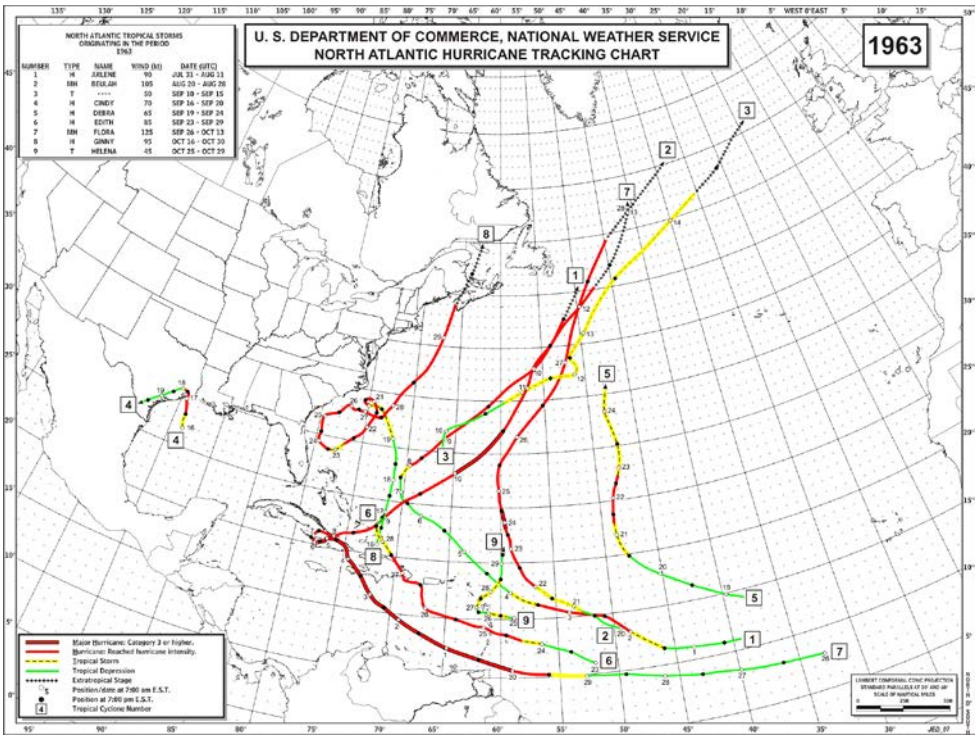

Figure 27. 1963 original track map.

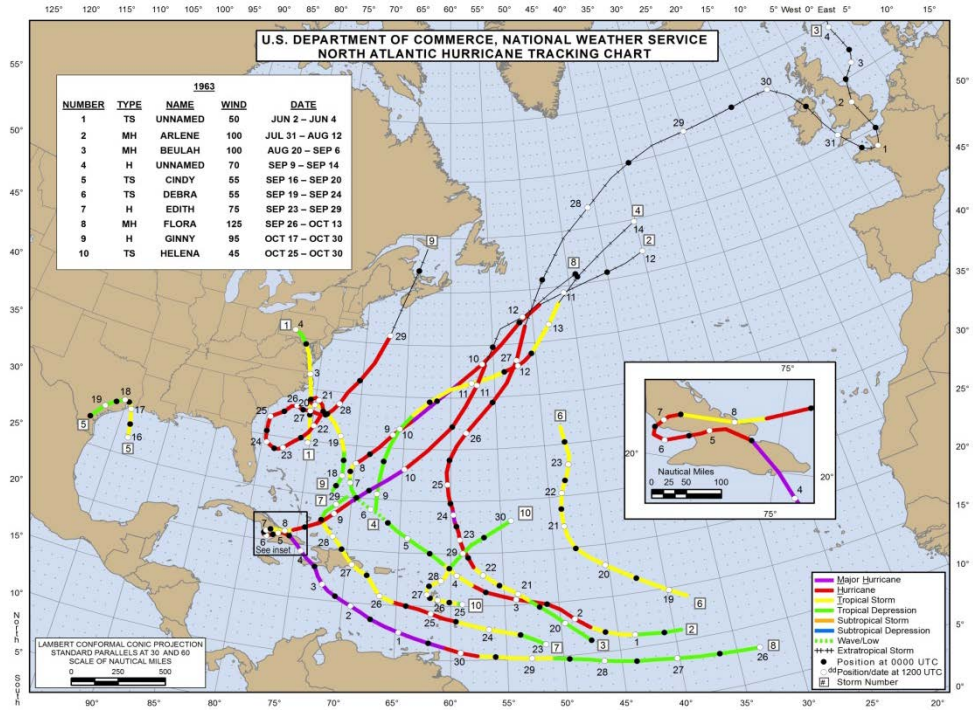

Figure 28. 1963 revised track map.

Revision for the 1963 Atlantic Hurricane Season

Name	Date	Original Peak Intensity (kt)	Revised Peak Intensity (kt)	Track Change	Intensity Change	Genesis/ Decay Change
Unnamed	06/02 - 06/04	-	50	-	-	-
Arlene	07/31 - 08/12	90	100	Minor	Minor	Decay 30 hr later
Beulah	08/20 – 09/06	105	100	Minor	Minor	Genesis 12 hr earlier, Decay 9 days later
Unnamed	09/09 – 09/14	50	70	Minor	Major	Genesis 24 hr earlier, Decay 18 hr earlier
Cindy	09/16 – 09/20	70	55	Minor	Major	None
Debra	09/19 – 09/24	65	55	Minor	Major	Decay 12 hr earlier
Edith	09/23 – 09/29	85	75	Minor	Minor	Decay 12 hr later
Flora	09/26 – 10/13	125	125	Minor	Major	Decay 12 hr earlier
Ginny	10/17 – 10/30	95	95	Minor	Minor	Genesis 30 hr later
Helena	10/25 – 10/30	45	45	Minor	Minor	Decay 18 hr later

Table 11. 1963 revisions.

CHAPTER 6

SUMMARY AND CONCLUSIONS

The years reanalyzed were generally active in the North Atlantic, especially so for the United States and the countries of the Caribbean (Tables 12, 13 and 14). A total of 14 hurricanes either made landfall in the United States or produced hurricane-force winds. Of these 8 were major hurricanes at landfall (Table 12). Originally in HURDAT, the average number of tropical cyclones per season in the Atlantic between 1954 and 1963 (inclusive) was 9.2 tropical storms, 6.0 hurricanes and 3.1 major hurricanes. The reanalysis added 20 new tropical storms, preliminarily increasing the total in HURDAT to 102. The number of hurricanes decreased from 60 to 55 and the number of major hurricanes also declined from 31 to 27. None of the tropical cyclones originally in HURDAT for these seasons were removed, though occasionally there have been cyclones taken out of HURDAT in earlier seasons. The new average is 11.2 tropical storms, 5.5 hurricanes and 2.7 major hurricanes. There were six category 5 hurricanes in the original HURDAT and five were downgraded; only Hurricane Janet in 1955 remained. The most noteworthy change for the United States was the decrease in intensity of Hurricane Audrey of 1957 from 125 kt originally in HURDAT to 105 kt. The most substantial change in the Atlantic was Hurricane Greta of 1956. The original peak intensity in HURDAT was 120 kt, and the reanalyzed intensity was 85 kt. Greta (Figure 29) was a large and slow-moving hurricane, with the radius of the outermost closed isobar extending to about 500 nm, similar to Hurricane Sandy of 2012.

The most significant changes in this reanalysis were related to the overestimation of the intensity of tropical cyclones. The estimated surface winds reported by the

reconnaissance aircrafts normally exhibited a high bias, leading to overestimation of the intensity overall. This bias was originally identified by Landsea (1993). Even though this pattern was recognized between 1954 and 1963, the Weather Bureau forecasters realized that this was occurring in the late 1950s and adjusted the estimated winds more reasonable values, likely using the formulas by Fletcher (1955) and Kraft (1961). Generally, there were minor alterations to the tracks. The most significant changes were generally extending the tracks of cyclones that had become extratropical into the North Atlantic and Western Europe.

The goals of this thesis were to document and reanalyze of all the original tropical cyclones in HURDAT for the years 1954 through 1963, inclusive, and to add the tropical cyclones that were not originally included in HURDAT for a range of reasons. The goal was to improve the completeness and accuracy of HURDAT, since it remains the prime source for the studies of climate change, risk assessment, insurance underwriting, planning, building code revision and the verification of model projections. An array of sources was used for the reanalysis included satellite images for the first time. Still, the most important source of data was the reconnaissance aircraft as they provided numerous central pressure measurements and eyewall diameter estimates. El Niño conditions prevailed during the 1957 season, while La Niña was present from 1954 through 1956 and neutral conditions were registered from 1958 through 1963. During all ten years, the AMO (Atlantic Multidecadal Oscillation) was in its warm phase.

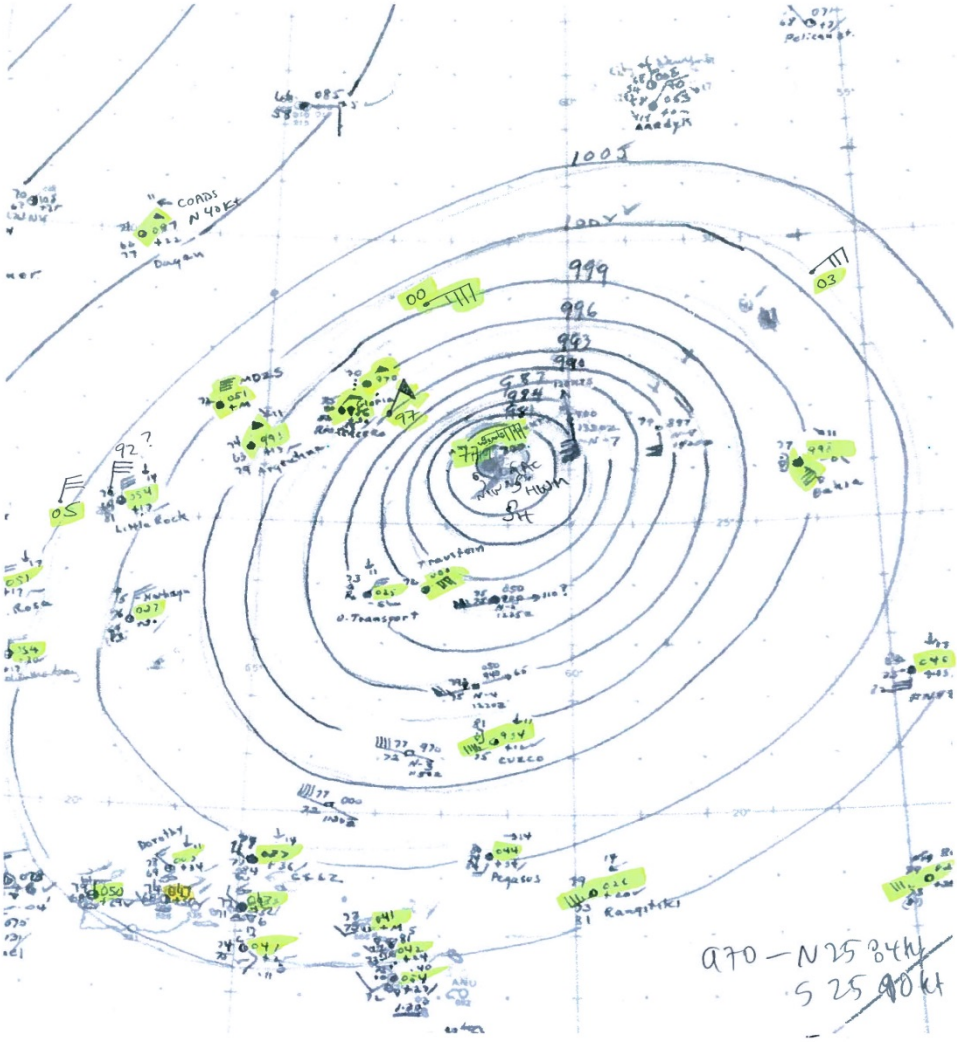

Figure 29. Microfilm map showing Hurricane Greta on November 4th, 1956, at 12Z.

Year	Name	Original Intensity	Revised Intensity	Original SSHWS at landfall	Revised SSHWS at landfall
1954	Carol	85 kt 85 kt 85 kt	95 kt 100 kt 100 kt	None NY3 RI3	NC1* NY3 CT2, RI3, MA2
1954	Edna	105 kt 90 kt 90 kt 70 kt	110 kt 105 kt 100 kt 75 kt	None None MA3 ME1	NC1* NY1* RI1*, MA3 Removed - ET
1954	Hazel	110 kt	120 kt	SC4, NC4, MD2	SC3, NC4
1955	Connie	70 kt	85 kt	NC3, VA1	NC2, VA1
1955	Diane	75 kt	65 kt	NC1	NC1
1955	Ione	90 kt	90 kt	NC3	NC2
1956	Flossy	80 kt 65 kt	80 kt 85 kt	LA2 AFL1	LA1 AFL2
1957	Audrey	125 kt	105 kt	CTX4, LA4	CTX2, LA3
1958	Helene		80 kt 110 kt	None NC3	SC1* NC3*
1959	Cindy	65 kt	60 kt	SC1	Removed – TS
1959	Debra	75 kt	75 kt	CTX1	CTX1
1959	Gracie	120 kt	115 kt	SC3	SC4, GA1
1960	Donna	115 kt 100 kt 95 kt 90 kt 90 kt	115 kt 100 kt 95 kt 85 kt 80 kt	None DFL2 NC3 NY3 RI1, MA1, NH1, ME1	BFL4, CFL2 DFL1 NC2, VA1* NY2 CT1, RI1, MA1
1960	Ethel	80 kt	70 kt	MS1	LA1*, MS1
1961	Carla	125 kt	120 kt	HRBTX4	TX4, CTX3, ATX1

* = Hurricane did not make landfall but produced hurricane-force winds

Table 12. Changes to US Landfalling Hurricanes (1954-1963)

Date	Name	Landfall time	Location	Original Intensity	Revised Intensity
07/29/1954	Barbara	10Z	Louisiana	35 kt	50 kt
08/01/1955	Brenda	17Z	Louisiana	60 kt	55 kt
08/27/1955	Unnamed	04Z	Louisiana	40 kt	45 kt
06/13/1956	Unnamed	17Z	Louisiana	50 kt	50 kt
10/15/1956	Unnamed	21Z	Florida	-	50 kt
05/01/1957	Unnamed	14Z	Louisiana	-	40 kt
06/09/1957	Unnamed	0030Z	Florida	35 kt	45 kt
08/10/1957	Bertha	06Z	Texas	45 kt	60 kt
09/08/1957	Debbie		Florida	35 kt	Removed - ET
09/18/1957	Esther	12Z	Louisiana	45 kt	55 kt
09/06/1958	Ella	08Z	Texas	40 kt	50 kt
05/30/1959	Arlene	21Z 23Z	Louisiana	40 kt 40 kt	55 kt 55 kt
06/18/1959	Unnamed	08Z	Florida	30 kt	40 kt
07/09/1959 07/11/1959 07/11/1959	Cindy	03Z 12Z 13Z	South Carolina Massachusetts Massachusetts	65 kt 50 kt 50 kt	60 kt 50 kt 50 kt
10/08/1959	Irene	10Z	Alabama	45 kt	40 kt
10/18/1959	Judith	14Z	Florida	45 kt	55 kt
06/24/1960	Unnamed	04Z	Texas	40 kt	45 kt
07/29/1960 07/29/1960	Brenda	06Z 21Z	Florida North Carolina	30 kt 45 kt	35 kt 55 kt
09/14/1961	Unnamed	09Z	North Carolina	30 kt	35 kt
09/26/1961 09/26/1961 09/26/1961	Esther	05Z 06Z 11Z	Massachusetts Massachusetts Maine	40 kt 35 kt 35 kt	50 kt 50 kt 35 kt
06/30/1962	Unnamed	21Z	North	-	55 kt

			Carolina		
06/03/1963	Unnamed	08Z	North Carolina	-	50 kt
09/17/1963	Cindy	14Z	Texas	65 kt	55 kt

Table 13. Changes to US Landfalling Tropical Storms (1954-1963)

Date	Name	Landfall time	Location	Lat (ºN)	Lon (ºW)	Cate-gory	Original Intensity	Revised Intensity
06/25/1954	Alice	14Z	Mexico	25.0	97.6	1	70 kt	80 kt
09/12/1954	Florence	11Z	Mexico	20.4	96.8	TS	65 kt	45 kt
09/27/1954	Gilda	17Z	Belize	16.7	88.4	TS	60 kt	55 kt
10/12/1954	Hazel	09Z	Haiti	18.3	74.2	2	85 kt	85 kt
10/13/1954		00Z	Haiti	19.6	73.4	2	85 kt	85 kt
10/13/1954		14Z	Bahamas	20.0	73.2	2	85 kt	85 kt
10/13/1954		23Z	Bahamas	22.6	73.5	2	90 kt	85 kt
01/02/1955	Alice	21Z	St. Martin	18.0	63.0	1	65 kt	65 kt
09/05/1955	Gladys	22Z	Mexico	23.1	97.8	TS	50 kt	60 kt
09/13/1955	Hilda	21Z	Cuba	20.1	74.2	1	70 kt	70 kt
09/15/1955		03Z	Cayman Islands	19.3	81.2	1	75 kt	65 kt
09/16/1955		12Z	Mexico	19.6	87.4	3	95 kt	105 kt
09/19/1955		11Z	Mexico	22.2	97.8	3	60 kt	105 kt
09/23/1955	Janet	00Z	Grenada	12.5	61.4	2	100 kt	90 kt
09/27/1955		23Z	Honduras	17.4	83.9	5	145 kt	140 kt
09/28/1955		05Z	Mexico	18.4	87.8	5	150 kt	150 kt
10/17/1955	Katie	06Z	Dominican Republic	18.0	71.8	2	100 kt	90 kt
07/26/1956	Anna	21Z	Mexico	21.7	97.5	1	70 kt	75 kt
08/11/1956	Betsy	1730Z	Guadeloupe	16.0	61.7	2	80 kt	90 kt
08/12/1956		1230Z	Puerto Rico	18.0	66.0	2	80 kt	85 kt
09/12/1956	Dora	18Z	Mexico	20.9	97.3	TS	50 kt	50 kt
09/22/1957	Carrie	16Z	Azores	38.7	27.3	1	70 kt	75 kt

06/15/1958	Alma	09Z	Mexico	24.4	97.7	TS	35 kt	60 kt
09/01/1958	Ella	12Z	Haiti	18.2	73.4	2	95 kt	95 kt
09/02/1958		00Z	Cuba	20.0	76.2	1	100 kt	75 kt
09/03/1958		11Z	Cuba	21.8	82.7	TS	55 kt	55 kt
09/03/1958		17Z	Cuba	22.1	84.0	TS	60 kt	60 kt
09/14/1958	Gerda	21Z	Dominican Republic	18.0	71.2	TS	60 kt	50 kt
09/14/1958		08Z	Mexico	24.5	97.7	TS	-	40 kt
10/06/1958	Janice	03Z	Cuba	22.0	80.3	TS	45 kt	50 kt
10/06/1958		16Z	Bahamas	24.2	78.0	TS	55 kt	55 kt
10/06/1958		21Z	Bahamas	25.1	77.1	TS	60 kt	60 kt
10/06/1958		23Z	Bahamas	25.5	76.8	1	60 kt	65 kt
06/19/1959	Beulah	02Z	Mexico	21.7	97.5	TS	-	35 kt
08/18/1959	Edith	12Z	Guadeloupe	15.9	61.5	TS	50 kt	40 kt
07/10/1960	Abby	11Z	St. Lucia	13.9	60.9	TS	65 kt	55 kt
07/15/1960		06Z	Honduras	16.3	86.6	1	70 kt	70 kt
07/15/1960		14Z	Belize	16.5	88.4	1	65 kt	70 kt
09/08/1960	Donna	05Z	Bahamas	22.3	74.1	3	130 kt	105 kt
09/08/1960		16Z	Bahamas	22.4	75.8	3	130 kt	105 kt
07/23/1961	Anna	12Z	Honduras	15.8	84.3	1	90 kt	70 kt
07/24/1961		01Z	Honduras	16.1	86.9	1	85 kt	75 kt
07/24/1961		10Z	Belize	16.4	88.5	1	80 kt	75 kt
09/05/1961	Debbie	13Z	Cape Verde Islands	15.0	23.4	TS	-	40 kt
10/01/1961	Frances	08Z	Guadeloupe	16.1	61.6	TS	40 kt	50 kt
10/03/1961		05Z	Dominican Republic	18.3	68.5	TS	50 kt	45 kt

10/31/1961	Hattie	13Z	Belize	17.1	88.3	4	120 kt	135 kt
08/09/1963	Arlene	1530Z	Bermuda	32.3	64.8	2	75 kt	95 kt
09/25/1963	Edith	07Z	St. Lucia	14.0	60.9	1	75 kt	75 kt
09/27/1963		10Z	Dominican Republic	18.4	69.1	TS	65 kt	60 kt
09/28/1963		18Z	Turks and Caicos	21.8	72.2	TS	35 kt	35 kt
09/30/1963	Flora	18Z	Tobago	11.2	60.7	3	105 kt	100 kt
10/04/1963		01Z	Haiti	18.2	73.0	4	125 kt	125 kt
10/04/1963		18Z	Cuba	20.0	74.9	3	105 kt	105 kt
10/07/1963		06Z	Cuba	20.8	78.1	2	80 kt	85 kt
10/09/1963		06Z	Bahamas	22.3	72.8	2	75 kt	85 kt
10/28/1963	Helena	02Z	Antigua	17.0	61.8	TS	35 kt	35 kt

Table 14. Changes to Non-US Landfalling Tropical Cyclones (1954-1963)

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APPENDIX

REANALYSIS MEDATA

1954 hurricane season

New Tropical Storm [May 27-31, 1954]

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37020 05/27/1954 M= 5  1 SNBR= 816 NOT NAMED       XING=0 SSS=0
37021 05/27*  0   0   0    0*  0   0   0    0*  0   0   0    0*275 815  20    0*
37021 05/28*284 810  20    0*298 806  25    0*307 800  30    0*313 793  35 1005*
37021 05/29*322 782  40    0*332 772  40    0*345 760  40    0*350 740  40    0*
37021 05/30*358 724  45    0*381 713  45    0E395 695  40    0E408 662  40    0*
37021 05/31E437 609  35    0E453 569  35    0E470 515  35    0E480 470  35    0*
37022 TS
```

This new tropical storm was not previously documented in HURDAT. Evidence for the existence of this system was extracted from the Cooperative Ocean-Atmosphere Data Set (COA), the Historical Weather Maps (HWM) series, the Climatological Data publication (NCDC), the Local Climatological Data forms (NCDC), the Monthly Weather Review Tracks of Centers of Cyclones (May 1954), and the United States Weather Bureau microfilm data.

May 26: HWM indicates a stalled surface front near 24N, 78W. The MWR Tracks of Centers of Cyclones does not list the system on this date. No gales or low pressures were observed.

May 27: HWM indicates a frontal wave over east-central Florida near 27N, 80W. The MWR Tracks of Centers of Cyclones does not list the system on this date. No gales or low pressures were observed.

May 28: HWM indicates a closed surface low of at most 1010 mb near 30.5N, 80W. The MWR Tracks of Centers of Cyclones lists the system with a pressure of 1011 mb at 31.1N, 81.6W (a.m.). Available observations suggest that the center of the tropical depression, located east of HWM's position, was situated at 31.0N, 80.5W. Ship highlights: 30 kt SE and 1008 mb at 31.6N, 78.6W at 18 UTC (COA). No gales or low pressures were observed.

May 29: HWM indicates a closed surface low of at most 1010 mb near 33.7N, 71.1W. The MWR Tracks of Centers of Cyclones lists the system with a pressure of 1009 mb at 35.3N, 75.5W (a.m.). Available observations suggest that the center of the tropical storm was situated at 34.5N, 76.0W. Ship highlights: 35 kt S and 1010 mb at 31.3N, 76.6W at 00 UTC (COA); 30 kt SW and 1009 mb at 32.5N, 75.7W at 12 UTC (COA); 30 kt SSW

and 1008 mb at 34.5N, 74.4W at 18 UTC (COA); 35 kt S and 1005 mb at 34.7N, 73.3W at 18 UTC (COA). No other gales or low pressures were observed. North Carolina conditions: “Finally, on the 27th, southerly winds began to add moisture as well as heat to the atmosphere, and showers became increasingly prevalent. Rain never became general, however, and the sun and winds brought temperatures up to several degrees above normal for the first time since the 3rd. On the final two afternoons the temperatures climbed to the upper 80’s and low 90’s in all sections of the State” (Climatological Data).

May 30: HWM indicates a baroclinic surface low, associated with a surface cold front, of at most 1010 mb near 40N, 68W. The MWR Tracks of Centers of Cyclones lists the system with a pressure of 1010 mb at 39.8N, 70.8W (a.m.). Available observations suggest that the center of the extratropical cyclone was situated at 39.5N, 69.5W. Ship highlights: 40 kt S and 997 mb (with SST of 22C) at 38.1N, 70.5W at 06 UTC (COA); 40 kt SSE and 1004 mb at 37.8N, 70.0W at 06 UTC (COA); 35 kt SSW and 1012 mb at 36.7N, 69.6W at 06 UTC (COA); 35 kt W and 1006 mb at 40.0N, 66.8W at 18 UTC (HWM). Several additional gales and low pressures were observed in association with the baroclinic system.

May 31: The MWR Tracks of Centers of Cyclones lists the system with a pressure of 997 mb at 47.6N, 51.4W (a.m.). Ship highlights: 10 kt SE and 1003 mb at 43.8N, 60.1W at 00 UTC (USWB); 35 kt WSW and 1009 mb at 43N, 51.7W at 12Z (HWM); 35 kt WSW and 1003 mb at 45N, 46.8W at 18Z (COA); 35 kt SW and 998 mb at 46.7N, 46.6W at 18Z (COA). Land highlights: 10 kt NNW and 999 mb at Cape Race, Newfoundland, at 12Z (USWB).

The genesis of this new tropical storm began on May 27. Early on May 26, a broad surface trough developed over the southeastern Gulf of Mexico. On this date, there were no indications of a developing circulation along the trough axis, based on available land and ship observations. Early on the 27th, signs of a developing circulation were evident, including a westerly ship wind near Key West and increasing turning of the winds over the southern Florida peninsula and adjacent Atlantic Ocean. As the area of vorticity moved north-northeast over Florida, available observations suggest that the circulation became quite defined, and it is estimated that a closed circulation was present by the afternoon. This conclusion is supported by good land data coverage from several Florida stations, including Everglades City (WSW wind), Fort Myers (WSW wind), Moore Haven (SSW wind), Melbourne (SE wind), and Tampa (E wind). Thus, it is estimated that a tropical depression developed by 18 UTC on the date. A few land stations observed 15 kt winds at the time, and the lowest observed pressures were 1013-1014 mb. The initial intensity is placed at 20 kt at 18 UTC. (It is also noted that the United States Weather Bureau microfilm data listed the system as a tropical cyclone on the 27th.) Early

on May 28, the depression maintained a closed circulation and moved north-northeast and entered the western Atlantic Ocean. At this time, the surface pressure gradient briefly weakened and the circulation became less defined around 00 UTC on the 28th. However, the system quickly organized as it moved offshore. Several ships reported 25-30 kt winds between 12 and 18 UTC. One of the ships recorded a peripheral pressure of 1008 mb and winds of 30 kt at 18 UTC. This pressure would support a plausible central pressure near 1005 mb. A central pressure of 1005 mb would substantiate a wind speed of 34 kt from the Brown et al. (2006) pressure-wind relationship for systems north of 25N – 35 kt is chosen for 18 UTC on the 28th. This estimate is also supported by the relatively small size of the system at the time. Based on available ship and land data, the system continued to intensify on May 29 as it bypassed the Carolinas. The first gale force ship wind (35 kt) was reported at 00 UTC on the 29th and was accompanied by a peripheral pressure of 1010 mb – 40 kt is chosen for 00 UTC. Several 20-30 kt ship observations were reported between 12 and 18 UTC on the 29th. At 18 UTC, another gale force wind (35 kt) was recorded in association with a peripheral pressure of 1005 mb. Based on a comparison with surrounding ship observations, this pressure may have been slightly too low, but it is believed to have been reasonably accurate. Based on the wind report, the peripheral pressure of 1005 mb would support a central pressure near 1001 mb. A central pressure of 1001 mb would support a wind speed of 46 kt from the Neumann et al. (1999) pressure-wind relationship for systems between 25-35N. For systems north of 35N, a wind speed of 47 kt would be supported. However, ship coverage was relatively good at this time, and the highest reported wind speed near the center was 35 kt. Furthermore, since the system was enlarging and was close to the boundary between the pressure-wind relationships, 40 kt is maintained at 18 UTC on the 29th. This intensity is also justified by subsequent data on May 30. Early on the 30th, the system accelerated and turned north-northeast ahead of an approaching mid-level trough. This movement occurred after a brief east-northeast movement on the 29th. Two ships reported 40 kt winds and peripheral pressures of 997 mb and 1004 mb at 06 UTC on the 30th, respectively. The 997 mb report would support a wind speed value of at least 53 kt from the Neumann et al. (1999) pressure-wind relationship for systems north of 35N. However, the forward speed was slower than climatology for this latitude. Thus, 45 kt is chosen for 00 and 06 UTC on this date. This wind speed is estimated to have been the peak intensity of the cyclone. Subsequently, available observations suggest that the system became an extratropical cyclone by 12 UTC. This conclusion is supported by the existence of a strong east to west surface temperature gradient in the vicinity of the system. Ships reported temperatures in the 70s on the south edge of this gradient, while adjacent reports indicated surface temperatures in the low 60s on the north side. Based on the data, a warm front was likely extending eastward from the extratropical low at this time. At this time, an approaching surface cold front was still located northwest of the system. Subsequently, observations

indicate that the strong surface cold front reformed farther east in association with the extratropical cyclone. As the extratropical low moved northeast, it gradually filled and weakened. After 18 UTC on May 31, the extratropical system was absorbed by another non-tropical low, which was situated farther northwest.

The reasons as to why this system was not originally included in HURDAT are unknown. Indeed, no known publications have explicitly mentioned this system or its nature. (However, the MWR Tracks of Centers of Cyclones did list the system during a portion of its life.) The circulation was concentric throughout the system's life as a tropical storm. The surrounding low level air mass was clearly barotropic, as evidenced by uniform temperatures in the 70s and low 80s. The system was not associated with an extensive or noticeable mid-level trough during its life. Additionally, the system remained over the Gulf Stream throughout its life prior to extratropical transition. As late as the 30th, ship reports indicated that surrounding SSTs were at least 22C. The confirmation of several gale force ship reports and corroborating low pressures justify the implementation of this new system in HURDAT.

New Tropical Storm [June 17-25, 1954]

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37265 06/17/1954 M= 9  2 SNBR= 820 NOT NAMED       XING=0 SSS=0
37265 06/17*  0   0   0    0*  0   0   0    0*  0   0   0    0*260 808  25    0*
37265 06/18*258 808  25    0*257 808  25    0*257 808  30    0*258 808  30    0*
37265 06/19*258 809  30    0*259 811  30    0*261 812  30    0*266 809  30    0*
37265 06/20*271 805  25    0*276 801  25    0*280 795  35    0*284 788  45    0*
37265 06/21*288 779  50    0*292 770  50    0*297 763  50    0*304 759  50    0*
37265 06/22*312 757  50    0*321 756  50    0*329 754  55    0*338 749  60    0*
37265 06/23*348 740  60    0*359 726  55    0*370 709  50    0*384 692  50    0*
37265 06/24*410 675  45    0E430 659  40    0E455 645  35    0E475 635  30    0*
37265 06/25E495 627  30    0*  0   0   0    0*  0   0   0    0*  0   0   0    0*
37285 TS
```

A new tropical storm has been added to HURDAT, not previously shown in McAdie et al. (2009). Evidence for its existence comes from the Historical Weather Map series, the microfilm maps at NHC (including Air Force reconnaissance observations), Climatological Data National Summary, the COADS ship database, and Monthly Weather Review.

June 17:

HWM does not analyze an organized system. HURDAT does not list a tropical cyclone. Microfilm shows a trough or tropical wave near 25N and along 80W at 12Z. MWR shows a low pressure of at most 1012 mb near 26.4N, 79.5W at 12Z. No gales or low pressures.

June 18:

HWM analyzes a low pressure of at most 1011 mb centered near 24.5N, 79.2W at 12Z. Microfilm shows a low pressure of at most 1008 mb centered near 25.6N, 81.2W at 12Z. MWR lists a low pressure of at most 1012 mb near 25.5N, 80.5W. Ship highlights: 35 kt E and 1012 mb near 24.8N, 80.6W at 18Z. Report from Microfilm.

June 19:

HWM analyzes a cold front stretching from the eastern Gulf of Mexico, across central Florida, and into the western Atlantic at 12Z. Microfilm shows a low pressure of at most 1008 mb centered near 26.0N, 81.5W at 12Z. MWR lists a low pressure of at most 1008 mb near 26.5N, 80.5W. Ship highlights: No gales or low pressures.

June 20:

HWM shows a closed low pressure of at most 1010 mb at 28.0N, 79.5W at 12Z. Microfilm analyzes a low pressure of at most 1008 mb near 28.0N, 79.5W at 12Z. MWR lists a low pressure of at most 1008 mb near 28.0N, 79.8W. Ship highlights: 40 kt ENE and 1007 mb near 29.2N, 78.2W at 18Z. 50 kt NE and 1008 mb near 30.0N, 78.5W at 18Z. All reports from Microfilm.

June 21:

HWM shows a closed low pressure of at most 1010 mb at 30.0N, 77.0W at 12Z. Microfilm shows a low pressure of at most 1008 mb centered near 29.5N, 75.7W at 12Z. MWR lists a low pressure of at most 1006 mb near 29.0N, 76.2W. Ship highlights: 45 kt ENE and 1011 mb near 30.3N, 77.6W at 00Z. Report from Microfilm.

June 22:

HWM shows a closed low pressure of at most 1005 mb at 33.2N, 75.0W at 12Z. Microfilm shows a low pressure of at most 1005 mb centered near 33.6N, 75.7W at 12Z. MWR lists a low pressure of at most 1009 mb near 33.2N, 75.9W. Ship highlights: 40 kt NNW and 1010 mb near 33.3N, 76.6W at 12Z. 35 kt NNW and 1008 mb near 33.7N, 76.1W at 15Z. 40 kt NNE and 1014 mb near 34.3N, 76.4W at 18Z. 35 kt S and 1013 mb near 32.9N, 73.4W at 18Z. All reports from COADS. Aircraft highlights: Air Force center fix at 1530Z at 33.2N, 75.3W; center fix at 1749Z at 33.7N, 75.9W, 998 mb and 70 kt winds; and center fix at 2000Z at 33.9N, 74.5W. All reports from Microfilm.

June 23:

HWM shows a closed low pressure of at most 1005 mb at 36.7N, 77.2W at 12Z. Microfilm shows a low pressure of at most 1002 mb centered near 37.3N, 76.3W at 12Z. MWR lists a low pressure of at most 1000 mb near 37.2N, 76.0W. Ship highlights: 40 kt

S and 1002 mb near 34.0N, 72.8W at 0Z. 40 kt SW and 1005 mb near 36.7N, 69.6W at 15Z. 35 kt NNE and 1014 mb near 35.5N, 73.7W at 18Z. 35 kt SW and 1008 mb near 36.7N, 69.6W at 18Z. All reports from COADS.

June 24:

HWM shows a closed low pressure of at most 1005 mb at 45.0N, 64.5W at 12Z. Microfilm shows a low pressure of at most 1002 mb centered near 45.5N, 64.5W at 12Z. MWR lists a low pressure of at most 998 mb near 44.5N, 64.8W. Ship highlights: 40 kt SE and 1005 mb near 41.2N, 64.8W at 03Z. 35 kt SSE and 1013 mb near 40.4N, 61.1W at 06Z. All reports from COADS.

This new tropical storm originated from a surface trough over southern Florida on the 17th of June. By 18Z on the 17th, a closed center had formed and - despite remaining over the Florida peninsula near the Everglades - a tropical depression is analyzed to begin at that point. The cyclone moved very little from the 17th through the 19th, remaining over land. At 18Z on the 18th, a ship well northeast of the center reported 35 kt ENE. However, due to other nearby observations indicating substantially less than that, the intensity is kept at 30 kt, just below tropical storm strength. At 12Z on the 19th, two observations of 35 kt S winds were reported from Carysfort Reef and Alligator Reef lighthouses. As these anemometers are elevated (30 m and 45 m, respectively), these winds reduce down to 32 and 30 kt, respectively, at 10 m. Intensity is kept at 30 kt at that time, though it is possible that the system was a minimal tropical storm, even though the center was still over land in southern Florida. As the cyclone's center began moving slowly northeastward late on the 19th and early on the 20th away from the Everglades, it appears that the system weakened slightly and an intensity of 25 kt is analyzed for 00Z and 06Z on the 20th. The system moved back over water around 06Z on the 20th. From that point, a rather pronounced intensification occurred. At 18Z on the 20th, two ships reported 40 kt ENE and 50 kt NE, respectively. It is analyzed that it became a tropical storm by 12Z on the 20th with 35 kt winds, 45 kt at 18Z, and 50 kt at 00Z on the 21st. It is noted that both the Historical Weather Map series and the NHC microfilm suggest a frontal boundary existed from the center of the system and extending eastward on the 19th and 20th for HWM and on the 20th and 21st for the microfilm. However, despite the cyclone showing a somewhat asymmetric structure both in the wind field and in the pressure field on these dates, it does not appear that a front actually existed. It could be, though, that on the 19th through the 21st that the system was a subtropical cyclone. (However, this designation is not utilized in HURDAT until 1968, with the advent of routine satellite imagery.) Little inner core observations were available on the 21st, so the intensity is held steady at 50 kt. Late on this date, the cyclone turned toward the north-northeast. There was one Air Force reconnaissance mission into the cyclone on the

22nd, as the system was becoming more symmetric and intensifying. This mission did not penetrate the center, but instead boxed the cyclone to provide three position fixes. However, it did obtain three observations helpful with the intensity. They were 70 kt SW surface winds (visually estimated) and 998 mb pressure (adjusted from flight level pressure) at 1745Z, 75 kt SW and 998 mb at 2050Z, and 20 kt SSW and 996 mb at unknown time (but later) all on the 22nd. The 996 mb peripheral pressure suggests winds of at least 50 kt (or at least 52 kt for intensifying tropical cyclones) from the Brown et al. north of 25N pressure-wind relationship. It is possible that the 996 mb and 20 kt observation suggests a 994 mb central pressure. However, it is not clear whether these two measurements were really simultaneous both in time and space. The intensity is analyzed to be 60 kt late on the 22nd and early on the 23rd, though it is possible that the system was a minimal hurricane. This is also the peak intensity for the cyclone. Late on the 22nd, the cyclone turned toward the northeast and began accelerating. Early on the 23rd, Wilmington, North Carolina experienced its peak fastest mile winds of the month - 29 kt NW – in association with this cyclone. (Cape Hatteras had its peak winds of the month of 28 kt on the 18th, not in association with this system.) It is likely that a portion of the North Carolina coast between Wilmington and Cape Hatteras experienced 35 kt tropical storm force winds. The cyclone gradually weakened on the 23rd. Peak observed winds were 40 kt at 15Z and the intensity is brought down to 50 kt at 12 and 18Z. On the 24th, the cyclone underwent extratropical transition as a cold front approached from the west and reached the center of the system around 06Z. After 06Z on the 24th, the extratropical cyclone made landfall in Nova Scotia, Canada. The system gradually weakened on this date and dropped below tropical storm strength by 18Z. The system continued diminishing and it is analyzed that it dissipated after 00Z on the 25th.

“The storm center was first located at 1530Z at three three two north seven five three west. At first entry the center was ill formed with a ring cloud to twenty five thousand feet in an arc from two seven zero degrees through one two zero degrees. By departure time 2100Z the ring cloud has risen above 35000 ft and covered the arc from three zero zero degrees through zero five zero degrees. The strata cumulus clouds gradually formed a perfect circle at 1830Z and by 1900Z took on the shape of the synoptic hurricane symbol of a six nine superimposed. The lowest sea level pressure was nine nine eight millibars and maximum surface wind was two three zero degrees at seven five knots in southeast quadrant. The weakest quadrant was north with no winds over three five knots the weather in the southeast quadrant was banded in twenty mile widths. With the exception of the cirro stratus and the wall of cumulonimbus no clouds were over ten thousand feet. Depressions at 500 and 700 millibars were superimposed over the surface center. The storm was boxed at 1500 feet and had a closed low cell wind pattern with a wind shear across the center of approximately eighty miles which later became about fifty miles.

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37265 06/24/1954 M= 3  1 SNBR= 820 ALICE       XING=0 SSS=0
37265 06/24/1954 M= 4  3 SNBR= 820 ALICE       XING=0 SSS=0
                     *  *

37270 06/24*  0   0   0    0*  0   0   0    0*220 940  50    0*231 949  50    0*
37270 06/24*213 923  30    0*217 930  35    0*222 937  45    0*228 945  55    0*
            *** ***  **      *** ***  **      *** ***  **      *** ***  **

37275 06/25*240 957  65    0*244 965  70    0*249 972  70    0*260 983  50    0*
37275 06/25*235 954  65    0*242 963  75    0*248 972  80  980*256 981  60    0*
            *** ***         *** ***  **      ***      **  *** *** ***  **

37280 06/26*271 992  40    0*278 998  25    0*2851003  25    0*2921008  25    0*
37280 06/26*266 990  45    0*278 998  40  999*2881006  35    0*2941015  30    0*
            *** ***  **                **  *** *******  **      *******  **

(The 27th is new to HURDAT.)
37282 06/27*2971027  25    0*3001040  25    0*  0   0   0    0*  0   0   0    0*

37285 HR
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Minor alterations are introduced to the track and to the intensity shown in McAdie et al. (2009). Evidence for these alterations comes from the Historical Weather Map series, the microfilm maps at NHC, the Navy aircraft reconnaissance book, Climatological Data, the COADS ship database, and Monthly Weather Review, and Connor (1956).

June 23:

HWM analyzes a low pressure of at most 1010 mb centered near 20.0N, 93.3W. HURDAT and microfilm did not previously list this system. No gales or equivalent in pressure were observed.

June 24:

HWM analyzes a tropical storm of at most 1005 mb centered near 22.0N, 94.5W. HURDAT lists this as a 50 knot tropical storm at 22.0N, 94.0W. Microfilm analyzes a closed low pressure of at most 1008 mb centered near 22.3N, 94.8W, at 18Z. Ship highlights: 50 kt E and 999 mb at 18Z near 23.1N, 94.5W. 30 kt SE and 1011 mb at 23Z near 23.2N, 94.2W. All ship reports come from the microfilm. “A tropical storm developed rapidly in the west Gulf of Mexico on the 24th of June” (MWR).

June 25:

HWM analyzes a tropical storm of at most 1005 mb centered near 24.7N, 97.5W. HURDAT lists this as a 70 knot hurricane at 24.9N, 97.2W. MWR shows this system as a hurricane near 24.9N, 97.5W at 12Z. In the microfilm at 12Z, the storm is analyzed as a hurricane of 990 mb centered near 25.1N, 97.3W. Ship highlights: 45 kt ESE and 997 mb

at 06Z near 24.0N, 97.0W; 75 kt N at 0817Z near 24.6N, 97.2W. All ship reports come from the microfilm. Aircraft highlights: NAVY center fix at 0650Z at 23.8N, 96.0W; center fix at 0726Z at 23.9N, 96.1W; center fix at 0907Z at 24.4N, 96.8W; center fix at 0932Z at 24.6N, 96.8W, center fix at 1530Z at 25.0N, 98.0W and flight level winds of 60 kt . Land highlight: 37 kt ESE and 1007 mb at 12Z at Brownsville (climo); 45 kt E (maximum 1-minute wind) at Brownsville sometime between 12Z-18Z (climo). 43 kt SE at 13-15Z and 1009 mb at 22Z at Port Isabel (Connor); 43 kt at 19Z and 1008 mb at 18Z at Harlingen (Connor); 55 kt SW and 1003 mb at 19Z at Mercedes (Connor); 45 kt SE at 15Z at Raymondville (Connor); 35 kt E at 20-21Z and 1006 mb at 21Z at Sarita (Connor); 35 kt SE at 0850Z and 1011 mb at 2130Z at Corpus Christi (Connor). All cities are in Texas. "By early on the 25th [Alice] was of hurricane force. It moved inland south of Brownsville, Tex., early on the morning of the 25th. A fishing camp along the Mexican coast, about 100 miles south of Brownsville, estimated a maximum wind of 70 to 80 mph." (MWR) An Aircraft report at 15Z indicated that the center was moving inland, "closed elliptical shape circulation over beach." (Hurricane Reconnaissance)

June 26:

HWM shows a closed low pressure of at most 1010 mb at 28.7N, 100.6W. HURDAT lists this as a 25 knot tropical depression at 28.5N, 100.3W. Microfilm analyzes a low pressure near 28.4N, 101.5W at 12Z. Land highlight: 37 kt NE and 999 mb at 0430Z at Laredo (Connor). 28 kt SE at Del Rio (NCDC/NHC Library). All cities are in Texas.

June 27:

HWM and HURDAT did not analyze previously this system. Microfilm lists a low pressure near 27.5N, 103.0W at 12Z. Land highlights: 10 kt W and 1008 mb at 06Z at Presidio, TX (microfilm).

"The storm of June 25-28 produced the maximum flood of record on the middle Rio Grande and lower Pecos Rivers … The river [Pecos] rose to approximately 70 feet above the stream bed on the night of June 26, at which time the trusses of the bridge were washed away. On the night of June 27, the river again rose to 85 feet, at which time the center pies of the bridge was completely washed away. Both of these floods were the direct result of the atmospheric circulation of the dying hurricane "Alice" remaining over the Lower Pecos Watershed for about 3 days" (NCDC/NHC Library).

Genesis originally begun unrealistically as 50 kt tropical storm at 12Z on the 24th. Data are quite sparse in the southwestern Gulf of Mexico on the 23rd and early on the 24th, making conclusive statement about genesis time and location problematic. A 50 kt E/999 mb ship report at 18Z suggested that the system was already well-developed by that time.

999 mb peripheral pressure suggests maximum winds of at least 49 kt from the Brown et al. south of 25N pressure-wind relationship. Intensity selected to be 55 kt at 12Z on the 24th, up from 50 kt originally. Decision was made to backtrack from that point to obtain positions earlier on the 24th and assume a rather rapid intensification rate of 10 kt per six hours to begin the system at 00Z on the 24th as a tropical depression. Genesis is thus indicated to have begun 12 hours earlier than shown originally. Minor track changes were introduced for the duration of the tropical cyclone. A ship reported 75 kt N at 0817Z on the 25th. On the 25th, aircraft reconnaissance was monitoring the cyclone, but only provided radar-based center fixes and no central pressures and no measurements of the peak wind.

The cyclone made landfall around 14Z on the 25th near 25.0N 97.6W, about 50 nm s of the Texas-Mexico border. No 1-min winds of hurricane force were recorded, with peak observed winds of 56 kt from Mercedes, Texas about 3 hours after landfall. Category 1 hurricane-force winds were estimated south of the center along the Mexican coast. About 15 hours after landfall, a 999 mb pressure (likely a central pressure reading) was recorded at Laredo, Texas. Using the Ho et al. pressure-decay model, this suggests a central pressure of 979 mb at landfall. Using a rounded value of 980 mb gives 80 kt from the south of 25N Brown et al. pressure-wind relationship for intensifying cyclones and 78 kt from the north of 25N relationship. 80 kt are chosen at the time of landfall and were likely the peak intensity of the hurricane. This also is consistent with the 75 kt ship report early on the 25th. 80 kt at landfall and at 12Z on the 25th is 10 kt higher than that indicated in HURDAT originally. This system was certainly at least a tropical storm impact for Texas and it is possible that it produced 1-min hurricane force winds inland in Texas. The reanalysis indicates 60 kt peak winds for Texas.

After landfall, the highest winds within 2 hours of synoptic time were 56 kt near 18Z on the 25th, no tropical storm force winds near 00Z on the 26th, and 36 kt near 06Z on the 26th. Runs of the Kaplan-DeMaria inland wind-decay model suggest intensity of 58 kt at 18Z on the 25th, 43 kt at 00Z on the 26th, and 32 kt at 06Z. Intensities are selected to be 60 kt at 18Z (up from 50 kt originally), 45 kt at 00Z (up from 40 kt originally), and 40 kt at 06Z (up from 25 kt originally). For the 06Z slot a 999 mb central pressure is added. This pressure would suggest 45 kt from the north of 25N pressure-wind relationship. Assuming 15% less because of overland exposure, this would be 37 kt – consistent with the increase of intensity at that time. The cyclone originally was dissipated after 18Z on the 26th. However, observations from west Texas indicate that a closed low was still present until 06Z on the 27th. HURDAT modified to keep system until that time with weakening to a depression at 18Z on the 26th, 12 hours later than originally indicated.

Tropical Storm Barbara [July 27-30, 1954]

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37290 07/27/1954 M= 4  2 SNBR= 821 BARBARA     XING=1 SSS=0
37290 07/27/1954 M= 4  4 SNBR= 821 BARBARA     XING=1 SSS=0
                         *

37295 07/27*  0   0   0    0*278 899  25    0*278 901  25    0*279 903  30    0*
37295 07/27*  0   0   0    0*  0   0   0    0*278 901  25    0*280 903  30    0*
                             *** ***  **                      ***

37300 07/28*280 905  35    0*280 907  35    0*281 910  35    0*283 914  40    0*
37300 07/28*282 905  30    0*283 907  35    0*283 911  40    0*285 915  50    0*
           ***      **      ***              *** ***  **      *** ***  **

37305 07/29*288 918  40    0*294 923  35    0*300 928  30    0*302 935  25    0*
37305 07/29*287 920  50    0*292 925  50    0*299 930  50    0*304 937  35 1003*
           *** ***  **      *** ***  **      *** ***  **      *** ***  ** ****

37310 07/30*305 944  25    0*310 956  25    0*315 967  25    0*322 979  20    0*
37310 07/30*307 946  30    0*310 956  25    0*315 967  25    0*  0   0   0    0*
           *** ***  **                                        *** ***  **

37315 TS
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U.S. Tropical Storm Landfall

07/29 10Z 29.7N 92.8W 50 kt LA

Minor changes to the track, but major alterations to the intensity shown in McAdie et al. (2009). Evidence for these alterations comes from the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Monthly Weather Review, the Climatological Data, Connor (1956) and the Navy aircraft reconnaissance book.

July 26:

HWM analyzes a low pressure located near 28.3N, 88.7W. HURDAT and MWR do not list this system. Microfilm analyzes a closed low of at most 1011 mb at 29.3N, 88.2W at 12Z. No gales.

July 27:

HWM analyzes a tropical storm located near 27.9N, 90.6W. HURDAT lists this as a 25 kt tropical depression at 27.8N, 90.1W. MWR shows this system centered near 26.6N, 92.0W with a central pressure of 1007 mb at 12Z. Microfilm analyzes a closed low of at most 1008 mb at 27.8N, 89.0W at 12Z. No gales.

July 28:

HWM analyzes a tropical storm of at most 1005 mb located near 28.0N, 92.3W. HURDAT lists this as a 35 kt tropical storm at 28.1N, 91.0W. MWR shows this system centered near 28.5N, 91.8W with a central pressure of 1004 mb at 12Z. Microfilm analyzes a closed low of at most 1005 mb at 28.3N, 92.5W at 12Z. Ship highlights: 35 kt ESE and 1012 mb at 12Z, near 28.6N, 89.2W. 40 kt S and 1005 mb at 18Z near 28.2N, 91.5W. 50 kt S and 1006 mb at 18Z near 28.4N, 90.7W. 45 kt SE and 1009 mb at 18Z near 29.4N, 89.9W. 45 kt S and 1004 mb at 21Z near 28.5N, 91.0W. 40 kt SE and 1005 mb at 21Z near 28.2N, 90.7W. All observations are from microfilm. Aircraft highlights: center fix at 2038Z at 28.2N, 93.0W, the measured central pressure was 1006 mb and 30 kt winds. “Elongated very poorly defined center … radar coverage not feasible as center defined by wind shifts and pressures only” (NAVY).

July 29:

HWM analyzes a tropical storm of at most 1005 mb located near 30.0N, 92.5W. HURDAT lists this as a 30 kt tropical depression at 30.0N, 92.8W. MWR shows this system centered near 31.0N, 93.0W with a central pressure of 1004 mb at 12Z. Microfilm analyzes a closed low of at most 1005 mb at 30.0N, 92.8W at 12Z. Ship highlights: 35 kt SE and 1008 mb at 0Z, near 28.0N, 90.3W (micro). 40 kt S and 1013 mb at 06Z near 27.1N, 90.6W (COA). 35 kt SSW and 1008 mb at 12Z near 28.0N, 92.7W (COA). 50 kt SSW and 1008 mb at 12Z near 28.6N, 92.3W (COA). 47 kt at Ship Shoal Lighthouse (CONNOR). Land highlight: Lake Charles recorded a probable central pressure of 1003 mb at 12Z (climo). 41 kt SE and 1003 mb at 10Z at Grand Isle (CONNOR), 1004 mb at 04Z at Morgan City (CONNOR), 40 kt SE at Jeanerette at 1230Z (CONNOR), 35 kt NE at 08Z at Lake Arthur (CONNOR). All cities in Louisiana.

July 30:

HWM analyzes a closed low of at most 1010 mb located near 31.1N, 96.0W. HURDAT lists this as a 25 kt tropical depression at 31.5N, 96.7W. MWR shows this system centered near 32.0N, 96.0W with a central pressure of 1008 mb at 12Z. Microfilm doesn’t analyze a closed low at 12Z. No gales.

“This storm formed in the north Gulf of Mexico off the Louisiana coast on July 28 and moved inland in the Vermilion Bay area early on the morning of the 29th. Highest wind reported was 60 mph by the Henry M. Dawes on the afternoon of the 28th. Some damage to crops, such as rice and corn, was reported from the heavy rains, but the general opinion was that the rains associated with the storm were far more beneficial than damaging” (MWR).

Genesis is delayed by six hours, as observations at 06Z on the 27th indicate that the system did not yet have a closed circulation. Minor track changes were introduced on all four days of this system's existence. Onset of tropical storm intensity was delayed by six hours to 06Z on the 28th through the evidence of numerous ship observations near the system's center. HURDAT originally had a peak of 40 kt intensity from 18Z 28th to 00Z 29th with landfall in Louisiana after 06Z as a 35 kt tropical storm. However, a few ship observations as well as some station reports from Louisiana indicate that the system peaked at 50 kt from 18Z on the 28th until landfall around 10Z on the 29th. Highest observations from ships were 50 kt S and 1006 mb at 18Z on the 28th and 50 kt SSW and 1008 mb at 12Z on the 29th (just after landfall). Highest observations from land were 52 kt from Ship Shoal Lighthouse, which after adjusting from 38 m anemometer height to 10 m suggest winds of 47 kt. After landfall, the cyclone went directly over Lake Charles, which observed a 1003 mb central pressure which occurred between 12 and 18Z on the 29th. 1003 mb central pressure suggests winds of 38 kt from the Brown et al. north of 25N pressure-wind relationship. Assuming reduced 1 min winds because of the overland exposure (a factor of 0.85), this would suggest 32 kt. Given that 50 kt was last observed just six hours earlier, intensity is analyzed to be 35 kt at 18Z, up from 30 kt originally. Weakening to a tropical depression is delayed by twelve hours to 00Z on the 30th. The cyclone dissipated after 12Z on the 30th, based upon numerous observations over the south Central United States. This dissipation is six hours earlier than that in HURDAT originally.

Hurricane Carol [August 25 – September 1, 1954]

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36665 08/25/1954 M= 8  3 SNBR= 807 CAROL       XING=1 SSS=3
36665 08/25/1954 M= 8  5 SNBR= 807 CAROL       XING=1 SSS=3
                       *

36670 08/25*  0   0   0    0*  0   0   0    0*240 749  30    0*251 755  40    0*
36670 08/25*  0   0   0    0*232 750  25    0*242 751  30    0*251 755  30    0*
                            *** ***  **      *** ***                    **

36675 08/26*261 760  45    0*270 763  55    0*277 764  60    0*284 763  60    0*
36675 08/26*261 760  35    0*270 763  40    0*278 764  45    0*285 763  45 1002*
                     **                **      ***       **      ***       ** ****

36680 08/27*289 762  70    0*293 763  75    0*296 765  80    0*298 766  85    0*
36680 08/27*290 762  50    0*293 763  55    0*296 765  60  995*298 766  70  984*
           ***       **                **                **  ***           **  ***

36685 08/28*299 767  85    0*301 769  85    0*303 772  85    0*304 774  85    0*
36685 08/28*299 767  80  981*301 769  85    0*303 772  85    0*304 774  85    0*
                     **  ***

36690 08/29*305 776  85    0*307 778  80    0*309 779  80    0*312 780  80    0*
36690 08/29*303 775  85    0*304 776  80    0*306 778  80    0*309 779  80    0*
           *** ***           *** ***           *** ***           *** ***
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36695 08/30*315 781  80    0*319 780  85    0*325 776  85    0*331 770  85    0*
36695 08/30*312 779  80    0*316 777  85    0*321 774  90    0*330 770  95    0*
           *** ***          *** ***          *** ***  **      ***       **

36700 08/31*342 761  85    0*373 742  85    0*402 729  85    0E431 718  75  976*
36700 08/31*342 761  95  960*366 739 100    0*393 729 100  955E431 714  75  973*
                     **  *** *** *** ***      ***     ***  ***     ***      ***

36705 09/01E462 711  60  987E489 712  50  992*  0   0   0    0*  0   0   0    0*
36705 09/01E462 711  50  987E489 712  40  992*  0   0   0    0*  0   0   0    0*
                     **                ** 

36710 HR NY3 CT3 RI3 NC2
36710 HR NY3 CT2 RI3 MA2 NC1
           ***     *** ***
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Landfall:

8/31 0230Z Closest approach to NC (offshore Cape Hatteras)
95 kt/960 mb, RMW 23 nm, NC1 impact

8/31/1430Z 40.9N 72.2W landfall in NY
100 kt/955 mb, RMW 22 nm, NY3 impact

8/31/1515Z 41.3N 72.0W landfall in CT
100 kt/957 mb, RMW 22 nm, CT2, RI3, MA2 impacts

Minor changes to the track, but major alterations to the intensity shown in Neumann et al. (1999). Evidence for these alterations comes from the Historical Weather Map series, Monthly Weather Review, daily Surface Weather Observations from NCDC, U.S. Weather Bureau six hourly maps available via microfilm at NHC, aircraft observations available from the Storm Wallets at NHC, the COADS ship database, McGuire (1954), Rhodes (1954), Dunn and Miller (1960), Harris (1963), Schwerdt et al. (1979), Ho et al. (1987), Jarrell et al. (1992), Boose et al. (2001), and Jarvinen (2006).

August 25: HWM does not analyze a closed low on this day. HURDAT listed the storm as a 30 kt tropical depression at 24.0N, 74.9W. Available observations suggest that the 30 kt tropical depression was centered at 24.2N, 75.1W. Ship highlights: No gales or low pressures present on this day.

August 26: HWM analyzes a closed low of at most 1010 mb centered near 28.0N, 76.6W. HURDAT listed the storm as a 60 kt tropical storm at 27.7N, 76.4W. The MWR Tracks of Lows for August 1954 (Chart IX) places the center at 29.9N, 76.8 W with a central pressure of 1011 mb. Available observations suggest that the 45 kt tropical storm was centered at 27.8N, 76.4W. Ship highlights: No gales or low pressures present on this day. The intensity on this day, as recorded by aircraft reconnaissance at 2050 UTC was 1002 mb at 28.8N, 76.2W. At 1:30 AM (630 UTC) on the 26th, it was centered near latitude

27N, longitude 76W, or 300 miles east-northeast of Miami (Climatological Data National Summary August 1954).

August 27: HWM analyzes a closed low of at most 1005 mb centered near 29.9N, 76.4W. HURDAT listed the storm as an 85 kt category 2 hurricane centered at 29.6N, 76.5W. The MWR Tracks of Lows for August 1954 (Chart IX) places the center at 29.9N, 76.8W with a central pressure of 995 mb. Available observations suggest that the 65 kt category 1 hurricane was centered at 29.6N, 76.5W. Ship highlights: 35 kt NNE at 12 UTC at 30.1N, 76.9W (COA ship # 9332). Aircraft reconnaissance recorded center fixes at 1400 UTC at 29.8N, 76.4W with 995 mb, at 2013 UTC at 29.9N, 76.6W with 984 mb, and at 2130 UTC at 29.9N, 76.5W with 981 mb.

August 28: HWM analyzes a closed low of at most 995 mb centered near 30.6N, 77.0W. HURDAT listed the storm as an 85 kt category 2 hurricane centered at 30.3N, 77.2W. The MWR Track of Lows for August 1954 (Chart IX) places the center at 31.0N, 76.9W with a central pressure of 975 mb. Available observations suggest that the 85 kt category 1 hurricane was centered at 30.3N, 77.2W. Ship observations: 35 kt NE at 18 UTC at 32.2N, 791.W (COA ship # 7622).

August 29: HWM analyzes a closed low of at most 995 mb centered near 31.0N, 78.2W. HURDAT listed the storm as an 80 kt category 1 hurricane centered at 30.9N, 77.9W. The MWR Tracks of Lows for August 1954 (Chart IX) places the center at 31.1N, 77.5W with a central pressure of 995 mb. Available observations suggest the 80 kt category 1 hurricane was centered at 30.6N, 77.8W. Ship observations: 1005 mb and 40 kt NE at 12 UTC at 32.0N, 78.5W (HWM); 1005 mb and 45 NE at12 UTC at kt 31.8, 78.3W (COA 8152). At 1:30 AM (0630 UTC) of the 29th (the storm) had traveled less than 300 miles to a central location near latitude 30N, longitude 77W, some 200 miles off the extreme northeastern coast of Florida. On the 29th, still moving sluggishly, Carol changed direction to northwestward. This change, at first, posing a threat to the South Carolina shore, developed within twenty-four hours into a return to a northerly heading.

August 30: HWM analyzes a closed low of at most 985 mb centered near 32.0N, 77.1W. HURDAT listed the storm as an 85 kt category 2 hurricane centered at 32.5N, 77.6W. The MWR Tracks of Lows for August 1954 (Chart IX) places the center at 32.4N, 77.3W with a central pressure of 966 mb. Available observations suggest the 90 kt category 2 hurricane was centered at 32.1N, 77.4W. Ship observations: 65 kt NNW at 12 UTC at 32.2N, 72.0W; 986mb and 65 kt N at 18 UTC at 33.5n, 77.3W; 991 mb and 65 kt NNE at 0 UTC at 31.5N, 78.5W. Land observations: 991 mb and 61 kt E at 1130 UTC at 33.8N, 78.0W (SWO Frying Pan Lightship, NC); 983 mb and 70 kt W at 1730 UTC at 33.8N, 78.0W (SWO Frying Pan Lightship, NC); 990 mb at 2330 UTC at 35.2N, 75.0W (SWO Diamond Shoals Lightship, NC). At 5 AM (10 UTC), the hurricane was centered near

latitude 32N, longitude 78W, or about 150 miles east-southeast of Charleston, SC; it was moving at about 5 mph toward the north. By noon (17 UTC), heading slightly east of north at the same slow speed, the center had reached latitude 33N, longitude 73W, or about 100 miles south-southeast of Wilmington, NC. Carol now grew into a large storm, was entered upon the second or mature stage of its career. An official bulletin issued at 1 PM (18 UTC) on the 30th stated that it was still moving very slowly north-northwestward but increasing in intensity. Winds near the center were reported to be over 100 mph, while winds of hurricane force extended over 100 miles to the east of the center and 50-60 miles to the west. Gales ranged further outwards, 200 miles to the east and about half that distance to the west. Elizabeth City, NC: lowest pressure reading was 29.25 inches at 2325E (0425 UTC). Norfolk Airport, VA: The tide reached a height of 5.6 feet above mean low water at midnight and began falling. The time of normal high tide would have been at 10:34 PM but due to strong NE winds the tide kept building until midnight. The tower reported observing gusts to 60 mph at 8:55 PM but the highest observed on the W.B. dial was 54 mph about 9:15 PM.

August 31: HWM analyzes a closed low of at most 975 mb centered near 40.0N, 72.5W. HURDAT listed the storm as an 85 kt category 2 hurricane centered at 40.2N, 72.9W. The MWR Tracks of Lows for August 1954 places the center of the storm at 40.2N, 72.8W with a central pressure of 960 mb. Available observations suggest the 100 kt category 3 hurricane was centered at 39.3N, 73.0W. Ship observations: 975mb at 9 UTC at 37.5N, 74.0W; 976 mb and 65 kt NNE at 12 UTC at 38.4N, 74.2W (COA ship # 77811); 984 mb and 55 kt N at 12 UTC at 39.8N, 73.9W (COA ship # 1791). Land observations: 957 mb and calm at 15 UTC at 41.3N, 72.1W (Jarvinen - Croton, CT); 960 mb at 40.8N, 72.6W at 14 UTC at 40.8N, 72.6W (SWO Suffolk County Air Force Base); 87 kt at 1505 UTC at 41.2N, 71.6W (SWO Block Island, RI). 78 kt ESE at 1530 UTC at 41.8N, 71.4W (SWO Providence, RI); 972 mb at 0223 UTC and 68 kt N at 35.3N, 75.6W (SWO Hatteras, NC). The intensity on this day, as recorded by aircraft reconnaissance at 1337 UTC was 964 mb at 40.2N, 72.6W. The western side of Carol lashed the shore from Wilmington northward to Cape Hatteras (NC). Damage amounted to an estimated $227,500. Strong winds tore down power and telephone lines, and the Trent and Neuse Rivers, their levels raised by the high water accompanying the storm, flooded the waterfront section of New Bern (NC). A peak gust of 78 mph was observed at the Hatteras station of the Weather Bureau. Late on the 30th (31 in UTC time), the hurricanes center passed a few miles east of Cape Hatteras. At 11 PM (4 UTC on 31st) Carol was centered near latitude 36N, longitude 75W, or about 100 miles south-southeast of Norfolk, VA. Its size and the strength of its winds remained about the same, but a rapid and sharp increase occurred in the rate of forward motion as it passed north-northeastward along the Middle Atlantic coast during the early morning of the 31st. The forward speed accelerated to 40 mph, brought the center over extreme eastern Long

Island by 9 AM (14 UTC). The effects of the hurricanes passage from the Virginia shore area to Long Island were comparatively slight. The track of the center was 75-100 miles east of the mainland, so that dangerous winds did not reach westward to the coast...The amount of damage in New Jersey was estimated at $250,000. No monetary estimates of damage in Virginia, Maryland and Delaware were received but it is known to have been minor. The impact of the storm on Long Island and New England was far more serious. The center crossed the south shore of Long Island slightly east of West Hampton about 8:30 AM (1330 UTC). An hour later it passed into Long Island Sound off Cutchogue. By 10:30 AM (1530 UTC) it was over the southeast shore of Connecticut near the mouth of the Connecticut River. Curving slightly on a northward course, the center passed 5-10 miles west of Worcester, MA, about noon (17 UTC) and penetrated into south-central New Hampshire about 1:30 PM (1830 UTC). In mid-afternoon, Carol passed into the third and final stage of its history. The strength of its winds and its speed of forward progress diminished as the center traveled northward over the rugged terrain of New Hampshire. Norfolk Airport, VA: Hurricane Carol passed 110 miles east of Norfolk at 2 AM (7 UTC) at a heading of 35o. Portland, ME: Hurricane Carol caused one death in Portland, one at Port Clyde and at Columbia Falls. Many hundreds of trees fell. Eye of storm passed west of Portland, moving from Concord, NH to near Bethel, Maine. These were highest winds ever recorded in August. East Boston, MA: Hurricane Carol moved north-northeastward from the Cape Hatteras area, entering southern New England on the morning of the 31st and thence sweeping northward into the St. Lawrence Valley early on Sept 1st. The course of the center of the storm extended across Rhode Island, eastern Massachusetts, and northward along the Maine-New Hampshire border; areas traversed suffered damage comparable to the Sept. 1938 Hurricane, but loss of life was much less. South Weymouth, MA: Lowest pressure observed as Hurricane Carol passed station was 28.677 inches at 1050 AM (1550 UTC), and maximum gust of 81 knots at 1028 AM (1528 UTC). Concord, NH: Winds extremely gusty, resulted in considerable local damage. Some trees and wires, as well as TV antennas blown down. Damage around Concord while important was not near so bad as in some other southern and central NH communities. The local rainfall was one of the heaviest on record. Driving on the roads was very hazardous due to the combined strong winds and reduced visibility from the extremely heavy rainfall.

Genesis of Carol is begun six hours earlier than in HURDAT originally from observations of a closed low at 06 UTC on the 25th. Only small alterations were introduced into the track of Carol on all days except for the 28th and 1st when no changes were made. Aircraft reconnaissance center fix observations were available for Carol for much of its lifetime. However, as is typical for hurricanes of the 1950s, most of these were from radar fixes rather than an aircraft penetration of the cyclone. Thus while there are several dozen radar fixes, there only are six central pressure measurements. For the

few actual penetrations, winds provided were visually estimated and not reliable (e.g., 125 kt winds for a central pressure of 984 mb). At 2050 UTC on the 26th, aircraft measured a central pressure of 1002 mb and a circular eye of 20 nm diameter. 1002 mb pressure suggests maximum winds of 40 kt from the north of 25N Brown et al. pressure-wind relationship. Given the small size of the reported eye, maximum winds are boosted to 45 kt in HURDAT, which is a reduction from the 60 kt originally at 18 UTC. Three reconnaissance central pressures were reported on the 27th: 995 mb with an 8 nm eye at 1400 UTC, 984 mb with a 13 nm eye at 2013 UTC, and 981 mb at 2130 UTC. The last observation suggests winds of 71 kt from the subtropical pressure-wind relationship. Given the small size, 80 kt at 0000 UTC on the 28th (down from 85 kt originally) was analyzed as the intensity. Carol likely became a hurricane around 18 UTC on the 27th, which is about 18 hours later than originally analyzed. No observations were available to determine the inner core intensity of Carol for all of the 28th and 29th and no changes were made to the HURDAT winds. Hurricane force winds and peripheral pressures as low as 983 mb were reported by ships, the Frying Pan Lightship, and Diamond Shoals Lightship on the 30th as Carol approached the Carolinas. An aircraft reconnaissance did measure a 960 mb central pressure late on the 30th southeast of North Carolina. This pressure suggests maximum winds of 95 kt from the Brown et al. north of 25N and 90 kt from the Landsea et al. north of 35N pressure-wind relationships, respectively. Ho et al. estimated a 23 nm RMW, which is slightly smaller (27 nm) than climatology for this latitude and central pressure. Thus 95 kt is chosen for HURDAT at 18 UTC on the 30th and 00 UTC on the 31st. This is an increase from the 85 kt originally indicated in HURDAT. Carol made its closest approach to North Carolina between 02 and 03 UTC on the 31st, as a pressure of 972 mb was observed in Cape Hatteras with 38 kt NNE winds at 0230 UTC followed by a 978 mb and 58 kt WNW wind at 0326 UTC. (A lower pressure value may have occurred at Cape Hatteras between these observations.) Thus it appears that the center of the eye stayed just offshore of North Carolina, but it is estimated that Category 1 conditions impacted a portion of the extreme eastern North Carolina coast (which is a downgrade from the Category 2 impact originally recorded). Carol accelerated north-northeastward after making a close by-pass of North Carolina and made landfall in New England about 12 hours later. A final aircraft reconnaissance mission reported a central pressure of 964 mb at 1337 UTC on the 31st just south of Long Island, New York.

Carol made a first landfall in Long Island around 1430 UTC on the 31st and a second landfall in Connecticut around 1515 UTC on the 31st. Ho et al. estimated a central pressure at landfall in New York of 961 mb. Jarrell et al. indicated a minimum central pressure at landfall in the United States as 960 mb, though it is ambiguous as to whether this was for North Carolina or New York. Jarvinen analyzed Carol as making an initial landfall with 955 mb central pressure in New York and 957 mb central pressure in

Connecticut, based upon an eye reading of 957 mb at Groton, Connecticut on the coast. This value is somewhat lower than the aircraft reconnaissance measurement, but given the uncertainties of the aircraft observational technologies at the time, their 964 mb value could have been biased high. Both Ho et al. and Jarvinen agree that Carol had about a 22 nm RMW at landfall in New England. 955 mb and 957 mb give 93 kt and 92 kt from the north of 35N pressure-wind relationship, respectively. Carol's RMW of 22 nm is slightly smaller than climatology for this pressure and latitude (26 nm - Vickery et al. 2000) and the hurricane was moving at about 40 kt at landfall. Both of these factors indicated a stronger wind at landfall than suggested by the pressure-wind relationship. Both at landfall in New York and in Connecticut the maximum sustained surface winds are estimated to be 100 kt. This is in agreement with Schwerdt et al., but is lower than the 113 kt and 110 kt values from the SLOSH runs at the New York and Connecticut coasts, respectively, provided by Jarvinen. (However, it is to be noted that the SLOSH runs do not take into account the cold water and stable conditions that occur around New England, which would reduce the SLOSH winds.) Based upon the landfall location and the RMW, the 100 kt maximum winds likely only occurred along easternmost New York and the Rhode Island coast, retaining New York and Rhode Island as Category 3 impacts. Both Connecticut and Massachusetts likely received a peak of Category 2 sustained winds, which is a downgrade from Category 3 originally for Connecticut but an upgrade (from no hurricane impact) for Massachusetts. Peak observed 1 minute winds were 87 kt at Block Island, R.I., but as usual the RMW intersected the coast at an area lacking in wind observations.

After landfall, the highest observed winds within two hours of the synoptic times were: at 18 UTC - 78 kt (Block Island at 1600 UTC), at 00 UTC on the 1st - 44 kt (Pollock Rip Lightship at 2345 UTC). Application of the Kaplan and DeMaria (2001) New England inland wind decay model suggests winds of 65 kt at 18 UTC and 43 kt at 00 UTC. Winds in HURDAT are retained at 75 kt at 18 UTC and lowered from 60 down to 50 kt at 00 UTC. Carol's transition to an extratropical storm at 18 UTC on the 31st is unaltered.

Hurricane Dolly [August 30 – September 4, 1954]

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37368 08/29/1954 M= 5  4 SNBR= 823 DOLLY       XING=0 SSS=0
37368 08/30/1954 M= 5  6 SNBR= 823 DOLLY       XING=0 SSS=0
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(The 30th is new to HURDAT.)
37370 08/30*  0   0   0    0*  0   0   0    0*  0   0   0    0*170 665  25    0*
                                                    ***  ***  **

37375 08/31*  0   0   0    0*193 677  30    0*209 684  45    0*228 690  55    0*
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37375 08/31*178 669  25    0*190 677  30    0*205 686  35    0*223 694  35 1011*
           *** ***  **      ***              *** ***  **      *** ***  ** ****

37380 09/01*248 695  65    0*268 699  75    0*290 702  85    0*317 701  85    0*
37380 09/01*246 698  45    0*266 699  55    0*288 700  65    0*317 701  70    0*
           *** ***  **      ***       **      *** ***  **                  **

37385 09/02*346 693  75    0*372 669  70    0*397 642  70    0E421 605  70    0*
37385 09/02*346 693  65  994*370 673  60    0*397 638  60    0E416 615  60    0*
                     **  *** *** ***  **          ***  **      *** ***  **

37390 09/03E443 564  65    0E458 519  55    0E468 474  50    0E476 429  45    0*
37390 09/03E443 564  60    0E458 519  55    0E468 474  50    0E476 429  45    0*
                     **

37395 09/04E483 383  40    0E490 335  40    0E497 288  35    0*  0   0   0    0*
37395 09/04E483 383  45    0E485 335  45    0E485 285  45    0E485 235  40    0*
                     **      ***       **      *** ***  **      **** ***  **

37400 HR
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Minor changes to the track, but major alterations to the intensity shown in McAdie et al. (2009). Evidence for these alterations comes from the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, the Navy aircraft reconnaissance book, and Monthly Weather Review.

August 28:

HWM analyzes a possible tropical wave or disturbance located near longitude 53W. HURDAT does not list this system and it is located outside the area of coverage of Microfilm and MWR.

August 29:

HWM analyzes a tropical wave located near longitude 60W, over the Lesser Antilles. HURDAT does not list this system. It is located outside the area of coverage of MWR.

August 30:

HWM analyzes a tropical storm of at most 1010 mb located near 16.8N, 64.2W. HURDAT and MWR do not list this system. Microfilm analyzes a closed low of at most 1008 mb at 19.4N, 64.0W at 12Z. Ship highlights: 15 SE and 1008 mb at 18Z near 17.0N and 64.8W. 20 kt SW and 1009 mb at 18Z near 14.2N, 66.1W. All observations from COADS. Aircraft highlights: “Large diffuse low pressure center on axis centered near Saint Croix with lowest observed pressure 1008 mb, no definite weather patterns on radar. Entire area of flight enclosed by 1010 mb isobar with weak cyclonic circulation, strongest winds observed 30 knots northeast of Virgin Islands.” (NAVY)

August 31:

HWM analyzes a tropical storm of at most 1010 mb located near 20.8N, 68.8W. HURDAT lists this as a 45 kt tropical storm at 20.9N, 68.4W at 12Z. MWR shows this system centered near 21.5N, 67.0W with a central pressure of 1008 mb at 12Z. Microfilm analyzes a closed low of at most 1011 mb at 21.0N, 68.9W at 12Z. Ship highlights: 35 kt E and 1011 mb at 12Z, near 22.4N, 67.8W (COADS). 30 kt ESE and 1019 mb at 12Z near 22.5N, 61.4W (COADS). 35 kt W and 1015 mb at 12Z near 18.9N, 67.5W (micro). 30 kt SSE and 1013 mb at 18Z near 21.1N, 67.2W (COADS). 30 kt SE and 1012 mb at 18Z near 22.1N, 67.2W (COADS). 30 kt SSE and 1013 mb at 18Z near 20.6N, 66.9W (COADS). Aircraft highlights: center fix at 2108Z at 22.9N, 70.0W, the measured central pressure was 1011 mb and peak flight level winds of 30 kt winds. (NAVY)

September 1:

HWM analyzes a hurricane of at most 1005 mb located near 29.0N, 69.9W. HURDAT lists this as a 85 kt hurricane at 29.0N, 70.2W at 12Z. MWR doesn't show this system. MWR shows this system centered near 28.9N, 69.2W with a central pressure of 998 mb at 12Z. Microfilm analyzes a closed low of at most 1005 mb at 28.5N, 70.0W at 12Z. Ship highlights: 35 kt SSE and 1012 mb at 03Z, near 25.4N, 60.5W (micro). 50 kt SE and 1001 mb at 03Z, near 25.8N, 68.8W (micro). 40 kt E and 1015 mb at 08Z near 30.0N, 69.0W (micro). 40 kt SSE at 08Z near 25.0N, 66.3W (micro). 50 kt SSE and 1011 mb at 08Z near 24.8N, 66.5W (micro). 35 kt S and 1021 mb at 09Z near 24.8N, 68.7W (micro). 40 kt SSE and 1016 mb at 12Z near 27.8N, 68.0W (micro). 50 kt SSE and 1019 mb at 12Z near 29.2N, 68.7W (micro). 40 kt ENE and 1009 mb at 12Z near 29.2N, 70.0W (micro). 45 kt N and 1000 mb at 13Z near 29.5N, 70.0W (micro). 40 kt SE and 1016 mb at 14Z near 30.4N, 67.3W (micro). 35 kt SE and 1017 mb at 14Z near 30.0N, 67.0W (COADS). 40 kt SE and 1016 mb at 15Z near 30.5N, 67.9W (micro). 50 kt ESE and 996 mb at 15Z near 30.7N, 69.6W (micro). 60 kt S and 1022 mb at 15Z near 29.4N, 68.8W (micro). 35 kt SSE and 1018 mb at 18Z near 30.0N, 66.0W (COADS). 50 kt S and 1022 mb at 18Z near 29.4N, 68.8W (micro). 50 kt SE and 1016 mb at 18Z near 30.5N, 68.0W (micro). 45 kt SE and 1017 mb at 18Z near 30.6N, 67.0W (micro). 40 kt SE and 1016 mb at 18Z near 33.0N, 68.2W (micro). 40 kt S and 1018 mb at 21Z near 30.3N, 67.8W (micro). 35 kt S and 1023 mb at 21Z near 29.2N, 69.8W (micro). "Strongest winds estimated by aircraft were around 100-115 mph on the afternoon of the 1st. This hurricane remained at sea and no damage was reported" (MWR). Aircraft highlights: center fix at 2103Z at 33.0N, 69.5W, the measured central pressure was 994 mb and estimated surface winds of 100 kt winds. "The storm is poorly defined for visual recognition but radar returns show a well-defined eye. The area is completely covered with stratus layers with breaks in the low layer in the eye, however, radar shows strongest

quadrants to be the northwest, northeast, and east with weaker returns to southeast and southwest. There is no calm area in the center with minimum winds in the eye estimated to 35 to 40 knots. Visual reconnaissance around the parameter of the wall indicates winds to 100 knots in the southwest and southeast and 80 knots in the northwest quadrant." (AF)

September 2:

HWM analyzes a closed low of at most 1005 mb located near 40.0N, 64.0W. HURDAT lists this as a 70 kt hurricane at 39.7N, 64.2W at 12Z. MWR shows this system centered near 39.2N, 64.4W with a central pressure of 996 mb at 12Z. Microfilm analyzes a closed low of at most 1002 mb at 39.7N, 63.8W at 12Z. Ship highlights: 30 kt SE and 1020 mb at 00Z near 30.0N, 67.7W (micro). 30 kt NE and 1014 mb at 06Z near 36.6N, 72.0W (COADS). 30 kt SW and 1015 mb at 06Z near 34.3N, 66.7W (COADS). 30 kt NE and 1003 mb at 18Z near 42.2N, 61.2W (COADS). 30 kt SSE and 1017 mb at 18Z near 40.1N, 59.7W (COADS). 50 kt S and 1016 mb at 18Z near 38.6N, 61.2W (COADS). 40 kt SW and 1015 mb at 18Z near 38.6N, 61.2W (COADS). 35 kt S and 1016 mb at 18Z near 39.5N, 59.4W (COADS). Aircraft highlight: center fix at 0530Z at 36.9N, 67.5W, 50 kt winds surface winds. (NAVY)

September 3:

HWM analyzes a closed low of at most 1005 mb located near 47.0N, 48.8W. HURDAT lists this as a 50 kt extratropical storm at 46.8N, 47.4W at 12Z. MWR shows this system centered near 47.0N, 47.2W with a central pressure of 1000 mb at 12Z. Microfilm analyzes a closed low of at most 1014 mb at 46.5N, 51.7W at 12Z. Ship highlights: 30 kt SW and 1022 mb at 0Z near 44.0N, 41.0W. 30 kt SW and 1021 at 03Z near 44.0N, 41.0W. 30 kt SW and 1018 mb at 06Z near 41.0N, 54.4W. 30 kt SW and 2021 mb at 06Z near 44.0N, 41.0W. 30 kt SW and 1021 mb at 09Z near 44.0N, 41.0W. 30 kt SW and 1022 mb at 12Z near 44.0N, 41.0W. 30 kt SSW and 1016 mb at 16Z near 45.0N, 45.0W. 30 kt SW and 1020 mb at 18Z near 44.0N, 41.0W. 45 kt SW and 1017 mb at 20Z near 44.0N, 44.0W. 30 kt SW and 1019 mb at 21Z near 44.0N, 41.0W. All observations come from COADS.

September 4:

HWM analyzes a closed low of at most 1000 mb located near 48.0N, 29.0W. HURDAT lists this as a 35 kt extratropical storm at 49.7N, 28.8W at 12Z. MWR shows this system centered near 50.2N, 29.5W with a central pressure of 995 mb at 12Z. Ship highlights: 35 kt SW and 1011 mb at 06Z near 44.8N, 34.2W. 25 kt SSW and 1003 mb at 06Z near 48.8N, 31.6W. 35 kt NW and 1015 mb at 12Z near 44.9N, 35.1W. 45 kt NW and 1008 mb at 12Z near 46.5N, 32.6W. 30 kt N and 1016 mb at 12Z near 48.2N, 32.8W. 30 kt N

and 1004 mb at 12Z near 48.5N, 31.5W. 15 kt SE and 1000 mb at 12Z near 48.7N, 27.3W. 35 kt NW and 1011 mb at 12Z near 52.8N, 35.5W. 35 kt NNW and 1001 mb at 18Z near 45.5N, 28.2W. 40 kt NNW and 1013 mb at 18Z near 46.8N, 31.0W. 40 kt NW and 1002 mb at 18Z near 46.5N, 27.3W. All observations come from COADS.

Genesis for Dolly is begun as a tropical depression twelve hours earlier than shown in HURDAT originally, due to ship and coastal station observations late on the 30th that showed a circulation center had developed south of Puerto Rico. Two aircraft reconnaissance missions were flown on that date: one early in the day in the eastern Caribbean (before formation of the tropical cyclone) and one late in the day north of Puerto Rico, which thus did not sample near the center of the system. The revised track has only minor modifications for the lifetime of this system, except for no changes on the 3rd. The upgrade to tropical storm remains at 12Z on the 31st, due to 35 kt ship observations at that time. An aircraft reconnaissance mission at 2108Z on the 31st obtained a central pressure of 1011 mb. This along with peak ship observations as earlier are the reason for a 35 kt intensity at 18Z on the 31st, which is a large reduction from the 55 kt in HURDAT originally. From that point, the cyclone began rapidly intensifying. A ship measured 1001 mb peripheral pressure along with simultaneous 50 kt SE winds at 03Z on the 1st. This pressure suggests winds of at least 45 kt from the south of 25N Brown et al. pressure-wind relationship and 42 kt from the north of 25N pressure-wind relationship. Also at 08Z on this day a separate ship had 50 kt SSE. The intensity is analyzed to be 45 kt at 00Z and 55 kt at 06Z, a major change from 65 kt and 75 kt, respectively. Later on the 1st, a ship measured 50 kt ESE with 996 mb and a separate ship observed 60 kt S both at 15Z. 996 mb suggests winds of at least 50 kt from the north of 25N pressure-wind relationship. An aircraft reconnaissance measured a central pressure of 994 mb at 2103Z on the 1st along with an eye diameter of 25 nm, but also visually estimated surface winds of 100 kt. These extremely high winds are very unlikely to be accurate and are discounted. 994 mb central pressure suggests maximum winds of 53 kt, though given its small RMW (~15-20 nm versus climatology of 26 nm for its latitude and central pressure) and its fast forward speed, intensities of 65 kt and 70 kt are selected at 12 and 18Z, respectively. These are large reductions from 85 kt in HURDAT originally for these two times. After late on the 1st, it appears that Dolly started weakening as it began extratropical transition. Aircraft reconnaissance into Dolly on the 2nd did not report a central pressure, but did provide an 850 mb minimum height value of 4700’ at 0530Z which corresponds to a reasonable range of central pressures between 995 and 1005 mb. These possible pressures suggest maximum winds between 40 and 56 kt from the Landsea et al. north of 35N pressure-wind relationship. Again, some boost over these values is reasonable given the quite rapid forward speed, thus 60 kt is selected at 06Z on the 2nd (down from 70 kt originally). Thus the duration that Dolly spent as a hurricane was only about 18 hours, compared with 42 hours originally. Transition to

extratropical is kept at 18Z on the 2nd as it was passing south of Canada. Gradually weakening of the system continued for the next couple of days until absorption of the system by a large extratropical low. Dissipation is delayed by six hours after that shown in HURDAT due to existence of a closed circulation through 18Z on the 4th.

Hurricane Edna [September 5-14, 1954]

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36400 09/02/1954 M=14  5 SNBR= 804 EDNA        XING=1 SSS=3
36400 09/05/1954 M=10  7 SNBR= 804 EDNA        XING=1 SSS=3
         **        **  *

(The 2nd through the 4th are removed from HURDAT.)
36405 09/02*  0   0   0    0*112 564  25    0*121 571  25    0*131 575  25    0*
36410 09/03*142 580  25    0*153 586  25    0*164 592  25    0*171 598  25    0*
36415 09/04*178 606  25    0*186 616  30    0*193 628  35    0*199 641  35    0*

36420 09/05*204 653  35    0*207 662  35    0*209 669  35    0*210 676  35    0*
36420 09/05*  0   0   0    0*207 662  30    0*209 672  35    0*210 682  40    0*
            *** ***  **                **          ***             ***  **

36425 09/06*212 682  40    0*214 688  45    0*215 694  50    0*218 701  55    0*
36425 09/06*212 690  45    0*214 698  45    0*215 705  50    0*216 710  50    0*
                ***  **          ***             ***           ***  ***  **

36430 09/07*222 708  65    0*225 715  70    0*230 722  70    0*237 734  70    0*
36430 09/07*218 715  50    0*223 721  50    0*230 728  55 1001*237 734  65  992*
            *** ***  **      *** ***  **          ***  ** ****          **  ***

36435 09/08*245 744  75    0*252 748  95    0*259 752 100    0*266 756 105    0*
36435 09/08*242 744  70    0*248 748  75    0*255 752  85  979*264 754  95  968*
            ***      **      ***      **      ***     ***  *** *** *** ***  ***

36440 09/09*273 759 105    0*280 761 105    0*287 761 105    0*293 761 105    0*
36440 09/09*270 755  95    0*276 760  95    0*281 765 100    0*286 764 105    0*
            *** *** ***      *** *** ***      *** *** ***      *** ***

36445 09/10*298 761 105    0*306 761 105    0*317 761 105    0*330 758 105    0*
36445 09/10*296 762 105    0*304 761 105    0*315 759 105    0*327 756 105    0*
            *** ***          ***              *** ***          *** ***

36450 09/11*345 753 105    0*360 744 100    0*380 730  90    0*412 708  80    0*
36450 09/11*340 750 110  943*360 738 110    0*383 725 110    0*413 707 105  948*
            *** *** ***  ***     *** ***      *** *** ***      *** *** ***  ***

36455 09/12E449 679  65    0E489 638  60    0E524 605  55    0E543 591  50    0*
36455 09/12E447 675  70    0E487 640  60    0E524 605  60    0E545 580  60    0*
            *** ***  **      *** ***                 **      *** ***  **

36460 09/13E555 577  45    0E569 561  40    0E580 545  40    0E584 524  35    0*
36460 09/13E563 565  60    0E579 555  60    0E590 545  60    0E595 530  60    0*
            *** ***  **      *** ***  **      ***     **      *** ***  **

36465 09/14E582 504  35    0E578 489  30    0E574 474  30    0E571 459  25    0*
36465 09/14E594 510  60    0E590 489  50    0*  0   0   0    0*  0   0   0    0*
            *** ***  **      ***      **     **** ***  **     **** ***  **

(The 15th is removed from HURDAT.)
36470 09/15E567 440  25    0E568 421  25    0*  0   0   0    0*  0   0   0    0*
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36475 HR     MA3         ME1
36475 HR NC1 MA3 NY1 RI1
         *** *** *** ***
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Landfalls:
11th/03Z - 35.0N 74.5W (closest point of approach) - 943 mb/110 kt -
15 nm RMW - 65 kt at NC coast
11th/18Z - 41.3N 70.7W - 948 mb/105 kt - 20 nm RMW
11th/19Z - 41.6N 70.5W - 950 mb/100 kt - 20 nm RMW
11th/2330Z - 44.6N 67.7W - Already extratropical - Winds at landfall 75 kt

Major changes to both the track and the intensity shown in McAdie et al. (2009). The system previously identified as Edna has been reanalyzed to instead be two separate tropical cyclones: a previously unrecognized tropical depression from September 1st to the 3rd and the main cyclone which instead formed on the 5th and became the hurricane that struck the United States. Evidence for these alterations comes from the Historical Weather Map series, Monthly Weather Review, daily Surface Weather Observations from NCDC, U.S. Weather Bureau six hourly maps available via microfilm at NHC, aircraft observations available from the Storm Wallets at NHC, the COADS ship database, Rhodes (1954), Dunn and Miller (1960), Schwerdt et al. (1979), Ho et al. (1987), Jarrell et al. (1992), and Boose et al. (2001).

September 1: HWM does not analyze a closed low in association with the system at 12 UTC on this day. Available observations indicate the formation of a 25 kt tropical depression (not pre-Edna) with a center located at 11.2N, 54.0W at 18 UTC on this day. HURDAT does not list a tropical depression in this area. Ship observations: no gales or low pressures reported on this day.

September 2: HWM does not analyze a closed low on this day. However, it does show a tropical wave along 51W from 15 to 25N. HURDAT listed a tropical depression with 25 kt winds with a center at 12.1N, 57.1W. Available observations suggest the tropical depression maintained its 25 kt wind speed as analyzed at on September 1 and is now located at 11.2N, 56.4W. Ship observations: no gales or low pressures reported on this day.

September 3: HWM analyzes a closed low associated with the new tropical depression with a pressure of at most 1010 mb and a center at 10.0N, 62.5W. HWM also shows a tropical wave along 57W from 17N to 27N. HURDAT listed a 25 kt tropical depression with a center at 16.4N, 59.2W.

Available observations indicate a single 25 kt tropical depression (not pre-Edna) with a center at 11.2N, 62.5W. No closed circulation is in the vicinity of the supposed

HURDAT pre-Edna depression location. Ship observations: no gales or low pressures reported on this day.

September 4: HWM analyzes a weak low near 13.5N, 68W. HWM also shows a tropical wave along 65W from 17N to 26W. HURDAT listed a 35 kt tropical storm (Edna) with a center at 19.3N, 62.8W. Available observations suggest the system tracked in HURDAT is not a closed low, but is an open wave. It is also analyzed that the (new) tropical depression dissipated around 06-12 UTC on the 4th in the vicinity of 11N, 65W. Ship observations: no gales or low pressures reported on this day.

September 5: HWM analyzes a closed low of at most 1010 mb at 13.5N, 72W and a tropical wave along 68W from 15N to 26W including a show a tropical storm symbol with a center at 19.2N, 68.5W. HURDAT listed this as a 35 kt tropical storm with a center at 20.9N, 66.9W. Available observations do suggest development of a 35 kt tropical storm with a center at 20.9N, 67.2W at 12 UTC on this day. Ship observations: 45 kt at 2100 UTC at 22.5N, 67.7W (MWR). September 1954 MWR:

"The first indication of an apparently closed circulation that subsequently became Edna was noted the night of September 5, in the extreme southwestern Atlantic between Puerto Rico and the Bahama Islands. Some forewarning of the possible formation of a tropical storm was given by a 2100 GMT, September 5 ship report from a position near 22.5N, 67.7W. This report from the Bulk Oil stated that she was encountering very heavy squalls, winds to 50 mph, with gusts to 70 mph, and rapidly falling barometer (MWR)"

September 6: HWM analyzes a closed low and a tropical storm of at most 1000 mb with a center at 21.8N, 69.5W. HURDAT listed this as a 50 kt tropical storm centered at 21.5N, 69.4W. The MWR Tracks of Centers of Cyclones (Chart X) places the center at 21.3N, 68.3W at 0 UTC on this day. The MWR Tracks of Centers of Cyclones (Chart X) places the center at 21.3N, 69.1W with a central pressure of 1006 mb at 12 UTC on this day. Figure 1 from the September 1954 issue of the Monthly Weather Review also places the center of the circulation at 22.0N, 69.3W at 12 UTC on this day. Available observations suggest a 50 kt tropical storm is present on this day with a center at 21.5N, 70.5W at 12 UTC on this day. Ship observations: 45 kt S at 18 UTC at 22.0N, 69.3W (COA ship # 77942); a few other gales of 35 and 40 kt reported throughout the day; no low pressures reported on this day. "Hurricane Edna formed in an easterly wave on the afternoon of September 6 near 22N, 70W, and increased to hurricane intensity during the night (MWR)"

September 7: HWM analyzes a closed low of at most 1005 mb centered near 23.3N, 72.3W. HURDAT listed this as a 70 kt category 1 hurricane at 23.0N, 72.2W. The MWR Tracks of Centers of Cyclones places the center at 22.0N, 70.7W at 0 UTC on this

day. The MWR Tracks of Centers of Cyclones (Chart X) places the center at 22.5N, 72.6W with a central pressure of 1002 mb at 12 UTC on this day. Figure 1 from the September 1954 issue of the Monthly Weather Review places a center of circulation at 23.5N, 72.8W at 12 UTC on this day. Available observations suggest a 55 kt tropical storm is present on this day with a center located at 23.0N, 70.5W at 12 UTC on this day. Aircraft Reconnaissance: 23.2N, 73.3W at 1443 UTC with 1001 mb central pressure and 85 kt estimated winds; 23.8N, 73.8W at 2000 UTC with 992 mb central pressure and 100 kt estimate winds; 23.8N, 73.8W at 2030 UTC with 990 mb central pressure and 100 kt estimated winds (NHC). Ship observations: 1002 mb and 65 kt NE at 18 UTC at 24.2N, 74.2W (COA ship # 00473); 45 kt ESE at 0 UTC at 22.9N, 68.9W (COA ship # 03981); 1004 mb at 12 UTC at 20.1N, 75.2W (HWM); a few other gales of 35 and 40 kt reported throughout the day. December 1954 MWR: "During the 7th and 8th it swept the outer Bahama Islands as it moved on a broad curving path northward. The center very close to San Salvador Island, Bahamas, late on the 7th where winds were up to hurricane force in gusts, but no appreciable wind damage resulted."

September 8: HWM analyzes a closed low of at most 1000 mb centered near 25.5N, 75.5W. HURDAT listed this as a 100 kt category 3 hurricanes at 25.9N, 75.2W. The MWR Tracks of Centers of Cyclones (Chart X) places the center at 24.0N, 74.0W at 0 UTC on this day. The MWR Tracks of Centers of Cyclones (Chart X) places the center at 25.3N, 75.1W with a central pressure of 991 mb at 12 UTC on this day. Figure 1 from the September 1954 issue of the Monthly Weather Review places a center of circulation at 25.7N, 75.3W at 12 UTC on this day. Available observations suggest an 85 kt category 2 hurricane centered at 23.3N, 75.2W at 12 UTC on this day. Aircraft Reconnaissance: Several radar fixes early on the 8th. 25.9N, 75.4W at 1413 UTC with 979 mb central pressure and 70 kt estimated wind; 26.4N,75.4W at 1934 UTC with 968 mb central pressure and 75 kt estimated wind (NHC). Ship observations: 975 mb mb and 120 kt at 16 UTC at 26.5N 75.5W (Rhodes); 997 mb and 70 kt NE at 12 UTC at 26.2N, 76.0W; 992 mb and 65 kt at 18 UTC at 25.9N, 75.7W (COADS); a few other gales of 35 and 40 kt reported throughout the day.

September 9: HWM analyzes a closed low of at most 995 mb centered near 28.7N, 76.2W. HURDAT listed this as a 105 kt category 3 hurricane at 28.7N, 76.1W. The MWR Tracks of Centers of Cyclones (Chart X) places the center at 26.9N, 75.7W at 0 UTC on this day. The MWR Tracks of Centers of Cyclones (Chart X) places the center at 28.2N, 76.5W with a central pressure of 978 mb at 12 UTC on this day. Figure 1 from the September 1954 issue of the Monthly Weather Review places a center of circulation at 28.8N, 76.9W at 12 UTC on this day. Available observations suggest a 100 kt Category 3 hurricane with a center at 28.5N, 76.8W at 12 UTC on this day. Ship observations: 50 kt N at 18 UTC at 28.3N, 79.8W (COA ship # 57111); a few gales of 35

kt reported throughout the day. Land observations: 999 mb at 2330 UTC at 36.1N, 76.6W (SWO Edenton, NC). December 1954 MWR: "During the 9th and 10th the storm moved northward very near the 76th meridian and gradually turned to the north-northeast closely paralleling Carols path 11 days earlier. It passed just east of Cape Hatteras early in the night of the 10th and winds of about 75 mph were felt on the North Carolina Capes from Cape Lookout to Manteo."

September 10: HWM analyzes a closed low of at most 990 mb centered near 31.1N, 75.8W. HURDAT listed this as a 105 kt category 3 hurricane at 31.7N, 76.1W. The MWR Tracks of Centers of Cyclones (Chart X) places the center at 29.5N, 76.1W at 0 UTC on this day. The MWR Tracks of Centers of Cyclones (Chart X) places the center at 31.2N, 75.9W with a central pressure of 980 mb at 12 UTC on this day. Figure 1 from the September 1954 issue of the Monthly Weather Review places a center of circulation at 31.3N, 76.0W at 12 UTC on this day. Available observations suggest a 105 kt Category 3 hurricane with a center at 31.5N, 75.9W at 12 UTC on this day. Ship observations: 60 kt SSE at 6 UTC at 28.2N, 72.7W (COA ship # 63001); 992 mb and 65 kt SE at 18 UTC at 33.0N, 73.5W (COA ship # 62061); a few other gales of 35 and 40 kt reported throughout the day. Land observations: 991 mb at 2224 UTC at 35.3N, 75.6W (SWO Hatteras, NC); 987 mb at 2230 UTC at 34.3N, 77.9W (SWO - Wilmington, NC). September 1954 Climatological Data National Summary (coastal North Carolina area): Storm center offshore; damage minor, but widespread. TV aerials, roofs, and piers damaged along most of coastline. Section of Outer Banks Highway washed out. Corn crop damaged 2 or 3 percent over large area.

September 11: HWM analyzes a closed low of at most 970 mb centered near 38.5N, 72.5W. HURDAT listed this as a 90 kt category 2 hurricane at 38.0N, 73.0W. The MWR Tracks of Centers of Cyclones (Chart X) places the center at 34.0N, 75.0W at 0 UTC on this day. The MWR Tracks of Centers of Cyclones (Chart X) places the center at 38.1N, 72.1W with a central pressure of 978 mb at 12 UTC on this day. Figure 1 from the September 1954 issue of the Monthly Weather Review places a center of circulation at 38.5N, 72.3W at 12 UTC on this day. Available observations suggest a 110 kt Category 3 hurricane with a center at 38.3N, 72.5W at 12 UTC on this day. Aircraft reconnaissance: 943 mb at 34.0N, 75.6W around 00 UTC; 947 mb at 39.7N, 71.3W around 15 UTC (Ho). Ship observations: 80 kt NW at 0 UTC at 30.4N, 76.5W (COA ship # 08342); 90 kt NNW at 6 UTC at 36.5N, 75.3W (COA ship # 1775); 982 mb and 70 kt S at 0 UTC at 32.3N, 74.5W (COA ship # 62061); 979 mb and 52 kt SE at 12 UTC at 38.5N, 71.1W (HWM). Land observations: 65 kt at Manteo, NC (Rhodes); 65 kt at Cape Lookout, NC (Rhodes); 983 mb at 0324 UTC and 49 kt NW at 0335 UTC at 35.3N, 75.6W (SWO Hatteras, NC); 83 kt at Brookhaven National Laboratory, Long Island, NY (MWR); 76 kt at 1930 UTC and 969 mb at 18 UTC at Block Island, RI (SWO); 954 mb

and 52 kt SSE at 1826 UTC at 41.3N, 70.1W (SWO Nantucket). December 1954 MWR: "It moved rapidly northeastward and passed over Cape Cod on the 11th." September 1954 Climatological Data National Summary (New Jersey shore and adjacent areas): "Some damage extending from Cape May County in South to Raritan Bay In north. Losses mostly minor, but totaling considerable sum. Estimate of damage includes estimated amount of damage by flooding of $15,000 in Newark and Elizabeth suburbs from heavy rains. Gale winds and heavy rains (some were 5 inches) a hurricane moved northeasterly, approximately 125 miles off New Jersey shore. Deaths due to traffic accidents, in which storm believed to have been contributing factor." September 1954 Climatological Data National Summary (New England southeaster and coastal sections): "Hurricane struck New England a glancing blow. Its center crossed Martha's Vineyard and Cape Cod shortly after 1 p.m. From then until it passed south and east of Eastport, Me., its course was northeastward, offshore and fairly parallel to New England east coast. Thus nearly all of New England (except Cape Cod and Islands to south). Being on west or north side of center was spared worst of storm with respect to wind force; highest speeds there came with Edna's" backlash, in gusts up to 93 m.p.h. In southern Rhode Island and up to 92 m.p.h. over central Maine coast. Gust speeds above 100 m.p.h. recorded at Martha's Vineyard and over outer Cape Cod. Attendant rainfall was of near-record intensity, measuring 4 to 8 Inches over coastal areas and southeast. Widespread floods and washouts produced by these excessive rains caused more damage then that produced by winds. Radar reports in afternoon of 11th indicated that hurricane had 2 'eyes' about 60 miles apart." September 1954 Climatological Data National Summary (Long Island, New York): "Hurricane winds which attained velocity of 95 m.p.h at Brookhaven National Laboratory swept Long Island where trees were blown down, numerous buildings. Many Small craft sunk, particularly on North Shore Highways and railroads washed out in places by high seas while benches seriously eroded. In Suffolk County, heavy rain washed potato tubers from soil so they were damaged by exposure to sun while other vegetable crops sustained substantial injuries."

September 12: HWM analyzes a closed extratropical low of at most 980 mb centered near 52.0N, 59.9W. HURDAT listed this as a 55 kt extratropical storm at 52.4N, 60.5W. The MWR Tracks of Centers of Cyclones (Chart X) places the center at 44.5N, 68.9W at 0 UTC on this day. The MWR Tracks of Centers of Cyclones (Chart X) places the center at 52.5N, 60.1W with a central pressure of 978 mb at 12 UTC on this day. Figure 1 from the September 1954 issue of the Monthly Weather Review places a center of circulation at 52.5N, 60.8W at 12 UTC on this day. Available observations suggest a 60 kt extratropical storm with a center at 52.4N, 60.5W at 12 UTC on this day. Land observations: 987 mb at 0 UTC at 45.5N, 69.6W (SWO Greenville, ME); 975 mb and 50 kt NNW at 0028 UTC at 44.8N, 66.8W (SWO Dow AFB, ME); 976 mb at 0228 UTC at 46.1N, 67.8W (SWO Houlton, ME). Ship observations: 992 mb at 21 UTC at 56.5N,

51.0W (COA ship # 07024); 997 mb and 45 kt at 0 UTC at 40.8N, 68.8W (COA ship # 309 7740).

September 13: HWM analyzes a closed extratropical low of at most 985 mb centered near 59.5N, 53.5W. HURDAT listed this as a 40 kt extratropical storm at 58.0N, 54.5W. The MWR Tracks of Centers of Cyclones (Chart X) places the center at 56.2N, 57.0W at 0 UTC on this day. The MWR Tracks of Centers of Cyclones (Chart X) places the center at 58.1N, 52.8W with a central pressure of 980 mb at 12 UTC on this day. Figure 1 from the September 1954 issue of the Monthly Weather Review places a center of circulation at 59.1N, 54.1W at 12 UTC on this day. Available observations suggest a 60 kt extratropical storm with a center at 59.0N, 54.5W at 12 UTC on this day. Ship observations: 988 mb at 0 UTC at 56.5N, 51.0W; 990 mb at 12 UTC at 62.0N, 49.0W (COA ship # 07024); 995 mb and 60 kt at 21 UTC at 56.5N, 51.0W (COA ship # 07024).

September 14: HWM analyzes a closed extratropical low of at most 995 mb centered near 57.3N, 47.9W. HURDAT listed this as a 30 kt extratropical storm at 57.4N, 47.4W. The MWR Tracks of Centers of Cyclones (Chart X) places the center at 59.2N, 50.1W at 0 UTC on this day. The MWR Tracks of Centers of Cyclones (Chart X) places the center at 56.8N, 46.5W with a central pressure of 989 mb at 12 UTC on this day. Available observations suggest a 50 kt extratropical storm with a center at 59.0N, 58.9W at 06 UTC on this day. Available observations also suggest that the extratropical storm is no longer closed at 12 UTC on this day. Ship observations: 993 mb and 60 kt WSW at 3 UTC at 57.5N, 51.5W (COA ship # 07024); 995 mb and 50 kt WSW at 0 UTC at 57.5N, 51.5W (COA ship # 07024).

September 15: The MWR Tracks of Centers of Cyclones (Chart X) places the center at 56.7N, 43.2W at 12 UTC on this day. Available observations do not suggest the presence of a closed low in this vicinity on this day. Ship observations: 988 mb at 0 UTC at 62.0N, 33.1W (COA ship # 014); 983 mb at 0 UTC at 55.0N, 30.0W (COA ship # 307 7858); 985 mb at 6 UTC at 59.5N, 33.9W (COA ship # 309 7858).

Observations clearly indicate that the system currently in HURDAT for Edna was instead two separate tropical cyclones. The first system formed around 18 UTC on the 1st, moved westward, passed close to the coasts of Trinidad and Venezuela on the 3rd, and dissipated around 06-12 UTC on the 4th. The system that became Edna is first seen as a tropical wave along 51W on the 2nd. It continued moving westward with little change until the 5th. By late on the 5th, the system became a tropical storm.

This major change from HURDAT is supported by rather abundant surface observations, the Historical Weather Map analysis, and the Monthly Weather Review's summary. The remaining track changes for this hurricane are minor. The intensity is slightly increased

late on the 5th and early on the 6th to account for observations from the Bulk Oil ship. The first aircraft reconnaissance to investigate the cyclone found 1001 mb central pressure, 28 nm eye, and 85 kt winds at 1433 UTC on the 7th. However, because of the crude instrumentation of the era for the Navy reconnaissance aircraft, these winds are likely not reliable. At 20 UTC on the 7th the pressure dropped to 992 mb and further down to 990 mb at 2030 UTC. These pressures suggest intensity of 45, 61 and 64 kt, respectively, from the Brown et al. south of 25N pressure-wind relationship. Additionally, a ship reported 65 kt winds at 18 UTC on the 7th. Thus intensities in HURDAT reduced down from 70 kt to 55 kt at 12 UTC, 70 kt to 65 kt at 18 UTC, and 75 kt to 70 kt at 00 UTC on the 8th. The next aircraft reconnaissance to provide a central pressure was 979 mb at 1413 UTC on the 8th with a 15 nm eye. This suggests maximum winds of 79 kt from the south of 25N and 74 kt from the north of 25N Brown et al. pressure-wind relationships (and 80 and 78 kt from the subset of intensifying cyclones, respectively). 85 kt chosen for HURDAT at 12 UTC (down from 100 kt originally) because of the small eye size. At 1934 UTC on the 8th aircraft reconnaissance measured 968 mb central pressure with a circular 12 nm eye. 968 mb suggests maximum winds of 87 kt from the north of 25N pressure-wind relationship (91 kt for the subset of intensifying cyclones). 95 kt (down from 105 kt originally) chosen for HURDAT at 18 UTC because of the small eye size. These two aircraft-measured central pressures were corroborated by a ship that measured 975 mb at 16 UTC, in between the 979 and 968 mb values. As was typical of the 1950s, there were only two additional hurricane penetrations from aircraft reconnaissance even though it remained off of the U.S. Atlantic coast for three more days. No ship or coastal stations reported hurricane force winds (or equivalent in pressure) from late on the 8th to late on the 10th. Thus it is relatively unknown how intense Edna was on these dates. Aircraft reconnaissance did measure 943 mb central pressure and a 15 nm eye around 00 UTC on the 11th. This pressure suggests maximum wind of 112 kt from the Brown et al. north of 25N and 101 kt from the Landsea et al. north of 35N pressure-wind relationships. 110 kt chosen at 00 UTC on the 11th (up slightly from 105 kt) because of the small eye size. Winds on the 9th and 10th are interpolated between the 1934 UTC September 8th and 00 UTC September 11th reconnaissance-based estimates, which made for slight reductions on the 9th and no changes on the 10th. Two locations in North Carolina - Mateo and Cape Lookout - observed minimal 1-min hurricane force winds. Thus Edna is revised to be considered Category 1 impact in North Carolina, as it bypassed the coast by about 60-75 nm. After passing North Carolina, the hurricane accelerated while moving north-northeast. A final reconnaissance penetration occurred around 15 UTC on the 11th and gave a 947 mb central pressure.

The hurricane made landfall first on Martha's Vineyard, MA around 18 UTC on the 11th and a second landfall around 19 UTC just west of Hyannis, MA. Lowest observed sea level pressure from a land station was 954 mb at Nantucket at 1826 UTC while the wind was blowing 52 kt SSE. Thus it is estimated that the first landfall was with a central pressure of 948 mb (just slightly higher than measured by reconn three hours earlier) and 950 mb at the second landfall. These pressures suggest intensities of 98 and 97 kt from the north of 35N pressure-wind relationship. Given the small RMW of 20 nm and translational velocity of about 35 kt at landfall, maximum 1 min surface winds are estimated at 105 and 100 kt at the first and second landfall. Massachusetts is retained as Category 3 impact and New York and Rhode Island are added as Category 1 impact based upon observed hurricane force sustained winds in both states. After landfall in Massachusetts, Edna moved back over the Atlantic Ocean for about 5 hours before making a final landfall in Maine at 2330 UTC on the 11th. Based upon available observations, Edna had transformed into a strong extratropical cyclone by 00 UTC on the 12th (as well as at landfall a half an hour earlier). Thus Maine is removed as having a Category 1 hurricane impact, though maximum 1 min winds at Maine landfall were about 75 kt. Winds during the 12th to the 14th were increased in its extratropical phase from observed ship observations. Edna's final position is now given as 06 UTC on the 14th, as observations and HWM analyses suggest that it had dissipated by 12 UTC on the 14th. Thus positions through 06 UTC on the 15th are removed.

Tropical Storm Florence [September 10-12, 1954]

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37660 09/11/1954 M= 2  6 SNBR= 829 FLORENCE    XING=0 SSS=0
37660 09/10/1954 M= 3  9 SNBR= 829 FLORENCE    XING=0 SSS=0
         **         *  *

(The 10th is new to HURDAT.)
37662 09/10*  0   0   0    0*  0   0   0    0*225 945  30    0*225 948  35    0*
                                            *** ***  **      *** ***  **

37665 09/11*  0   0   0    0*209 947  45    0*210 951  50    0*210 955  55    0*
37665 09/11*224 950  45    0*223 952  45    0*220 953  45    0*215 955  45    0*
           *** ***  **      *** ***  **      *** ***  **      ***       **

37670 09/12*208 959  65    0*205 963  65    0*203 968  35    0*198 974  20    0*
37670 09/12*210 959  45 1001*206 964  45    0*204 970  45    0*202 978  25    0*
           ***       ** **** *** ***  **      *** ***  **      *** ***  **

37675 HR
37675 TS
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Minor changes to the track, but major alterations to the intensity shown in McAdie et al. (2009). Evidence for these alterations comes from the NHC microfilm maps, the

Historical Weather Maps series, the COADS ship database, the Navy aircraft reconnaissance book, and Monthly Weather Review.

September 10:

HWM and HURDAT do not analyze a tropical system. Microfilm shows a possible low pressure near 22.5N, 94.0W at 12Z. Ship highlights: 30 kt E and 1012 mb at 6Z near 24.0N, 90.0W (COADS). Aircraft highlights: "No wind circulation found, max wind in squall 60º 25 kt, heavy rain band located 23N, between 91.3W and 94.4W, 60 miles wide. Scattered cumulus along track, much high cirrus, overcast sky most of track west of 85W." (NAVY)

September 11:

HWM analyzes a tropical storm located near 22.5N, 95.2W. HURDAT lists this as a 50 kt tropical storm at 21.0N, 95.1W at 12Z. Microfilm shows this system centered near 22.0N, 94.2W at 12Z. Ship highlights: 35 kt NE and 1009 mb at 0Z near 23.0N, 95.3W (COADS). 45 kt ESE and 1012 mb at 01Z near 22.8N, 89.7W (micro), possible error and the longitude was likely 94.7W. Aircraft highlights: center fix at 2155Z at 21.2N, 95.8W, the measured central pressure was 1001 mb and 60 kt winds in the southwest quadrant, eye diameter was 50 miles. "Poorly defined … turbulence moderate to heavy, seas high to very high close to eye. "(NAVY)

September 12:

HWM analyzes a tropical storm of at most 1005 mb located near 20.5N, 96.5W. HURDAT lists this as a 35 kt tropical storm at 20.3N, 96.8W AT 12Z. Microfilm analyzes a closed low of at most 1005 mb at 20.4N, 96.8W at 12Z. No gale winds.

"This storm formed in the southwestern Gulf of Mexico and moved into Mexico between Tuxpan and Nautla on the morning of September 12. The highest wind reported by reconnaissance aircraft was about 65 mph. The press reported 5 dead and more than $1,500,000 damage around the oil center of Poza Rica, mostly to the banana crop. The storm was possibly of hurricane force as it hit the coast."

Genesis for Florence is begun as a tropical depression at 12Z on the 10th, 18 hours earlier than shown in HURDAT originally. The reason for the earlier genesis is due to indications that a closed low existed by 12Z on the 10th, as well as the system being very well developed with two gale force ship winds around 00z on the 11th. One aircraft reconnaissance mission was flown on the 10th but remained northwest of the tropical cyclone and did not sample near the center. The revised track has only minor

modifications for the lifetime of this system. The upgrade to tropical storm occurred at 18Z on the 10th, six hours earlier than shown in HURDAT due to a 35 kt NE ship at 00Z and a 45 kt ESE ship at 01Z on the 11th. An aircraft reconnaissance mission was flown on the 11th measuring 1001 mb central pressure at 2155Z. This central pressure is added to HURDAT at 00Z on the 12th. This pressure suggests maximum winds of 45 kt from the south of 25N Brown et al. pressure-wind relationship. The aircraft also measured a RMW of 35-40 nmi, which is larger than climatology of 18 nm for this latitude and central pressure. Given this information, the intensity is kept at 45 kt until landfall on the 12th. This is a large reduction from 65 kt in HURDAT originally at 00Z and 06Z on the 12th. This reduction also means that Florence is downgraded from a hurricane to a tropical storm for peak intensity. Aircraft reconnaissance on the 12th arrived in the vicinity of the cyclone around 14Z and indicated that Florence had either moved inland and/or degenerated into an area of squally weather. After making landfall in Veracruz, Mexico on the 12th at 11Z near 20.4N 96.8W, the system quickly dissipated over the mountainous terrain. Dissipation after 18Z on the 12th is unchanged.

Tropical Storm Gilda [September 24-30, 1954]

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37680 09/24/1954 M= 4  7 SNBR= 830 GILDA       XING=0 SSS=0
37680 09/24/1954 M= 7 10 SNBR= 830 GILDA       XING=0 SSS=0
                    * **

37685 09/24*  0   0   0    0*  0   0   0    0*  0   0   0    0*141 768  35    0*
37685 09/24*  0   0   0    0*  0   0   0    0*  0   0   0    0*141 758  35    0*
                                                              ***

37690 09/25*143 777  40    0*144 788  45    0*146 800  50    0*149 811  50    0*
37690 09/25*143 769  35    0*144 782  40    0*146 796  40    0*149 814  40    0*
                ***  **          ***  **          ***  **          ***  **

37695 09/26*153 821  55    0*159 835  60    0*164 847  60    0*165 855  60    0*
37695 09/26*155 830  45    0*160 842  45    0*163 852  50    0*165 860  50    0*
              *** ***  **      *** ***  **      *** ***  **          ***  **

37700 09/27*165 863  60    0*166 872  60    0*168 880  60    0*169 888  35    0*
37700 09/27*166 868  55  998*166 872  55    0*166 878  55    0*167 886  55    0*
              *** ***  **  ***          **      *** ***  **      *** ***  **

(The 28th,29th and 30th are new to HURDAT.)
37701 09/28*169 892  45    0*174 896  35    0*180 902  30    0*186 908  35    0*
37702 09/29*192 915  30    0*197 925  30    0*200 939  30    0*203 954  30    0*
37703 09/30*208 968  30    0*217 980  25    0*000 000  00    0*000 000  00    0*
37705 TS
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Minor changes to the track, but major alterations to the intensity shown in McAdie et al. (2009). Three additional days are added to the end of this cyclone. Evidence for these alterations comes from the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, the Navy aircraft reconnaissance book, and Monthly Weather Review.

September 23:

HWM analyzes a low pressure of at most 1010 mb located near 15.8N, 83.5W.HURDAT and microfilm does not analyze a tropical system. No gales or low pressures.

September 24:

HWM analyzes a low pressure of at most 1010 mb located near 15.5N, 82.5W. HURDAT lists this as a 35 kt tropical storm at 14.1N, 76.8W at 18Z. Microfilm shows this system centered near 13.0N, 79.6W at 18Z. Ship highlights: 30 kt ESE and 1010 mb at 18Z near 15.3N, 73.6W. All observations from COADS.

September 25:

HWM analyzes a low pressure located near 14.7N, 79.5W. HURDAT lists this as a 45 kt tropical storm at 14.6N, 80.0W AT 12Z. Microfilm analyzes a low pressure at 13.6N, 81.7W at 12Z. Ship highlights: 30 kt ESE and 1010 mb at 0Z near 14.6N, 72.5W. 30 kt ENE and 1011 mb at 18Z near 19.1N, 78.4W. All observations from COADS. “Small tropical storm Gilda formed in the Caribbean Sea east of Cape Gracias, Nicaragua on September 25” (MWR).

September 26:

HWM analyzes a tropical storm of at most 1005 mb located near 16.0N, 85.3W. HURDAT lists this as a 60 kt tropical storm at 16.4N, 84.7W AT 12Z. Microfilm analyzes a closed low pressure of at most 1002 mb at 16.2N, 84.7W at 12Z. Ship highlights: 25 kt E and 1008 mb at 12Z near 17.3N, 84.0W (MICRO). 35 kt E and 1012 mb at 18Z near 19.6N, 86.2W (COADS). 30 kt SE and 1010 mb at 18Z near 18.4N, 83.0W (COADS). 40 kt SE and 1009 mb at 21Z near 20.0N, 85.8W (MICRO). 35 kt E and 1012 mb at 23Z near 19.5N, 86.1W (MICRO). Ship highlights: 5 kt WNW and 1003 mb at 00Z in Cabo Gracias a Dios, Honduras. 50 kt E at 15Z in Guanaja, Honduras. Aircraft highlights: center fix at 2240Z at 16.7N, 86.6W, the measured central pressure was 998 mb, 45 kt winds and an eye diameter of 20 miles. (NAVY)

September 27:

HWM analyzes a tropical storm of at most 1005 mb located near 16.8N, 87.2W. HURDAT lists this as a 60 kt tropical storm of at most 1002 mb at 16.8N, 88.0W AT 12Z. Microfilm analyzes a tropical storm at 16.4N, 87.9W at 12Z. Ship highlights: 30 kt SE and 1007 mb at 18Z near 17.6N, 86.1W (COADS). Land highlight: 5 kt SW and 1004 mb at 00Z in Tela, Honduras. 10 kt NNE and 1006 mb at 0Z in Belize City, Belize. 10 kt N and 1006 mb at 06Z in Belize City, Belize. 30 kt S and 1005 mb at 12Z in Tela,

Honduras. 20 kt NE and 1005 mb at 12Z in Dandriga, Belize. 10 kt NE and 1006 mb at 12Z in Belize City, Belize. 25 kt NE and 1002 mb at 18Z in Dandriga, Belize. All observations from the Microfilm. "…moved westward along the north coast of Honduras and into British Honduras near Stann Creek, about 60 miles south of Belize, around 1530 EST of the 27th. The storm was less than hurricane force throughout its life, with highest winds of 60 to 70 mph in squalls. Damage was slight to buildings and no casualties resulted from the storm. Rainfall was very heavy in northern Honduras, resulting in disastrous floods, especially around San Pedro Sula, La Lima, and the adjacent valley areas. Press reports indicated 29 dead and thousands homeless and marooned in the flooded areas, and extensive damage to property and crops." (MWR)

September 28:

HWM analyzes a low pressure of at most 1005 mb located near 16.5N, 90.0W. HURDAT does not list this system. Microfilm analyzes a low pressure of at most 1005 mb located near 16.8N, 89.8W at 12Z. Ship highlights: 30 kt SE and 1009 mb at 06Z near 18.2N, 86.3W (COADS). Land highlight: 25 kt S and 1007 mb at 12Z in Dandriga, Belize. 30 kt S and 1008 mb at 18Z in Dandriga, Belize. All observations from the Microfilm.

September 29:

HWM and microfilm does not analyze a low pressure. HURDAT does not list this system. Ship highlights: 10 kt ENE and 1003 mb at 00Z near 19.5N, 91.5W. Land highlight: 10 kt E and 1003 mb at 00Z in Campeche, Mexico. 10 kt NW and 1004 mb at 00Z in Isla del Carmen, Mexico. All observations from the Microfilm.

September 30:

HWM does not analyze a low pressure. Microfilm analyses a low pressure near 22.2N, 95.9W at 00Z. HURDAT does not list this system. Land highlight: 10 kt N and 1003 mb at 00Z in Tuxpan, Mexico. 10 kt SE and 1004 mb at 00Z in Veracruz, Mexico. 5 kt S and 1005 mb at 06Z in Tampico, Mexico. All observations from the Microfilm.

No changes are made to the genesis time for this tropical cyclone, which is retained as starting as a 35 kt tropical storm at 18Z on the 24th of September, as a 30 kt ESE ship was observed at that time. Minor track alterations were made for all four of the existing days of this cyclone. Intensity is reduced by 5-10 kt on the 25th, due to numerous ship and coastal stations indicating a somewhat weaker system on those dates. At 00Z on the 26th, a 1003 mb peripheral pressure with 5 kt WNW winds was measured at Cabo Gracias, Honduras. This suggests maximum winds of at least 41 kt from the south of 25N Brown et al. pressure-wind relationship. 45 kt is selected at that time for the

intensity, down from 55 kt previously. The cyclone continued westward just north of the Honduras coastline and 50 kt E winds were reported from Isla Guanaja around 16Z on the 26th. A single aircraft reconnaissance mission into this storm measured 998 mb central pressure and an RMW of about 15 nm at 2240Z on the 26th, which suggests maximum winds of 51 kt. Given the small size of the cyclone, intensity is analyzed to be 55 kt at 00Z on the 27th. This intensity is also the peak for the tropical storm, which previously was 60 kt. No further inner core observations were available until after landfall later that day in Belize. Landfall is analyzed to have occurred around 17Z on the 27th near 16.7N 88.4W, south of Belize City with an intensity of 55 kt (previously indicated in HURDAT to be 60 kt in the last synoptic time before landfall).

Previously in HURDAT, the cyclone was analyzed to have dissipated after 18Z on the 27th. However, numerous ship and land-based observations indicate that the system continued for three more days, albeit as a weak tropical cyclone. While inner core observations are sparse on the 28th after landfall, a reasonable weakening down to 45 k at 00Z on the 28th, 35 kt at 06Z, 30 kt at 12Z, and 30 kt at 18Z is assumed, which is in agreement with the 30 kt S wind observed at Belize City at 18Z. The cyclone moved toward the northwest on the 28th, across southeastern Mexico. By 00Z on the 29th, the system reached the Gulf of Mexico. Two observations – one ship and one land station – of 1003 mb both with 10 kt suggest maximum winds of at least 41 kt from the Brown et al. south of 25N pressure-wind relationship. Given the slow motion, low environmental pressures, and that the cyclone's circulation was still primarily overland, an intensity at that time of 30 kt analyzed. Unfortunately, little to no ship data were available for the remainder of the 29th and early on the 30th. However, observations from Veracruz, Tuxpan, and Tampico, Mexico indicate that the system made a second landfall just south of Tampico, around 04Z near 21.3N 97.6W. No tropical storm force winds were observed in the Gulf of Mexico or from the Mexican stations. However, Tuxpan measured 1003 mb with N 10 kt wind at 00Z, which suggests maximum wind from that pressure of at least 41 kt. Again because of the low environmental pressure, the intensity at 00Z and at landfall a few hours later is estimated to be 30 kt. However, it is quite possible that the system regained tropical storm intensity before the second landfall. After landfall, it is analyzed that the cyclone continued northwestward over Mexico and dissipated after 06Z on the 30th. The addition of three more days for the existence of this system is a major change.

Unnamed Hurricane 8 [September 25 - October 6, 1954]

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37710 09/25/1954 M=13  8 SNBR= 831 NOT NAMED   XING=0 SSS=0
37710 09/25/1954 M=12 11 SNBR= 831 NOT NAMED   XING=0 SSS=0
                    ** **

37715 09/25*  0   0   0    0*278 561  25    0*278 556  25    0*278 552  25    0*
37715 09/25*  0   0   0    0*292 565  25    0*290 560  25    0*288 555  25    0*
                            *** ***          *** ***          *** ***

37720 09/26*279 548  25    0*280 543  25    0*281 537  25    0*283 531  25    0*
37720 09/26*286 549  30    0*284 543  30    0*285 537  30    0*287 530  30    0*
            *** ***  **      ***       **      ***       **      *** ***  **

37725 09/27*285 524  25    0*289 518  25    0*293 513  25    0*295 510  25    0*
37725 09/27*291 523  30    0*296 516  30    0*298 510  30    0*299 507  30    0*
            *** ***  **      *** ***  **      *** ***  **      *** ***  **

37730 09/28*297 507  25    0*299 503  25    0*301 500  25    0*303 497  25    0*
37730 09/28*299 504  30    0*299 502  30    0*299 500  30    0*299 497  30    0*
            *** ***  **           ***  **      ***       **      ***       **

37735 09/29*306 494  25    0*309 491  30    0*312 487  30    0*316 484  35    0*
37735 09/29*299 494  30    0*299 491  30    0*300 487  30    0*302 486  35    0*
            *** ***  **      ***               ***               *** ***

37740 09/30*320 483  40    0*323 483  45    0*325 486  45    0*327 493  45    0*
37740 09/30*306 486  40    0*310 488  45    0*312 490  45    0*313 495  45    0*
            *** ***          *** ***          *** ***          *** ***

37745 10/01*328 499  50    0*328 505  55    0*326 512  60    0*319 520  60    0*
37745 10/01*314 503  50    0*315 512  55    0*315 520  60    0*314 528  65    0*
            *** ***          *** ***          *** ***          *** ***  **

37750 10/02*310 530  65    0*304 539  70    0*299 547  70    0*298 557  70    0*
37750 10/02*311 535  65    0*307 541  70    0*304 547  70    0*305 545  75    0*
            *** ***          *** ***          ***               *** ***  **

37755 10/03*297 566  70    0*305 570  70    0*313 565  70    0*322 556  70    0*
37755 10/03*307 556  75    0*311 559  75    0*315 560  75    0*318 557  75    0*
            *** ***  **      *** ***  **      *** ***  **      *** ***  **

37760 10/04*330 547  75    0*334 539  80    0*337 530  80    0*342 517  80    0*
37760 10/04*321 551  75    0*325 542  80    0*330 530  80    0*336 517  80    0*
            *** ***          *** ***          *** ***          ***

37765 10/05*347 501  80    0*352 491  85    0*358 478  85    0*371 444  85    0*
37765 10/05*343 503  80    0*351 489  85    0*360 475  85    0*370 453  85    0*
            *** ***          *** ***          *** ***          *** ***

37770 10/06*389 404  80    0*408 374  75    0*432 345  70    0E474 317  65    0*
37770 10/06*380 420  80    0*  0   0   0    0*  0   0   0    0*  0   0   0    0*
            *** ***          *** ***  **      *** ***  **      **** ***  **

(The 7th is removed from HURDAT.)
37775 10/07E542 290  60    0*  0   0   0    0*  0   0   0    0*  0   0   0    0*

37780 HR
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Minor changes to the track and intensity shown in McAdie et al. (2009). One major change to this system is to indicate dissipation 24 hours earlier than shown in HURDAT.

Evidence for these alterations comes from the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, and Monthly Weather Review.

September 24:

HWM analyzes a trough of low pressure extending from latitude 20N to 35N near longitude 54W. HURDAT does not list this system. Microfilm shows a low pressure near 32.0N, 64.5W at 18Z. Ship highlights: No gales or low pressures.

September 25:

HWM analyzes a low pressure of at most 1015 mb centered near 28.8N, 56.2W with a trough extending as well as a dissipating cold front to the system's northwest. HURDAT lists this as a 25 kt tropical depression at 27.8N, 55.6W at 12Z. Microfilm does not show an organized system. Ship highlights: No gales or low pressures.

September 26:

HWM analyzes a low pressure of at most 1015 mb centered near 28.5N, 53.0W. HURDAT lists this as a 25 kt tropical depression at 28.1N, 53.7W at 12Z. Microfilm shows a low pressure near 23.3N, 56.8. Ship highlights: 25 kt S and 1017 mb at 0Z near 27.9N, 51.3W. 15 kt SSW and 1015 mb at 06Z near 27.4N, 52.8W. 25 kt SW and 1017 mb at 06Z near 28.1N, 50.0W. All observations from COADS.

September 27:

HWM analyzes a low pressure of at most 1015 mb centered near 30.0N, 50.5W. HURDAT lists this as a 25 kt tropical depression at 29.3N, 51.3W at 12Z. Microfilm does not show an organized system. Ship highlights: 30 kt SE and 1014 mb at 12Z near 30.8N, 49.3W. 15 kt NW and 1014 mb at 12Z near 29.1N, 52.4W. All observations from COADS.

September 28:

HWM analyzes a low pressure centered near 29.8N, 51.5W. HURDAT lists this as a 25 kt tropical depression at 30.1N, 50.0W at 12Z. Microfilm does not show an organized system. Ship highlights: 25 kt ESE and 1014 mb at 0Z near 31.0N, 49.7W. 20 kt S and 1009 mb at 06Z near 29.5N, 49.5W. 20 kt NW and 1013 mb at 12Z near 28.8N, 50.9W. All observations from COADS.

September 29:

HWM analyzes a low pressure centered near 30.5N, 50.6W. HURDAT lists this as a 30 kt tropical depression at 31.2N, 48.7W at 12Z. Microfilm does not show an

organized system. Ship highlights: 30 kt SE and 1009 mb at 06Z near 29.0N, 47.0W. 30 kt NW and 1010 mb at 12Z near 29.0N, 48.0W. 20 kt W and 1013 mb at 18Z near 28.0N, 48.0W. All observations from COADS.

September 30:

HWM analyzes a low pressure of at most 1010 mb centered near 31.4N, 49.2W. HURDAT lists this as a 45 kt tropical storm at 32.5N, 48.6W at 12Z. Microfilm shows a low pressure of at most 1017 mb near 32.5N, 47.5W. Ship highlights: 25 kt NE and 1016 mb at 12Z near 33.6N, 49.7W. 5 kt W and 1011 mb at 18Z near 29.9N, 49.5. All observations from COADS.

October 1:

HWM analyzes a low pressure of at most 1005 mb centered near 32.5N, 52.0W. HURDAT lists this as a 60 kt tropical storm at 32.6N, 51.2W at 12Z. Microfilm shows a low pressure of at most 996 mb near 32.3N, 51.6W. MWR analyzes a low pressure near 32.8N, 52.0W. Ship highlights: 35 kt E and 1005 mb at 06Z near 32.3N, 50.1W (COADS). 40 kt NW and 999 mb at 12Z near 31.5N, 53.0W (MICRO). 30 SE kt and 1002 mb at 12Z near 31.7N, 51.1W (COADS). 35 kt WSW and 1013 mb at 12Z near 29.7N, 51.4W (COADS). 40 kt ESE and 996 mb at 17Z near 31.0N, 51.5W (MICRO). 60 kt NW at 18Z near 31.6N, 53.6W (COADS). 35 kt WSW and 1005 mb at 18Z near 30.4N, 52.9W (COADS). 50 kt SE and 992 mb at 18Z near 31.1N, 52.2W (COADS).

October 2:

HWM analyzes a low pressure of at most 1000 mb centered near 30.7N, 54.9W. HURDAT lists this as a 70 kt hurricane at 29.9N, 54.7W at 12Z. Microfilm shows a low pressure of at most 999 mb near 29.6N, 54.3W. MWR analyzes a low pressure near 28.8N, 54.2W. Ship highlights: 55 kt ESE and 990 mb at 0Z near 31.7N, 53.2W. 45 kt SE and 998 mb at 0Z near 30.5N, 52.7W. 55 kt WSW and 1000 mb at 06Z near 30.2N, 53.7W. 50 kt SE and 994 mb at 06Z near 30.0N, 53.1W. 30 kt W and 1001 mb at 06Z near 29.5N, 55.0W. 55 kt SW and 1001 mb at 12Z near 30.0N, 54.2W. 35 kt SW and 1008 mb at 12Z near 29.4N, 54.0W. 50 kt SE and 989 mb at 12Z near 29.4N, 53.8W. 40 kt SW and 1006 mb at 18Z near 29.0N, 54.9W. 55 kt S and 986 mb at 18Z near 29.2N, 54.3W. 35 kt SW and 1009 mb at 18Z near 29.8N, 52.9W. All observations from COADS.

October 3:

HWM analyzes a low pressure of at most 1000 mb centered near 31.8N, 55.7W. HURDAT lists this as a 70 kt hurricane at 31.3N, 56.5W at 12Z. Microfilm shows a low

pressure of at most 1011 mb near 33.8N, 56.0W. MWR analyzes a low pressure near 30.5N, 56.8W. Ship highlights: 35 kt SW and 1007 mb at 0Z near 29.6N, 56.3W. 55 kt S and 996 mb at 0Z near 28.8N, 54.1W. 30 kt SE and 1014 mb at 0Z near 31.8N, 53.9W. 40 kt SSW and 1003 mb at 06Z near 28.5N, 54.2W. 30 kt WNW and 1010 mb at 12Z near 29.8N, 57.2W. 30 kt SW and 1009 mb at 12Z near 28.1N, 54.7W. 45 kt NE and 1008 mb at 12Z near 32.9N, 56.9W. 30 kt SW and 1011 mb at 18Z near 28.8N, 55.5W. All observations from COADS.

October 4:

HWM analyzes a low pressure of at most 1000 mb centered near 32.5N, 53.7W. HURDAT lists this as a 80 kt hurricane at 33.7N, 53.0W at 12Z. Microfilm shows a low pressure of at most 996 mb near 33.4N, 53.7W. MWR analyzes a low pressure near 32.8N, 53.7W. Ship highlights: 75 kt S and 998 mb at 0Z near 32.0N, 54.0W (MICRO). 30 kt S and 1017 mb at 06Z near 29.1N, 50.2W (COADS). 30 kt S and 1018 mb at 06Z near 29.0N, 49.0W (COADS). 35 kt E and 1001 mb at 06Z near 33.7N, 54.9W (MICRO). 30 kt SW and 1016 mb at 12Z near 28.5N, 54.4W (COADS). 30 kt SW and 1018 mb at 12Z near 27.9N, 51.2W (COADS). 50 kt S and 999 mb at 12Z near 32.8N, 53.1W (MICRO). 55 kt SE and 1006 mb at 12Z near 34.2N, 52.2W (MICRO). 45 kt SE and 1010 mb at 12Z near 34.6N, 50.4W (MICRO). 30 kt N and 1008 mb at 12Z near 33.4N, 55.9W (MICRO). 50 kt WSW and 1012 mb at 15Z near 32.4N, 53.2W (MICRO). 75 kt SSE and 979 mb at 1515Z near 33.6N, 51.5W (MICRO). 30 kt S and 1014 mb at 18Z near 31.3N, 49.5W. 50 kt S and 1000 mb at 18Z near 34.1N, 48.7W (MICRO). 50 kt SW and 1003 mb at 18Z near 33.4N, 50.0W (MICRO).

October 5:

HWM analyzes a hurricane of at most 985 mb centered near 38.1N, 47.3W. HURDAT lists this as a 85 kt hurricane at 35.8N, 47.8W at 12Z. Microfilm shows a low pressure of at most 987 mb near 35.4N, 47.6W. MWR analyzes a low pressure near 36.2N, 46.6W. Ship highlights: 45 kt S and 1005 mb at 0Z near 34.9N, 48.0W (COADS). 40 kt S and 1010 mb at 0Z near 34.8N, 47.3W (COADS). 60 kt S and 990 mb at 0Z near 34.3N, 50.0W (MICRO). 50 kt S and 1002 mb at 0Z near 34.4N, 48.5W (MICRO). 65 kt S and 997 mb at 03Z near 34.8N, 48.0W (COADS). 75 kt S and 984 mb at 06Z near 34.8N, 48.0W (COADS). 40 kt SSE and 1002 mb at 06Z near 35.1N, 46.4W (COADS). 40 kt S and 1009 mb at 06Z near 33.0N, 46.3W (COADS). 30 kt S and 1015 mb at 06Z near 29.6N, 48.2W (COADS). 80 kt WSW and 984 mb at 09Z near 34.8N, 48.0W (COADS). 30 kt SW and 1012 mb at 12Z near 32.5N, 48.8W (COADS). 60 kt W and 999 mb at 12Z near 34.8N, 48.0W (COADS). 40 kt SW and 1011 mb at 12Z near 32.4N, 45.7W (COADS). 70 kt SSW and 990 mb at 12Z near 35.3N, 45.5W (COADS). 30 kt SW and 1012 mb at 12Z near 32.5N, 48.8W (COADS). 45 kt W and 1006 at 15Z near

34.8N, 48.0W (COADS). 70 kt SSW and 985 mb at 15Z near 36.0N, 44.6W (COADS). 35 kt S and 1000 mb at 18Z near 36.8N, 41.3W (COADS). 35 kt S and 1008 mb at 12Z near 36.1N, 40.0W (COADS). 75 kt S and 997 mb at 18Z near 37.0N, 44.0W (MICRO). 30 kt W and 1010 mb at 21Z near 34.5N, 48.0W (COADS). 60 kt W and 977 mb at 21Z near 37.0N, 44.0W (COADS).

October 6:

HWM analyzes a hurricane of at most 980 mb centered near 44.6N, 35.0W. HURDAT lists this as a 70 kt hurricane at 43.2N, 34.5W at 12Z. MWR analyzes a low pressure near 42.7N, 34.8W. Ship highlights: 60 kt W and 992 mb at 0Z near 37.2N, 44.2W. 35 kt S and 983 mb at 0Z near 36.6N, 41.4W. 50 kt S and 1005 mb at 06Z near 35.3N, 39.7W. 35 kt S and 1013 mb at 0Z near 39.0N, 34.5W. 35 kt SE and 1016 mb at 0Z near 39.3N, 31.6W. 35 kt SSE and 998 mb at 06Z near 40.4N, 35.1W. 35 kt SSE and 984 mb at 12Z near 45.7N, 33.4W. 40 kt SW and 1013 mb at 12Z near 36.8N, 35.3W. 35 kt S and 1011 mb at 12Z near 36.8N, 31.2W. 40 kt S and 1016 mb at 12Z near 37.7N, 29.5W. 60 kt SSE and 998 mb at 18Z near 49.0N, 29.1W. 50 kt SE and 964 mb at 18Z near 50.7N, 30.7W. All observations from COADS.

October 7:

HWM does not analyze a system. HURDAT lists this as a 60 kt extratropical cyclone at 54.2N, 29.0W at 0Z. Ship highlights: 50 kt SW and 993 mb at 0Z near 51.2N, 27.0W. 50 kt SW and 994 mb at 0Z near 51.5N, 27.4W. All observations from COADS.

The genesis for this system is unchanged from that previously in HURDAT at 06Z on the 26th of September, though the first definitive evidence for a closed circulation was at 12Z on the 25th. Minor track changes were introduced for all of the days of its existence. It should be noted that on the 1st and 2nd of October, in particular, there were several ship observations that provided contradictory information (more than usual), likely because of difficulty in the ships knowing their true location over the open Atlantic Ocean. While the intensity is increased slightly from 25 to 30 kt on the 27th through 00Z on the 29th, there is no evidence to introduce a change to the time of intensification to a tropical storm from the 18Z 29th originally shown in HURDAT. (This does keep in HURDAT the somewhat unlikely classification of a tropical depression for the first four and a half days of its existence. However, it is certainly possible that tropical storm intensity was reached earlier than shown here.) Several observations on the 1st of October indicated a well-developed tropical storm. At 18Z on the 1st, a ship reported 60 kt NW winds and a separate ship observed 50 kt SE winds with 992 mb pressure. This pressure suggests maximum winds of at least 56 kt from the Brown et al. north of 25N pressure-wind relationship and at least 59 kt from the intensifying subset. Given the high environmental

pressure and the single observation of 60 kt, the maximum winds at that time are analyzed to be 65 kt (5 kt higher than HURDAT originally). Intensification to hurricane stage at that time is six hours earlier than in HURDAT originally. On the 2nd, a ship at 18Z reported 55 kt S and 986 mb pressure. This peripheral pressure reading suggests winds of at least 65 kt and at least 68 kt from the same pressure-wind relationships. The intensity at that time is analyzed to be 75 kt (70 kt originally), again in part because of the high environmental pressures. On the 4th, a ship at 1515Z reported 75 kt SSE and 979 mb. This pressure suggests at least 74 kt and at least 77 kt from the same pressure-wind relationships. 80 kt is analyzed for the intensity at both 12 and 18Z, no change from HURDAT, as the environmental pressures had returned to near normal. At 21Z on the 5th, a ship reported 60 kt W winds and 977 mb pressure. This pressure suggests maximum winds of 76 kt from the Landsea et al. north of 35N pressure-wind relationship. Because of the fast movement of the hurricane toward the northeast, the intensity is estimated to be 85 kt at 18Z on the 5th and 80 kt at 00Z on the 6th (no change to HURDAT). Late on the 5th and early on the 6th, the hurricane quickly was overtaken and absorbed by a very large and powerful extratropical cyclone. Numerous observations show at 06Z on the 6th that the system no longer had a closed circulation. Thus the last best track position is indicated to be at 00Z on the 6th, still as an 80 kt cyclone. With the system becoming absorbed into the extratropical low, the last point at 00Z on the 6th is shown as extratropical. Such a dissipation for a hurricane is somewhat rare with the last intensity at such a high value of 80 kt. It is worth noting that the extratropical low that absorbed the hurricane continued with extremely low pressures (into the 940s) and very strong winds for a few more days as it moved across the high latitudes of the North Atlantic.

Hurricane Hazel [October 5-18]

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36605 10/05/1954 M=14  9 SNBR= 808 HAZEL       XING=1 SSS=4
36605 10/05/1954 M=14 12 SNBR= 808 HAZEL       XING=1 SSS=4
                      **

36610 10/05*  0   0   0    0*124 592  60    0*127 602  60    0*128 611  70    0*
36610 10/05*  0   0   0    0*120 585  40    0*120 595  50    0*121 605  55 1002*
                           *** ***  **      *** ***  **      *** ***  ** ****

36615 10/06*129 621  75    0*131 631  80    0*132 641  85    0*133 651  85    0*
36615 10/06*122 616  65    0*123 629  70    0*125 643  70  998*126 656  70  998*
            *** ***  **      *** ***  **      *** ***  **  *** *** ***  **  ***

36620 10/07*133 661  90    0*133 672 100    0*133 682 105    0*133 691 105    0*
36620 10/07*127 667  70    0*129 677  70    0*132 687  70  997*135 697  70  994*
            *** ***  **      *** *** ***      *** *** ***  *** *** *** ***  ***

36625 10/08*134 699 105    0*135 709 110    0*136 719 110    0*136 725 110    0*
36625 10/08*136 706  75    0*136 713  75    0*136 718  75  986*137 720  80    0*
            *** *** ***      *** *** ***          *** ***  *** *** *** ***
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```
36630 10/09*136 731 115    0*136 737 115    0*137 742 115    0*139 748 115    0*
36630 10/09*138 724  85    0*139 732  90    0*140 740  95    0*142 747 100    0*
           *** *** ***      *** *** ***      *** *** ***      *** *** ***

36635 10/10*142 753 115    0*146 756 110    0*150 756 105    0*154 756 105    0*
36635 10/10*144 752 105    0*147 755 105    0*150 756 105    0*153 756 105    0*
           *** *** ***      *** *** ***                       ***

36640 10/11*157 755 105    0*161 753 105    0*165 751 105    0*171 748 105    0*
36640 10/11*156 755 105    0*159 753 105    0*164 751 105    0*169 749 105    0*
           ***              ***              ***              *** ***

36645 10/12*177 744 105    0*182 741  85    0*187 738  85    0*193 735  85    0*
36645 10/12*174 747 105    0*180 743  95    0*186 740  85    0*191 737  85    0*
           *** ***          *** ***  **      *** ***          *** ***

36650 10/13*199 733  85    0*205 732  85    0*210 732  85  994*216 733  85    0*
36650 10/13*196 734  85    0*201 731  85    0*208 731  85    0*217 733  85  972*
           *** ***          *** ***          *** ***      *** ***          ***

36655 10/14*226 735  90    0*240 739 100    0*255 746 105    0*270 757 110    0*
36655 10/14*227 735  85  974*238 738  90    0*252 746 100    0*270 757 110    0*
           ***      **  *** *** *** ***      ***      ***

36660 10/15*286 768 115    0*302 778 120    0*328 787 110  937E368 782  80  970*
36660 10/15*288 768 115    0*307 780 120    0*327 787 120  938E360 783  80  970*
           ***              *** ***          ***      ***  *** *** ***

36665 10/16E410 774  70    0E452 786  60    0E488 800  50    0E507 800  45    0*
36665 10/16E410 774  70    0E460 793  60    0E488 800  50  982E515 795  45  988*
                             *** ***                      *** *** ***      ***

36670 10/17E517 799  45    0E528 792  35    0E540 782  35    0E556 762  35    0*
36670 10/17E532 795  45    0E545 795  35    0E555 795  35    0E563 788  35    0*
           *** ***          *** ***          *** ***          *** ***

36675 10/18E570 730  30    0E581 694  25    0E588 651  25    0*  0   0   0    0*
36675 10/18E570 770  30    0E581 750  25    0*  0   0   0    0*  0   0   0    0*
                ***              ***          **** ***  **

36680 HR SC4 NC4 MD2
36680 HR SC3 NC4
         ***     ***
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Landfall:
10/15 1530Z 33.9N 78.5W, 12 nm RMW, 938 mb central pressure, 26 kt speed,
120 kt maximum sustained surface winds

Minor changes to the track, but major adjustments to the intensity shown in McAdie et al. (2009). Evidence for these alterations comes from the Historical Weather Map series, Monthly Weather Review, daily Surface Weather Observations from NCDC, U.S. Weather Bureau six hourly maps available via microfilm at NHC, aircraft observations available from the Storm Wallets at NHC, the COADS ship database, Rhodes (1954), Dunn and Miller (1960), Schwerdt et al. (1979), Ho et al. (1987), Jarrell et al. (1992), and Perez et al. (2000).

October 5: HWM indicates a closed low of at most 1010mb near 13N, 61W. HURDAT lists this as a Tropical Storm with 60kt winds at 12.7N, 60.2W at 12 UTC. Station highlight: No gales or low pressures. Ship highlight: No gales or low pressures. Aircraft highlight: 85kt with pressure of 1002mb at 12.1N, 61.0W at 2037 UTC (Navy). "This hurricane developed in an easterly wave at latitude 12N, longitude 61.2W, on October 5 at which time highest winds were estimated about 100 mph. The hurricane passed near or slightly north of the island of Grenada in the Windward Islands and into the Caribbean Sea during the evening of the 5th" (MWR). "The center of the storm passed between the islands of Grenada and Carriacou during the evening of the 5th. All of the Grenadine Islands except Carriacou escaped with only minor damage and no loss of life. Total losses on this island were estimated at $35,000 to property, $5,000 to crops and $2,500 to livestock" (Rhodes).

October 6: HWM indicates a storm with a pressure of most 1010mb near 13.5N, 64W. HURDAT lists this as a Category 2 hurricane with 85kt winds at 13.2N, 64.1W at 12 UTC. Station highlight: No gales or low pressures. Ship highlight: 35kt NW with pressure of 1002mb at 12.9N, 62.8W at 0625 UTC (USWB). Aircraft highlight: 90kt with pressure of 998mb at 12.5N, 64.3W at 1200 UTC (NAVY).

October 7: HWM indicates a storm with a pressure of at most 1005mb near 13N, 64W. HURDAT lists this as a Category 3 hurricane with 105kt winds at 13.3N, 68.2W at 12 UTC. Station highlight: No gales or low pressures. Ship highlight: 35kt ENE with pressure of 1010mb at 15.4N, 68.1W at 1800 UTC (COA). Aircraft highlight: 110kt with pressure of 997mb at 12.9N, 68.7W at 1153 UTC (NAVY). "Highest winds were 115mph on the 7th ... as estimated by reconnaissance aircraft" (MWR).

October 8: HWM indicates a storm with a pressure of at most 1000mb near 13.8N, 72W. HURDAT lists this as a Category 3 hurricane with 110kt winds at 13.6N, 70.9W at 12 UTC. Station highlight: No gales or low pressures. Ship highlight: No gales or low pressures. Aircraft highlight: 100kt with pressure of 986mb at 13.5N, 71.9W at 1200 UTC (NAVY). Highest winds estimated by reconnaissance aircraft were "125mph on the 8th" (MWR). Also on the 8th, "the Navy reconnaissance plane encountered severe turbulence and one member of the crew was severely injured, requiring hospitalization, and another sustained minor injuries" (MWR).

October 9: HWM indicates a storm with a pressure of at most 995mb near 14N, 73.9W. HURDAT lists this as a Category 4 hurricane with 115kt winds at 13.6N, 73.7W at 12 UTC. Station highlight: No gales or low pressures. Ship highlight: 10kt E with pressure of 999mb at 12.8N, 70.2W at 1200 UTC (COA). Aircraft highlight: No gales or low

pressures. The MWR Tracks of Centers of Cyclones at Sea Level showed a center at 14N, 74W with 990mb (12 UTC). "[Hazel] continued on a west to west-northwest course until the night of the 9th-10th when it slowed down in forward speed and curved northward" (MWR).

October 10: HWM indicates a storm with a pressure of at most 990mb near 15.3N, 76W. HURDAT lists this as a Category 3 hurricane with 105kt winds at 15.0N, 75.6W at 12 UTC. Station highlight: No gales or low pressures. Ship highlights: 55kt E with pressure of 1000mb at 15.4N, 75.5W at 1800 UTC (COA); 35kt SW with pressure of 992mb at 14.6N, 75.3W at 1800 UTC (COA). Aircraft highlight: 100kt at 15.2N, 75.6W at 1441 UTC (NAVY). The MWR Tracks of Centers of Cyclones at Sea Level showed a center at 14N, 15W (0 UTC) and at 14.8N, 75.5W with 990mb (12 UTC). "The hurricane moved on a north-northeast course from the night of the 10th-11th until it passed through the Windward Channel and into the southeast Bahamas on the morning of the 13th" (MWR).

October 11: HWM indicates a storm with a pressure of at most 990mb near 16.5N, 75W. HURDAT lists this as a Category 3 hurricane with 105kt winds at 16.5N, 75.1W at 12 UTC. Station highlight: 44kt NNW with pressure of 1001mb at Morant Point (17.9N, 76.2W) at 1800 UTC (USWB). Ship highlights: 52kt NNE with pressure of 1001mb at 16.3N, 75.9W at 0700 UTC (USWB); 30kt ESE with pressure of 995mb at 15.8N, 74.6W at 0000 UTC (COA). Aircraft highlight: 35kt ENE at 18.2N, 75.6W at 1330 UTC (USWB). The MWR Tracks of Centers of Cyclones at Sea Level showed a center at 15.5N, 75.5W (0 UTC) and at 16.3N, 75.2W with 988mb (12 UTC).

October 12: HWM indicates a storm with a pressure of at most 990mb near 19N, 74W. HURDAT lists this as a Category 2 hurricane with 85kt winds at 18.7N, 73.8W at 12 UTC. Station highlight: 30kt NE with pressure of 998 at Baracoa at 2130 UTC (USWB). Ship highlights: 50kt S with pressure of 1005mb at 16.4N, 72.4W at 0000 UTC (COA); 12kt ESE with pressure of 999mb at 19.3N, 73.8W at 0230 UTC (USWB). Aircraft highlight: 61kt E at 20.0N, 74.0W at 1815 UTC (USWB). The MWR Tracks of Centers of Cyclones at Sea Level showed a center at 17.4N, 74.9W (0 UTC) and at 18.9N, 74.2W with 988mb (12 UTC). "Considerable damage and loss of life resulted in Haiti, especially on the SW peninsula. This area is very mountainous, with peaks of 8,000 ft in the western portion. High winds and seas and torrential rains resulting in floods and landslides accounted for the loss of life, estimated between 400 and 1,000 including 200 or more buried in landslides" (MWR). "The center passed over the western tip of the south peninsula of Haiti during the early morning of October 12, and crossed the northwest peninsula that evening. The western portions of both Haitian peninsula were devastated by the hurricane. Several towns were almost totally demolished, including Dame Marie,

Anse d' Hainault, Mole St. Nicolas, and Jean Rabel. The larger cities of Jeremie, Les Cayes, and Port de Paix suffered severe damage from hurricane winds. High tides on the southern coast from Les Cayes westward added to the destruction. Torrential rains fell over most of Haiti, flooding rivers, washing out roads, and destroying property, livestock, and crops. A landslide caused by heavy rains a few days after the hurricane buried the mountain village of Berley...Estimates of total damage in Haiti are not available. The number of deaths were estimated between 400 and 1,000, including 200 or more buried in the landslide. Extreme winds of 125 mph at several places in the western part of the southern peninsula were reported by the Coprs d'Aviation, Bowen Field, Port-au-Prince, Haiti" (Rhodes).

October 13: HWM indicates a storm with a pressure of at most 990mb near 20.6N, 73W. HURDAT lists this as a Category 2 hurricane with 85kt winds at 21.0N, 73.2W at 12 UTC. Station highlight: 22kt ENE with pressure of 994mb at Great Inagua (20.9N, 73.6W) at 1200 UTC (HWM); 52kt SSW at Mayaguana (22.3N, 72.9W) at 21.30 UTC (USWB). Ship highlight: 35kt W with pressure of 1005mb at 17.5N, 73.8W at 0000 UTC (COA); 30kt NNW with pressure of 999mb at 20.2N, 74.3W at 0630 UTC (USWB). Aircraft highlight: 100kt with pressure of 974mb at 22.2N, 73.5W at 2136 UTC (NAVY); 80kt with pressure of 972mb at 21.6N, 73.4W at 1615 UTC (NAVY). The MWR Tracks of Centers of Cyclones at

Sea Level showed a center at 20N, 73.5W (0 UTC) and at 21N, 73W with 987mb (12 UTC). "[Hazel] changed course to north then to north-northwest on the 13th, continuing on that course until it passed inland on the North Carolina coast about 0915 EST of the 15th" (MWR). "After passing through the Windward Channel the hurricane moved northward and passed directly over the Island of Great Inagua and between Mayaguana and Acklin Islands, and passed a short distance east of the remainder of the Bahamas. A minimum pressure of 29.34 inches and a maximum wind of only 40 mph were reported at Great Inagua Island. The low wind speed was thought to be due to distortion of the hurricane in its passage through the mountainous terrain bordering the Windward Channel. Damage was minor in the Bahamas. Six lives were lost out of a total of 15 aboard a sailboat that capsized when it was trying to take shelter at Inagua" (Rhodes). "Hazel - October 12-13 - Category 1 impact in Cuba" (Perez).

October 14: HWM indicates a storm with a pressure of at most 990mb near 25.5N, 74.6W. HURDAT lists this as a Category 3 hurricane with 105kt winds at 25.5N, 74.6W at 12 UTC. Station highlight: 52kt SSW at Mayuguana at 0030 UTC (USWB); 30kt ENE with pressure of 992mb at San Salvador at 0930 UTC (USWB). Ship highlight: 52kt NE with pressure of 988mb at 28.2N, 77.5W at 2130 UTC (USWB); 26kt N with pressure of 982mb at 33.2N, 77.8W at 2330 UTC (USWB). Aircraft highlight: 52kt SE at 27.8N,

72.5W at 1354 UTC (USWB); 100kt with pressure of 974mb at 22.5N, 73.4W at 0045 UTC (NAVY). The MWR Tracks of Centers of Cyclones at Sea Level showed a center at 23.1N, 73W (0 UTC) and at 25.5N, 74W with 987mb (12 UTC). "Storm warnings were hoisted at 1100 EST on the 14th from Charleston, S.C., northward on the Virginia Capes, and the remainder of the coast northward to New England was placed on the alert by Washington and Boston Weather Bureau offices" (MWR).

October 15: HWM indicates a closed low of at most 980mb near 33N, 78.5W. HURDAT lists this as a Category 3 hurricane with 110kt winds at 32.8N, 78.7W at 12 UTC. Station highlight: 70kt SW at Kinston at 1845 UTC (SWO); 966mb at Spartanburg (34.9N, 81.9W) at 1750 UTC (SWO). Ship highlight: 35kt N with pressure of 972mb at 31.3N, 78.8W at 0800 UTC (USWB); 70kt ENE with pressure of 1006mb at 32.4N, 77.8W at 0000 UTC (COA). Aircraft highlight: No gales or low pressures. The MWR Tracks of Centers of Cyclones at Sea Level showed a center at 28.9N, 76.8W (0 UTC) and at 33.8N, 78.5W with 976mb (12 UTC). "During the 14th and 15th, and until the hurricane passed inland, the highest winds were estimated in all warning messages in excess of 100mph. Wilmington, N.C., reported a top gust of 98mph and the fastest mile was 82mph. Minimum pressure there was 28.68in. Myrtle Beach, S.C., reported top gusts of 106 mph and lowest pressure reported of 28.47in. (This was the lowest pressure reported on land although 27.70in was reported by a fishing boat at Tilgham Point while in the eye of the storm at 10:30 a.m. EST.) Wind estimates from several points between Myrtle Beach and Cape Fear varied from 130 to 150mph. The devastation along the North and South Carolina beaches was staggering. Every pier in a distance of 170 miles of coastline was demolished and whole lines of beach homes literally disappeared. In some places the tide was over 17ft higher than the mean low water" (MWR). "Total casualties in the Carolinas were 20, most of which were drownings. Damage to the Carolinas is estimated at around $163 million with $36 million from the N. Carolina beach area, $25 million from the S. Carolina beach area, and the remainder from crop and property losses in the interior" (MWR). "More than one half of the total damage in the US occurred in N. Carolina" (Seamon). "Long Beach (NC) was completely destroyed with all of its 300 houses gone, as was Holden Beach with lost all of its 200 houses, and Ocean Isle where no houses remained" (Seamon). "Total losses for South Carolina totaled $27,000,000 all occurring along the coast except $2,000,000 in the interior" (Seamon). "Tropical Cyclones in the South Atlantic States - Carolinas and Georgia - 1954 - Oct. 15 (Hazel) - Carolinas - Extreme [Category 4 or 5] - 20 killed, damage $163,000,000. Tropical Cyclones in the Middle Atlantic States - 1954 - Oct. 15 (Hazel) - All Sections - Major [Category 2 or 3] - 74 killed, damage $88,595,000" (Dunn and Miller). "1011 mb environmental pressure, 114 kt maximum sustained winds at the coast" (Schwerdt et al.). "Hazel - Oct. 15 - 938 mb central pressure at landfall - 25 nmi RMW - 26 kt forward

speed - 33.9N, 78.5W landfall point" (Ho et al.) "1954 Oct SC, NC 4; MD, 2 - 938 mb central pressure - Hazel" (Jarrell et al.)

October 16: HWM indicates a closed low of at most 985mb near 51N, 79.5W. HURDAT lists this as an Extratropical storm with 50kt winds at 48.8N, 80.0W at 12 UTC. Station highlight: 60kt SE at Binghampton (42.1N, 75.9W) at 0246 UTC (SWO); 975mb at Sampson AFB (42.8N, 76.9W) at 0226 UTC (SWO); 984 mb and 12 kt N at Kirkland Lake, Canada (47.7N, 79.8W) at 1130 UTC (USWB). 990 mb and 12 kt NW at Moosonee, Canada (51.3N, 80.7W) at 1730 UTC (USWB). Ship highlight: 45kt SE with pressure of 998mb at 0000 UTC at 40.1N, 73.4W (COA); 45kt SE with pressure of 998mb at 40.1N, 73.4W at 0000 UTC. Aircraft highlight: No gales or low pressures. The MWR Tracks of Centers of Cyclones at Sea Level showed a center at 42N, 78W (0 UTC) and at 48.8N, 79.5W with 981mb (12 UTC). "Twenty-one deaths were attributed to Hazel in New York and damage ran in the millions. Heavy rains in the extreme west flooded basements and washed out several bridges" (Seamon).

October 17: HWM indicates a closed low of at most 995mb near 56N, 77W. HURDAT lists this as an Extratropical storm with 35kt winds at 54.0N, 78.2W at 12 UTC. Station highlight: 43kt SE 993mb at 55.0N, 780.W at 1200 UTC. No ship or Aircraft data. The MWR Tracks of Centers of Cyclones at Sea Level showed a center at 52N, 79W (0 UTC) and at 53.4N, 77.5W with 990mb (12 UTC).

October 18: HWM indicates a closed low of at most 990mb near 61N, 56W. HURDAT lists this as an Extratropical storm with 25kt winds at 58.8N, 65.1W at 12 UTC. The MWR Tracks of Centers of Cyclones at Sea Level showed a center at 57N, 72.5W (0 UTC). Station highlight: 993mb at 63.0N, 49.0W at 1200 UTC. No ship or aircraft data.

No change is made to the genesis of Hazel, though the first report in HURDAT is now begun with a 40 kt intensity rather than 60 kt originally. Track changes are introduced for the entire lifecycle of Hazel, but all are minor adjustments. A central pressure of 1002 mb with a tiny eye diameter of 4 nm was measured by aircraft reconnaissance at 2037 UTC on the 5th along with estimated winds of 85 kt. (From here on in, the estimated winds will not be mentioned, as they are unreliable.) 1002 mb central pressure suggests maximum winds of 43 kt from the Brown et al. south of 25N pressure-wind relationship. Given the extremely tiny size and slightly weighting the estimated winds, the intensities are chosen to be 55 kt at 18 UTC and 65 kt at 00 UTC on the 6th, down from 70 and 75 kt, respectively. A central pressure of 998 mb was observed twice, once with an eye diameter of 10 nm and and once with 5 nm by aircraft at 12 UTC and 1920 UTC. 998 mb central pressure suggests maximum winds of 51 kt from the south of 25N pressure-wind relationship. At 12 and 18 UTC, the intensities are analyzed to be 70 kt due to the tiny size of Hazel - down from 85 kt originally. On the 7th, aircraft measured

central pressure of 997 mb with a 7 nm eye at 1153 UTC and 994 mb with a 10 nm eye at 1930 UTC. These pressures suggest maximum winds of 53 and 58 kt, respectively, from the south of 25N pressure-wind relationship. Intensities are set at 70 kt at 12 and 18 UTC on the 7th (down from 105 kt originally) due to the small size of Hazel. At 12 UTC on the 8th, aircraft reconnaissance measured 986 mb central pressure with an eye diameter of 25 nm. This suggests maximum winds of 70 kt from the south of 25N pressure-wind relationship. Maximum winds chosen to be 75 kt (down from 110 kt originally) from a blend of the deepening the occurred between the 7th and the 8th but also accounting for the inner core size of the hurricane becoming larger. This was the last aircraft penetration for five days until the 13th. From the 9th until the 12th, Hazel moved over the central Caribbean Sea with no ships, aircraft, or land stations within the inner core of strongest winds and lowest pressure. Thus maximum winds are gradually ramped up from 75 kt at the 12 UTC on the 8th to the 105 kt originally shown in HURDAT by 12 UTC on the 10th. The resulting reduction in maximum winds on the 9th (from 115 kt down to 95 kt at 12 UTC) is somewhat supported by the ragged and open eye reported from the radar aircraft reports on that date. By the 10th and 11th, the radar observations suggest a smaller and closed eye, suggesting the Category 3 conditions originally shown in HURDAT are reasonable.

Hazel's landfall in Haiti was disastrous for that country, and while no measured extreme observations were available, retaining Hazel as a 105 kt hurricane at landfall appears to be prudent. After passing Haiti (with some weakening likely due to interaction with the mountainous island), Hazel moved slowly off to the north over the Atlantic. The 994 mb central pressure in HURDAT originally at 12 UTC on the 13th is erroneous. This value was from Great Inagua, but they were not in the eye at the time, so the value is a peripheral measurement. Aircraft penetrations at 1615 UTC (13th), 2136 UTC (13th), and 0045 UTC (14th) measured 972 mb, 974 mb with an eye diameter of 17 nm, and 974 mb with an eye diameter of 15 nm, respectively. These central pressures suggest maximum winds of 88, 85, and 85 kt from the southern pressure-wind relationship. 85 kt at 18 UTC on the 13th and at 00 UTC on the 14th are chosen for HURDAT, the same as original at 18 UTC and down from 90 kt originally at 00 UTC.

No further aircraft penetrations were available for the next 36 hours until landfall in the Carolinas. A ship at the Carolina's coast reported a central pressure in the eye of Hazel of 938 mb at 1530 UTC on the 15th. Aircraft radar suggested an eye diameter of 18 nm, which is equivalent to roughly 13-14 nm RMW (Kimball and Mulekar 2004). Assuming that the 938 mb is the central pressure at landfall (which agrees with Ho et al. and Jarrell et al.), this value suggests maximum winds of 116 kt from the Brown et al. north of 25N pressure-wind relationship. The RMW size being smaller than climatology for this pressure and latitude (23 nm) and fast moving (~25 kt at landfall) would argue for a

slightly stronger wind for this pressure, while the roughly 1008 mb outer closed isobar would suggest slightly less winds. Winds are thus estimated to be 120 kt at landfall, keeping it a Category 4 hurricane. As Hazel made landfall right at the North Carolina/South Carolina border, it is estimated that South Carolina missed experiencing the peak (Category 4) winds and is thus assessed as a Category 3 impact. The winds in HURDAT are adjusted up slightly at 12 UTC on the 15th from 110 kt to 115 kt. After landfall, peak observed winds within 2 hours of the synoptic times were 70 kt at Kinston, NC around 18 UTC on the 15th and 60 kt at Philadelphia, PA around 00 UTC on the 16th. A run of the Kaplan/DeMaria inland decay model suggests winds of 68 kt at 18 UTC on the 15th, though the system was judged to be extratropical at that point (unchanged from originally in HURDAT), so the Kaplan/DeMaria model may not be very applicable by this time. 80 kt are retained in HURDAT at 18 UTC on the 15th. Given the extratropical transition occurring around 18 UTC on the 15th while the system was over North Carolina, impacts farther north would not be considered as a tropical cyclone. It should be noted that observed 1 min hurricane force winds were also observed in Virginia and Washington D.C., and likely also occurred in Maryland, Pennsylvania, and New York as well. Thus the "MD2" (Maryland - Saffir-Simpson Hurricane Scale Category 2) originally in HURDAT is removed. A couple of analyzed central pressures of 982 mb and 988 mb were added for 12 and 18 UTC on the 16th based upon land-based observations. Post-tropical Hazel likely was absorbed by a larger extratropical low by 12 UTC on the 18th, thus this position is removed from HURDAT.

Unnamed Tropical Storm 10 [November 16-21, 1954]

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37865 11/16/1954 M= 6 10 SNBR= 833 NOT NAMED   XING=0 SSS=0
37865 11/16/1954 M= 6 13 SNBR= 833 NOT NAMED   XING=0 SSS=0
                         **

37870 11/16*  0   0   0    0*  0   0   0    0*  0   0   0    0*237 438  30    0*
37870 11/16*  0   0   0    0*  0   0   0    0*  0   0   0    0*237 435  30    0*
                                                              ***

37875 11/17*238 445  35    0*239 450  40    0*239 455  45    0*239 462  45    0*
37875 11/17*238 445  30    0*239 455  30    0*239 463  35    0*237 470  35    0*
                     **          ***  **          ***  **      ***  ***  **

37880 11/18*239 470  45    0*240 475  45    0*240 480  45    0*240 486  45    0*
37880 11/18*235 475  35    0*237 479  35    0*240 484  35    0*242 490  35 1005*
            ***  ***  **      ***  ***  **          ***  **      ***  ***  ** ****

37885 11/19*240 492  45    0*240 499  45    0*240 507  45    0*240 516  45    0*
37885 11/19*243 495  30    0*245 501  30    0*246 507  30    0*244 515  30    0*
            ***  ***  **      ***  ***  **      ***       **      ***  ***  **

37890 11/20*240 525  45    0*243 533  45    0*248 541  45    0*252 548  45    0*
37890 11/20*241 523  30    0*241 530  30    0*243 536  30    0*245 541  30    0*
            ***  ***  **      ***  ***  **      ***  ***  **      ***  ***  **
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37895 11/21*255 556  45    0*256 563  40    0*258 571  30    0*256 578  25    0*
37895 11/21*246 551  30    0*248 558  30    0*250 565  30    0*252 572  25    0*
           *** ***  **      *** ***  **      *** ***          *** ***

37900 TS
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Minor changes to the track and intensity shown in McAdie et al. (2009). Evidence for these alterations comes from the NHC microfilm maps, the Historical Weather Maps series, and the COADS ship database.

November 16:

HWM analyzes a warm front between 23N and 35N and near 43W. HURDAT lists this as a 30 kt tropical depression at 23.9N, 43.8W at 18Z. Ship highlights: 20 kt SE and 1009 mb at 18Z near 23.9N, 41.2W (COADS).

November 17:

HWM analyzes a low pressure of at most 1010 mb centered near 23.5N, 46.5W. HURDAT lists this as a 45 kt tropical storm at 23.9N, 45.5W at 12Z. Ship highlights:15 kt N and 1011 mb at 0Z near 24.2N, 46.2W (COADS). 15 kt SE and 1013 mb at 0Z near 22.0N, 42.9W (COADS). 25 kt SE and 1012 mb at 0Z near 23.2N, 39.9W (COADS). 15 kt N and 1010 mb at 06Z near 23.5N, 47.0W (COADS). 25 kt N and 1011 mb at 12Z near 23.9N, 48.8W (HWM). 30 kt NE and 1014 mb at 12Z near 27.0N, 47.0W (COADS). 15 kt NNW and 1010 mb at 18Z near 22.0N, 48.7W (COADS).

November 18:

HWM analyses a low pressure of at most 1010 mb centered near 24.1N, 47.9W. HURDAT lists this as a 45 kt tropical storm at 24.0N, 48.0W at 12Z. Ship highlights: 30 kt ENE and 1013 mb at 0Z near 28.3N, 49.4W. 10 kt NW and 1010 mb at 0Z near 21.4N, 49.3W. 15 kt WSW and 1008 mb at 06Z near 27.2N, 46.2W. 10 kt ENE and 1006 mb at 18Z near 25.4N, 49.1W. 15 kt WSW and 1007 mb at 18Z near 23.9N, 49.2W. All observations from COADS.

November 19:

HWM analyses a low pressure of at most 1010 mb centered near 24.5N, 49.8W. HURDAT lists this as a 45 kt tropical storm at 24.0N, 50.7W at 12Z. Ship highlights: 10 kt ENE and 1008 mb at 0Z near 24.5N, 50.6W. 10 kt NW and 1008 mb at 06Z near 23.6N, 51.9W. 25 kt NE and 1012 mb at 12Z near 26.5N, 53.4W. 10 kt NNW and 1011 mb at 12Z near 22.6N, 53.3W. 20 kt NE and 1009 mb at 18Z near 25.3N, 52.9W. All observations from COADS.

November 20:

HWM analyses a low pressure of at most 1010 mb centered near 23.1N, 54.2W. HURDAT lists this as a 45 kt tropical storm at 24.8N, 54.1W at 12Z. Ship highlights: 15 kt NE and 1012 mb at 0Z near 24.5N, 53.4W. 30 kt ENE and 1015 mb at 06Z near 29.1N, 55.3W. 15 kt NE and 1012 mb at 12Z near 24.6N, 57.9W. 15 kt NE and 1011 mb at 18Z near 25.2N, 56.6W. All observations from COADS.

November 21:

HWM analyses a low pressure of at most 1010 mb centered near 22.7N, 55.2W. HURDAT lists this as a 30 kt tropical depression at 25.8N, 57.1W at 12Z. Microfilm shows a low pressure of at most 1011 mb at 12Z near 22.5N, 60.5W. Ship highlights: 30 kt SE and 1012 mb at 0Z near 25.6N, 51.7W. 15 kt NE and 1011 mb at 0Z near 26.0N, 55.5W. 30 kt S and 1013 mb at 12Z near 24.5N, 53.8W. 30 kt SE and 1019 mb at 18Z near 25.6N, 51.7W. All observations from COADS.

No changes are made to the genesis time of this late season tropical storm. Minor track changes are introduced for the six day duration of this system. Numerous observations from ships on the 17th to the 21st indicate that the cyclone was weaker than the 45 kt shown in HURDAT for those dates. Based upon a 30 kt NE ship observation at 12Z on the 17th, an intensity of 35 kt is estimated at that time. This time is now the new onset of tropical storm intensity, twelve hours later than originally shown. A few other 30 kt ship reports were observed between that date and the 21st, but no gales were reported during the lifetime of this system. A central pressure of 1005 mb is analyzed at 18Z on the 18th, from a ship with 1006 mb and 10 kt ENE and another ship close by with 1007 mb and 15 kt WSW. 1005 mb central pressure suggests maximum winds of 37 kt from the Brown et al. south of 25N pressure-wind relationship and 34 kt from the north of 25N relationship. Given the structure with strongest winds 100-250 nm from the center (resembling a subtropical cyclone), intensity at this time is analyzed to be 35 kt, which could be somewhat generous. Numerous observations of higher pressure and lower winds on the 19th and the 20th strongly suggest that the cyclone weakened and the intensity is analyzed to be 30 kt for all of the times of those two dates, down from 45 kt originally in HURDAT. Thus the new peak intensity of this system is 35 kt from 12Z on the 17th until 18Z on the 18th, down from 45 kt originally. It is to be noted that there were no explicit tropical storm force winds observed in the reanalysis effort and it is possible that this system never truly achieved tropical storm intensity. However, the ship observations are not complete and therefore it is not conclusive in removing the system from HURDAT. Further weakening occurred on the 21st, as the cyclone opened up to a trough after 18Z. No change to the dissipation stage is indicated.

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37905 12/30/1954 M= 8 11 SNBR= 834 ALICE       XING=0 SSS=0                    L
37905 12/30/1954 M= 8 14 SNBR= 834 ALICE       XING=0 SSS=0                    L
                         **

37910 12/30*  0   0   0    0*221 509  30    0*220 516  35 1007*216 524  40    0*
37915 12/31*213 533  50    0*210 543  55    0*206 552  65    0*203 560  65    0*
37920 01/01*201 568  65    0*199 574  65    0*197 581  65    0*193 592  65    0*
37920 01/01*201 568  70    0*199 574  70    0*197 581  75    0*193 592  80    0*
                     **                **                **                **

37925 01/02*188 605  65    0*184 616  65    0*180 624  65    0*178 628  65    0*
37925 01/02*188 605  80    0*185 616  75    0*183 624  70    0*181 628  65  991*
                     **      ***       **      ***       **      ***         ***

37930 01/03*176 632  70    0*173 636  70    0*170 640  70    0*165 647  70    0*
37930 01/03*178 632  60    0*174 636  60    0*168 641  55  999*163 647  55    0*
          ***        **      ***       **      *** ***  **  *** ***       **

37935 01/04*160 653  65    0*155 652  65    0*151 649  55    0*147 644  50    0*
37935 01/04*159 650  50 1000*155 652  45    0*151 650  40    0*147 648  35    0*
          *** ***  ** ****           **          ***  **          ***  **

37940 01/05*144 640  40    0*140 636  35    0*136 633  30    0*133 631  25    0*
37940 01/05*144 648  35    0*140 648  30    0*136 650  25    0*133 650  25    0*
                ***  **          ***  **          ***  **          ***

37945 01/06*130 630  25    0*128 630  25    0*  0   0   0    0*  0   0   0    0*
37945 01/06*130 650  25    0*  0   0   0    0*  0   0   0    0*  0   0   0    0*
                ***           *** ***  **
37950 HR
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Major changes to both the track and intensity shown in McAdie et al. (2009). Evidence for these alterations comes from the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, the Navy aircraft reconnaissance book, and three Monthly Weather Review articles (the 1955 hurricane season summary, Colon (1956), and O'Neill and Jordan (1962)).

December 29:

HWM analyzes a low pressure of at most 1010 mb centered near 19.5N, 49.5W. HURDAT does not analyze this system. Ship highlights: 30 kt E and 1015 mb at 00Z near 23.9N, 45.1W. 30 kt ENE and 1015 mb at 12Z near 21.3N, 53.8W. 35 kt ENE and 1013 mb at 18Z near 22.1N, 52.7W. All observations from COADS.

December 30:

HWM analyzes a low pressure of at most 1010 mb centered near 22.0N, 52.7W. HURDAT lists this as a 35 kt tropical storm at 22.0N, 51.6W at 12Z. Ship highlights: 20 kt NE and 1008 mb at 06Z near 22.7N, 51.7W. 30 kt SE and 1010 mb at 12Z near 23.6N, 50.5W. 30 kt S and 1006 mb at 12Z near 23.7N, 50.9W. 40 kt E and 1011 mb at 18Z near 23.9N, 50.0W. 25 kt S and 1005 mb at 18Z near 21.5N, 53.6W. All observations from

COADS. “A low pressure of extra-tropical or nature was noted some 600 miles northeast of the Leeward Islands on December 30 …” (MWR) “The first tropical disturbance of the 1955 season was first detected as an easterly wave, labeled locally “December 1,” on 30 December 1954 (Figure A-5).” (ATSR)

December 31:

HWM analyses a tropical storm of at most 1000 mb centered near 21.5N, 54.2W. HURDAT lists this as a 65 kt hurricane at 20.6N, 55.2W at 12Z. Microfilm shows a low pressure system located near 20.0N, 55.5W at 12Z. Ship highlights: 20 kt SE and 1007 mb at 00Z near 22.0N, 53.0W. 30 kt E and 1014 mb at 00Z near 24.8N, 49.9W. 20 kt SW and 1006 mb at 06Z near 20.1N, 54.7W. 30 kt N and 1003 mb at 12Z near 21.2N, 55.7W. 30 kt ENE and 1007 mb at 18Z near 22.0N, 57.0W. All observations from COADS.

January 1:

HWM analyses a tropical storm of at most 1005 mb centered near 19.6N, 58.0W. HURDAT lists this as a 65 kt hurricane at 19.7N, 58.1W at 12Z. Microfilm shows a low pressure system near 19.2N, 57.6W at 12Z. Ship highlights: 30 kt ENE and 1011 mb at 00Z near 22.7N, 58.1W (COADS). 30 kt NE and 1012 mb at 00Z near 21.3N, 60.0W (COADS). 25 kt NNE and 1008 mb at 18Z near 19.6N, 61.6W (COADS). 30 kt E and 1009 mb at 18Z near 21.8N, 59.1W (COADS). 70 kt W and 987 mb at 1919Z near 19.2N, 59.2W; “west wind 12, barometer 987, temperature 66, visibility nil” (MWR). 47 kt and 998 mb at 2330Z (MWR). “… on January 1 it reached hurricane intensity with definite tropical characteristics.” (MWR) “This very rare wintertime disturbance moved westward at about 12 knots until 1830Z on 1 January (Figure A-11), when it became apparent that a vortex, possibly of tropical storm intensity, had formed in the Atlantic Caribbean area for the 1st time of record.” (ATSR)

January 2:

HWM analyses a hurricane of at most 1005 mb centered near 18.5N, 62.0W. HURDAT lists this as a 65 kt hurricane at 18.0N, 62.4W at 12Z. Microfilm shows a low pressure system near 18.5N, 62.1W at 12Z. Ship highlights: 35 kt ESE and 1011 mb at 00Z near 20.5N, 60.2W (COADS). 45 kt WNW and 1000 mb at 00Z near 18.6N, 60.5W (COADS). 25 kt ENE and 1006 mb at 06Z near 19.7N, 61.8W (COADS). 30 kt NE and 1007 mb at 06Z near 19.6N, 61.7W (COADS). 30 kt NE and 1009 mb at 12Z near 18.7N, 63.1W (COADS). 45 kt E and 1010 mb at 15Z near 20.0N, 61.4W (MICRO). 35 kt ENE and 1007 mb at 15Z near 19.1N, 63.2W (MICRO). 35 kt NNE and 1006 mb at 15Z near 18.4N, 63.5W (MICRO). 40 kt NE and 1003 mb at 18Z near 18.4N, 63.5W (COADS). 30 kt N and 1005 mb at 18Z near 17.7N, 64.2W (COADS). 1002 mb at 18Z near 17.2N, 64.1W (COADS). Land highlights: 991 mb at Sint Maarten (MWR). 991 mb at St.

Barthelemy, maximum winds 35 kt S (MWR). 60-70 kt and 997 mb at 12Z at St. Barthelemy (MICRO). 10 kt W and 1008 mb at 12Z at St. Kitts (MICRO). 10 kt S and 1007 mb at 12Z at Antigua (MICRO). 15 kt SW and 1004 mb at 18Z at St. Kitts (MICRO). 25 kt W and 1004 mb at 18Z at St. Eustatius (MICRO). St. Kitts reported 25-35 kt, SW winds and 1002.4 mb (MWR). St. Eustatius reported 1001.4 mb (MWR). "It moved on a west-southwestward course passing through the Leeward Islands on January 2. An estimated wind of 75 mph was reported at St. Kitts and the last observation from St. Barthélemy indicated wind speeds ranging from 69 to 81 mph. Winds of hurricane intensity were observed at other points." (MWR) "Confirmation of "Tropical Storm Alice" came on 2 January via a delayed report from a US Naval Ship which reported maximum observed surface winds of 47 knots and an eye with a spiral weather band clearly defined on radar. Coordination was effected with the San Juan Weather Bureau Office and Warning Number One on "Tropical Storm Alice" was released as of 021900Z, locating the center near St. Barthelemy, Leeward Islands." (ATSR) " The maximum wind velocity reported from a land station was 38 knots at St. Barthelemy late on 2 January 1955." (ATSR)

January 3:

HWM analyses a hurricane of at most 1005 mb centered near 16.3N, 64.4W. HURDAT lists this as a 70 kt hurricane at 17.0N, 64.0W at 12Z. Microfilm shows a hurricane of at most 1002 mb at 12Z near 16.7N, 64.2W. Ship highlights: 40 kt WNW and 1001 mb at 00Z near 17.1N, 64.0W. 30 kt NE and 1012 mb at 00Z near 19.8N, 69.5W. 30 kt NE and 1012 mb at 06Z near 21.2N, 67.3W. 25 kt W and 1006 mb at 06Z near 16.0N, 64.4W. 20 kt NE and 1001 mb at 09Z near 19.9N, 64.4W. 30 kt NNW and 1008 mb at 12Z near 16.5N, 65.0W. 25 kt SE and 1007 mb at 18Z near 17.2N, 64.5W. All observations from COADS. Land Highlights: 15 kt SSE and 1007 mb at 00Z at St. Kitts. 20 kt NE and 1008 mb at 06Z at St. Thomas. All observations from microfilm. Aircraft Highlights: Air Force center fix at 1355Z at 16.6N, 64.2W with 999 mb central pressure and 55 kt max winds (MICRO, ATSR). NAVY center fix at 2100Z at 16.1N, 65.2W with 1000 mb central pressure and 50 kt max winds (MICRO, ATSR). NAVY center fix at 2215Z at 16.1N, 65.5W (ATSR). "On January 3, aircraft reconnaissance reported maximum winds of 86 mph and a dropsonde in the eye confirmed the warm-core system. After January 3, the hurricane diminished rapidly in intensity." (MWR) "On 3 January, weather reconnaissance aircraft found a poorly defined eye, visually and on radar, with maximum winds of about 55 knots." (ATSR)

January 4:

HWM analyses a tropical storm of at most 1010 mb centered near 14.6N, 64.9W. HURDAT lists this as a 55 kt tropical storm at 15.1N, 64.9W at 12Z. Microfilm shows a

low pressure system of at most 1011 mb at 12Z near 15.4N, 64.9W. Ship highlights: 25 kt NE and 1012 mb at 00Z near 16.6N, 68.7W. 30 kt S and 1007 mb at 12Z near 15.2N, 63.9W. 30 kt N and 1008 mb at 18Z near 15.2N, 66.1W. 20 kt W and 1008 mb at 18Z near 14.1N, 65.1W. All observations from COADS. Aircraft Highlights: NAVY center fix at 1346Z at 15.1N, 64.8W with 30-35 kt (ATSR). “On 4 January, U.S. Navy reconnaissance aircraft reported only scattered showers with a weak wind circulation center near 15N and 65W. Maximum winds were now only 30 to 35 knots in squalls some distance from the circulation center. The final warning on “Tropical Storm Alice” was issued on 041600Z.” (ATSR)

January 5:

HURDAT lists this as a 30 kt tropical depression at 13.6N, 63.3W at 12Z. HWM and microfilm does not show an organized system. Ship highlights: 20 kt NE and 1009 mb at 00Z near 16.5N, 65.0W. 15 kt N and 1009 mb at 00Z near 14.5N, 65.0W. 10 kt N and 1008 mb at 06Z near 13.8N, 65.9W. 15 kt NE and 1009 mb at 06Z near 16.0N, 65.0W. 15 kt W and 1009 mb at 18Z near 13.0N, 64.9W. All observations from COADS.

January 6:

HURDAT lists this as a 25 kt tropical depression at 12.8N, 63.0W at 06Z. HWM and microfilm does not show an organized system. Ship highlights: 20 kt NE and 1014 mb at 00Z near 14.7N, 66.6W. 15 kt NNW and 1010 mb at 00Z near 12.9N, 65.6W. 15 kt N and 1011 mb at 06Z near 12.7N, 67.1W. All observations from COADS.

“The records do indicate, however, that a winter hurricane of somewhat similar origin passed through the Leeward Islands on March 8, 1908, with Basseterre, St. Kitts, reporting a minimum pressure of 29.28 inches. Columbus described several of the winter storms encountered by him on his journeys to the New World as “hurricanes.” Brooks [4], however, has found they were probably normal winter storms. Occasional winter hurricanes do occur in the Pacific Ocean and tropical Lows are more rarely observed in the Atlantic, but it is most unusual for one of the latter to reach full hurricane intensity during the winter season. Possibly this may be another consequence of the general warming observed during the past several decades. There was no loss of life from Alice and damage is estimated at around $100,000. The rainfall was beneficial in Puerto Rico where it alleviated a dry period which had persisted since the middle of the previous October.” (MWR)

“Alice” was believed to be of hurricane intensity but from post analysis it never appeared to have attained winds greater than 55 knots. From inception, “Alice” moved on a southwesterly course at speeds ranging from 5 to 10 knots. The flow at the 500 mb level indicated a more west-southwest movement of “Alice” with possible movement more

westerly as the storm moved across the Caribbean. The exact flow at the 200 mb level over the Caribbean was doubtful, reports were sparse and at times, non-existent, therefore it can only be conjecture as to what really caused “Alice” to swing to the southwest and finally weaken and dissipate while moving slowly south to southeast. “Alice” was never a very large circulation. Further weakening was due to the southerly component of motion plus the lack of sufficient divergence aloft to maintain the circulation. As far as is known, no damage to shipping or shore installations resulted from “Alice.””

No change to the genesis of this rare out-of-season hurricane, which likely formed from an old frontal boundary that had pushed quite far equatorward. No track changes were introduced for the first three days of its lifecycle. Minor alterations were made on the 2nd to the 5th of January and a large change was introduced for the very last position kept in HURDAT due to additional ship observations not available to earlier analyses. Only one central pressure was in HURDAT originally for this system – 1007 mb at 12Z on the 30th of December. While no such observation could be located to confirm it, this value appears to be in the right ballpark so it is retained. A believable 40 kt ship with 1011 mb pressure at 18Z on the 30th was obtained. No change to the intensity of 40 kt listed in HURDAT at that time and no change to the timing of upgrade to a tropical storm (12Z on the 30th) were made. Little inner core data was available on the 31st and the transition to hurricane intensity at 12Z on that date is retained. At 1919Z on the 1st of January, the ship Arawak reported 70 kt W wind with 987 mb pressure. This peripheral pressure suggests peak winds of at least 68 kt from the Brown et al. south of 25N pressure-wind relationship. Additionally, radar imagery from a separate ship – the USS Midway – depicted a complete eyewall of 25 nm diameter just a few hours later. This suggests an RMW of about 15-20 nm, which is nearly the same as climatology (16 nm – Vickery et al. 2000) for its latitude and a central pressure ~980mb. The intensity is estimated to be 80 kt at 18Z on the 1st and 00Z on the 2nd, which is the new peak for the cyclone’s lifetime (previously the lifetime peak was 70 kt on the 3rd). On the 2nd, the hurricane had begun weakening and passed over St. Martin and St. Barthelemy with 991 mb pressure and near calm winds reported. While the time of these observations was not given, it is likely that these were just after 18Z on the 2nd and 991 mb is added to HURDAT as a central pressure. This central pressure suggests winds of 62 kt. Observations from the Leeward Islands were confused as various articles from the Monthly Weather Review are contradictory. For example, “estimated wind of 75 m.p.h. was reported at St. Kitts” in the seasonal summary published in December 1955, though Colon’s table in the January 1956 article showed “force 6-8” (25-35 kt). Likewise, the seasonal summary had 69 to 81 m.p.h. (likely converted from 60-70 kt) at St. Barthelemy, while Colon showed a maximum wind of only 35 kt for the same location. Colon did report strongest wind of 75 m.p.h. estimated at Saba. An intensity of 65 kt at 18Z is selected, which is the same as HURDAT previously. A landfall is indicated for St.

Martin around 21Z on the 2nd near 18.0N 63.0W and Category 1 sustained hurricane force winds likely occurred in St. Martin, Anguilla, Saba, and St. Barthelemy. As the cyclone moved into the northeastern Caribbean Sea, it continued weakening. Two aircraft reconnaissance flights were undertaken on the 3rd and one on the 4th. At 1355Z on the 3rd, the Air Force reconnaissance reported 999 mb central pressure, a poorly defined eye of 15 nm diameter (suggesting an RMW of ~10-15 nm), and estimated maximum flight level winds of 55 kt as seen in the microfilm. (It is noted that the MWR summary article stated that winds of 86 m.p.h. were reported from reconnaissance. However, this is contradicted by all of the remaining reports.) 999 mb central pressure suggests winds of 49 kt. 55 kt is reanalyzed for the intensity at 12Z and 18Z on the 3rd (in part due to the small size) down originally from 70 kt. A 2110Z Navy center fix from the same day measured 1000 mb central pressure and estimated maximum flight level winds of 50 kt. This central pressure suggests maximum winds of 47 kt. 50 kt is analyzed for 00Z (again slightly boosted because of the small size), down from 65 kt originally. The revised intensities are lowered to below hurricane force at 00Z on the 3rd, 36 hours earlier than in HURDAT originally. The last reconnaissance at 1346Z on the 4th by the Navy gave no central pressure, but did indicate that the highest estimated flight-level winds were down 30 to 35 kt. The intensity is reduced to 40 kt at 12Z on the 4th, down from 55 kt originally. While the intensity was dropped by at least 15 kt between 12Z on the 3rd to 18Z on the 4th, only one synoptic time – 06Z on the 4th - had a 20 kt reduction, a major change. Observations on the 5th and 6th over the eastern Caribbean continued to indicate gradual weakening and the cyclone is analyzed to have degraded to a depression around 06Z on the 5th (six hours earlier than originally) and dissipated after 00Z on the 6th (also six hours earlier than originally). The genesis and track of this rare December-January hurricane is analogous to Tropical Storm Zeta in 2005 and Tropical Storm Olga in 2007. It is also of note that in January 1951 yet another out-of-season cyclone developed, which has been reanalyzed to be a tropical storm.

1954 - Additional Notes

1) Historical Weather Maps and Microfilm depict a low pressure system northeast of the Leeward Islands with gale-force winds that moved generally northeast before becoming absorbed by a cold front. On the 25th of January, the tail-end of a frontal boundary was located north of Puerto Rico and by the 26th, a 1015 mb low pressure had developed north of the Leeward Islands on the tail of the frontal boundary. HWM also depicts on the 26th a trough or wave extending from 20N to 10N along 57W. These systems interacted and on the 27th, HWM shows a 1010 mb low pressure along the northern part of the trough near 23N 57W. By this time, HWM indicates that the frontal boundary had

dissipated. On the 28th, the system continued slowly moving north or northwest. The first gales associated with this disturbance appear at 18Z on the 28th. COADS shows a 35 kt ship near 27.1N 52.5W and another 35 kt ship near 23.2N 50.2W. Other available data at this time indicate that a low pressure may have been present but is not sufficient to close it. On the 29th, a strong cold front moved across the area and absorbed the system. Therefore, it is not added to HURDAT; but it might be considered as a possible hybrid or subtropical storm. This system is on David Roth's list of suspects.

DAY	LAT	LON	STATUS
Jan. 27	23N	57W	Subtropical Depression
Jan. 28	25N	59W	Subtropical Storm?
Jan. 29	33N	55W	Extratropical

2) Historical Weather Maps depicts an extratropical low pressure system meandering over the north Atlantic for almost two weeks during the 2nd and 3rd week of April. The system is first shown on the 13th near 40N 55W associated with an eastward-moving cold front. Over the next few days, the strong extratropical cyclone drifts to the northeast and on the 16th, HWM shows a low pressure of at most 995 mb near 44N 51W. Over the next 2 days it moves to the southeast and on the 18th it's located near 35N 45W. At this time, HWM shows that the cold front associated with the disturbance has begun to dissipate as it evolves into a large occluded cyclone of at most 1005 mb. Over the next 3 days, the low pressure drift to the southeast and continues to show a large circulation associated with a non-tropical cyclone. On the 22nd it's located near 32N 43W as a cold front is approaching from the northwest. HWM shows an elongated low pressure system, likely as a response to the approaching cold front. The circulation remains broad and gale-force winds are depicted over 200 miles away from the center, indicating that the system is likely non-tropical. By the 23th, the system is gone from HWM, likely absorbed by the cold front. Therefore, it is not added to HURDAT; but it might be considered as a possible hybrid or subtropical storm. This system is on David Roth's list of suspects.

DAY	LAT	LON	STATUS
Apr. 21	32N	42W	Extratropical
Apr. 22	32N	43W	Subtropical Storm?
Apr. 23	41N	29W	Extratropical

3) Historical Weather Maps depicts an extratropical cyclone embedded within a cold front near 47N 30W. The non-tropical system moved south over the next 3 days and on the 19th of May it's located near 41N 31W. By this time, HWM shows that the frontal system has dissipated and the storm has developed into an occluded cyclone of at most

1010 mb. Over the next few days, the cyclone moves southwest and weakens until dissipation by the 26th over the central Atlantic. Gale-force winds are reported by a ship on the 20th but this ship is about 4 degrees of longitude to the west of the center of the cyclone, an indication that the strongest winds are away from the low pressure, which is normal in non-tropical cyclones. Therefore, it is not added to HURDAT; but it might be considered as a possible hybrid or subtropical storm. This system is on David Roth's list of suspects.

DAY	LAT	LON	STATUS
May 19	41N	31W	Subtropical Depression
May 20	39N	30W	Subtropical Storm?
May 21	38N	30W	Subtropical Storm?
May 22	35N	33W	Subtropical Depression
May 23	33N	36W	Subtropical Depression
May 24	30N	37W	Subtropical Depression
May 25	27N	43W	Subtropical Depression

4) Historical Weather Maps depicts a stationary cold front over the central Atlantic on the 21st of June. The system slowly moves to the east and on the 23rd a low pressure of at most 1020 mb is shown near 32N 54W. On the 24th, HWM shows a trough of low pressure extending from 35N to 25N and along 54W. At 18Z on the 24th, there is some indication that a small low pressure could have been located near 33N 53W. HWM shows a 30 kt ship near 33.7N 51.2W but microfilm shows 40 kt in relation to the same ship. Unfortunately, there is not enough data to close the low pressure. At 0Z on the 25th the low pressure looks better defined based on the plotted COADS' data and could have been located near 34.5N 53W. But at this time there are no gales or low pressures to indicate that it was a tropical storm. Later on the day, a cold front approaching from the west absorbs the small system. Therefore, it is not added to HURDAT; but it might be considered as a possible tropical storm.

DAY	LAT	LON	STATUS
June 23	32N	54W	Tropical Depression
June 24	33N	53W	Tropical Storm?
June 25	35N	32W	Absorbed

5) Historical Weather Maps and Microfilm depict a cold front across the southeast of the United States on July 9. By July 10, a low pressure had developed near the Georgia coast and on July 11, the system had moved over the Atlantic Ocean and began to intensify. At this time, the low pressure was moving to the northeast over or near the Gulf Current. The first gale on COADS appears on July 11 at 18Z, 45 kt S and 1011 mb. On the 12th, the storm continued to move northeast and made its closest approach to North Carolina. At 0Z, a ship reported 35 kt NE and 1006 mb. At 6Z, the Flying Pan lighttower reported

35 kt at a height of 56 ft or 17 meters, which is 34 kt at 10 meters. At 12Z, another ship reported 35 kt SW and 1010 mb. On the 13th, the system accelerates to the northeast and is rapidly absorbed by an approaching cold front. During the analyses it was decided that the system did not completely lose its non-tropical characteristics. The dew point values over land but near the coast were in the 40s and 50s late on the 12th and early on the 13th, indicating cold, dry air over the western portion of the system. But it's possible that it may have been a subtropical or tropical storm. Therefore, it's not added to HURDAT.

DAY	LAT	LON	STATUS
July 10	31N	81W	Extratropical
July 11	33N	78W	Subtropical Storm?
July 12	34N	75W	Tropical Storm?
July 13	38N	71W	Tropical Depression

6) Historical Weather Maps and Microfilm depict a cold front between Bermuda and the SE United States on the last week of July. By the 28th, a low pressure had formed along the cold front or trough and it was moving to the southwest. By the 29th, the system turns to the west while ships in the area indicate that the surface pressures were rising. By July 31, the weakened system was approaching the coast and appears to have dissipated by August 1st. No gales appear on COADS, HWM or Microfilm. Therefore, it is not added to HURDAT. This system is on David Roth's list of suspects.

DAY	LAT	LON	STATUS
July 28	35N	71W	Extratropical
July 29	31N	73W	Subtropical Depression
July 30	31N	76W	Subtropical Depression
July 31	30N	80W	Subtropical Depression

7) Historical Weather Maps, the microfilm maps, COADS, and Monthly Weather Review observations indicate that a system that was indicated to be the early portion of Hurricane Edna on the 2nd through the 4th of September was instead a separate tropical depression. The cyclone formed east of the Lesser Antilles on the 1st of September and moved due westward over the next three days before dissipating over South America late on the 4th. No gales or low pressures were observed from this system, but it is possible that it reached tropical storm intensity at some point during its lifetime.

DAY	LAT	LON	STATUS
Sep 1	11N	54W	Tropical Depression
Sep 2	11N	56W	Tropical Depression
Sep 3	11N	62W	Tropical Depression
Sep 4	11N	65W	Tropical Depression

8) Historical Weather Map, Microfilm and Monthly Weather Review depict a trough or low pressure system that moved across the Gulf of Mexico during the second week of September. On September 14 at 12Z, HWM indicates that a low pressure was present just north of the Yucatan peninsula. On the 15th at 12Z, HWM indicates a closed low pressure system of at most 1005 mb near 25.5N, 89.0W. MWR puts the system near 25N, 89W. A NAVY aircraft flew into the disturbance late on the 15th and didn't find a closed circulation. Three gales, all from the ship named "Gulf Skipper," are on COADS and microfilm on the 15th but other ship data indicates that these gales are likely too high. On the 16th at 12Z, HWM shows a closed system of at most 1005 mb near 27N, 93W. MWR places the center much further south at the same time, located near 23N, 90W. The NAVY aircraft had 2 flights and in both cases found no closed circulation. On the second flight it did find 40-kt winds at 20Z near 29N, 88W, about 300 miles away from the apparent center. Two ships reported gale-force winds on the 16th at 0Z and appear to be consistent with the winds reported by the nearby ships. Unfortunately, there is no information available to indicate that a closed low pressure was present. At 18Z, 2 more gales are present on the NE quadrant of the system and winds in the coast of Louisiana are up to 25 kt, which is possibly a result of the pressure gradient with the strong high pressure over the SE of the United States. On September 17 at 12Z, the low pressure system was near 26N, 95W according to HWM and near 25N, 95W according to MWR. No gales or low pressures were present on the 17th and based on the data, the system was inland over NE Mexico by 18Z. Dissipation occurred on September 18. Therefore, it is not added to HURDAT but it's possible it may have been a tropical storm. This system is on Jack Beven's list of suspects.

DAY	LAT	LON	STATUS
September 14	24N	87W	Disturbance
September 15	25N	89W	Tropical Depression
September 16	27N	93W	Tropical Storm?
September 17	26N	95W	Tropical Storm?
September 18	26N	99W	Dissipated

9) Historical Weather Map and Microfilm depict a trough or low pressure system over the Gulf of Mexico that moved generally to the west during the first week of October. Three flights made by the NAVY aircrafts indicate that the disturbance had a closed low-level circulation but no winds of gale force or low pressures were measured. No gales were observed on COADS and only one 35-kt ship appears on microfilm on October 3rd at 18Z. Due to the lack of evidence of tropical storm force winds, this system is not added to HURDAT but it may have been a weak tropical storm. This system is on Jack Beven's and David Roth's list of suspects.

DAY	LAT	LON	STATUS
October 2	23N	85W	Tropical Depression
October 3	24N	93W	Tropical Depression
October 4	27N	97W	Tropical Depression
October 5	28N	101W	Dissipated

10) Historical Weather Map depicts a cold front on the 26th in the Central Atlantic. A low pressure develops near 29N, 57W along the frontal boundary on the 27th. On the 28th, the system is located near 31N, 52W and although the HWM shows it associated with a frontal feature; ships in the area indicate that the front may have already dissipated. On the 29th at 0Z, a stationary ship at 35N, 48W reported 35 kt but it reports the lowest central pressure of 1011 mb nine hours later and 25 kt. On the 29th at 12Z, the well-defined low pressure was located near 36N, 46W and a strong cold front was approaching from the northwest. By the 30th, the low pressure had become embedded with the cold front. It's possible that this system was a tropical storm but at the moment there's insufficient data and won't be added to HURDAT.

DAY	LAT	LON	STATUS
October 27	24N	57W	Low Pressure
October 28	31N	52W	Tropical Depression
October 29	36N	46W	Tropical Storm?
October 30	37N	45W	Extratropical

11) Historical Weather Maps, Monthly Weather Review and Microfilm depict a low pressure system in the Gulf of Mexico during the second week of November that moved generally north and became an extratropical cyclone before moving over the southeast. A cold front dropped into the Gulf of Mexico on the first week of November and a low pressure is depicted in the HWM on the 12th near 22N, 93W. MWR shows the system located near 24N, 92W. Ship and land reports show a cold airmass over the western Gulf of Mexico. The cold air subsided over the next few days as the system moved north, but it remained too cold to allow for subtropical or tropical transition before frontogenesis took place on the 15th. Therefore, this system is not added to HURDAT. This system is on Jack Beven's list of suspects.

DAY	LAT	LON	STATUS
November 11	20N	93W	Extratropical
November 12	22N	93W	Extratropical
November 13	25N	93W	Extratropical
November 14	26N	93W	Extratropical
November 15	28N	90W	Extratropical

12) Historical Weather Maps depict an extratropical low pressure on the third week of December over the north Atlantic. The system moves southeast and becomes occluded by

the 20th near 31N, 45W. Gale-force winds were present but temperature reports from nearby ships indicate that the low pressure remained embedded within a cold airmass and the system never transitioned to a subtropical or tropical storm. Therefore, this system is not added to HURDAT. This system is on David Roth's list of suspects.

DAY	LAT	LON	STATUS
December 18	40N	43W	Extratropical
December 19	37N	41W	Extratropical
December 20	36N	46W	Occluded
December 21	27N	45W	Occluded
December 22	24N	39W	Occluded
December 23	22N	39W	Occluded
December 24	22N	39W	Occluded
December 25			Dissipated

1955 hurricane season

Tropical Storm Brenda [July 31 – August 3, 1955]

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38600 07/31/1955 M= 4  1 SNBR= 846 BRENDA      XING=1 SSS=0

38605 07/31*  0   0   0    0*  0   0   0    0*  0   0   0    0*275 884  50    0*
38605 07/31*  0   0   0    0*  0   0   0    0*274 879  35    0*278 882  45    0*
                                             *** ***  **      *** ***  **

38610 08/01*282 886  55    0*288 888  60    0*293 890  60    0*299 895  55    0*
38610 08/01*282 884  45 1005*286 886  50    0*293 890  55    0*299 895  55    0*
              ***  ** **** *** ***  **                 **
38615 08/02*306 904  45    0*311 916  35    0*315 928  30    0*318 938  25    0*
38615 08/02*306 904  40    0*311 916  30    0*315 928  25    0*318 938  25    0*
                    **                **                 **
38620 08/03*321 950  25    0*325 962  25    0*  0   0   0    0*  0   0   0    0*
38620 08/03*322 947  25    0*327 950  20    0*  0   0   0    0*  0   0   0    0*
           *** ***          *** ***  **

38625 TS
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U.S. Tropical Storm Landfall

08/01 17Z 29.7N 89.4W 55 kt LA

Minor changes to the track and to the intensity shown in McAdie et al. (2009). Evidence for these alterations comes from the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Monthly Weather Review, the Local Climatological Data, Connor (1956) and the Navy aircraft reconnaissance book.

July 30:

HWM and HURDAT does not analyze an organized system. Microfilm analyzes a low pressure centered near 27.5N, 84.2W at 12Z. MWR shows a low pressure of 1010 mb located near 30.5N, 87.2W at 12Z. Ship highlights: No gales or low pressures.

July 31:

HWM shows a closed low pressure of at most 1010 mb centered near 28.0N, 88.2W at 12Z. HURDAT lists this as a 50 knot tropical storm at 27.5N, 88.4W at 18Z. Microfilm analyzes a closed low pressure of at most 1011 mb centered near 27.0N, 88.0W at 12Z. MWR shows a low pressure of 1007 mb located near 27.3N, 87.5W at 12Z. Ship highlights: 35 kt WNW and 1014 mb at 12Z near 26.6N, 87.8W (COADS). 45 kt SW and 1014 mb at 15Z near 26.9N, 87.9W (micro). 35 kt W and 1008 mb at 18Z near 26.9N, 88.9W (COADS). 40 kt WSW and 1012 mb at 18Z near 27.6N, 88.3W (COADS). 35 kt and 1009 mb at 18Z near 27.3N, 88.0W (COADS). Aircraft highlights: NAVY center fix at 2105Z at 27.6N, 88.3W (micro).

August 1:

HWM shows a tropical storm of at most 1005 mb centered near 29.5N, 88.5W at 12Z. HURDAT lists this as a 60 kt tropical storm at 29.3N, 89.0W at 12Z. Microfilm analyzes a closed low pressure of at most 1005 mb centered near 29.2N, 89.0W at 12Z. MWR shows a low pressure of 1003 mb located near 29.5N, 88.5W at 12Z. Ship highlights: 40 kt SSW and 1004 mb at 00Z near 28.0N, 87.6W (micro). 35 kt WSW and 1010 mb at 00Z near 26.5N, 88.8W (COADS). 45 kt SW and 1010 mb at 00Z near 26.6N, 88.0W (COADS). 35 kt W and 1010 mb at 06Z near 26.5N, 89.7W (COADS). Aircraft highlights: NAVY center fix at 0025Z at 28.1N, 88.4W, max winds of 35 kt and 1005 mb (micro). NAVY center fix near 1630Z at 29.7N, 89.1W, max winds of 60 kt and 998 mb (peripheral) (micro). Land highlights: 25 kt SW and 1000 mb at Pilottown, LA at 13Z (micro). 40 kt SSE and 1008 mb at Fort Morgan, AL at 15Z (micro/CONNOR). 35 kt SSE at Bay St. Louis, MS (CONNOR). 1003 mb at New Orleans (CLIMA)

August 2:

HWM shows a closed low pressure of at most 1010 mb centered near 31.3N, 92.5W at 12Z. HURDAT lists this as a 30 kt tropical depression at 31.5N, 92.8W at 12Z. Microfilm analyzes a closed low pressure of at most 1011 mb centered near 32.5N, 93.5W at 12Z. MWR shows a low pressure of 1007 mb located near 31.7N, 93.0W at 12Z. Land highlights: 39 kt at Gulfport, MS, at 0340Z (CONNOR). 15 kt NW and 1004 mb at Baton Rouge, LA (CLIMA). 30 kt at Lake Charles, LA (MWR 1955).

August 3:

HWM shows a closed low pressure of at most 1010 mb centered near 33.2N, 95.0W at 12Z. HURDAT lists this as a 25 kt tropical depression at 32.5N, 96.2W at 06Z (last position). Microfilm does not analyze a tropical low pressure at 12Z. MWR shows a low pressure of 1007 mb located near 33.7N, 95.9W at 12Z.

ATSR: “Tropical Storm Brenda,” the second storm of the 1955 season, formed and behaved quite the same as tropical storm “Barbara” of the 1954 season (see annual Tropical Storm Report – 1954). Both storms generated from a weak low pressure circulation associated with a quasi-stationary front extending westward from the Atlantic Seaboard into Georgia and Alabama. The first indication of the extratropical low was detected on 30 July at 0030Z and by 0300Z a closed low was also evident at the 700 mb level. The surface low was watched carefully for tropical storm development since the surface low was moving slowly southward toward the warm waters of the Gulf of Mexico and was being subjected to divergent flow aloft at the 500 and 200 mb levels. By 310300Z, the surface and 700 mb low had deepened and slightly intensified as it had moved southwesterly to the south of Burrwood, Louisiana.

Aircraft weather reconnaissance was immediately ordered for the afternoon of 31 July. Shortly after arriving in the area, the weather reconnaissance aircraft reported maximum winds of 50 knots on the southern edge of a large calm area centered near 27.6N 88.3W at 312105Z. This elongated, calm area was without tropical eye characteristics but was located by wind shift and minimum pressure. The first coordinated warning on "Tropical Storm Brenda" was issued at 312300Z on the basis at the aircraft reports and the 311830Z surface reports. At this time, "Brenda" was expected to intensify and move toward the west or west-northwest with the flow in which it was embedded. Instead, "Brenda's" center became larger and orientated north-south while drifting slowly some 120 miles to the north before changing course to the west. By 011830Z, "Brenda" appeared to have become more tropical in character. The pressure gradient had increased and it is probable that an eye had replaced the weak circulation center. It was fortunate that "Brenda" passed inland before being able to intensify into a destructive hurricane. "Brenda" moved inland between Gulfport, Mississippi, and New Orleans, Louisiana, about 012030Z without significant damage to the coast. The final warning was issued at 012200Z, August, placing the storm just north of Lake Pontchartrain, Louisiana, moving westward and weakening rapidly.

"Tropical Storm Brenda" and "Barbara" of the 1954 season were almost identical twins. Both formed from a low center associated with a frontal trough which moved south of the southern United States into the Gulf of Mexico. They were both unique in that they were "hybrid" storms, half tropical and half extra-tropical, Neither, as far as is known, attained an "eye" but "Brenda" most probably would have assumed complete tropical characteristics had it remained over the waters of the Gulf of Mexico for a slightly longer period of time.

MWR: July 31-August 2. A weak low-pressure area over the northern Gulf of Mexico on July 29 and 30 was designated Tropical Storm Brenda on July 31 when it was about 100 miles south-southeast of Burrwood, LA. Winds were estimated at 50 to 60 mph near the center. The storm moved slowly for several hours, crossed the Louisiana coast during the afternoon at August 1 and was centered about 30 miles northeast of New Orleans. After moving inland the storm weakened rapidly and at 10 pm had reached a position 20 miles northwest of Baton Rouge, LA, with the strongest winds near the center 20 to 25 mph. Two deaths occurred in automobile accidents directly attributable to the storm. Damage along the Mississippi, Louisiana, and Alabama coasts was limited to small piers, fishing and pleasure craft, and flooding of highways.

Genesis for Brenda is begun six hours earlier than originally shown in HURDAT, as observations at 12Z on July 31st indicate that the system did have a closed circulation. The system is started as a tropical storm through the evidence of ship observations near

the system's center. Observations early on the 31st indicate that the circulation was still very elongated and broad, therefore, a depression stage is not shown. Minor track changes were introduced on all four days of this system's existence except for the 2nd of August. The largest change (> deg) on the last position of the cyclone (06Z on the 3rd).

The Navy Aircraft Reconnaissance flew three missions to the cyclone making three fixes. On August 1st at 0025Z, it measured a central pressure of 1005 mb, which suggests winds of 34 kt from the Brown et al. north of 25N pressure-wind relationship and 36 kt intensifying. An intensity of 45 kt is selected for August 1st at 0Z based on the Reconnaissance data and ship observations (down from 55 kt originally). On August 1st at 1906Z, the NAVY airplane measured a peripheral pressure of 998 mb, which suggests maximum winds of at least 47 kt north of 25N and 49 kt intensifying. Based on the 1000 mb measured in Pilottown, LA at 13Z and 998 mb measured by reconnaissance near 1630Z, an intensity of 50 kt is selected during 12Z to 18Z. 55 kt is the peak intensity for this cyclone (originally 60 kt). The tropical storm made landfall in SE Louisiana around 17Z on the 1st near 29.7N, 89.4W with maximum winds around 55 kt. This is five knots lower than the last synoptic time before landfall in HURDAT originally. Highest observations from land were 25 kt SW and 1000 mb at Pilottown, LA, at 13Z on August 1st, 40 kt SSE at Fort Morgan, AL, at 15Z on the 1st and 39 kt at Gulfport, MS, at 0340Z on the 2nd. After landfall, the cyclone moved west-northwest across Louisiana entering eastern Texas late on the 2nd. New Orleans, LA measured 1003 mb on August 1st and 1004 mb were recorded at Baton Rouge, LA on the 2nd. Gradual weakening took place after landfall and weakening to a tropical depression occurred at 06Z on August 2nd, six hours earlier than originally shown in HURDAT. The cyclone dissipated after 06Z on the 3rd, based upon numerous observations over the south Central United States.

Hurricane Connie [August 3-15, 1955]

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38630 08/03/1955 M=13  2 SNBR= 847 CONNIE      XING=1 SSS=3
38630 08/03/1955 M=13  2 SNBR= 847 CONNIE      XING=1 SSS=2
                                                     *
38635 08/03*  0   0   0    0*153 356  30    0*157 392  35    0*161 427  40    0*
38635 08/03*  0   0   0    0*153 400  30    0*157 421  35    0*161 442  40 1004*
                           ***             ***             ***     ****

38640 08/04*164 453  40    0*167 470  40    0*170 487  45 1002*174 509  50    0*
38640 08/04*165 460  50    0*170 475  60    0*176 488  70    0*180 505  70    0*
           *** ***  **      *** ***  **      *** ***  **    * *** ***  **

38645 08/05*177 530  60    0*180 549  95    0*183 566 110  985*187 577 115    0*
38645 08/05*181 523  70    0*182 542  70    0*183 561  75    0*184 579  75  985*
           *** ***  **      *** ***  **      *** ***  **    * *** ***  **  ***

38650 08/06*190 588 120    0*193 603 120    0*196 619 125  982*197 636 125    0*
38650 08/06*187 595  80    0*190 609  85    0*193 624  90    0*196 639 100  968*
           *** ***  **      *** ***  **      *** ***  **    * *** *** ***  ***
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38655 08/07*202 652 125    0*209 667 125    0*220 680 125  952*229 691 125  944*
38655 08/07*204 652 100    0*212 664 105    0*220 676 110  952*228 688 115  944*
           ***     ***      ***  ***  ***          ***  ***      ***  ***  ***

38660 08/08*239 700 125    0*250 708 125    0*262 715 125  944*273 720 125  936*
38660 08/08*239 700 115    0*250 711 110    0*261 718 110  944*270 723 105  944*
                   ***          ***  ***      ***  ***  ***      ***  ***  ***  ***

38665 08/09*283 726 125    0*292 732 125    0*297 737 125  958*300 742 125  954*
38665 08/09*279 729 105    0*287 734 100    0*294 738 100  958*300 742  95  954*
           ***  ***  ***      ***  ***  ***      ***  ***  ***                **

38670 08/10*304 746 125    0*306 749 125  977*308 753 125  970*309 760 120    0*
38670 08/10*304 748  85    0*307 753  85    0*309 758  85  972*311 764  85  970*
                ***  **      ***  ***  **    * ***  ***  **  ***  ***  ***  **  ***

38675 08/11*311 768 115    0*315 769 105    0*321 770  95  975*328 770  90    0*
38675 08/11*313 769  80  973*316 770  80    0*321 770  75  978*327 771  75  977*
           ***  ***  **  ***  ***  ***  **                **  ***  ***  ***  **  ***

38680 08/12*336 770  85    0*342 766  80    0*348 762  70  965*356 760  65  962*
38680 08/12*332 770  80    0*337 769  80    0*343 768  85  965*350 766  85  962*
           ***      **      ***  ***          ***  ***  **      ***  ***  **  ***

38685 08/13*366 759  60  969*379 759  50  974*392 764  45  982*407 774  35  995*
38685 08/13*363 761  75    0*377 762  60    0*391 766  45    0*405 774  35  995*
           ***  ***  **    * ***  ***  **    * ***  ***        * ***

38690 08/14*420 787  30  998*429 802  25 1002*437 816  25 1006*445 826  25 1010*
38690 08/14*419 793  30  998*429 813  25 1002*437 825  25 1006*445 833  25 1010*
           ***  ***           ***                ***           ***  ***

38695 08/15*454 830  25    0*463 830  25    0*  0   0   0    0*  0   0   0    0*
38695 08/15*454 830  25 1011*  0   0   0    0*  0   0   0    0*  0   0   0    0*
                        ****   *   *   *

38700 HR NC3 VA1
38700 HR NC2 VA1
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U.S. Hurricane:
Aug 12th – 15Z – 34.7N 76.7W – 85 kt – Category 2 – 962 mb – 1011 mb OCI – 425 nm ROCI

Major track and intensity changes are analyzed for this classic Cape Verde hurricane that made landfall in North Carolina. A major change is made to the time this cyclone first became a hurricane and a major hurricane. Evidence for these alterations comes from the Historical Weather Maps Series, the COADS ship database, Monthly Weather Review, USWB/NHC microfilm of synoptic weather maps, the Climatological Data, Schwerdt et al. (1979), Ho et al. (1987) and Jarrell et al. (1992).

August 2:

HWM shows a closed low pressure of at most 1010 mb centered near 11.0N, 41.0W along the ITCZ at 12Z. HURDAT does not analyze an organized system on this date. Microfilm is not available. Ship highlights: No gales or low pressures. “The

irregular Cape Verde reports provide no evidence of any unstable wave passing through the area in which Connie might later have developed" (MWR).

August 3:

HWM shows a closed low pressure of at most 1010 mb centered near 12.0N, 44.0W along the ITCZ at 12Z. HURDAT lists this as a 35 knot tropical storm at 15.7N, 39.2W at 12Z. Microfilm analyzes a closed low pressure of at most 1011 mb centered near 16.5N, 44.0W at 18Z (first available). Ship highlights: 10 kt NW and 1005 mb at 18Z near 15.8N, 44.5W (COADS/MICRO). "The first indications of hurricane Connie were noted on the morning of August 3 when the SS Mormacreed reported unusually strong westerly winds and showery, squally weather between Latitudes 5º and 10º N, and Longitudes 50º and 55ºW. At the same time another ship, the African Sun, passed through a strong easterly wave in the vicinity of Latitude 16ºN and Longitude 45ºW" (MWR). "On the 2nd and 3rd of August, the tropical analysis to the east of the Lesser Antilles, from the scant number of reports, indicated a weak vortex, in the Intertropical Convergence Zone (ITC), moving along the 12th parallel. In addition, an easterly wave, previously believed to be of weak to moderate intensity, indicated possible vortex development in the vicinity of 13N and 46W at 031230Z. Later the combined ship reports from the BONAIRE and KFDE at 031230Z and 031830Z indicated the vortex had developed slightly further north in the vicinity of 15N 46.5W" (ATSR).

August 4:

HWM shows a closed low pressure of at most 1000 mb centered near 17.7N, 48.8W at 12Z. HURDAT lists this as a 45 knot tropical storm at 17.0N, 48.7W at 12Z. Microfilm analyzes a closed low pressure of at most 999 mb centered near 18.1N, 48.5W at 18Z. Ship highlights: 40 kt NW and 996 mb at 03Z near 17.0N, 47.2W. 30-40 kt NW and 997 mb at 17.8N, 49.5W at 1130Z. 30 kt S and 1003 mb at 17.0N, 50.5W at 15Z. All observations from MICRO. "The SS Bonaire reported a pressure of 996.2 mb (29.42 inches) and a wind of east-northeast force 8 at 2200 EST of the 3rd, providing the first indication that a strong vortex had formed in the northern end of the easterly wave. Earlier in the day, there were some indications of a vortex in the southern end but the principal cyclogenesis took place in the top end of the wave, as is usually the case, and hurricane Connie was born. Reconnaissance aircraft on the 4th reported the eye at Latitude 15.8ºN and Longitude 52.8ºW, with a false radar eye about 75 miles northeast of this position. Highest wind observed was 55 knots in the northeast quadrant. As it turned out, the false eye proved to be the real vortex which developed rapidly into hurricane Connie" (MWR). "A later report from the ship BONAIRE at 040300Z was the first definite indication that the disturbance was deepening rapidly. Their surface pressure had fallen from 1005 mbs to 996.2 mbs in three hours and the wind had veered from north to

east-northeast 40 knots. This revealed the center to be very near the position of the BONAIRE at 040300Z and that the disturbance was of storm intensity. A good fix was obtained at 041130Z on the center of "Storm Connie" when the ship LINDA ELRA, heading on a south-west course at a speed of advance of 15 knots, passed within an estimated 12 miles of the storm center. Hourly reports received from this ship showed the winds backing from northeast to northwest and increasing to 40 knots, and the pressure falling from 1002.4 mbs to 996.6 mbs in an hour and a half, as the ship neared the estimated position of the storm center. From this information, a speed check indicated the storm center to be moving west-northwest at 15 knots. Aircraft reconnaissance was first made into "Connie" by an Air Force flight from Bermuda on the 4th of August. Flying at the 500 mb level, the center fix reported by the reconnaissance flight was approximately 150 miles to the southwest of the expected storm track, therefore, it was believed unreliable in weight of other data, and was not used" (ATSR).

August 5:

HWM shows a hurricane of at most 1000 mb centered near 18.3N, 57.9W at 12Z. HURDAT lists this as a 110 kt hurricane at 18.3N, 56.6W at 12Z. Microfilm analyzes a closed low pressure of at most 993 mb centered at 18.2N, 57.0W at 12Z. Ship highlights: 65 kt N and 1008 mb at 18.1N, 58.5W at 21Z (MICRO). Aircraft highlights: Penetration center fix at 18.2N, 56.7W at 1110Z (ATSR); Penetration center fix, 75-90 kt max surface winds, 985 mb central pressure centered at 18.4N, 57.9W at 1805Z (MICRO). "The storm moved west to west-northwest at 14 to 16 mph, gradually increasing in size and intensity and by the morning of the 5th, maximum winds were estimated at 125 mph with a central pressure of 985 mb (29.09 inches)" (MWR). "The second reconnaissance flight was made by a Navy reconnaissance aircraft with a low level center penetration. This center fix obtained at 051110Z revealed that "Connie" had continued on a west to west-northwest course, as anticipated, at a speed of about 18 knots and had not dipped to the southwest as the first reconnaissance flight had indicated. Maximum winds reported had increased to 110 knots and the minimum central surface pressure had decreased to 985 mbs showing a considerable intensification during the past 24 hours" (ATSR).

August 6:

HWM shows a hurricane of at most 995 mb centered near 20.3N, 62.0W at 12Z. HURDAT lists this as a 125 kt hurricane at 19.6N, 61.9W at 12Z. MWR shows a low pressure of 992 mb located near 20.0N, 62.3W at 12Z. Microfilm analyzes a closed low pressure of at most 1002 mb centered at 20.0N, 62.0W at 12Z. Ship highlights: 45 kt ESE and 1005 mb at 21.1N, 60.5W at 12Z. 40 kt E and 1006 mb at 22.5N, 62.0W at 12Z. 65 kt N and 979 mb at 19.8N, 64.5W at 18Z. 50 kt E and 1008 mb at 21.0N, 60.7W at 18Z. 35 kt S and 977 mb at 19.8N, 64.6W at 21Z. All observations from MICRO. Land

highlights: 20 kt W and 1002 mb at St. Kitts and Navis at 9Z. 45 kt SW and 1002 mb at Anguilla at 15Z. 35 kt S and 1004 mb at Anguilla at 21Z. All observations from MICRO. Aircraft highlights: Radar center fix at 19.1N, 60.9W at 0609Z (ATSR); Radar center fix at 19.9N, 62.8W at 1009Z (ATSR); Penetration center fix measured a central pressure of 978 at 19.5N, 63.8W at 1712Z (micro); Penetration center fix measured a central pressure of 968 mb and max surface winds of 125 kt centered at 19.6N, 63.9W at 18Z (micro); Penetration center fix at 20.3N, 64.6W at 2005Z (ATSR). “The hurricane center passed some 40 to 50 miles north of the northern Leeward Islands and Puerto Rico, attended by gale winds with peak gusts of 80 to 100 mph and moderately heavy rains in the islands” (MWR).

August 7:

HWM shows a hurricane of at most 995 mb centered near 22.5N, 67.5W at 12Z. HURDAT lists this as a 125 kt hurricane at 22.0N, 68.0W at 12Z. MWR shows a low pressure of 980 mb located near 22.5N, 67.9W at 12Z. Microfilm analyzes a closed low pressure of at most 990 mb centered at 22.3N, 68.3W at 12Z. Ship highlights: 45 kt SSE and 998 mb at 20.3N, 64.7W at 0Z (COADS/MICRO). 50 kt SE and 1003 mb at 20.8N, 64.9W at 6Z (COADS). 55 kt ENE and 1003 mb at 23.9N, 68.0W at 15Z (MICRO). 65 kt E and 999 mb at 23.7N, 60.6W at 18Z (COADS). 100 kt WNW and 995 mb at 23.4N, 69.3W at 21Z (COADS). 100 kt SE and 998 mb at 23.7N, 67.5 W at 21Z (micro). Land highlights: 15 kt SW and 1004 mb at San Juan, Puerto Rico at 0Z (MICRO). 20 kt SW and 1003 mb at Punta Cana, Dominican Republic at 12Z. 25 kt WNW and 1002 mb at Grand Turk at 21Z. Aircraft highlights: Radar center fix at 20.8N, 65.9W at 0304Z (ATSR); Radar center fix at 21.7N 66.8W at 0634Z (ATSR); Radar center fix at 22.0N, 67.7W at 1251Z (ATSR); Penetration center fix at 22.4N, 68.3W at 1355Z (ATSR); Penetration center fix at 22.4N, 68.3W at 1430Z (ATSR); Penetration center fix at 22.3N, 68.4W at 1530Z (ATSR); Penetration center fix at 22.4N, 68.4W at 16Z (ATSR); Penetration center fix at 22.9N, 68.6W at 1730Z (ATSR); Penetration center fix measured max surface winds of 125 kt, central pressure of 944 mb and a 38 mile diameter eye at 22.8N, 68.8W at 1800Z (micro). “On August 7 the eye was described by the observer as being shaped like an inverted cone, with the calm area less than 8 miles in diameter at the surface and 38 miles across at 18,000 feet. Maximum surface wind at this time was estimated at 145 mph and lowest pressure was 952 mb (28.11 inches) measured by dropsonde” (MWR). “Lowest pressure in the hurricane eye estimated 27.88 inches” (WBO).

August 8:

HWM shows a hurricane of at most 995 mb centered near 26.7N, 71.3W at 12Z. HURDAT lists this as a 125 kt hurricane at 26.2N, 71.5W at 12Z. MWR shows a low

pressure of 960 mb located near 26.8N, 71.9W at 12Z. Microfilm analyzes a closed low pressure of at most 984 mb centered at 26.0N, 72.0W at 12Z. Ship highlights: 55 kt SE and 1002 mb at 24.3N, 67.6W at 0Z (COADS). 80 kt SE and 1004 mb at 23.9N, 67.5W at 0Z (COADS). 55 kt SE and 1006 mb at 25.5N, 68.0W at 6Z (COADS). 55 kt SE and 1004 mb at 27.0N, 72.0W at 18Z (MICRO). Land highlights: 20 kt SW and 1003 mb at Grand Turk at 0Z. 25 kt NW and 1002 mb at San Salvador, Bahamas at 9Z. 25 kt W and 1005 mb at San Salvador, Bahamas at 21Z. All observations from MICRO. Aircraft highlights: Radar center fix measured a 28 mi diameter eye at 24.3N, 70.7W at 02Z (ATSR/micro); Radar center fix measured a 35 mi diameter eye at 25.0N, 71.6W at 06Z (ATSR/micro); Penetration center fix at 26.5N, 71.9W at 1350Z (ATSR); Penetration center fix measured max surface winds of 120 kt, a central pressure of 944 mb and a 40 mile diameter eye at 27.0N, 72.5W at 1600Z (MICRO); Penetration center fix measured max surface winds of 110 kt, a central pressure of 944 mb and a 40 mile diameter eye at 26.8N, 72.2W at 1704Z (MICRO). “On the next day, the central pressure had diminished to 944 mb (27.88 inches) the lowest during the life of the hurricane, as it moved northwestward some 200 to 250 miles east of the Bahama Islands” (MWR). “The Navy Reconnaissance plane this morning found the eye 40 miles in diameter and the central pressure 27.88 inches” (WBO). “Air Force and Navy Reconnaissance planes late this forenoon found that the central pressure was remaining steady at 27.88 inches” (WBO).

August 9:

HWM shows a hurricane of at most 990 mb centered near 30.2N, 73.3W at 12Z. HURDAT lists this as a 125 kt hurricane at 29.7N, 73.7W at 12Z. MWR shows a low pressure of 960 mb located near 29.8N, 74.0W at 12Z. Microfilm analyzes a closed low pressure of at most 987 mb centered at 30.0N, 74.0W at 12Z. Ship highlights: 50 kt SE and 1007 mb at 31.3N, 71.2W at 10Z (MICRO). 50 kt SE and 1007 mb at 31.2N, 70.0W at 15Z (MICRO). 50 kt SE and 1007 mb at 31.5N, 71.5W at 18Z (COADS). 50 kt N and 1005 mb at 31.5N, 77.2W at 18Z (MICRO). Aircraft highlights: Penetration center fix at 28.5N, 73.0W at 0245Z (ATSR); Penetration center fix at 28.5N, 73.0W at 0330Z (ATSR); Penetration center fix at 28.7N, 74.1W at 0630Z (ATSR); Penetration center fix at 29.1N, 73.3W at 0706Z (ATSR); Penetration center fix at 29.2N, 73.5W at 08Z (ATSR); Penetration center fix measured a central pressure of 959 mb and a 35 mile diameter eye at 29.9N, 74.1W at 1440Z (ATSR); Penetration center fix measured a central pressure of 961 mb and a 34 mile diameter eye at 30.1N, 74.5W at 20Z (MICRO); Penetration center fix measured max surface winds of 135 kt at 30.2N, 74.8W at 2248Z (micro). “The hurricane slowed to 6 to 8 mph in forward speed 400 to 500 miles off the northeastern coast of Florida and central pressure had filled to 954 mb (28.17 inches) by the afternoon of the 9th” (MWR). “From the time of the second aircraft reconnaissance flight until the time in which “Connie” encroached upon the mainland of the United

States, almost constant aircraft surveillance was maintained. The center fixes by aircraft reconnaissance were so numerous from the 9th of August until the 12th of August that at times the reports were difficult to plot when the storm movement was slow and erratic. The aircraft center fixes during this period revealed erratic storm movement which is discussed in Section II (2) of the report on "Connie" (ATSR).

August 10:

HWM shows a hurricane of at most 990 mb centered near 31.2N, 75.6W at 12Z. HURDAT lists this as a 125 kt hurricane at 30.8N, 75.3W at 12Z. MWR shows a low pressure of 960 mb located near 29.8N, 74.0W at 12Z. Microfilm analyzes a closed low pressure of at most 993 mb centered at 31.0N, 76.0W at 12Z. Ship highlights: 50 kt W and 998 mb at 28.9N, 77.0W at 6Z (COADS). 50 kt NNW and 1005 mb at 31.5N, 79.2W at 12Z (COADS). 50 kt NE and 1006 mb at 33.5N, 77.5W at 15Z (MICRO). 55 kt NNW and 1002 mb at 31.3N, 79.3W at 18Z (COADS). Aircraft highlights: Penetration center fix measured a 35 mile diameter eye at 30.6N, 75.5W at 0410Z (micro); Penetration center fix measured a central pressure of 972 mb at 31.0N, 75.7W at 1232Z; Penetration center fix measured a central pressure of 977 mb and a 30 mile diameter eye at 31.0N, 75.3W at 1432Z; Penetration center fix measured max surface winds of 120 kt, a central pressure of 970 mb and a 35 mile diameter eye at 31.1N, 76.7W at 18Z; Penetration center fix measured a central pressure of 980 mb at 31.3N, 76.6W at 1916Z; Penetration center fix at 31.3N, 76.5W at 2004Z; Penetration center fix measured a central pressure of 973 mb and a 50 mile diameter eye at 31.1N, 76.9W at 2229Z. All observations from MICRO. "…977 mb (28.85 inches) by the morning of the 10th. Penetration during the 10th indicated the eye was becoming filled with clouds and poorly defined. Connie drifted slowly towards the west-northwest and west on the 9th and 10th and north-northeast on the 11th" (MWR). "The central pressure in the hurricane has filled about nine tenths of an inch during the past 36 to 48 hours and is now 28.70 inches" (WBO).

August 11:

HWM shows a hurricane of at most 990 mb centered near 32.8N, 76.8W at 12Z. HURDAT lists this as a 95 kt hurricane at 32.1N, 77.0W at 12Z. MWR shows a low pressure of 972 mb located near 32.5N, 77.2W at 12Z. Microfilm analyzes a closed low pressure of at most 990 mb centered at 32.2N, 77.3W at 12Z. Ship highlights: 70 kt ENE and 999 mb at 33.5N, 77.5W at 0Z (MICRO). 60 kt N and 1003 mb at 31.1N, 79.5W at 0Z (COADS). 60 kt SW and 992 mb at 31.5N, 76.4W at 15Z (MICRO). 60 kt WSW and 992 mb at 31.1N, 76.4W at 18Z (COADS). Land highlights: 30 kt NE and 997 mb at Wilmington, NC at 19Z (MICRO). Aircraft highlights: 978 mb at 32.3N, 77.5W at 13Z. 977 mb at 32.0N, 77.2W at 1540Z. 977 mb at 32.4N, 77.0W at 1715Z. 976 mb at 32.8N,

77.3W at 19Z. 965 mb at 32.8N, 77.0W at 20Z. 976 mb at 32.8N, 77.3W at 2050Z. 976 mb at 32.7N, 77.2W at 2130Z. All observations from MICRO.

August 12:

HWM shows a hurricane of at most 985 mb centered near 34.7N, 75.8W at 12Z. HURDAT lists this as a 70 kt hurricane at 34.8N, 76.2W at 12Z. MWR shows a low pressure of 972 mb located near 34.5N, 76.5W at 12Z. Microfilm analyzes a closed low pressure of at most 981 mb centered at 34.8N, 76.4W at 12Z. Ship highlights: 60 kt WSW and 992 mb at 31.2N, 76.5W at 0Z (COADS). 65 kt SW and 992 mb at 32.3N, 77.1W at 03Z (MICRO). 60 kt SW and 992 mb at 32.3N, 75.8W at 06Z (COADS). 67 kt N and 981 mb at Frying Pan Lighthouse at 8Z (MICRO). 65 kt SE and 996 mb at Diamond Shoals Lighthouse at 8Z (MICRO). 60 kt SE and 989 mb at 34.4N, 75.0W at 15Z (MICRO). Land highlights: 63 kt (gusts to 72 kt) at Wilmington, NC, no time given (MWR). 60 kt NE and 992 mb at Newport, NC at 03Z (MICRO). 67 kt SE and 997 mb at Frying Pan Lighthouse at 6Z (MICRO). 50 kt NNE and 969 mb at Newport, NC at 15Z (MICRO). 30 kt W and 976 mb at Newport, NC at 18Z (MICRO). 962 mb at Fort Macon, NC, no time given (MWR). Aircraft highlights: Center fix at 33.3N, 77.1W at 01Z (ATSR); Center fix at 33.4N, 77.0W at 06Z (ATSR); Center fix at 34.1N, 76.5W at 0956Z (ATSR) and center fix at 35.0N, 76.8W at 1715Z (ATSR). “It then turned northward again on the 12th as it passed inland on the North Carolina coast near Morehead City. At Wilmington, NC, the fastest measured mile was 72 mph, and the peak gust was 83 mph during the evening of the 11th as the hurricane passed about 100 miles to the southeast and east of the station. Winds of 75 mph with peak gusts of 100 mph and lowest pressure of 962 mb (28.40 inches) were reported at Fort Macon, NC, near the point where the hurricane crossed the coastline. However, it has not been established whether this was a measured or an estimated speed” (MWR). “After making numerous erratic changes in course and speed from the 9th through the 12th of August, the center moved inland over Morehead City, North Carolina. The partial blocking action of the high ridge to the north of the storm was being gradually eliminated as the trough over the Great Lakes region on the 10th of August deepened as it moved eastward” (ATSR). “34.7N, 76.1W – 962 mb at 34.7N, 76.1W – 1011 mb Penv – RMW 45 nmi – speed 7 kt – 71 kt est max sustained 10m, 10-min wind” (Schwardt et al. (1979)). “ 28.40” (961.7 mb) central pressure measured by land barometer at Fort Macon, NC – RMW 38 nmi – 7 kt forward speed – landfall pt 34.9N, 76.2W” (Ho et al. (1987). “Aug – NC3, VA1 – Cat 3 – 962 mb” (Jarrell et al. (1992).

August 13:

HWM shows a hurricane of at most 990 mb centered near 39.8N, 75.5W at 12Z. HURDAT lists this as a 45 kt tropical storm at 39.2N, 76.4W at 12Z. MWR shows a low

pressure of 983 mb located near 39.5N, 76.5W at 12Z. Microfilm analyzes a closed low pressure of at most 987 mb centered at 39.4N, 76.5W at 12Z. Ship highlights: 50 kt SSW and 993 mb at 35.2N, 74.6W at 0Z (COADS). 50 kt SSE and 997 mb at 38.3N, 72.9W at 6Z (COADS). 40 kt SSE and 1002 mb at 38.6N, 73.0W at 12Z (COADS). Land highlights: 20 kt NW and 978 mb at Elizabeth City at 0Z (micro). 53 kt E at Philadelphia, PA, no time given (CLIMA). 39 kt E at Reading, PA, no time given (CLIMA). 49 kt NE at Rochester, NY, no time given (CLIMA). 38 kt NE at Buffalo, NY, no time given (CLIMA). 30 kt NE and 988 mb at Washington, DC at 09Z (micro). "At the 200 mb level the trough was shallow on the 11th as it approached the Great Lakes, but deepened during the next 24 hours, and on the 13th of August a low center had formed over Illinois. Thus, a natural path of least resistance was created to the north of the center which caused "Hurricane Connie" to move in that direction as a more rapid rate during the final day of her existence. "Hurricane Connie" had shown a rapid decrease in intensity on 11 August while she remained nearly stationary off the North Carolina coast and at the time in which the center moved inland, the maximum winds reported were 80 knots in a very small area near the center. Further decrease in intensity continued as the center moved over land becoming less than hurricane intensity at 131000Z" (ATSR).

August 14:

HWM shows a low pressure of at most 1010 mb centered near 44.0N, 81.0W at 12Z. HURDAT lists this as a 25 kt tropical depression at 43.7N, 81.6W at 12Z. MWR shows a low pressure of 1006 mb located near 43N, 82W at 12Z. Microfilm analyzes a closed low pressure of at most 1008 mb centered at 43.5N, 82W at 12Z. Land highlights: 20 kt NE and 1002 mb at Buffalo, NY at 00Z (MICRO) and 5 kt SE and 1003 mb at London, Canada at 06Z (MICRO).

August 15:

HWM shows a spot low pressure centered near 46.0N, 81.0W at 12Z. HURDAT lists this as a 25 kt tropical depression at 46.3N, 83.0W at 06Z (last position). Microfilm analyzes a closed low pressure of at most 1014 mb centered at 49N, 91W with fronts to the east and southwest at 12Z. A trough exist in microfilm along 83W between 43N and 47N.

"Tornadic activity was reported in the Carolinas during the afternoon and evening of August 10, while the hurricane was about due east of the Georgia coast, and before the winds had increased to strong along the Carolina coasts. One tornado occurred in North Carolina at Penderlea in northern Pender County and five others were reported in South Carolina from Georgetown northward. These tornadoes were reported as moving from east to west. Beach erosion on the North Carolina coast was considerable, as tides rose to

as much as 7 feet above normal from Southport to Nags Head, and to 5 to 8 feet above normal in the sounds at the mouths of the rivers. Total damage in North Carolina was estimated at $40 million, of which about ¾ was crop damage. The hurricane caused no deaths or serious injuries in North Carolina. The slow and somewhat meandering course of Connie and the loss of intensity while off the south Atlantic coast for a 48 to 72 hour period from late on the 8th to early on the 11th were the principal forecast problems during the life of the storm. Synoptically, on August 8, a strong (1027 mb) surface high pressure system was located over the eastern Atlantic with a ridge extending to the middle Atlantic coast. At the 500-mb level the picture was rather similar, with the ridge aloft along the Atlantic coast trending to move slowly northward with time. Several rather weak polar troughs moved eastward over northern latitudes with little effect in the latitude of and the area immediately to the north of the hurricane. The situation in the sub-Tropics was more complicated in the middle and upper troposphere. A cold Low extended down below the 500-mb surface and at the 500-mb level moved from a position off the Georgia coast on the 6th southwestward into the central Gulf of Mexico by the 8th. Heights of the 500-mb surface continues to build to the northeast of the dying hurricane as it progressed into the Middle Atlantic States and eventually into Michigan where it filled. Apparently during the period of slow movement, the average gradients on all sides of Connie were well balanced but tended to become progressively a little stronger on the east side and no polar trough extended sufficiently far south to materially disturb this balance. Hurricane Diane was forming during this period and developing hurricane intensity. However, since Connie was larger and more intense, the "Fujiwara effect" on it was slight, but what there was would exert some equator-ward pull." (MWR)

"No reports of property damages or personal injury were noted through the West Indies, since the path of the strong and damaging winds of "Connie" were too far from the land areas. As "Connie" moved ashore, the Carolina coastal regions were buffeted with damaging winds, but greater damage in this region was caused by the pounding of heavy seas which were built up while the storm center was lying, nearly stationary, off the Carolina coast. In North Carolina, approximately 14,000 personas were forced from their beach homes into emergency shelters as the hurricane moved inland. Piers, boats and beach buildings sustained extensive damage. "Connie's" final damaging blow was to cause heavy rains in the northeastern section of the United States resulting in flash floods, power failures and other related damages. New York City reported its heaviest downpour since 1926. The wake of the hurricane had left a death toll of 2 persons and property damage estimated to be at least $15,000,000." (ATSR)

Genesis for this system remains at 06Z on the 3rd of August, unchanged from the original HURDAT. Unfortunately, there is little data available over the eastern and central Atlantic and a closed circulation cannot be corroborated to have been present at the time

of genesis. A major change in the track is made on the 3rd as the positions shown in HURDAT indicate a very fast motion of about 36 kt in the first 12 hours of existence of the tropical cyclone that does not appear to be real. The intensity remains unchanged at 06Z and 12Z on August 3rd, 30 kt and 35 kt respectively. No change is made to the time the cyclone became a tropical storm (six hours after genesis). The first definitive indication that a well-defined closed circulation is present is at 18Z on the 3rd when the ship KFDE measured 10 kt NW and 1005 mb. A central pressure of 1004 mb at has been added at 18Z on the 3rd. A central pressure of 1004 mb yields 39 kt according to the Brown et al. southern pressure-wind relationship. The original intensity analyzed by HURDAT of 40 kt at 18Z is kept. Later at 03Z on the 4th of August, the ship BONAIRE measured 40 kt NE and 996 mb. A peripheral pressure of 996 mb yields maximum winds greater than 54 kt according to the Brown et al. southern pressure-wind relationship. A pressure of 1002 mb was originally in HURDAT at 12Z on the 4th but this pressure has been removed because the ship Linda Elra reported a pressure of 997 mb and winds of 40 kt at this time. The first reconnaissance aircraft to reach the cyclone occurred at 1820Z on the 4th making a center fix at 15.8N and 52.8W. Clearly it missed the storm and reported a "false" eye 75 miles to the NE of the fix, which was likely the true center of Connie. The intensity of Connie on the 4th is reanalyzed to be 50 kt at 0Z, 60 kt at 06Z, and 70 kt at 12Z and 18Z. The original intensity on this date in HURDAT was 40 kt, 40 kt, 45 kt, and 50 kt, respectively. This suggests that Connie became a hurricane about 18 hours before originally shown. Two aircraft penetrations occurred on August 5th, one at 1110Z making a center fix at 18.2N, 56.7W and another one at 1805Z at 18.4N, 57.9W. The second fix measured a pressure of 985 mb, which corresponds to 71 kt in the pressure-wind relationship south of 25N. The aircraft also reported an eye of a 20 mile diameter, indicating an RMW of 15 nm, which is the same as suggested by climatology. An intensity of 75 kt is selected for the 5th at 18Z, a major change from 115 kt originally in HURDAT. Moreover, the 985 mb central pressure was originally at 12Z in HURDAT, and it has been moved to 18Z. Major changes to the intensity were also made at 06Z and 12Z on the 5th and the intensity selected for those times is 70 kt, down from 95 kt and 110 kt, respectively. At 21Z, a ship at 18.1N, 58.5W reported 65 kt N. On the 6th of August, Connie made its closest approach to the northern Leeward Islands passing about 90 nm while on a west-northwest to northwest heading. The strongest winds in the islands shown in microfilm were 45 kt SW at 15Z at Anguilla. Later on the 6th, a ship named Pelican State passed very close, if not through the center of Connie. At 18Z, it reported 65 kt N and 979 mb and at 21Z, 35 kt S and 977 mb. A central pressure of 982 mb is originally shown in HURDAT at 12Z on the 6th but it has been removed since observations do not support it. At 18Z, an aircraft penetration made a center fix measuring a central pressure of 968 mb and a surface wind of 125 kt is reported. A central pressure of 968 mb yields 92 kt in the pressure-wind relationship south of 25N

and 93 kt south of 25N intensifying. An intensity of 100 kt is selected for 18Z on the 6th making Connie a major hurricane, but down from 125 kt originally in HURDAT. Major changes in intensity are also shown on the 6th as HURDAT originally had 120 kt at 0Z and 06Z, and 125 kt at 12Z and 18Z. Eight center fixes were made by the aircrafts on the 6th helping to identify the position of the hurricane and only minor track changes are added.

Connie continued to steadily intensity on the 7th of August as it moved towards the northwest, east of the Bahamas. At 18Z, an aircraft center fix reported a central pressure of 944 mb, a diameter of 40 miles, and the report indicates that the eye was shaped like an inverted cone. The diameter information indicates that Connie had an RMW of 30 nm at 18Z and climatology suggests an RMW of 15 nm. A central pressure of 944 mb yields 117 kt south of 25N and 119 kt south of 25N intensifying. An intensity of 115 kt is selected for 18Z on the 7th, down from 125 kt originally in HURDAT. 115 kt is also the peak intensity for the lifetime of hurricane Connie. Major changes in the intensity are indicated at 0Z, 06Z and 12Z on the 7th as the intensities selected are 100 kt, 105 kt and 110 kt, respectively, down from 125 kt. At 21Z, a ship at 23.7N, 67.5 W measured 100 kt SE and 998 mb. Minor changes are introduced for the track on the 7th. At 18Z on the 8th, an aircraft reconnaissance measured a central pressure of 944 mb and an eye diameter of 40 miles. A central pressure of 944 mb yields 111 kt north of 25N. The eye diameter information indicates an RMW of 30 nm and climatology suggest 17 nm. Therefore, an intensity of 105 kt is selected for 18Z on the 8th, down from 125 kt originally in HURDAT. Thus on the 7th, Connie started to weaken. A central pressure of 936 mb is originally shown in HURDAT at 18Z but the corresponding advisory shows that it was 944 mb at this time. Starting on the 9th of August, Connie began to move at a slower rate of speed. The intensity continued to decrease and the last position in which the cyclone was a major hurricane was at 12Z on the 9th. At 1440Z and 20Z, aircraft center fixes reported central pressures of 959 and 961 mb, respectively. It is apparent that these central pressures were believed to be a bit high in 1955 because the MWR article on Connie indicates that the central pressure late on the 9th was 954 mb. A central pressure of 954 mb yields 101 kt north of 25N and 97 kt weakening north of 25N according to the pressure-wind relationship. At 1440Z, an eye diameter of 35 miles is reported. This indicates an RMW of about 25 nm and climatology suggests 21 nm. The cyclone is also moving at about 8 kt. Thus, an intensity of 95 kt is selected for 18Z on the 9th, down from 125 kt originally in HURDAT, a major change.

The hurricane continued to fill on the 10th while the track changed to a more west-northwest heading, just to the southeast of the Carolinas. At 18Z on the 10th, a central pressure of 970 mb was measured by the reconnaissance aircraft. A central pressure of 970 yields 84 kt north of 25N and 81 kt north of 25N weakening according to the

pressure-wind relationship. The aircraft also reported an eye of a 35 mile diameter, which allows us to calculate a RMW of about 25 nm. This is close to the suggested climatological RMW of 23 nm. The aircraft as well reported a visual estimate of the wind of 120 kt, which is not given much weighting here. Hence, an intensity of 85 kt is selected for 18Z on the 10th. The Air Force reconnaissance plane measured central pressures of 977 mb at 1432Z and 980 mb at 1916Z, which are higher than the reports from the Navy, and discounted in the reanalysis. Ships in the area avoided getting close to Connie and the strongest winds reported on this day were 50 kt. At 2229Z, an aircraft reconnaissance measured a central pressure of 973 mb and this is added to 0Z on the 11th. This pressure yields 81 kt on the N25N according to the pressure-wind relationship. An intensity of 80 kt is selected for this time. On August 11th, Connie turned to the north and continued to slowly move towards the East Coast of the United States. Other central pressures were reported at 13Z and 1715Z, 978 mb and 977 mb, respectively. The last report indicated that the diameter of the eye had decreased to 20 miles, which gives a RMW of about 15 nm. Climatology suggests a RMW of 25 nm. These central pressures yield about 75 kt on the N25N pressure-wind relationship. An intensity of 75 kt is selected for 12Z and 18Z on the 11th.

Hurricane Connie began to move faster on the 12th of August making landfall near Fort Macon, NC at 15Z. Fort Macon, NC measured a central pressure of 962 mb, which yields 93 kt north of 25N and 88 kt north of 35N according to the pressure-wind relationship. Ho et al. indicates that the RMW at landfall is 38 nm and climatology suggests 27 nm. When Connie made landfall, it was moving at around 8 kt. An intensity of 85 kt is selected for 12Z and 18Z on the 12th, which is an increase from 70 kt and 65 kt respectively, as originally shown in HURDAT. The last center fix was at 1715Z over eastern North Carolina. The radar in Cape Hatteras allowed for center fixes to be made from 1050Z to 1725Z. Before making landfall, ships in the area measured winds up to 65 kt. Over land, Wilmington measured sustained winds of 63 kt and Newport reported 60 kt. After landfall, Connie moved generally north-northeast over extreme eastern North Carolina possibly moving back briefly over the Atlantic Ocean around 0Z on the 13th of August near the North Carolina/Virginia border. The Kaplan and DeMaria model was not run because the cyclone straddled the coast for a day. Interaction with land caused the hurricane to weaken, especially later on the 13th when it moved toward the north-northwest and into the Mid-Atlantic States. Connie weakened to a tropical storm at 06Z on the 13th. Washington DC reported 30 kt NE and 988 mb at 09Z on August 13th, Philadelphia reported 53 kt E (no time given) and Buffalo, NY reported 38 kt NE (no time given). Early on the day, ships reported top winds of 50 kt. The central pressures originally shown in HURDAT from 0Z to 12Z on the 13th are likely to have been estimated a bit lower than the actual value. 969 mb indicated at 0Z was likely around 972-975 mb, 974 mb at 06Z was likely around 981-985 mb and 982 mb at 12Z was likely

around 988-992. The estimate of 995 mb at 18Z appears to be correct. A gradual weakening is shown, 75 kt at 0Z, 60 kt at 06Z, 45 kt at 12Z and 35 kt at 18Z (up from 60 kt at 0Z, 50 kt at 6Z, same for 12Z and 18Z, as originally shown in HURDAT). Late on the 13th, Connie turned to the northwest and moved over the Great Lakes early on the 14th. Transition to a tropical depression remains unchanged at 0Z on the 14th. The central pressures indicated on the synoptic times of the 14th appear to be correct. Dissipation occurred after 00Z on the 15th as an approaching cold front absorbed the weakened cyclone. A central pressure of 1011 mb is added at this time. Dissipation is six hours earlier than originally shown in HURDAT.

Hurricane Daine [August 7-23, 1955]

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38705 08/07/1955 M=15  3 SNBR= 848 DIANE       XING=1 SSS=1
38705 08/07/1955 M=17  3 SNBR= 848 DIANE       XING=1 SSS=1
                    **

38710 08/07*  0   0   0    0*170 430  25    0*171 440  25    0*172 451  25    0*
38710 08/07*  0   0   0    0*157 412  25    0*160 425  25    0*161 438  25    0*
                            *** ***          *** ***          *** ***

38715 08/08*173 461  25    0*175 469  25    0*177 478  25    0*179 490  25    0*
38715 08/08*162 452  25    0*163 466  25    0*165 480  25    0*166 497  25    0*
            *** ***          *** ***          *** ***          *** ***

38720 08/09*180 502  25    0*182 514  30    0*185 526  30    0*189 543  35    0*
38720 08/09*167 507  25    0*168 519  30    0*170 531  30    0*173 545  35    0*
            *** ***          *** ***          *** ***          *** ***

38725 08/10*193 559  35    0*198 570  35    0*203 580  35    0*211 589  40    0*
38725 08/10*177 560  35    0*182 574  35    0*190 586  35    0*200 595  40    0*
            *** ***          *** ***          *** ***          *** ***

38730 08/11*220 598  45    0*227 604  50    0*233 608  55    0*236 611  60    0*
38730 08/11*212 600  45    0*223 606  45    0*233 613  45    0*238 618  45 1004*
            *** ***          *** ***  **          ***  **       *** ***  ** ****

38735 08/12*240 611  65    0*247 610  90    0*253 608 105  975*259 607 105    0*
38735 08/12*242 616  50    0*246 614  60    0*250 612  70    0*255 610  75  975*
            *** ***  **       *** ***  **       *** ***  **    * *** ***  **  ***

38740 08/13*264 605 105    0*269 605 105  969*274 610 105    0*274 622 105    0*
38740 08/13*260 608  70  980*267 614  70    0*273 614  80    0*274 626  90  969*
            *** ***  **  *** *** ***  **    * *** ***  **          ***  **  ***

38745 08/14*272 634 105    0*273 644 105    0*274 654 105    0*276 667 105    0*
38745 08/14*272 638  90    0*273 647  80  976*275 657  75  980*278 668  70    0*
                ***  **          ***  **  *** *** ***  **  *** *** ***  **

38750 08/15*280 681 100    0*285 694  95    0*291 706  95    0*296 720  90    0*
38750 08/15*282 681  75    0*287 695  80  973*292 709  80    0*297 723  80  973*
            ***      **       *** ***  **  *** *** ***  **       *** ***  **  ***

38755 08/16*302 734  85    0*307 743  85    0*312 750  85    0*320 760  80    0*
38755 08/16*300 734  75    0*304 744  75    0*309 753  75  982*317 762  75  983*
            ***      **       *** ***  **       *** ***  **  *** *** ***  **  ***
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38760 08/17*328 769  75    0*335 775  75    0*343 780  60  986*354 785  60  990*
38760 08/17*326 769  70  984*334 774  65    0*342 780  65  985*353 785  55  990*
           ***      **  *** *** ***  **      ***      **  *** ***      **

38765 08/18*366 790  60  993*377 790  55  999*388 781  50 1001*396 768  45 1004*
38765 08/18*365 788  50  993*378 788  45  999*388 781  40 1001*396 769  35 1004*
           *** ***  **      *** ***  **                **           ***  **

38770 08/19*402 753  40 1003*407 737  40 1002*410 721  35 1000*413 704  35    0*
38770 08/19*402 757  35 1003*405 745  40 1001*407 730  40  998*409 715  40    0*
               ***  **      *** ***     **** *** ***  **  *** *** ***  **

38775 08/20*415 686  35    0*418 666  35    0*421 640  35    0E426 607  35    0*
38775 08/20*410 699  40    0*412 675  45    0*415 645  45    0*423 618  45    0*
           *** ***  **      *** ***  **      *** ***  **     **** ***  **

38780 08/21E433 570  35    0E442 532  35    0E450 493  35    0E462 459  30    0*
38780 08/21E430 584  50    0E438 535  50    0E450 480  50    0E470 420  50    0*
           *** ***  **      *** ***  **          ***  **      *** ***  **

(August 22nd and 23rd are new to HURDAT)
38781 08/22E490 360  55    0E525 340  55    0E560 330  55    0E585 325  55    0*
38783 08/23E605 320  50    0E620 320  45    0E635 310  40    0E650 290  35    0*

38785 HR NC1
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U.S. Hurricane:
Aug 17th – 11Z – 34.0N 78.0W – 65 kt – Category 1 – 986 mb – 1011 mb OCI – 400 nm ROCI

Major track and intensity changes are analyzed for this classic Cape Verde hurricane that made landfall in North Carolina and later affected the Mid-Atlantic and Northeast. A major alteration is to add two additional days at the end of the cyclone's lifetime. Evidence for these alterations comes from the Historical Weather Maps Series, the COADS ship database, Monthly Weather Review, USWB/NHC microfilm of synoptic weather maps, the Climatological Data, and Jarrell et al. (1992).

August 6:

HWM shows a spot low centered near 15.0N, 38.5W along the ITCZ at 12Z. HURDAT does not analyze an organized system on this date. Microfilm and MWR are not available on this date. Ship highlights: No gales or low pressures.

August 7:

HWM shows a closed low of at most 1010 mb centered near 16.0N, 43.0W along the ITCZ at 12Z. HURDAT lists this as a 25 knot tropical depression at 17.1N, 44.0W at 12Z. Microfilm and MWR are not available on this date. Ship highlights: No gales or low pressures.

August 8:

HWM shows a closed low of at most 1010 mb centered near 17.0N, 50.0W along the ITCZ at 12Z. HURDAT lists this as a 25 knot tropical depression at 17.7N, 47.8W at 12Z. Microfilm and MWR are not available on this date on this date. Ship highlights: No gales or low pressures.

August 9:

HWM shows a closed low of at most 1010 mb centered near 18.0N, 53.0W along the ITCZ at 12Z. HURDAT lists this as a 30 knot tropical depression at 18.5N, 52.6W at 12Z. Microfilm and MWR are not available on this date. Ship highlights: No gales or low pressures.

August 10:

HWM shows a closed low pressure of at most 1010 mb centered near 19.5N, 59.0W at 12Z. HURDAT lists this as a 35 knot tropical storm at 20.3N, 58.0W at 12Z. Microfilm does not analyze an organized system at 12Z. MWR is not available on this date. Ship highlights: No gales or low pressures. "There were some indications of a weak easterly wave earlier but the first conclusive evidence of the disturbance that was to become Diane was observed on August 10. Analysis that morning indicated a cyclonic circulation northeast of the Leeward Islands and at 1930 EST ships some 400 to 500 miles from the northernmost islands reported heavy showers and east to southeast winds of 35 to 45 mph" (MWR). "On the 10th of August, as "Hurricane Connie" progressed slowly and erratically northwestward toward the North Carolina coast, attention was called to the area about 300 miles northeast of the Lesser Antilles. An easterly wave, labeled locally as "August #2" after being verified on the "time cross-section" as being of moderate intensity, had shown development of a weak vortex to the north of the Lesser Antilles at 101230Z. The lack of reports in the area, at this time, prohibited determination of the intensity of the vortex and a reasonably accurate position of the center. Belief was expressed but forecasters from both the Fleet Weather Center, Miami, and the Weather Bureau Office, Miami, that there was drought of any rapid and intense development following so close in the wake of "Hurricane Connie" but the area needed watching. Action taken to obtain more data for the area consisted of a request by the Weather Bureau Office at San Juan for special ship reports and the Air Force Hurricane Liaison Officer scheduled an early flight for the 11th of August from Bermuda to the area" (ATSR).

August 11:

HWM shows a tropical storm of at most 1005 mb centered near 23.5N, 60.6W at 12Z. HURDAT lists this as a 55 knot tropical storm at 23.3N, 60.8W at 12Z. Microfilm analyses a closed low pressure of at most 1011 mb at 23N, 62W at 12Z. MWR shows a

low pressure of 1004 mb located near 23N, 62W at 12Z. Ship highlights: 35 kt ENE and 1006 mb at 22.9N, 59.3W at 0Z (COADS); 45 kt E and 1009 mb at 24.0N, 60.0W at 6Z (COADS); 40 kt ENE and 1003 mb at 19.2N, 61.9W at 15Z (micro), and 20 kt NE and 1005 mb at 24.0N, 62.0W at 21Z (COADS). Aircraft highlights: Penetration center fix measured a central pressure of 1004 mb at 23.9N, 62.2W at 1655Z (ATSR/micro). "On August 11 the first aircraft reconnaissance of Diane found the lowest pressure of 1004 mb (29.65 inches) with maximum winds of 46 mph, representing little or no wind increase from that shown by the ship observations 24 hours earlier. Clouds and rain extended in all directions from the pressure center with no variation of weather in the various quadrants. This early stage of growth was typical in the poorly defined eye and lack of organization" (MWR). "Ship reports received in the area for 110030Z indicated the intensity near the center of the vortex to be about 40 knots and the center to be near 20N 60W. Data compiled on the "Detection Sheet" revealed favorable conditions for tropical storm development and intensification. Thus, it appeared only a matter of time before it would be necessary to announce the birth of "Tropical Storm Diane" in the form of a numbered warning. Although the area was picked up and carried by the Fleet Weather Central, Washington, as a Gale Warning and it would have been desirable to await the reconnaissance flight information scheduled for early the next morning, it became advisable to coordinate a Warning Number One for "Tropical Storm Diane" which was issued at 111200Z. From the time of the first aircraft reconnaissance fix at 111655Z until "Diane" entered the coast, close surveillance was maintained by weather reconnaissance aircraft. During this time, no special eccentricities of the storm structure were noted, but there appeared to be a pattern of gradual increase in intensity, with slight variations in cloud formations, to the maximum intensity of an average hurricane, then a gradual decrease in intensity before entering the coast" (ATSR).

August 12:

HWM shows a hurricane of at most 995 mb centered near 25.7N, 61.2W at 12Z. HURDAT lists this as a 105 knot hurricane at 25.3N, 60.8W at 12Z. Microfilm analyses a closed low pressure of at most 999 mb at 25N, 61W at 12Z. MWR shows a low pressure of 981 mb located near 25.8N, 61.8W at 12Z. Ship highlights: 40 kt SE and 1000 mb at 24.5N, 61.0W at 0Z (micro); 45 kt NNE and 996 mb at 25.0N, 61.0W at 9Z (micro); 40 kt ESE and 1009 mb at 24.2N, 60.0W at 13Z (micro), and 35 kt SW and 1004 mb at 24.0N, 60.0W at 18Z (COADS). Aircraft highlights: Penetration center fix at 25.6N, 60.1W at 1210Z (ATSR); Penetration center fix at 25.1N, 61.2W at 1250Z (ATSR); Penetration center fix measured a central pressure of 975 mb and an eye of a 50 mile diameter at 25.7N, 61.0W at 20Z (ATSR/micro). "During the night the storm curved abruptly from a northwest course and began moving toward the northeast, at the same time undergoing rapid intensification. The MS Coourg, just west of center on a parallel

course to the northeast during part of the night, turned southward and eastward in evasive maneuvers early on the morning of the 12th. The intensification was so rapid that even though the ship was southeast of the center and the distance between it and the hurricane was increasing, the barometer continued to drop and the wind to increase, leading the crew to believe that the storm was looping back in their direction. The reconnaissance plane on the 12th reported that winds had increased to 125 mph and the central pressure was found to be 975 mb (28.79 inches). The eye by this time was well-defined and 30 miles in diameter. It was described by the observer as resembling an inverted teacup. The weather distribution had become more typical with the northeast quadrant showing more activity than the others. An interesting feature of the reconnaissance was a secondary pressure minimum, at first thought to be the principal center, located 62 miles northeast of the primary eye. In view of the rapid growth, sudden change in direction and multiple eye structure, it is interesting to speculate as to what extent factors other than strictly steering currents were involved in the storm's course at this stage. Possibly a process in which more rapid deepening was favored to the northeast of the storm than in other quadrants was partially responsible for the movement. It is likely that the original easterly wave began deepening as it moved under a cold Low (with super-imposed warm air at still higher levels) and that this condition provided added instability for growth and imposed the cyclonic flow of the large scale cold Low on the movement of the smaller warm vortex" (MWR). "Tropical Storm Diane" became of hurricane intensity at 120000Z and remained hurricane intensity until 171800Z. The average maximum winds during hurricane intensity were 105 knots between 121200Z and 141200Z with a gradual decrease in intensity to 70 knots upon entering the coast" (ATSR).

August 13:

HWM shows a hurricane of at most 995 mb centered near 27.2N, 60.8W at 12Z. HURDAT lists this as a 105 knot hurricane at 27.4N, 61.0W at 12Z. Microfilm analyses a closed low pressure of at most 999 mb at 27N, 61.5W at 12Z. MWR shows a low pressure of 977 mb located near 27.5N, 61.2W at 12Z. Ship highlights: 35 kt SW and 1005 mb at 24.0N, 60.0W at 0Z (COADS); 50 kt E and 1003 mb at 27.8N, 60.0W at 6Z (COADS); 60 kt E and 999 mb at 27.8N, 60.0W at 9Z (micro), 70 kt ESE and 1000 mb at 27.6N, 59.9W at 12Z (COADS), and 65 kt ESE and 1005 mb at 27.8N, 60.0W at 18Z (micro). Aircraft highlights: Penetration center fix measured a central pressure of 980 mb at 26.4N, 60.5W at 2Z (ATSR); Radar center fix measured an eye of a 30 mile diameter at 26.6N, 61.3W at 0808Z (ATSR/micro); Penetration center fix at 27.4N, 61.9W at 1515Z (ATSR); Penetration center fix at 27.4N, 62.0W at 1545Z (ATSR); Penetration center fix at 27.4N, 63.0W at 19Z (ATSR); and penetration center fix measured max surface winds of 80 kt and a central pressure of 969 mb at 27.1N, 63.2W at 20Z (ATSR/micro). "Diane followed this cyclonic path until August 13 when it became re-

established on a more normal west-northwest-ward course. By this time the developing system had caused warming through the deep layer, resulting in a weakening of the cold Low and its influence on the hurricane's movement. The possibility of some influence from the "Fujiwhara effect", or tendency for cyclonic rotation of cyclone pairs about a point representing the center of mass, should also be considered here. Diane's erratic movement was at least in general agreement with this effect. A more normal path was resumed when Connie weakened and moved farther north. The lowest pressure measured in the storm was 969 mb (28.62 inches) by dropsonde on August 13" (MWR).

August 14:

HWM shows a hurricane of at most 995 mb centered near 27.5N, 65.4W at 12Z. HURDAT lists this as a 105 knot hurricane at 27.4N, 65.4W at 12Z. Microfilm analyses a closed low pressure of at most 1005 mb at 27N, 66W at 12Z. MWR shows a low pressure of 972 mb located near 28N, 66W at 12Z. Ship highlights: 10 kt NW and 989 mb at 26.9N, 64.1W at 0Z (micro); 45 kt SE and 1007 mb at 28.1N, 62.2W at 12Z (COADS); 40 kt E and 1019 mb at 32.8N, 65.0W at 18Z (COADS), and 30 kt NW and 1004 mb at 25.5N, 68.2W at 20Z (micro). Aircraft highlights: Penetration center fix measured a central pressure of 984 mb and an eye of a 30 mile diameter at 27.1N, 64.4W at 0240Z (ATSR/micro); Penetration center fix measured a central pressure of 976 mb at 27.3N, 64.7W at 0745Z (ATSR/micro); Penetration center fix measured a central pressure of 980 mb and an eye of a 30 mile diameter at 27.7N, 66.2W at 1440Z (ATSR/micro); and penetration center fix at 28.1N, 67.4W at 20Z (ATSR). "After the 13th a tendency for slight filling began and, coincidental with this, there was a gradual cooling of the layer below about 750 mb" (MWR).

August 15:

HWM shows a hurricane of at most 990 mb centered near 29.5N, 70.8W at 12Z. HURDAT lists this as a 95 knot hurricane at 29.1N, 70.6W at 12Z. Microfilm analyses a closed low pressure of at most 999 mb at 29N, 71W at 12Z. MWR shows a low pressure of 978 mb located near 29.2N, 71.3W at 12Z. Ship highlights: 55 kt SSE and 1011 mb at 30.8N, 69.0W at 0Z (micro); 40 kt N and 1006 mb at 29.6N, 72.0W at 6Z (COADS); 50 kt NW and 998 mb at 28.7N, 72.0W at 12Z (COADS), and 60 kt NE and 1009 mb at 32.5N, 73.0W at 15Z (micro). Aircraft highlights: Penetration center fix measured a central pressure of 975 mb at 28.7N, 68.8W at 0340Z (ATSR/micro); Radar center fix measured a central pressure of 973 mb at 28.8N, 70.1W at 08Z (ATSR/micro); Penetration center fix measured a central pressure of 973 mb at 29.6N, 72.1W at 1715Z (ATSR), and penetration center fix measured a central pressure of 975 mb at 29.9N, 72.6W at 20Z (ATSR/micro). "On the 15th, the eye was reported as poorly defined and completely filled with clouds" (MWR).

August 16:

HWM shows a hurricane of at most 995 mb centered near 31.3N, 75.5W at 12Z. HURDAT lists this as an 85 knot hurricane at 31.2N, 75.0W at 12Z. Microfilm analyses a closed low pressure of at most 993 mb at 31.3N, 75.6W at 12Z. MWR shows a low pressure of 980 mb located near 31.2N, 75.4W at 12Z. Ship highlights: 35 kt SE and 1013 mb at 35.1N, 72.8W at 0Z (COADS); 55 kt SSE and 1013 mb at 29.6N, 68.6W at 6Z (COADS); 35 kt SE and 1011 mb at 30.2N, 71.4W at 12Z (COADS), and 20 kt S and 1000 mb at 30.4N, 75.5W at 18Z (COADS). Land highlights: 45 kt NE and 1006 mb at Frying Pan at 12Z; 30 kt NE and 1003 mb at Frying Pan at 18Z, and 25 kt NE and 1005 mb at Wilmington at 20Z. All observations from micro. Aircraft highlights: Radar center fix measured an eye of a 8 mile diameter at 30.1N, 74.1W at 0230Z (ATSR/micro); Penetration center fix at 30.2N, 74.2W at 0459Z (ATSR); Radar center fix measured an eye of a 10 mile diameter 30.3N, 74.3W at 0630Z (ATSR/micro); Radar center fix measured a central pressure of 986 mb at 30.4N, 74.7W at 0823Z (ATSR/micro); Penetration center fix measured a central pressure of 982 mb and an eye of a 10 mile diameter at 31.1N, 75.4W at 13Z (ATSR/ micro); Penetration center fix at 31.1N, 75.4W at 1345Z (ATSR); Penetration center fix at 31.3N, 75.8W at 1448Z (ATSR); Penetration center fix measured a central pressure of 983 mb and an eye of a 10 mile diameter at 31.6N, 75.8W at 1720Z (ATSR/micro); Penetration center fix at 31.9N, 76.5W at 20Z (ATSR); Penetration center fix at 31.7N, 76.4W at 2015Z (ATSR); Penetration center fix at 31.8N, 76.6W at 2115Z (ATSR); and penetration center fix measured max surface winds of 65 kt and a central pressure of 984 mb at 31.9N, 76.5W at 2230Z (ATSR/ micro). “Maximum winds were down to 86 mph on the 16th” (MWR). “On the 16th of August at all levels from the surface to the 200 mb level, a north-south trough extending from the Great Lakes to the Gulf of Mexico was in evidence. A small closed low, centered near St. Louis, Missouri, was also in evidence at all levels above the surface layer” (ATSR).

August 17:

HWM shows a hurricane of at most 995 mb centered near 34.2N, 77.9W at 12Z. HURDAT lists this as a 60 knot tropical storm at 34.3N, 78.0W at 12Z. Microfilm analyses a closed low pressure of at most 990 mb at 34.0N, 78.0W at 12Z. MWR shows a low pressure of 986 mb located near 34.2N, 77.8W at 12Z. Ship highlights: 50 kt SSE and 1008 mb at 33.0N, 73.9W at 0Z (micro); 35 kt SSE and 1010 mb at 32.2N, 73.2W at 6Z (COADS); 45 kt SE and 1013 mb at 36.1N, 73.4W at 12Z (COADS), and 35 kt E and 1009 mb at 37.5N, 76.1W at 18Z (COADS). Land highlights: 45 kt NE and 1001 mb at Frying Pan at 0Z; 40 kt N and 989 mb at Frying Pan at 6Z, 20 kt E and 988 mb at Wilmington at 12Z, 40 kt S and 992 mb at Frying Pan at 12Z, and 20 kt E and 994 mb at

Raleigh at 18Z. 45 kt at Cape Hatteras (time not given) (MWR). All observations from micro. Aircraft highlights: Penetration center fix at 33.3N, 77.0W at 0445Z (ATSR); Penetration center fix at 33.6N, 77.5W at 0730Z (ATSR), and radar center fix measured an eye of a 45 mile diameter at 08Z (ATSR/micro). "When the center passed very close to Wilmington on the morning of the 17th, the highest sustained winds reported from any weather station was 50 mph at Hatteras, wind gusts of 74 mph at Wilmington. It is estimated that winds of just about hurricane intensity were experienced at a few exposed points on the coast between Cape Hatteras and Cape Fear. While some damage resulted from the storm tide and wave action along the coast, it was not extensive" (MWR). "As "Diane" preceded on a northwest course from the 15th to the 17th of August, being steered by the Bermuda high, the trough over the Midwest states remained stationary and broadened slightly. The low aloft had moved southward down the trough to be centered over Mississippi late on the 17th of August and the Bermuda high at all levels was pushing westward onto the coast. This resulted in moist southerly flow accompanying and following the movement of "Diane" inland which caused record rains and floods throughout the Northeastern United States" (ATSR). "Aug – NC1 – Cat 1 – 987 mb" (Jarrell et al. (1992).

August 18:

HWM shows a closed low pressure of at most 1005 mb centered near 38.5N, 77.9W at 12Z. HURDAT lists this as a 50 knot tropical storm at 38.8N, 78.1W at 12Z. Microfilm analyses a closed low pressure of at most 1008 mb at 39.0N, 78.5W at 12Z. MWR shows a low pressure of 1001 mb located near 38.5N, 78.0W at 12Z. Ship highlights: 45 kt S and 1014 mb at 35.6N, 73.2W at 0Z; 45 kt SSE and 1010 mb at 36.0N, 74.9W at 6Z; 40 kt S and 1012 mb at 35.2N, 75.2W at 12Z, and 40 kt SSW and 1016 mb at 34.3N, 74.2W at 12Z. All observations from COADS. Land highlights: 15 kt SW and 997 mb at Raleigh at 0Z; 10 kt NW and 1000 mb at Lynchburg at 6Z, and 15 kt SSW and 1005 mb at Quantico at 18Z. All observations from micro.

August 19:

HWM shows a closed low pressure of at most 1000 mb centered near 41.0N, 73.0W at 12Z. HURDAT lists this as a 35 knot tropical storm at 41.0N, 72.1W at 12Z. Microfilm analyses a closed low pressure of at most 1008 mb at 41.2N, 72.3W at 12Z. MWR shows a low pressure of 1003 mb located near 41.0N, 73.0W at 12Z. Ship highlights: 15 kt SW and 1000 mb at 40.1N, 73.6W at 12Z; 5 kt E and 1001 mb at 41.3N, 71.3W at 18Z, and 40 kt NE and 1013 mb at 34.4N, 76.2W at 18Z. All observations from COADS. Land highlights: 10 kt W and 1005 mb at Harrisburg at 0Z; 15 kt NW and 1002 mb at Philadelphia at 6Z; 30 kt NNW and 1003 mb at New York City at 12Z, and 20 kt ESE and 1004 mb at Nantucket at 18Z. All observations from micro.

August 20:

HWM shows a closed low pressure of at most 1000 mb centered near 43.0N, 65.0W at 12Z. HURDAT lists this as a 35 knot tropical storm at 42.1N, 64.0W at 12Z (last position as a tropical system). Microfilm analyses a closed low pressure of at most 1005 mb at 43.0N, 63.0W at 12Z. MWR shows a low pressure of 1001 mb located near 42.0N, 64.2W at 12Z. Ship highlights: 20 kt SW and 1001 mb at 41.1N, 69.2W at 0Z; 20 kt W and 996 mb at 40.5N, 68.4W at 6Z; 30 kt W and 995 mb at 40.9N, 65.3W at 12Z; 30 kt W and 995 mb at 41.3N, 62.2W at 18Z and 50 kt WSW and 1009 mb at 39.0N, 62.0W at 20Z. All observations from COADS. Land highlights: 15 kt N and 1000 mb at Nantucket at 0Z; 20 kt ENE and 1005 mb at Yarmouth at 6Z; 10 kt NE and 1004 mb at Halifax at 12Z, and 10 kt NE and 1001 mb at Sable Island at 18Z. All observations from micro.

August 21:

HWM shows a closed low pressure of at most 990 mb centered near 45.0N, 47.0W at 12Z. HURDAT lists this as a 35 knot extratropical cyclone at 45.0N, 49.3W at 12Z. Microfilm analyses a closed low pressure of at most 996 mb at 47.5N, 47.0W at 12Z. MWR shows a low pressure of 993 mb located near 45.2N, 49.7W at 12Z. Ship highlights: 30 kt W and 995 mb at 41.7N, 59.1W at 0Z; 40 kt SW and 998 mb at 41.6N, 54.0W at 6Z; 40 kt S and 994 mb at 44.8N, 45.5W at 12Z; and 45 kt S and 990 mb at 46.6N, 40.1W at 18Z. All observations from COADS. Land highlights: 15 kt NE and 1003 mb at Sable Island at 0Z, and 35 kt NNW and 1008 mb at Sable Island at 06Z. All observations from micro.

August 22:

HWM shows a closed low pressure of at most 980 mb centered near 57.0N, 33.0W at 12Z. HURDAT does not list this system on this date. Microfilm analyses a low pressure at 56.2N, 29.8W at 6Z. MWR shows a low pressure of 976 mb located near 55.5N, 32.0W at 12Z. Ship highlights: 50 kt NNE and 981 mb at 50.5N, 38.0W at 0Z; 40 kt SSE and 979 mb at 52.8N, 35.5W at 3Z; 40 kt W and 984 mb at 53.7N, 33.7W at 12Z; and 30 kt SW and 997 mb at 54.6N, 27.3W at 18Z. All observations from COADS.

August 23:

HWM shows a closed low pressure of at most 985 mb centered near 63.0N, 31.0W at 12Z. HURDAT does not list this system on this date. Microfilm is not available on this date. MWR shows a low pressure of 978 mb located near 63.5N, 30.5W at 12Z. Ship highlights: 25 kt W and 978 mb at 61.9N, 32.5W at 0Z; 5 kt NW and 974 mb at

62.0N, 32.5W at 6Z; 35 kt WNW and 984 mb at 62.0N, 32.9W at 12Z; and 30 kt NW and 996 mb at 61.9N, 32.7W at 18Z. All observations from COADS.

August 24:

HWM shows a closed low pressure of at most 995 mb centered near 73.0N, 11.0W at 12Z. HURDAT does not list this system on this date. Microfilm and MWR are not available on this date. Land highlights: 10 kt SSE and 999 mb at Jan Mayer Island at 12Z (HWM).

Genesis for this tropical cyclone remains at 06Z on the 7th of August as a 25 kt tropical depression, unchanged from the original HURDAT. The data available during the first few days of Diane's existence as a cyclone is very sparse but a ship report at 12Z on the 7th indicates that the center needs to be repositioned to the southeast of the position originally shown in HURDAT. Due to this change, the track of Diane has been shifted about a degree and a half southeast than originally shown in HURDAT on August 7th and 8th. Ship data on the 9th continued to indicate that the center of this tropical cyclone was located farther south than originally shown in HURDAT. Intensification to a tropical storm remains at 18Z on the 9th, unchanged from the original HURDAT, though the sparse amount of observations makes the timing quite uncertain. No gales or low pressure were reported from August 7th to the 10th. The first gale-force winds (35 kt) were reported at 00Z on the 11th by a ship located in the northeast quadrant of the tropical storm. The highest winds for the day were 45 kt at 06Z by a ship located near 24N 60W. The first aircraft reconnaissance mission to reach the storm occurred at 1655Z on the 11th measuring a central pressure of 1004 mb. A central pressure of 1004 mb yields 39 kt according to the Brown et al. southern pressure-wind relationship. An intensity of 45 kt has been analyzed for 18Z on August 11th, down from 60 kt originally in HURDAT. Also, a central pressure of 1004 mb has been added at 18Z on the 11th. Diane continued to intensify on the 12th while located north of the Lesser Antilles. HURDAT originally has the system reaching hurricane intensity at 00Z on the 12th and rapidly intensifying to a major hurricane 12 hours later. Fortunately, another reconnaissance aircraft reached Diane late on the 12Z measuring a central pressure of 975 mb at 20Z. A central pressure of 975 mb yields 79 kt north of 25N (82 kt for the intensifying subset) according to the Brown et al. pressure-wind relationship. The aircraft also reported an eye of a 50 mile diameter, which allows computing a 35-40 nm RMW, and climatology suggests a 19 nm RMW for this central pressure and latitude. Furthermore, the storm was moving very slowly, at about 5 kt at this time. Thus, because of the large RMW and slow movement, an intensity of 75 kt is analyzed for 18Z on the 12th, a major change from 105 kt originally in HURDAT. A central pressure of 975 mb has been added to 18Z on the 12th. Major intensity changes are also analyzed for 06Z and 12Z as the intensities chosen are

60 kt and 70 kt, respectively, compared to 90 kt and 105 kt, respectively, originally in HURDAT. A few gales were reported on the 12th, most significant being 45 kt and 996 mb at 09Z by a ship located near 25N 61W. An aircraft reconnaissance mission reached Diane at 02Z on the 13th measuring a central pressure of 980 mb, indicating that the deepening had ended and a slight filling of the hurricane occurred. A central pressure of 980 mb yields 73 kt north of 25N according to the pressure-wind relationship. An intensity of 70 kt has been analyzed for 00Z on the 13th, a major change from 105 kt originally in HURDAT. Also, a central pressure of 980 mb has been added at 00Z n the 13th. At 20Z on the 13th of August, another reconnaissance aircraft reached Diane measuring a central pressure of 969 mb, an indication that the system had re-intensified. A central pressure of 969 mb yields 86 kt north of 25N (89 kt for the intensifying subset), according to the pressure-wind relationship. As the translational speed had increased to about 12 kt (but the size was unknown), an intensity of 90 kt is analyzed for 18Z on the 13th. 90 kt is also the new peak for the lifetime of Diane - a category 2 hurricane - and not as a major hurricane (105 kt) as shown originally in HURDAT. Major changes are also shown at 06Z and 12Z as HURDAT originally showed 105 kt and the intensity has been analyzed at 70 kt and 80 kt, respectively. The central pressure of 969 mb was originally in HURDAT incorrectly at 06Z and has been moved to 18Z on the 13th. Several reports of strong winds were observed on the 13th, including a report of 70 kt and 1000 mb by a ship located at 27.6N, 59.9W. A center fix by the reconnaissance aircraft on the 14th measured a central pressure of 976 mb at 0745Z. A central pressure of 976 mb yields 77 kt according to the north of 25N pressure-wind relationship. An intensity of 80 kt was selected for 06Z, down from 105 kt originally in HURDAT, a major change. A central pressure of 976 mb has been added to 06Z on the 14th. Another center fix measured a central pressure of 980 mb at 1440Z. A central pressure of 980 mb yields 73 kt according to the north of 25N pressure-wind relationship. The aircraft also reported an eye diameter of 30 miles, allowing the computation of about 20-25 nm RMW, and climatology suggests a 21 nm RMW. Therefore, with near climatological RMW and speed (11 kt), an intensity of 75 kt was selected for 12Z, down from 105 kt originally in HURDAT, a major change. A central pressure of 980 mb has been added to 12Z on the 14th. Major changes to the intensity also occurred at 00Z as the intensity is analyzed as 90 kt, respectively, down from 105 kt originally in HURDAT. A slight deepening occurred on the 15th as the central pressure dropped to 973 mb according to reconnaissance aircraft reports at 08Z and 20Z. A central pressure of 973 mb yields 81 kt according to the north of 25N pressure-wind relationship. An intensity of 80 kt was selected for 06Z, 12Z and 18Z, down from 95 kt, 95 kt, and 90 kt, respectively, as originally shown in HURDAT. Central pressures of 973 mb have been added to 06Z and 18Z on the 15th. Diane weakened again on August 16th as an aircraft reconnaissance mission measured a central pressure of 982 mb at 13Z. A central pressure of 982 mb

yields 70 kt according to the north of 25N pressure-wind relationship. The report also indicated a 10 mile eye diameter, yielding a small RMW of about 7-8 nm, and climatology suggests an RMW of about 24 nm. A central pressure of 982 mb has been added to 12Z on the 16th. Another reconnaissance mission reported a central pressure of 983 mb at 1720Z, suggesting maximum winds of 69 kt according to the north of 25N pressure-wind relationship. Due to the quite small size but somewhat slow moving (8 kt) hurricane, an intensity of 75 kt is analyzed for both 12Z and 18Z on the 16th. A central pressure of 983 mb has been added to 18Z on the 16th.

On the 17th, Diane approached the North Carolina coastline making landfall very near Wilmington at 11Z. Just before landfall, the Frying Pan Shoals light reported 40 kt and 989 mb at 06Z. At 12Z, Wilmington was reporting 20 kt and 988 mb, and HURDAT originally had a 986 mb central pressure at 12Z. The Frying Pan Shoals and Wilmington observations support a central pressure of 985 mb at landfall and is also added to 12Z. A central pressure of 985 mb yields 66 kt north of 25N and 68 kt from the Landsea et al. north of 35N the pressure-wind relationships. The radar in Cape Hatteras estimated an eye diameter of 50 miles, allowing computing a 35-40 nm RMW while climatology (of central pressure and latitude) suggests an RMW of about 30 nm. The hurricane was moving at about 9 kt. Thus, an intensity of 65 kt is selected for 12Z, up from 60 kt originally in HURDAT. This makes Diane a Category 1 hurricane landfall for North Carolina, which is the same as originally analyzed in HURDAT. The highest surface wind reports were 45 kt from Cape Hatteras at an unknown time. Late on the 17th, Diane continued inland approaching Virginia early on the 18th. The Kaplan and DeMaria model was run for 18Z on the 17th yielding 37 kt and for 00Z on the 18th yielding 32 kt. However, at 18Z on the 17th, the Diamond Shoals Lighthouse was reporting 50 kt and an intensity of 55 kt is analyzed. Diane is shown to have weakened to a tropical storm at 18Z on the 17th, 6 hours later than originally in HURDAT. At 00Z on the 18th, an intensity of 50 kt is selected as 45 kt winds are reported by a ship near the coast at 06Z. Winds of tropical storm force likely affected portions of eastern South Carolina, Virginia and Maryland on the 17th and early on the 18th. Minor changes were analyzed for the rest of the 18th as the system began to turn to the northeast and continued to weaken. (It is of note that HURDAT had central pressures included every six hours from 12Z on the 17th through 12Z on the 19th. Undoubtedly, someone had included central pressure analyses that were not all based upon actual central pressure measurements. [Such comprehensive analyses have also been included in HURDAT for other very destructive hurricanes.] Most of these appeared to be reasonable, even if they could not be confirmed by explicit observations. Minor adjustments to these central pressures were made at 12Z on the 17th and 06Z and 12Z on the 19th.)

Early on the 19th, Diane returned to the Atlantic Ocean near New York City still as a tropical storm as various ships continued to report gale-force winds. The highest winds reported by ships on the 19th were 40 kt at 06Z, and this is the intensity selected from 06Z to 18Z, up from 35 kt at 12Z and 18Z as originally shown in HURDAT. Transition to an extratropical cyclone is originally shown at 18Z on the 20th but data at this time suggests that the frontal boundary was still to the north of the cyclone. Therefore, extratropical transition is delayed 6 hours until 00Z on the 21st. On the 21st, HURDAT originally showed that Diane weakened to 30 kt at 18Z and this was the final point, likely indicating that the system had been absorbed by the frontal system. However, data suggests that the extratropical system did not weaken and dissipate, but instead strengthened reaching an intensity of 50 kt on the 21st according to ship reports close to storm. The Monthly Weather Review Track of Centers of Cyclones for the month of August also indicates that Diane continued into the north Atlantic and was not absorbed by the frontal system. On the 22nd, the intensity further increased to 55 kt based on ship reports. Data suggests that the extratropical cyclone began to weaken on the 23rd, while located between Greenland and Iceland, and dissipated after 18Z. Adding two additional days to the dissipation phase of Diane is a major change.

Tropical Storm Edith [August 21 – September 5, 1955]

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38790 08/21/1955 M=14  4 SNBR= 849 EDITH       XING=0 SSS=0
38790 08/21/1955 M=16  4 SNBR= 849 EDITH       XING=0 SSS=0
                    **

38795 08/21*  0   0   0    0*  0   0   0    0*124 410  25    0*128 423  25    0*
38795 08/21*  0   0   0    0*  0   0   0    0*124 420  25    0*128 431  25    0*
                                              ***               ***

38800 08/22*132 435  25    0*136 447  25    0*139 459  25    0*142 470  25    0*
38800 08/22*132 442  25    0*136 453  25    0*139 465  25    0*142 477  25    0*
                ***               ***               ***               ***

38805 08/23*145 480  25    0*150 495  30    0*153 510  45    0*157 523  45    0*
38805 08/23*145 488  25    0*150 499  30    0*153 510  35    0*158 521  35    0*
                ***               ***                **      *** ***  **

38810 08/24*163 533  60    0*172 540  60    0*183 546  60    0*199 552  60    0*
38810 08/24*166 532  40    0*177 541  40    0*190 550  45    0*202 559  45    0*
           *** ***  **      *** ***  **      *** ***  **      *** ***  **

38815 08/25*213 563  70    0*221 574  70    0*228 586  70    0*234 596  75    0*
38815 08/25*213 569  50    0*223 580  50    0*229 590  50    0*234 600  50  998*
                ***  **      *** ***  **      *** ***  **      *** ***  **  ***

38820 08/26*240 606  75    0*246 615  75    0*252 623  75    0*257 628  75    0*
38820 08/26*238 609  55    0*242 617  60    0*247 624  60    0*253 631  60  987*
           *** ***  **      *** ***  **      *** ***  **      *** ***  **  ***

38825 08/27*260 631  80    0*263 634  80    0*266 637  80    0*269 639  80    0*
38825 08/27*259 634  55    0*263 636  55    0*267 638  50  992*271 640  50  993*
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            *** ***  **          ***  **      *** ***  **  *** *** ***  **  ***

38830 08/28*273 640  80    0*277 641  85    0*281 641  85    0*285 640  85    0*
38830 08/28*274 642  50    0*276 643  50    0*279 642  55    0*283 640  55  990*
            *** ***  **      *** ***  **      *** ***  **      ***        **  ***

38835 08/29*290 639  85    0*296 636  85    0*305 631  85    0*316 622  85    0*
38835 08/29*288 638  55    0*294 636  55    0*302 631  55    0*313 624  55    0*
            *** ***  **      ***        **      ***        **      *** ***  **

38840 08/30*329 611  85    0*349 594  85    0*369 578  80    0*380 565  75    0*
38840 08/30*324 615  55    0*336 605  55    0*350 594  50    0*365 581  50    0*
            *** ***  **      *** ***  **      *** ***  **      *** ***  **

38845 08/31*390 553  70    0*399 539  65    0E406 526  65    0E410 511  60    0*
38845 08/31*380 560  50    0*396 542  45    0E406 526  45    0E408 514  45    0*
            *** ***  **      *** ***  **                **      *** ***  **


38850 09/01E405 497  55    0E401 490  50    0E395 491  45    0E386 497  35    0*
38850 09/01E405 500  45    0E396 503  40    0E385 508  40    0*377 516  40    0*
                ***  **      *** ***  **      *** ***  **      **** ***  **

38855 09/02E378 508  35    0E371 525  35    0E370 540  35    0E370 546  35    0*
38855 09/02*372 526  40    0*370 535  40    0*372 545  35    0*376 556  35    0*
            **** ***  **      **** ***  **      **** ***         **** ***

38860 09/03E370 551  35    0E370 555  35    0E370 560  35    0E372 563  35    0*
38860 09/03*380 567  35    0*383 568  35    0*381 574  35    0*378 580  35    0*
            **** ***         **** ***         **** ***         **** ***


(September 4th and 5th are new to HURDAT)
38861 09/04*375 582  35    0*370 582  35    0*372 575  35    0*375 563  35    0*
            *** ***  **      *** ***  **      *** ***  **      *** ***  **

38863 09/05*390 555  30    0*405 550  25    0*  0   0   0    0*  0   0   0    0*
            *** ***  **      *** ***  **

38865 HR
38865 TS
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Major track and intensity changes are analyzed for this hurricane that remained over the open Atlantic. A major alteration is to add two additional days at the end of the cyclone's lifetime. Evidence for these alterations comes from the Historical Weather Maps Series, the COADS ship database, Monthly Weather Review, and USWB/NHC microfilm of synoptic weather maps.

August 20:

HWM shows a closed low pressure of at most 1010 mb centered near 17.0N, 29.0W along the ITCZ at 12Z. HURDAT and microfilm do not analyze an organized system. MWR is not available. Ship highlights: No gales or low pressures.

August 21:

HWM shows a closed low pressure of at most 1010 mb centered near 11.0N, 43.0W along the ITCZ at 12Z. HURDAT lists this as a 25 knot tropical depression at 12.4N, 41.0W at 12Z. Microfilm does not analyze an organized system. MWR is not available. Ship highlights: No gales or low pressures.

August 22:

HWM shows a closed low pressure of at most 1010 mb centered near 12.0N, 45.0W along the ITCZ at 12Z. HURDAT lists this as a 25 knot tropical depression at 13.9N, 45.9W at 12Z. Microfilm does not analyze an organized system. MWR is not available. Ship highlights: No gales or low pressures. “Hurricane Edith” was first detected as an easterly wave, labeled locally “August #4,” on 22 August. The wave was situated some 400 to 500 miles east of the Antilles in an area of sparse reports. From available surface indicates there appeared to be a wave of weak to moderate intensity” (ATSR).

August 23:

HWM shows a closed low pressure of at most 1010 mb centered near 14.0N, 47.0W along the ITCZ at 12Z. HURDAT lists this as a 45 knot tropical storm at 15.3N, 51.0W at 12Z. Microfilm does not analyze an organized system. MWR is not available. Ship highlights: No gales or low pressures.

August 24:

HWM shows a tropical storm of at most 1005 mb centered near 18.3N, 54.8W at 12Z. HURDAT lists this as a 60 knot tropical storm at 18.3N, 54.6W at 12Z. Microfilm does not analyze an organized system at 12Z. MWR is not available. Ship highlights: No gales or low pressures. “Late on 23 August “August #4” passed into southern Antilles moving very slowly with an orientation NE to SW. By 240300Z the wave was evident at the 700 mb level. During the morning of the 24th the northern half of the wave progressed very slowly indicating a possible vortex development to the northeast” (ATSR).

August 25:

HWM shows a hurricane of at most 1000 mb centered near 22.8N, 58.5W at 12Z. HURDAT lists this as a 70 knot hurricane at 22.8N, 58.6W at 12Z. Microfilm shows a closed low pressure of at most 1005 mb centered near 23.2N, 59.2W at 12Z. MWR is not available. Ship highlights: 35 kt SW and 1012 mb at 19.9N, 55.8W at 0Z (micro); 45 kt SE and 999 mb (pressure likely 4 mb too low) at 22.4N, 57.9W at 06Z (COADS); 45 kt SE and 1013 mb at 22.6N, 56.9W at 12Z (COADS), and 40 kt SE and 1017 mb at 23.0N,

57.1W at 15Z (micro). Aircraft highlights: Penetration center fix measured a max surface winds of 65 kt, a central pressure of 1002 mb and an eye of a 100 mile diameter at 23.2N, 59.4W at 15Z (micro); Penetration center fix measured central pressure of 998 mb near 23.7N, 60.5W at 20Z (ATSR/micro). “The Air Force Gull Nectar flight was diverted to investigate this suspicious area and arrived in the area late on the 24th of August flying at the 500 mb level. Continuous cloud layers prevented a location of an eye but maximum winds of 70 kt were reported to the east of the circulation. “Edith” intensified very slowly during the next few days as it moved to the northwest along the southwest periphery of the 500 mb Bermuda high” (ATSR).

August 26:

HWM shows a hurricane of at most 1000 mb centered near 25.5N, 62.5W at 12Z. HURDAT lists this as a 75 knot hurricane at 25.2N, 62.3W at 12Z. Microfilm shows a closed low pressure of at most 1005 mb centered near 25.2N, 63.0W at 12Z. MWR indicates a low pressure of 1004 mb located near 25.8N, 63.2W at 12Z. Ship highlights: 35 kt N at 24.7N, 62.9W at 03Z (micro). 35 kt SSE and 1004 mb at 25.8N, 62.6W at 21Z (micro). Aircraft highlights: Penetration center fix at 25.0N, 61.7W at 0524Z (ATSR); Penetration center fix measured an eye of a 25 mile diameter at 25.4N, 62.1W at 08Z (ATSR/micro); Penetration center fix at 25.1N, 63.3W at 14Z (ATSR); Penetration center fix at 25.2N, 63.2W at 1415Z (ATSR); Penetration center fix at 25.3N, 63.1W at 1830Z (ATSR); Penetration center fix at 25.4N, 63.4W at 19Z (ATSR); Penetration center fix at 25.4N, 63.3W at 1930Z (ATSR), and penetration center fix measured a central pressure of 987 mb and an eye of a 40 mile diameter at 25.7N, 63.4W at 20Z (ATSR/micro).

August 27:

HWM shows a hurricane of at most 1000 mb centered near 26.8N, 63.8W at 12Z. HURDAT lists this as an 80 knot hurricane at 26.6N, 63.7W at 12Z. Microfilm shows a closed low pressure of at most 1005 mb centered near 27.0N, 64.0W at 12Z. MWR indicates a low pressure of 996 mb located near 27.0N, 64.2W at 12Z. Ship highlights: 25 kt SSW and 1003 mb at 25.2N, 62.9W at 06Z (COADS); 35 kt S and 1011 mb at 24.5N, 61.9W at 18Z (COADS). Aircraft highlights: Penetration center fix at 27.0N, 63.8W at 1330Z (ATSR); Penetration center fix measured max surface winds of 50 kt and a central pressure of 992 mb at 27.0N, 64.0W at 1456Z (ATSR), and a penetration center fix measured a central pressure of 993 mb and an eye of a 60 mile diameter at 27.3N, 64.0W at 20Z (ATSR/micro). “Late on the 26th “Edith” began to recurved and slowed in forward movement to 5 knots. This deceleration and recurvature were the resultant of the weak gradient surrounding the storm at 500 mb and the orientation of the 500 mb steering high to the northeast of the storm center. The weak gradient continued through the 27th and 28th of August” (ATSR).

August 28:

HWM shows a hurricane of at most 1000 mb centered near 28.4N, 64.2W at 12Z. HURDAT lists this as an 85 knot hurricane at 28.1N, 64.1W at 12Z. Microfilm shows a closed low pressure of at most 996 mb centered near 27.8N, 64.2W at 12Z. MWR indicates a low pressure of 990 mb located near 28.7N, 64.2W at 12Z. Ship highlights: No gales or low pressures. Aircraft highlights: Penetration center fix measured an eye of an 80 mile diameter at 27.3N, 64.4W at 0250Z (ATSR/micro); Penetration center fix measured an eye of an 80 mile diameter at 27.6N, 64.8W at 0730Z (ATSR/micro); Penetration center fix measured an eye of a 60 mile diameter at 28.0N, 64.1W at 1548Z (ATSR/micro); Penetration center fix measured an eye of a 75 mile diameter at 28.3N, 63.7W at 1855Z (ATSR/micro); and penetration center fix measured a central pressure of 990 mb and an eye of a 60 mile diameter at 28.6N, 63.7W at 0730Z (ATSR/micro). "However, by 280300Z, the slowly moving 500 mb trough approaching the storm from the east coast of the United States pulled the hurricane to the north and through recurvature slowly" (ATSR).

August 29:

HWM shows a hurricane of at most 1000 mb centered near 30.6N, 63.1W at 12Z. HURDAT lists this as an 85 knot hurricane at 30.5N, 63.1W at 12Z. Microfilm shows a closed low pressure of at most 996 mb centered near 30.7N, 63.3W at 12Z. MWR indicates a low pressure of 992 mb located near 30.8N, 63.9W at 12Z. Ship highlights: 25 kt SW and 1005 mb at 27.9N, 62.5W at 06Z (COADS); 35 kt SSW and 1015 mb at 29.9N, 57.6W at 12Z (COADS), and 35 kt SSW and 1014 mb at 29.7N, 58.1W at 18Z (COADS). Aircraft highlights: Penetration center fix measured an eye of a 60 mile diameter at 29.4N, 63.8W at 0415Z (ATSR/micro); Penetration center fix at 31.1N, 62.8W at 1545Z (ATSR), and Penetration center fix at 31.2N, 62.3W at 1750Z (ATSR). "By 290300Z, "Edith" had completed recurvature and accelerated from 2.5 knots at 280300Z to 6.5 knots" (ATSR).

August 30:

HWM shows a tropical storm of at most 1000 mb centered near 37.2N, 57.5W at 12Z. HURDAT lists this as an 80 knot hurricane at 36.9N, 57.8W at 12Z. Microfilm shows a closed low pressure of at most 1002 mb centered near 36.0N, 59.0W at 12Z. MWR indicates a low pressure of 990 mb located near 35.2N, 60.0W at 12Z. Ship highlights: 50 kt SSE and 1008 mb at 32.5N, 58.9W at 0Z (COADS); 50 kt SSW and 1010 mb at 32.5N, 58.5W at 06Z (COADS); 40 kt E and 999 mb at 36.8N, 59.5W at 12Z (micro), and 45 kt E and 999 mb at 36.5N, 59.4W at 18Z (COADS). Aircraft highlights: Penetration center fix measured an eye of a 40 mile diameter at 35.7N, 59.0W at 1449Z

(ATSR/micro). “Edith” continued accelerating slowly and by 301600Z was moving toward the northeast at 20 knots. Between 290300Z and 300300Z, “Edith” 500 mb cyclonic circulation was completely destroyed by the deep trough in the Westerlies. Thus, “Edith” entered post maturity with attendant decrease in maximum wind velocity and, in this case, frontogenesis” (ATSR).

August 31:

HWM shows a tropical storm of at most 1005 mb with a warm front extending to the northeast and a cold front extending to the south, centered near 40.5N, 52.3W at 12Z. HURDAT lists this as a 65 knot extratropical cyclone at 40.6N, 52.6W at 12Z. Microfilm shows a closed low pressure of at most 1011 mb centered near 41.0N, 53.0W at 12Z. MWR indicates a low pressure of 996 mb located near 41.0N, 53.0W at 12Z. Ship highlights: 40 kt E and 1013 mb at 42.0N, 53.5W at 12Z (COADS), and 40 kt NE and 1014 mb at 42.5N, 51.3W at 18Z (COADS).

September 1:

HWM shows a closed low pressure of at most 1010 mb with a warm front extending to the northeast and a cold front extending to the south, centered near 38.5N, 50.0W at 12Z. HURDAT lists this as a 45 knot extratropical cyclone at 39.5N, 49.1W at 12Z. Microfilm shows a closed low pressure of at most 1014 mb centered near 37.0N, 51.0W at 12Z. MWR indicates a low pressure of 1012 mb located near 39.5N, 48.7W at 12Z. Ship highlights: 40 kt NNE and 1014 mb at 40.9N, 53.0W at 0Z (COADS), and 40 kt NW and 1019 mb at 36.2N, 54.5W at 12Z (COADS).

September 2:

HWM shows a closed low pressure of at most 1010 mb centered near 36.2N, 54.3W at 12Z. HURDAT lists this as a 35 knot extratropical cyclone at 37.0N, 54.0W at 12Z. Microfilm shows a closed low pressure of at most 1014 mb centered near 37.5N, 56.5W at 12Z. MWR indicates a low pressure of 1006 mb located near 37.0N, 54.0W at 12Z. Ship highlights: 35 kt N and 1007 mb at 38.0N, 55.4W at 06Z (COADS).

September 3:

HWM shows a closed low pressure of at most 1010 mb centered near 36.2N, 56.2W with a stationary front to the north at 12Z. HURDAT lists this as a 35 knot extratropical cyclone at 37.0N, 56.0W at 12Z. Microfilm shows a closed low pressure of at most 1008 mb centered near 38.0N, 57.5W at 12Z. MWR indicates a low pressure of 1006 mb located near 37.6N, 57.8W at 12Z. Ship highlights: 20 kt SE and 1008 mb at 38.0N, 57.1W at 12Z (COADS).

September 4:

HWM shows a spot low centered near 37.5N, 47.5W with a stationary front to the northwest at 12Z. HURDAT and MWR are not available for this date. Microfilm shows a closed low pressure of at most 1017 mb centered near 38.0N, 51.0W at 12Z. MWR is not available on this date at 12Z. Ship highlights: 30 kt SW and 1015 mb at 36.1N, 56.1W at 18Z (COADS).

September 5:

HWM shows a stationary front associated with a 1015 mb low pressure southeast of Nova Scotia at 12Z. HURDAT and MWR are not available for this date. Microfilm shows a closed low pressure of at most 1017 mb centered near 41.0N, 56.0W at 06Z. MWR is not available on this date. Ship highlights: No gales or low pressures.

MWR: “Hurricane Edith formed on August 24 in an easterly and moved on a smooth parabolic curve passing well to the east of Bermuda on the 29th. Highest winds reported by reconnaissance were 90 mph. The lowest pressure in the center was 991 mb (29.26 inches) measured by dropsondes in the eye on the same dates.”

Genesis for this tropical cyclone remains at 12Z on the 21st of August as a 25 kt tropical depression, unchanged from the original HURDAT. Data is very sparse between the 21st and 24th, but a ship at 12Z on the 21st located near 10N, 41W reported 15 kt SW and 1010 mb. This indicates that the center of the cyclone was located about a degree farther west than originally shown in HURDAT. Intensification to a tropical storm remains at 12Z on the 23rd, unchanged from the original HURDAT. The original intensity in HURDAT at 06Z and 12Z is 30 kt and 45 kt, respectively. The data on the 23rd is very sparse and does not justify such a large 15 kt increase in intensity over six hours. Thus, an intensity of 30 kt and 35 kt has been selected for the aforementioned times. The first reconnaissance aircraft mission occurred late on the 24th of August, but it was unsuccessful in obtaining a center fix, although aircraft and ship observations suggest that the center was near 20N, 55W at 21Z. A gradual intensification is shown on the 24th, including major changes at 00Z and 06Z as an intensity of 40 kt is selected for those times, down from 60 kt originally in HURDAT. The first winds of gale force were reported on the 25th, including 45 kt at 06Z, 09Z, and 12Z. An aircraft reconnaissance mission on the 25th measured central pressures of 1002 mb at 15Z and 998 mb at 20Z. A central pressure of 998 mb yields 51 kt according to Brown et al. southern pressure-wind relationship. An intensity of 50 kt is selected for 18Z on the 25th, down from 75 kt originally in HURDAT, a major change. A central pressure of 998 mb was also added to 18Z on the 25th. Major changes in intensity are thus indicated from 00Z to 12Z on the 25th as an intensity of 50 kt has been selected, down from 70 kt originally in HURDAT.

Edith continued to strengthen on the 26th while located southeast of Bermuda. Another aircraft mission reached the storm on the 26th at 20Z measuring a central pressure of 987 mb. A central pressure of 987 mb yields 68 kt south of 25N, 64 kt north of 25N, and 66 kt north of 25N intensifying subset of the pressure-wind relationships. The aircraft also reported an eye diameter of 40 miles, which allows computing an RMW of about 30 nm and climatology suggests 20 nm. Thus, an intensity of 60 kt is selected for 18Z, down from 75 kt originally in HURDAT. A central pressure of 987 mb has been added to 18Z on the 26th. 60 kt is also the new peak intensity for the lifetime of Edith. (The original peak intensity of Edith was 85 kt from the 28th through the 30th. Thus the revision in peak intensity reduces Edith down from a Category 2 hurricane to a high end tropical storm.) A major change is shown at 00Z on the 26th as 55 kt is selected as the intensity, down from 75 kt originally in HURDAT. Some weakening occurred on the 27th, as a central pressure of 992 mb was measured by a reconnaissance aircraft at 1456Z. A central pressure of 992 mb yields 56 kt north of 25N and 54 kt north of 25N weakening subset of the pressure-wind relationships. Another aircraft mission at 20Z measured a central pressure of 993 mb and an eye diameter of 60 miles, which allows calculating an RMW of about 45 nm while climatology suggests an RMW of 23 nm. Thus, an intensity of 50 kt has been selected for 12Z and 18Z, down from 80 kt originally in HURDAT, a major change. Central pressures of 992 mb and 993 mb have been added to 12Z and 18Z, respectively. Major changes are also indicated at 00Z and 06Z on the 27th, as 55 kt have been selected for those times, down from 80 kt originally in HURDAT. Slight deepening occurred on the 28th as a central pressure of 990 mb was measured by a reconnaissance aircraft at 2012Z. A central pressure of 990 mb yields 59 kt north of 25N according to the pressure-wind relationship. The aircraft also reported a large eye diameter of 60 nm. Thus, an intensity of 55 kt is selected for 18Z, down from 85 kt originally in HURDAT. A central pressure of 990 mb is added to 18Z on the 28th. Major changes in intensity are also shown from 0Z to 12Z on the 28th. HURDAT originally had 80 kt at 0Z, and 85 kt at 06Z and 12Z. 50 kt was selected for 00Z and 06Z, and 55 kt for 12Z. On the 29th, Edith passed to the east of Bermuda and only a few ships reported gale-force winds on this day. An intensity of 55 kt is analyzed from 00Z to 18Z – persisting with the reanalyzed intensity from the day before, down from 85 kt originally in HURDAT, a major change.

On the 30th of August, the ship 12201 reported winds of 50 kt at 00Z and 06Z. An intensity of 55 kt has been analyzed at those times, down from 85 kt originally at HURDAT, a major change. At 12Z and 18Z, HURDAT originally showed 80 kt and 75 kt, respectively. An intensity of 50 kt has been analyzed for those times, a major change. At 18Z, the position of the ship Mulberry Hills appears to be wrong although the data looks consistent with a nearby ship Coruth. Transition to an extratropical cyclone remains at 12Z on the 31st, as originally shown in HURDAT. Major changes in intensity are indicated from 00Z to 12Z. HURDAT originally showed 70 kt at 00Z, and 65 kt at 06Z

and 12Z. 50 kt has been analyzed at 00Z, and 45 kt at 06Z and 12Z. Late on September 1st, data indicates that the temperature gradient that had been surrounding the storm for the past day was nearly non-existent, the circulation had become more circular and no frontal system was present near the center of circulation. Therefore, Edith is analyzed to have become a tropical cyclone again at 18Z on this date. (The original HURDAT did not indicate a tropical transition stage.) Edith remained a tropical cyclone for the remainder of its lifetime. Various ships reported gale-force winds on the 1st, including 40 kt at 0Z and 12Z. The last gale-force winds were reported at 06Z on the 2nd. Minor intensity and track changes are evaluated on the 2nd and 3rd of September. The last position in HURDAT is at 18Z on the 3rd, but data on the 4th suggests that a closed circulation was still present. An approaching cold front started to interact with Edith on the 4th and by 12Z on the 5th, the circulation had dissipated. The last position is analyzed at 06Z on the 5th as a 25 kt tropical depression. Adding 36 hours to the lifetime of Edith is a major change to HURDAT.

Unnamed Tropical Storm 5 [August 23–28, 1955]

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38870 08/23/1955 M= 8  5 SNBR= 850 NOT NAMED   XING=1 SSS=0
38870 08/23/1955 M= 6  5 SNBR= 850 NOT NAMED   XING=1 SSS=0
                    *

38875 08/23*  0   0   0    0*177 800  35    0*189 811  35    0*195 816  35    0*
38875 08/23*  0   0   0    0*187 814  25    0*194 818  25    0*200 822  25    0*
                           *** ***  **      *** ***  **      *** ***  **

38880 08/24*200 820  35    0*205 824  35    0*210 827  35    0*216 833  35    0*
38880 08/24*205 825  25    0*210 829  25    0*215 832  25    0*220 834  25    0*
            *** ***  **      *** ***  **      *** ***  **      *** ***  **

38885 08/25*223 838  35    0*229 841  35    0*235 844  35    0*243 848  35    0*
38885 08/25W227 837  25    0W234 842  25    0W240 847  25    0*246 851  30    0*
            **** ***  **     **** ***  **     **** ***  **      *** ***  **

38890 08/26*254 853  35    0*265 857  35    0*277 861  40    0*288 870  40    0*
38890 08/26*251 853  35    0*260 857  35    0*274 861  35    0*289 870  40 1004*
            ***             ***             *** ***  **      ***         ****

38895 08/27*296 883  40    0*301 897  40    0*303 911  40    0*305 923  40    0*
38895 08/27*297 883  45    0*301 897  45    0*303 913  40    0*305 929  35    0*
            ***      **                **          ***              ***  **

38900 08/28*306 933  40    0*308 939  35    0*313 945  35    0*322 950  35    0*
38900 08/28*305 937  30    0*306 942  25    0*310 948  25    0*315 953  25    0*
            *** ***  **      *** ***  **      *** ***  **      *** ***  **

38905 08/29*335 955  30    0*350 955  30    0*364 947  25    0*376 926  25    0*
38910 08/29*  0   0   0    0*  0   0   0    0*  0   0   0    0*  0   0   0    0*
              *   *   *        *   *   *        *   *   *        *   *   *

38910 08/30*387 903  25    0*  0   0   0    0*  0   0   0    0*  0   0   0    0*
38910 08/30*  0   0   0    0*  0   0   0    0*  0   0   0    0*  0   0   0    0*
              *   *   *
38915 TS
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U.S. Tropical Storm Landfall

08/27 04Z 30.0N 89.2W 45 kt LA

Minor changes to the track and to the intensity shown in McAdie et al. (2009). Two major alterations are to show a wave stage on the 25th and to indicate dissipation 30 hours earlier than originally shown. Evidence for these alterations comes from the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Monthly Weather Review, the Local Climatological Data, Connor (1956), Mexican weather maps,the Navy aircraft reconnaissance book, and Perez et al. (2000).

August 21:

HWM, HURDAT, Microfilm and MWR do not analyze an organized system on this date. Ship highlights: No gales or low pressures.

August 22:

HWM, HURDAT, and MWR do not analyze an organized system on this date. Microfilm shows a closed low pressure of at most 1011 mb at 19.0N, 81.0W at 18Z. Ship highlights: No gales or low pressures.

August 23:

HWM shows a spot low centered near 17.3N, 82.0W at 12Z. HURDAT lists this as a 35 knot tropical storm at 18.9N, 81.1W at 12Z. Microfilm analyzes a closed low pressure of at most 1008 mb centered near 20.5N, 81.0W at 12Z. MWR shows a low pressure of 1008 mb located near 19.2N, 82.0W at 12Z. Ship highlights: No gales or low pressures. "A weak circulation was observed near Grand Cayman on August 23" (MWR).

August 24:

HWM shows a spot low centered near 20.5N, 82.5W at 12Z. HURDAT lists this as a 35 knot tropical storm at 21.0N, 82.7W at 12Z. Microfilm analyzes a closed low pressure of at most 1008 mb centered near 21.0N, 82.0W at 12Z. MWR shows a low pressure of 1007 mb located near 21.0N, 83.8W at 12Z. Ship highlights: No gales or low pressures. "Tropical Storm landfall in Cuba, August 24" (Perez et al.)

August 25:

HWM shows a spot low centered near 24.5N, 88.0W at 12Z. HURDAT lists this as a 35 knot tropical storm at 23.5N, 84.4W at 12Z. Microfilm analyzes a closed low pressure of at most 1008 mb centered near 25.0N, 88.0W at 12Z. MWR shows a low

pressure of 1009 mb located near 22.5N, 86.0W and new center of 1009 mb located near 28.2N, 85.8W at 12Z. Ship highlights: No gales or low pressures.

August 26:

HWM shows a closed low pressure of at most 1010 mb centered near 28.0N, 88.0W at 12Z. HURDAT lists this as a 40 knot tropical storm at 27.7N, 86.1W at 12Z. Microfilm analyzes a closed low pressure of at most 1008 mb centered near 25.5N, 86.0W at 12Z. MWR shows a low pressure of 1009 mb located near 27.4N, 86.2W at 12Z. Ship highlights: No gales or low pressures. Aircraft highlights: Navy reconnaissance measured a central pressure of 1004 mb and surface winds of 40 kt at 29.0N, 89.0W at 18Z (micro).

August 27:

HWM shows a spot low centered near 29.2N, 92.2W at 12Z. HURDAT lists this as a 40 knot tropical storm at 30.3N, 91.1W at 12Z. Microfilm analyzes a closed low pressure of at most 1005 mb centered near 30.5N, 91.5W at 12Z. MWR does not analyze an organized system on this date. Ship highlights: No gales or low pressures. Land highlights: Max surface winds of 35-45 kt and 1000 mb at New Orleans at 29.8N, 90.0W (likely around 07Z)(MWR), and 1004 mb at Baton Rouge at 12Z (CLIMO). "It moved on a northwestward course and gained intensity very slowly, passing between New Orleans Airport and the Naval Air Station about 0200 EST, August 27. The highest wind was 40 to 50 mph with lowest pressure 1000.3 mb (29.54 inches). Only very minor damage was reported" (MWR).

August 28:

HWM shows a spot low centered near 31.0N, 94.8W at 12Z. HURDAT lists this as a 35 knot tropical storm at 31.3N, 94.5W at 12Z. Microfilm and MWR does not analyze an organized system on this date. Land highlights: 1005 mb at Lake Charles (likely early on the 28th) (CLIMO).

August 29:

HWM shows a cold front across the central states of the United States at 12Z. HURDAT lists this as a 25 knot tropical depression at 36.4N, 94.7W at 12Z. Microfilm and MWR does not analyze an organized system on this date.

August 30:

HWM shows a cold front stretching from the Great Lakes to Texas at 12Z. HURDAT lists this as a 25 knot tropical depression at 38.7N, 90.3W at 0Z (last position). Microfilm and MWR does not analyze an organized system on this date.

This unnamed tropical storm developed from a tropical wave over the western Caribbean Sea late on August. The genesis is unchanged from 06Z on the 23rd although the system may not have had a well-defined low level circulation according to the land stations in the area. Winds on the 23rd stayed below gale force winds and no surface pressures below 1008 mb were reported. Therefore, the cyclone is started as a 25 kt tropical depression and this intensity is kept from the 06Z to 18Z on the 23rd. This is a decrease from the 35 kt originally shown in HURDAT from the 06Z to 18Z on the 23rd. On the 24th the organization of the cyclone did not improve according to the observations from the western Caribbean and western Cuba. The depression moved slowly to the northwest and then to north-northwest making landfall in Pinar del Rio late on the 24th. HURDAT originally had 35 kt throughout the day but the intensity is kept at 25 kt since no gales or low pressures were observed on the 24th. Note that this assessment does not agree with Perez et al., as they had the system as a Cuban tropical storm impact.

Early on the 25th of August, observations across the eastern Gulf of Mexico and western Caribbean indicate that the depression dissipated into a trough of low pressure and a new center formed farther to the northwest later in the day. The MWR Tracks of Lows for the month of August also agrees on this solution. The new low level circulation became better organized by 18Z on the 25th and the cyclone redeveloped with winds of 30 kt. The highest winds for the 25th were 30 kt reported by a ship at 12Z. The cyclone is analyzed to have reached tropical storm intensity at 0Z on the 26th. A reconnaissance aircraft reached the tropical cyclone at 18Z on the 26th measuring a central pressure of 1004 mb and surface winds of 40 kt. A central pressure of 1004 mb suggests maximum winds of 36 kt north of 25N and 38 kt north of 25N intensifying from the Brown et al. pressure-wind relationships. Given the visual estimate of the intensity and the fast-forward motion of the storm, the intensity is kept at 40 kt at 18Z on the 26th. The cyclone turned to the northwest and west-northwest late on the 26th and early on the 27th making landfall at 04Z on the 27th in southeast Louisiana. Three hours later, New Orleans, LA, measured a pressure of 1000 mb, which indicates maximum winds of at least 44 kt according to the pressure-wind relationship. (It is unknown whether this was a central pressure.) Thus, a peak wind of 45 kt is selected for 00Z and 06Z on the 27th, up from 40 kt originally shown in HURDAT. 45 kt is also the intensity at landfall. New Orleans reported winds of 35-45 kt, consistent with this analysis. The small tropical storm continued moving over southern Louisiana on August 27th weakening to a tropical depression at 0Z on the 28th. Dissipation is shown over eastern Texas at 18Z on the 28th based on surface observations. HURDAT originally kept the cyclone as a tropical storm until 18Z on the

28th, downgrading it to a tropical depression at 0Z on the 29th and finally dissipating it at 0Z on August 30th. Thus, dissipation 30 hours earlier is a major change to HURDAT.

Hurricane Flora [September 2–10, 1955]

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38920 09/02/1955 M= 8  6 SNBR= 851 FLORA       XING=0 SSS=0
38920 09/02/1955 M= 9  6 SNBR= 851 FLORA       XING=0 SSS=0
                    *

38925 09/02*  0   0   0    0*190 311  35    0*192 331  35    0*194 353  40    0*
38925 09/02*  0   0   0    0*190 311  35    0*192 331  35    0*194 351  40    0*
                                                            ***

38930 09/03*198 371  45    0*204 387  55    0*210 402  65    0*216 417  65    0*
38930 09/03*198 370  45    0*204 387  55    0*210 402  65    0*216 417  65    0*
                ***

38935 09/04*222 432  65    0*229 448  65    0*237 464  65    0*246 481  65    0*
38935 09/04*222 432  65    0*229 448  65    0*237 466  65    0*247 485  65  989*
                                             ***          ***  ***       ***

38940 09/05*255 498  65    0*265 513  65    0*274 524  65    0*282 533  65    0*
38940 09/05*256 500  70    0*265 513  75    0*274 524  80  975*282 533  85  971*
          *** ***  **              **                **  ***          **  ***

38945 09/06*290 540  65    0*299 546  70    0*307 551  80    0*316 553  85  967*
38945 09/06*293 539  85    0*298 544  85    0*305 548  90    0*313 552  90  967*
          *** ***  **      *** ***  **      *** ***  **      *** ***  **

38950 09/07*324 554  90    0*331 554  90    0*339 552  90    0*353 547  90    0*
38950 09/07*321 554  90    0*330 554  90    0*339 552  90    0*349 548  90    0*
          ***               ***                            *** ***

38955 09/08*368 539  90    0*380 527  90    0*393 512  90    0*407 497  90  972*
38955 09/08*362 539  90    0*376 527  85    0*391 514  85    0*407 497  80  975*
          ***               ***      **      *** ***  **                **  ***

38960 09/09E424 472  85    0E445 437  80    0E466 401  70    0*  0   0   0    0*
38960 09/09*422 470  75    0E440 440  70  976E460 390  65    0E480 320  60    0*
          *** ***  **      *** ***  **  *** *** ***  **     **** ***  **

(September 10th is new to HURDAT)
38963 09/10E495 270  55    0E510 220  50    0E525 180  45    0E535 135  40    0*
          **** ***  **     **** ***  **     **** ***  **     **** ***  **

38965 HR
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Minor track and major intensity changes are analyzed for this hurricane that remained over the open Atlantic. A major alteration is to add 1 additional day at the end of the cyclone's lifetime. Evidence for these alterations comes from the Historical Weather Maps Series, the COADS ship database, Monthly Weather Review, and USWB/NHC microfilm of synoptic weather maps.

August 30:

HWM and HURDAT do not analyze an organized system on this date. Microfilm and MWR are not available on this date. Ship highlights: No gales or low pressures.

August 31:

HWM and HURDAT do not analyze an organized system on this date. Microfilm and MWR are not available on this date. Ship highlights: No gales or low pressures.

September 1:

HWM and HURDAT do not analyze an organized system on this date. Microfilm and MWR are not available on this date. Ship highlights: No gales or low pressures.

September 2:

HWM shows a spot low centered near 14.5N, 40W at 12Z. HURDAT lists this as a 35 knot tropical storm at 19.0N, 31.1W at 12Z. Microfilm and MWR are not available on this date. Ship highlights: No gales or low pressures.

September 3:

HWM shows a tropical storm of at most 1010 mb centered near 18.0N, 42.0W at 12Z. HURDAT lists this as a 65 knot hurricane at 21.0N, 40.2W at 12Z. Microfilm shows a closed low pressure of at most 1008 mb at 21.0N, 40.2W at 12Z. MWR is not available on this date. Ship highlights: 55 kt NE and 1015 mb at 21.9N, 40.5W at 12Z, and 50 kt NE and 1006 mb at 22.3N, 42.0W at 18Z. All observations from micro. “On 31 August the surface reports from the Cape Verde Islands indicated the passage of an easterly wave with a possible vortex. The vortex was extrapolated westward at 12.5 knots on each succeeding surface chart but no reports were received in the vicinity of the disturbance until 3 September when the SS Belmare and the SS Almora reports indicated a small but intense tropical storm near 22N 42W late on 3 September” (ATSR).

September 4:

HWM shows a hurricane of at most 1010 mb centered near 23.2N, 45.1W at 12Z. HURDAT lists this as a 65 knot hurricane at 23.7N, 46.4W at 12Z. Microfilm shows a closed low pressure of at most 1002 mb at 24.0N, 46.8W at 12Z. MWR is not available on this date. Ship highlights: 55 kt NE and 1008 mb at 22.3N, 42.0W at 0Z; 45 kt S and 1000 mb at 24.7N, 46.0W at 12Z, and 45 kt NNW and 1013 mb at 24.0N, 48.6W at 15Z. All observations from micro. Aircraft highlight: Penetration center fix measured a central pressure of 989 mb and an eye of a 20 mile diameter at 24.7N, 48.5W at 1810Z (ATSR/micro). “Aircraft reconnaissance was ordered and Warning Number One on “Hurricane Flora” was issued at 040400Z. Between the 31st of August and detection late

on the 3rd of September, “Flora” had moved on a course of about 295 degrees at 14 to 16 knots. This movement continued for the next 24 hours” (ATSR).

September 5:

HWM shows a hurricane of at most 1005 mb centered near 27.5N, 52.7W at 12Z. HURDAT lists this as a 65 knot hurricane at 27.4N, 52.4W at 12Z. Microfilm shows a closed low pressure of at most 996 mb at 27.5N, 52.8W at 12Z. MWR is not available on this date. Ship highlights: 45 kt N and 1004 mb at 29.1N, 54.5W at 21Z, and 35 kt NNW and 1013 mb at 29.3N, 55.5W at 21Z. All observations from micro. Aircraft highlight: Penetration center fix measured a central pressure of 975 mb and an eye of a 40 mile diameter at 27.9N, 53.0W at 1430Z (ATSR/micro). Penetration center fix measured a central pressure of 971 mb and an eye of a 40 mile diameter at 28.2N, 54.2W at 2010Z (ATSR/micro). “Beginning late on 4 September “Flora” began turning to the northwest and decelerating. By 050300Z, “Flora” was moving northwest at 13 knots with maximum winds barely of hurricane force” (ATSR).

September 6:

HWM shows a hurricane of at most 1005 mb centered near 30.7N, 55.5W at 12Z. HURDAT lists this as a 80 knot hurricane at 30.7N, 55.1W at 12Z. Microfilm shows a closed low pressure of at most 999 mb at 30.8N, 55.0W at 12Z. MWR analyses a low pressure of at most 980 mb at 30.5N, 55.2W at 12Z. Ship highlights: 50 kt N and 994 mb at 29.5N, 54.0W at 0Z; 60 kt NNE and 991 mb at 30.0N, 54.5W at 0730Z, and 40 kt SE and 1019 mb at 30.0N, 51.5W at 12Z. All observations from micro. Aircraft highlight: Penetration center fix measured a central pressure of 977 mb and an eye of a 30 mile diameter at 29.2N, 54.0W at 02Z (ATSR/micro). Penetration center fix measured an eye of a 30 mile diameter at 28.2N, 54.3W at 0230Z (ATSR/micro). Penetration center fix measured an eye of a 40 mile diameter at 30.1N, 54.9W at 0730Z (ATSR/micro). Penetration center fix measured a central pressure of 967 mb and an eye of a 30 mile diameter at 31.5N, 54.2W at 1947Z (ATSR/micro). ““Flora” remained a very small storm as far as size and maximum wind velocity were concerned. Not until late on the 6th of September did “Flora’s” course pass through north and speed decrease to the minimum. At approximately the same time, the maximum wind velocity began to increase as the pressure gradient increased on the eastern side of the hurricane” (ATSR).

September 7:

HWM shows a hurricane of at most 1000 mb centered near 33.9N, 55.2W at 12Z. HURDAT lists this as a 90 knot hurricane at 33.9N, 55.2W at 12Z. Microfilm shows a closed low pressure of at most 1005 mb at 33.9N, 55.2W at 12Z. MWR analyses a low pressure of at most 980 mb at 33.9N, 56.2W at 12Z. Ship highlights: 45 kt SE and 1014

mb at 32.0N, 53.0W at 12Z, and 40 kt SW and 1014 mb at 32.0N, 53.8W at 18Z. All observations from COADS. Aircraft highlight: Penetration center fix at 33.9N, 55.2W at 1230Z (ATSR). Penetration center fix measured an eye of a 40 mile diameter at 34.9N, 54.8W at 1830Z (ATSR/micro).

September 8:

HWM shows a hurricane of at most 1000 mb centered near 38.8N, 52.6W at 12Z. HURDAT lists this as a 90 knot hurricane at 39.3N, 51.2W at 12Z. Microfilm shows a closed low pressure of at most 999 mb at 39.0N, 52.0W at 12Z. MWR analyses a low pressure of at most 984 mb at 38.9N, 52.5W at 12Z. Ship highlights: 50 kt S and 993 mb at 36.5N, 51.0W at 06Z (micro), 50 kt SW and 1001 mb at 36.2N, 51.3W at 12Z (COADS), and 35 kt S and 1016 mb at 38.7N, 47.0W at 18Z (COADS). Aircraft highlight: Penetration center fix at 40.5N, 50.7W at 1650Z (ATSR). Penetration center fix measured a central pressure of 975 mb and an eye of a 38 mile diameter at 41.0N, 49.4W at 1930Z (ATSR/micro).

September 9:

HWM shows a closed low pressure of at most 1005 mb with a cold front going through the cyclone centered near 47.0N, 40.0W at 12Z. HURDAT lists this as a 70 knot extratropical cyclone at 46.6N, 40.1W (last position) at 12Z. Microfilm shows a closed low pressure of at most 1002 mb at 46.5N, 40.0W at 12Z. MWR analyses a low pressure of at most 992 mb at 46.5N, 41.0W at 12Z. Ship highlights: 35 kt SW and 1022 mb at 40.0N, 42.4W at 0Z (micro); 40 kt S and 1012 mb at 43.6N, 41.7W at 06Z (micro); Queen Eleonor measured a central pressure of 976 mb at 43.7N, 42.5W at 0826Z (micro); 45-55 kt WSW and 1008 mb at 43.5N, 40.9W at 12Z (micro), and 45 kt SSE and 1002 mb at 48.2N, 31.4W at 18Z (COADS). “As “Flora” moved to the northeast and later east-northeast it was overtaken by the cold front resulting in further degeneration and development of extratropical characteristics. “Flora” was completely absorbed by the cold front on the 9th of September and rapidly lost its identity as an extratropical low. The last warning was issued at 091600Z. The last identifiable position was near 48N, 33W at 092200Z.

September 10:

HWM shows a closed low pressure of at most 1005 mb centered near 52.0N, 17.0W with a warm front to the northeast and a cold front to the south at 12Z. HURDAT does not list an organized system on this date. Microfilm and MWR are not available on this date. Ship highlights: 35 kt W and 1012 mb at 48.0N, 30.0W at 0Z (COADS); 45 kt SW and 1007 mb at 49.0N, 22.8W at 06Z (COADS), and 35 kt SW and 1009 mb at 49.8N, 16.4W at 12Z (COADS).

September 11:

HWM shows a closed low pressure of at most 980 mb centered near 67.0N, 6.0W with a warm front to the northeast at 12Z. HURDAT does not list an organized system on this date. Microfilm and HWM are not available on this date. Ship highlights: No gales or low pressures.

MWR: "An unstable easterly wave passed through the Cape Verde Islands during August 30-31. A message was received on the 30th from Panair du Brazil at Recife, Brazil: Tropical storm evident. Cyclonic circulation aloft to 4000 meters. Center approximately 11ºN, 21ºW. Displacement 18 mph WNW. Storm associated with easterly wave along ITC [intertropical convergence zone]. This weak circulation was the genesis of Flora which reached hurricane intensity on September 3 at approximately Latitude 21ºN and Longitude 40ºW. Hurricane Flora moved on a smooth parabolic path northward through the middle Atlantic, passing some 9º east of Bermuda on the 6th and early on the 7th. The highest wind reported was 104 mph at 1230 EST on the 8th at Latitude 41.0ºN and Longitude 49.4ºW, with central pressure of 972 mb (28.70 inches). The lowest reported pressure during the storm's history was 967 mb (28.55 inches) at 31.5ºN and 55.3ºW on the 6th."

Genesis for this tropical cyclone remains at 06Z on the 2nd of September as a 35 kt tropical storm, unchanged from the original HURDAT. Data over the eastern and central Atlantic are very sparse and the exact time of formation cannot be confirmed. The first ship to encounter Flora occurred at 12Z on the 3rd when Belmare reported 55 kt NE winds and 1015 mb. This is the time that Flora reaches hurricane intensity as originally shown in HURDAT and our reanalysis concurs with this assessment. The first airplane reconnaissance reached Flora at 1810Z on the 4th measuring a central pressure of 989 mb and an eye diameter of 20 miles. This allows computing an RMW of about 15 nm and climatology suggests an RMW of 20 nm. A central pressure of 989 mb yields 65 kt according to Brown et al. southern pressure-wind relationship and 61 kt in the northern. Thus, an intensity of 65 kt is analyzed at 18Z, which agrees with HURDAT original assessment and the surface winds estimated by the reconnaissance mission. A central pressure of 989 mb has been added at 18Z on the 4th. On the 5th, reconnaissance aircraft reported a central pressure of 975 mb at 1430Z and 971 mb at 2010Z. A central pressure of 975 mb yields 79 kt north of 25N and 82 kt north of 25N in the intensifying subset of the pressure-wind relationships. An intensity of 80 kt has been selected for 12Z on the 5th, up from 65 kt originally in HURDAT. A central pressure of 975 mb has been added to 12Z on the 5th. A central pressure of 971 mb yields 83 kt north of 25N and 87 kt north of 25N in the intensifying subset of the pressure-wind relationships. This mission also measured an eye diameter of 40 miles, which allows computing an RMW of about 30

nm, somewhat larger than climatology at 22 nm. The hurricane was also moving at about 16 kt, a fairly rapid rate. Therefore, an intensity of 85 kt has been selected for 18Z on the 4th and a central pressure of 971 mb has been added to this time. Major changes are analyzed at 18Z on the 5th and 00Z on the 6th as HURDAT originally showed 65 kt, while 85 kt have been selected for the aforementioned times. The highest maximum winds reported by ships on the 5th were 45 kt at 21Z and on the 6th were 60 kt at 0730Z.

Another aircraft reconnaissance mission measured 977 mb on the 6th at 02Z but this information is believed to be unreliable as it is not supported by previous and subsequent drops. A cause for the anomaly could be that the drop was made at 500 mb, compared to the 700 mb level for the other drops, with the dropsonde likely landing in the eyewall and not the eye. Therefore, this data was not used on the reanalysis. At 1947Z on the 6th, a central pressure of 967 mb was measured by a reconnaissance aircraft. This report also indicated an eye diameter of 30 miles, which allows computing an RMW of about 20-25 nm versus a climatology of 25 nm. A central pressure of 967 mb yields 88 kt north of 25N and 92 kt north of 25N and intensifying, according to the pressure-wind relationships. Hence, an intensity of 90 kt has been selected for 18Z on the 6th. 90 kt is also the peak intensity for the lifetime of Flora, which is unchanged from that originally shown in HURDAT. No change in intensity is analyzed to have occurred between 12Z on the 6th to 00Z on the 8th. The next reconnaissance aircraft to measure a central pressure was at 1930Z on the 8th measuring 975 mb. A central pressure of 975 mb yields 78 kt north of 35N according to the Landsea et al. pressure-wind relationship. The aircraft also reported an eye diameter of 38 miles, which allows computing an RMW of about 30 nm while climatology gives 34 nm. Thus, an intensity of 80 kt is selected for 18Z on the 8th, down from 90 kt as originally shown in HURDAT. 85 kt was selected for 06Z and 12Z on the 8th, down from 90 kt originally in HURDAT. A few ships reported gale-force winds on the 8th, including 60 kt measured at 12Z. On the 9th, Flora started to rapidly accelerate to the northeast while losing its tropical characteristics. Extratropical transition was originally shown in HURDAT to have occurred at 00Z on the 9th but the data suggests that the cold front was still to the northwest of the cyclone. By 06Z, Flora was already part of the frontal system and transition to an extratropical cyclone is analyzed to have occurred at this time, six hours later than shown in HURDAT. Early on the 9th, the ship Queen Eleanor passed through the center of Flora measuring a central pressure of 976 mb at 0826Z. A central pressure of 976 mb has been added to 06Z on the 9th. The last position originally on HURDAT is at 12Z on the 9th possibly indicating that Flora had been absorbed by a larger extratropical system. Nevertheless, data suggests that Flora continued moving northeast and later, east-northeast, towards the northeast Atlantic. The extratropical cyclone gradually weakened and dissipated after 18Z on the 10th. Adding 30 hours to the lifetime of Flora is a major change to HURDAT.

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38970 09/04/1955 M= 3  7 SNBR= 852 GLADYS      XING=0 SSS=0
38970 09/02/1955 M= 5  7 SNBR= 852 GLADYS      XING=0 SSS=0
         **          *

(September 2nd and 3rd are new to HURDAT)
38971 09/02*  0   0   0    0*  0   0   0    0*200 950  25    0*197 945  25    0*
                                              *** ***  **      *** ***  **

38973 09/03*195 940  25    0*195 935  25    0*195 932  25    0*195 933  25    0*
            *** ***  **      *** ***  **      *** ***  **      *** ***  **

38975 09/04*  0   0   0    0*  0   0   0    0*206 941  30    0*215 946  35    0*
38975 09/04*196 940  25    0*200 947  25    0*208 953  30    0*216 957  35    0*
            *** ***  **      *** ***  **      *** ***          *** ***

38980 09/05*223 952  40    0*231 959  60    0*236 967  80    0*234 973  75    0*
38980 09/05*223 961  40    0*226 965  50    0*230 970  60  997*233 975  60    0*
                ***  **      *** ***  **      *** ***  **      *** ***  **

38985 09/06*228 977  50    0*221 978  45    0*215 978  40    0*207 978  40    0*
38985 09/06*229 979  50    0*221 979  40    0*214 978  35    0*212 975  25    0*
            *** ***             ***  **      ***      **      *** ***  **

38990 HR
38990 TS
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Minor alterations are introduced to the track and major changes to the intensity shown in McAdie et al. (2009). Additionally, two days have been added to the lifetime of this cyclone. Evidence for these alterations comes from the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Monthly Weather Review, Mexican synoptic maps and the Navy aircraft reconnaissance book.

September 2:

HWM shows a closed low pressure of at most 1005 mb centered near 20.0N, 96.0W at 12Z. HURDAT does not list an organized system on this date. Microfilm shows a closed low pressure of at most 1005 mb at 21.0N, 94.0W at 12Z. MWR is not available on this date. Ship highlights: No low pressures or gales. “As early as 27 August a weak vortex with an associated easterly trough was detected while located just west of Balboa, Canal Zone. The vortex was tracked as it progressed slowly westward along with the associated upper trough at 700 mb and 500 mb. By 1 September, the disturbance was still not unduly suspicious but was centered over the Gulf of Campeche whose warm waters are most productive of tropical storms. The upper trough was reflected on the surface and extended northeastward into a quasi-stationary frontal area. During the next three days it was not apparent that any appreciable intensification had taken place but it was evident that the vortex was slowly drifting northward” (ATSR).

September 3:

HWM shows a closed low pressure of at most 1005 mb centered near 20.5N, 92.5W at 12Z. HURDAT does not list an organized system on this date. Microfilm shows an elongated closed low pressure of at most 1008 mb near 20.5N, 93.5W at 12Z. MWR is not available on this date. Ship highlights: No low pressures or gales. Land highlights: 5 kt N and 1005 mb at Ciudad del Carmen at 0Z (micro), and 5 kt NE and 1005 mb at Coatzacoalcos at 0Z (micro).

September 4:

HWM shows a closed low pressure of at most 1005 mb centered near 22.1N, 95.5W at 12Z. HURDAT lists a 30 kt tropical depression near 20.8N, 95.3W at 12Z. Microfilm shows a closed low pressure of at most 1005 mb near 22.0N, 95.5W at 12Z. MWR shows a low pressure of 1004 mb at 21.0N, 95.0W at 12Z. Ship highlights: 5 kt W and 1005 mb at 19.0N, 91.9W at 0Z (micro), and 25 kt NNW and 1003 mb at 23.1N, 97.5W at 21Z (micro). Land highlights: 10 kt N and 1004 mb at Veracruz at 0Z (micro). "Beginning on the 4th of September, ships in the Western Gulf of Mexico began reporting squally weather with surface winds of 20 to 30 knots. These reports, as were the land station reports, were at some distance from the center of the tropical disturbance. It was decided to send an investigative flight into the Western Gulf to locate the center of the disturbance. In the meantime, an unnumbered tropical depression warning was issued at 042100Z with an estimated position of the center" (ATSR).

September 5:

HWM shows a tropical storm of at most 1005 mb centered near 23.5N, 96.3W at 12Z. HURDAT lists an 80 kt hurricane near 23.6N, 96.7W at 12Z. Microfilm shows a closed low pressure of at most 1002 mb near 23.5N, 96.8W at 12Z. MWR shows a low pressure of 1006 mb at 23.3N, 96.8W at 12Z. Ship highlights: 25 kt N and 1003 mb at 23.3N, 97.2W at 0Z (micro), and 35 kt N and 1011 mb at 25.2N, 96.5W at 06Z (micro). Aircraft highlights: Penetration center fix measured a central pressure of 997 mb and an eye of a 20 mile diameter at 23.1N, 97.1W at 1403Z (ATSR/micro), and penetration center fix at 23.3M, 97.3W at 1615Z (ATSR). "Navy reconnaissance aircraft on the 5th found a poorly defined eye, visually and by radar. A center fix was made on the surface wind circulation. The maximum wind velocity was reported as 80 knots near the center and minimum central pressure of 996 mb. "Gladys" was thus typical of most of the storms forming in the Gulf which have poorly defined eyes, relatively high central pressures, yet at times have strong winds over a small area. The four aircraft fixes reported on the morning of the 5th showed the hurricane to be on a west-northwest to

northwest course moving at about 8 knots. The last reconnaissance fix placed the center at 23.5N, 97.4W only 20 miles off the coast of Mexico" (ATSR).

September 6:

HWM shows a tropical storm of at most 1005 mb centered near 21.5N, 97.5W at 12Z. HURDAT lists an 40 kt tropical storm near 21.5N, 97.8W at 12Z. Microfilm shows a spot low near 24.5N, 96.2W at 12Z. MWR shows a low pressure of 1006 mb at 24.7N, 97.8W at 12Z. Ship highlights: No gales or low pressures. Land highlights: 42 kt NW at Tampico (no time given but likely early on the 6th) (MWR), and 20 kt ENE and 1001 mb at Tampico at 06Z (micro). "On the 4th and 5th, a trough in the westerlies, extending from the Great Lakes region into Northern Texas, was almost stationary. The trough in the easterlies associated with "Gladys" was moving slowly westward and also extended from the surface through 500 mb. Between 050300Z and 060300Z, the westward movement of "Gladys" trough was arrested by the westerly trough and it began an oscillation westward and eastward all the while oriented north-south along the Texas and Mexican Gulf Coast. The two troughs met and merged in northeastern Texas resulting in heavy rain and extremely squally weather along the trough axis. "Gladys" weakened rapidly and filled when the troughs merged. The filling took place near Tampico, Mexico, and by 061830Z all that remained of "Gladys" was a large flat low centered east of Tampico. The final regular numbered warning of "Hurricane Gladys" was issued at 061000Z. The storm had filled rapidly and lost force almost as suddenly as it had developed. Degeneration had come as a result of the westerly trough and passage over land" (ATSR).

September 7:

HWM, HURDAT and Microfilm does not show an organized system on this date. MWR shows a low pressure of 1010 mb at 27.4N, 96.5W at 12Z. Ship highlights: No gales or low pressures.

MWR: "This tropical storm formed in the Gulf of Campeche and moved first northwestward and later southward entering the coast of Mexico north of Tampico. Highest wind reported from Tampico was 48 mph from the northwest but higher winds may have occurred along the coast to the north of Tampico. The lowest pressure reported by reconnaissance was 997 mb (29.44 mb). Winds of 81 mph were reported by the reconnaissance plane on one occasion and also by a civilian plane on the same date, and therefore, Gladys has been classified as of hurricane intensity. There was a fairly report of 25 inches of rain in 3 days at Tampico beginning the sequence of hurricane-associated rains which culminated in the Tampico disaster. Meager reports indicate some deaths and damage along the Mexican coast. At the same time an area of heavy squalls developed off the middle Texas coast on September 5 and moved inland on the 6th. Highest winds

reported were 45 mph in the Corpus Christi-Port O'Connor area, and an oil rig 15 miles east of Port Aransas, Tex., reported gusts of 55 to 65 mph. The Naval Air Station at Corpus Christi received 12.23 inches of rain in 24 hours and a high tide of 4.5 feet was reported in the Bay. Damage was estimated at $500,000 in the Corpus Christi area. It is reported that radar observations during this period indicated briefly the presence of a cyclonic circulation, consequently this may have been a separate tropical storm."

Genesis is originally begun at 12Z on September 4th as a 30 kt tropical depression. Observations from land stations and ships in the Bay of Campeche suggest that a well-defined low pressure center was present as early as the 2nd. Therefore, the cyclone is begun as a 25 kt tropical depression at 12Z on September 2nd. This is a major change to HURDAT. In the next 24 hours, the depression slowly moved to the east, indicated by a drop in the barometric pressures in the land stations along the southeast Bay of Campeche. Late on the 3rd, the cyclone began to move to the west. The highest surface winds on September 2nd and 3rd were 25 kt on from a ship located at 22.5N, 93.2W at 18Z on the 3rd. Based on this, the intensity is kept at 25 kt from September 2nd at 12Z to the 4th at 6Z. Although no gales were reported on this date by ships or land stations, the system was getting better organized structurally and a barometric pressure of 1003 mb was reported by a ship at 21Z on the 4th. 1003 mb peripheral pressure suggests maximum winds of at least 41 kt from the Brown et al. pressure-wind relationship. Intensification to a tropical storm is thus retained at 18Z on the 4th as shown in HURDAT. Gladys turned to the northwest on the 4th and continued this general motion on the 5th. The first gale associated with the cyclone is reported at 6Z on the 5th as a ship reported 35 kt N and 1011 mb at 25.2N, 96.5W. Later on the 5th, a single aircraft reconnaissance mission into this storm measured an RMW of about 15 nm and a 997 mb central pressure at 1403Z, which suggests maximum winds of 53 kt south of 25N Brown et al. Given the small size of the cyclone and providing a small weighting on the visual estimate of 80 kt, intensity is analyzed to be 60 kt at 12Z and 18Z on the 5th. This intensity is also the peak for the tropical storm, which previously was 80 kt, a major change to HURDAT. No further inner core observations were available until after landfall later that day in Tamaulipas, Mexico. Landfall is analyzed to have occurred around 22Z on the 5th near 23.1N 97.8W, north of Tampico with an intensity of 60 kt. HURDAT originally had Gladys making landfall around 05Z on the 6th as a weakening tropical storm.

Late on the 5th, Gladys turned to the southwest causing the center to move inland. On the 6th, the system moved generally to the south passing close or over Tampico around 06Z. Microfilm at this time shows a barometric pressure of 1001 mb being reported by Tampico. MWR also reports that the city reported maximum winds of 42 kt at an unknown time on September 6th, but it is likely that these winds occurred early in the day. HURDAT originally kept the system moving south inland and the last point at 18Z on the

6th had an intensity of 40 kt. Weakening to a tropical depression is now shown at 18Z on the 6th with dissipation shortly afterwards.

Hurricane Ione [September 10–25, 1955]

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39060 09/10/1955 M=15  9 SNBR= 854 IONE        XING=1 SSS=3
39060 09/10/1955 M=16  8 SNBR= 854 IONE        XING=1 SSS=3
                    **  *

39065 09/10*  0   0   0    0*154 432  25    0*154 442  35    0*154 454  35    0*
39065 09/10*  0   0   0    0*128 405  25    0*130 420  35    0*132 435  35    0*
                           *** ***          *** ***          *** ***

39070 09/11*153 467  35    0*153 480  35    0*152 493  35    0*149 505  35    0*
39070 09/11*133 450  35    0*134 465  35    0*135 480  35    0*135 496  35    0*
            *** ***          *** ***          *** ***          *** ***

39075 09/12*147 517  35    0*144 529  35    0*142 541  35    0*144 553  40 1008*
39075 09/12*136 513  35    0*137 530  35    0*138 545  35    0*140 558  35 1007*
            *** ***          *** ***          *** ***          *** ***  ** ****

39080 09/13*150 565  40    0*157 575  40    0*164 582  45    0*169 588  45    0*
39080 09/13*144 569  35    0*149 580  35    0*155 588  35    0*161 593  40    0*
            *** ***  **      *** ***  **      *** ***  **      *** ***  **

39085 09/14*174 593  50    0*177 597  55    0*180 602  60    0*185 612  60    0*
39085 09/14*167 597  45    0*173 601  45    0*179 606  50 1001*185 614  55 1000*
            *** ***  **      *** ***  **      *** ***  ** ****     ***  ** ****

39090 09/15*193 623  65    0*207 628  65    0*221 633  70  990*229 652  70    0*
39090 09/15*193 623  60    0*206 633  65    0*219 644  70  990*228 656  70    0*
                     **      *** ***          *** ***          *** ***

39095 09/16*234 671  75    0*238 681  75    0*242 691  80  990*247 704  85    0*
39095 09/16*233 670  75    0*237 683  75    0*241 693  80  985*246 702  85    0*
            *** ***          *** ***          *** ***      *** *** ***

39100 09/17*252 714  90    0*258 720  95    0*265 727 100  950*273 733 100  938*
39100 09/17*251 711  90    0*257 719  90  971*263 725 105  950*270 732 120  938*
            *** ***          *** ***  **  *** *** *** ***      *** *** ***

39105 09/18*281 740 100    0*289 747 105    0*298 753 100  940*312 758 100    0*
39105 09/18*279 740 120    0*288 747 115    0*298 753 110  943*312 758 105    0*
            ***     ***      ***     ***                ***  ***         ***

39110 09/19*328 762 100    0*339 766  90    0*348 767  65  960*356 765  60    0*
39110 09/19*326 761 100    0*337 765  95    0*348 770  90  960*355 767  80    0*
            *** ***          *** ***  **          ***  **      *** ***  **

39115 09/20*364 754  60    0*367 745  65    0*370 734  90    0*378 711  85  982*
39115 09/20*362 763  70  976*366 757  65    0*371 742  70    0*380 720  75  982*
            *** ***  **  *** *** ***          *** ***  **      *** ***  **

39120 09/21*394 678  75    0E423 625  60    0E450 594  50    0E467 574  45    0*
39120 09/21*393 683  80  976E415 640  80    0E450 594  75    0E485 550  75    0*
            *** ***  **  *** *** ***  **                **      *** ***  **

39125 09/22E484 558  45    0E501 547  45    0E518 530  45    0E531 499  45    0*
39125 09/22E503 545  70    0E507 545  70    0E510 538  65    0E525 510  65    0*
            *** ***  **      *** ***  **      *** ***  **      *** ***  **
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39130 09/23E534 468  45    0E533 437  45    0E531 406  45    0E546 350  45    0*
39130 09/23E534 468  60    0E533 437  55    0E531 406  50    0E546 350  45    0*
                     **                **                **
39135 09/24E572 293  45    0*  0   0   0    0*  0   0   0    0*  0   0   0    0*
39135 09/24E572 293  45    0E600 220  45    0E625 155  45    0E650 140  40    0*
                             *** ***  **      *** ***  **      *** ***  **
September 25th is new in HURDAT
39137 09/25E675 115  40    0E690 095  35    0E700 080  35    0E710 070  30    0*
            *** ***  **      *** ***  **      *** ***  **      *** ***  **
39140 HR NC3
39140 HR NC2
         ***
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U.S. Hurricane:
Sep 19th – 11Z – 34.9N 76.7W – 90 kt – Category 2 – 960 mb – 1013 mb OCI – 375 nm ROCI

Major track and intensity changes are analyzed for this classic Cape Verde hurricane that made landfall in North Carolina before moving away into the North Atlantic. A major alteration is to add one additional day at the end of the cyclone's lifetime. Evidence for these alterations comes from the Historical Weather Maps Series, the COADS ship database, Monthly Weather Review, USWB/NHC microfilm of synoptic weather maps, the Climatological Data, the Navy aircraft reconnaissance book, Schwerdt et al. (1979), Ho et al. (1987) and Jarrell et al. (1992).

September 9:

HWM shows a spot low centered near 14.5N, 34.0W at 12Z. HURDAT does not analyze an organized system on this date. Microfilm does not show an organized system on this date. MWR is not available on this date. Ship highlights: No gales or low pressures.

September 10:

HWM shows a closed low pressure of at most 1010 mb centered near 11.5N, 41.0W at 12Z. HURDAT lists this as a 35 knot tropical storm at 15.4N, 44.2W at 12Z. Microfilm does not show an organized system on this date. MWR is not available on this date. Ship highlights: No gales or low pressures.

September 11:

HWM shows a closed low pressure of at most 1010 mb centered near 12.5N, 49.5W at 12Z. HURDAT lists this as a 35 knot tropical storm at 15.2N, 49.3W at 12Z. Microfilm does not show an organized system on this date. MWR is not available on this date. Ship highlights: No gales or low pressures. Aircraft highlights: GULL aircraft

reported an “eye” near 15.7N, 45.5W at 1545Z (micro). “The birth of “Hurricane Ione” followed close in the wake of “Hurricane Hilda.” In the easterly flow in the tropical regions to the east of the Lesser Antilles, were embedded two easterly waves approximately 1000 miles apart. The firt of these waves developed a vortex which later became “Hurricane Hilda” and moved in almost a due west direction into Mexico. The second easterly wave, later labeled locally “September #2,” appeared the stronger of the two waves, while east of the islands, and subsequently developed into “Hurricane Ione. A weak vortex indicated on “September #2” on the 11th of September was showing slight intensification as it moved northwestward; therefore, an investigative flight was ordered to reconnoiter the area in the vicinity of 17N and 55W early on the 12th of September” (ATSR).

September 12:

HWM shows a closed low pressure of at most 1005 mb centered near 13.5N, 54.2W at 12Z. HURDAT lists this as a 35 knot tropical storm at 14.2N, 54.1W at 12Z. Microfilm shows a closed low pressure of at most 1005 mb centered near 14.0N, 57.0W at 18Z. MWR is not available on this date. Ship highlights: No gales or low pressures. “The collection of reports received from the reconnaissance flight showed the maximum winds in squalls to be 35 knots. No definite cyclonic circulation was revealed by the reports, however, a weak circulation with a minimum surface pressure of about 1008 mb was estimated to be to the south of the reports in the vicinity of 14N 55W at 121600Z” (ATSR).

September 13:

HWM shows a tropical storm of at most 1005 mb centered near 14.8N, 55.8W at 12Z. HURDAT lists this as a 45 knot tropical storm at 16.4N, 58.2W at 12Z. Microfilm shows a closed low pressure of at most 1011 mb centered near 14.5N, 62.5W at 12Z. MWR is not available on this date. Ship highlights: 35 kt E and 1015 mb at 21.1N, 58.9W at 21Z (micro).

September 14:

HWM shows a tropical storm of at most 1005 mb centered near 18.2N, 60.3W at 12Z. HURDAT lists this as a 60 knot tropical storm at 18.0N, 60.2W at 12Z. Microfilm shows a closed low pressure of at most 1005 mb centered near 18.0N, 61.0W at 12Z. MWR is not available on this date. Ship highlights: 45 kt ENE and 1013 mb at 20.4N, 59.5W at 0Z (micro); 40 kt ENE and 1011 mb at 19.7N, 59.5W at 0Z (micro); 35 kt E and 1007 mb at 20.5N, 61.2W at 18Z (COADS), and 40 kt N and 1005 mb at 18.1N, 63.5W at 18Z (micro). Land highlights: 15 kt SW and 1005 mb at St. Kitts and Navis at 12Z (micro), and 10 kt NW and 1005 mb at Anguilla at 21Z (micro). Aircraft highlight:

Penetration center fix measured a central pressure of 1001 mb and surface winds of 60 kt at 18.0N, 60.5W at 1145Z (micro); Penetration center fix measured a central pressure of 1000 mb and an eye of a 30 mile diameter at 18.3N, 61.5W at 1830Z (ATSR/micro). "The next aircraft reconnaissance flight, on the 14th of September, revealed that the vortex had intensified gradually to tropical storm intensity as it moved northwestward. Winds of 60 knots in a small area near the center and a minimum pressure of 1001 mbs were reported by the aircraft. Coordination was thus completed for Warning Number One on "Tropical Storm Ione" centered at 19.1N 61.2W ar 141500Z" (ATSR).

September 15:

HWM shows a hurricane of at most 1000 mb centered near 21.9N, 63.2W at 12Z. HURDAT lists this as a 70 knot hurricane at 22.1N, 63.3W at 12Z. Microfilm shows a closed low pressure of at most 1005 mb centered near 21.7N, 63.5W at 12Z. MWR shows a low pressure of 996 mb at 21.1N, 64.0W at 12Z. Ship highlights: 35 kt NE and 1010 mb at 19.8N, 61.5W at 0Z (COADS); 35 kt E and 1008 mb at 22.0N, 60.4W at 06Z (micro), 70 kt E and 1007 mb at 21.8N, 63.0W at 12Z (micro), and 40 kt NNE and 1008 mb at 24.1N, 69.3W at 21Z (micro). Aircraft highlight: Penetration center fix measured surface winds of 66 kt at 21.7N, 63.2W at 1052Z (ATSR); Penetration center fix at 23.1N, 65.4W at 1725Z (ATSR); Penetration center fix at 22.7N, 66.0W at 18Z (ATSR), and penetration center fix at 23.2N, 66.3W at 2024Z (ATSR). ""Ione" continued to increase gradually in intensity reaching hurricane force at 150000Z" (ATSR).

September 16:

HWM shows a hurricane of at most 1000 mb centered near 24.7N, 69.2W at 12Z. HURDAT lists this as an 80 knot hurricane at 24.2N, 69.1W at 12Z. Microfilm shows a closed low pressure of at most 1002 mb centered near 24.2N, 69.8W at 12Z. MWR shows a low pressure of 988 mb at 24.5N, 69.8W at 12Z. Ship highlights: 40 kt NNE and 1008 mb at 24.2N, 69.2W at 0Z (micro); 30 kt W and 994 mb at 23.7N, 69.1W at 09Z (micro), and 50 kt W and 1002 mb at 28.2N, 69.7W at 18Z (micro). Aircraft highlight: Penetration center fix measured surface winds of 80 kt, a central pressure of 985 mb and an eye of a 50 mile diameter at 24.3N, 69.4W at 1317Z (ATSR); Penetration center fix at 24.2N, 69.6W at 14Z (ATSR); and penetration center fix at 24.7N, 70.4W at 22Z (ATSR).

September 17:

HWM shows a hurricane of at most 995 mb centered near 26.4N, 72.7W at 12Z. HURDAT lists this as a 100 knot hurricane at 26.5N, 72.7W at 12Z. Microfilm shows a closed low pressure of at most 1002 mb centered near 26.5N, 72.3W at 12Z. MWR shows a low pressure of 988 mb at 26.2N, 73.0W at 12Z. Ship highlights: 45 kt SE and

1000 mb at 25.4N, 69.0W at 0Z (micro); 50 kt SE and 999 mb at 25.8N, 71.1W at 06Z (micro); 70 kt SE and 981 mb at 25.6N, 72.0W at 12Z (micro), and 60 kt SSE and 1004 mb at 26.4N, 71.9W at 18Z (micro). Land highlights: 20 kt NW and 1005 mb at Mayaguana, Bahamas at 06Z (micro). Aircraft highlights: Penetration center fix measure an eye of a 5 mile diameter at 25.4N, 71.7W at 02Z (ATSR/ micro); Penetration center fix at 25.7N, 72.0W at 07Z (ATSR); Penetration center fix measured surface winds of 100 kt, central pressure of 971 mb and an eye of a 15 mile diameter at 25.7N, 72.0W at 0745Z (ATSR/micro); Penetration center fix measure an eye of a 15 mile diameter at 26.4N, 72.8W at 14Z (ATSR); Penetration center fix at 26.7N, 73.1W at 1707Z (ATSR); Penetration center fix at 26.8N, 73.1W at 1709Z (ATSR); Penetration center fix at 27.2N, 73.5W at 1927Z (ATSR); and penetration center fix measured surface winds of 100 kt, central pressure of 938 mb and an eye of a 15 mile diameter at 27.3N, 73.6W at 20Z (ATSR/micro). "…and 100 knots near the center on the 17th of September" (ATSR).

September 18:

HWM shows a hurricane of at most 995 mb centered near 29.8N, 75.5W at 12Z. HURDAT lists this as a 100 knot hurricane at 29.8N, 75.3W at 12Z. Microfilm shows a closed low pressure of at most 978 mb centered near 30.2N, 75.4W at 12Z. MWR shows a low pressure of 988 mb at 29.5N, 75.3W at 12Z. Ship highlights: 60 kt NE and 997 mb at 29.0N, 75.0W at 03Z (micro); 40 kt ESE and 1014 mb at 31.7N, 72.2W at 12Z (COADS); 50 kt NE and 1008 mb at 32.1N, 78.1W at 15Z (micro); 50 kt NE and 1005 mb at 31.8N, 78.8W at 18Z (micro); and 55 kt NNW and 998 mb at 31.2N, 77.9W at 21Z (micro). Aircraft highlight: Penetration center fix at 28.7N, 74.7W at 0525Z (ATSR); Penetration center fix at 29.1N, 75.0W at 08Z (ATSR); Penetration center fix measured surface winds of 95 kt and a central pressure of 943 mb at 30.1N, 75.5W at 1340Z (ATSR/micro); Penetration center fix at 30.3N, 75.5W at 14Z (ATSR); Penetration center fix at 31.3N, 75.7W at 1825Z (ATSR); and penetration center fix at 31.7N, 75.9W at 1930Z (ATSR). "…then reached her maximum intensity of about 110 knots on the 18th of September" (ATSR).

September 19:

HWM shows a hurricane of at most 985 mb centered near 35.0N, 76.2W at 12Z. HURDAT lists this as a 65 knot hurricane at 34.8N, 76.7W at 12Z. Microfilm shows a closed low pressure of at most 987 mb centered near 35.0N, 76.8W at 12Z. MWR shows a low pressure of 976 mb at 35.0N, 77.0W at 12Z. Ship highlights: 50 kt E and 1009 mb at 34.8N, 74.2W at 03Z (micro); 45 kt SW and 1004 mb at 32.0N, 72.5W at 06Z (micro); 40 kt S and 1015 mb at 315N, 70.4W at 12Z (micro)l; 55 kt SSW and 1010 mb at 31.6N, 74.4W at 18Z (COADS), and 20 kt ESE and 991 mb at 36.5N, 74.8W at 18Z (micro). Land highlights: 987 mb at Wilmington (no time given) (CLIMO); 960 mb at Morehead

City (no time given, but likely around 11Z) (MWR/Ho et al.); 67 kt E at Diamond Shoals at 06Z (micro); 962 mb at 1127Z at Cherry Point (MWR); 40 kt E and 965 mb at Cherry Point at 12Z (micro); 40 kt SW and 987 mb at Cape Hatteras at 18Z (micro); 25 kt SE and 986 mb at Elizabeth City at 21Z (micro). Aircraft highlight: Penetration center fix at 32.7N, 76.1W at 0137Z (ATSR); Penetration center fix at 32.8N, 76.3W at 02Z (ATSR); Penetration center fix at 32.5N, 76.5W at 0220Z (ATSR), and penetration center fix at 34.2N, 76.4W at 0723Z (ATSR). "960 mb at 34.7N, 76.7W – 1016 mb PenV – RMW 42 nmi – speed 9 kt – 78 kt est max sustained 10m, 10-min wind, (Schwerdt et al.), "960 mb central pressure measured by land barometer at Morehead City, NC – RMW 22 nmi – 9 kt forward speed – landfall pt 34.7N, 76.7W, (Ho et al.)," "NC3-Cat 3-960 mb (Jarrell et al.). "Fortunately, a rapid decrease in intensity occurred on 19 September as "Ione" moved ashore" (ATSR).

September 20:

HWM shows a hurricane of at most 985 mb centered near 37.5N, 73.5W with a cold front to the northwest at 12Z. HURDAT lists this as a 90 knot hurricane at 37.0N, 73.4W at 12Z. Microfilm shows a closed low pressure of at most 990 mb centered near 37.5N, 73.5W at 12Z. MWR shows a low pressure of 976 mb at 37.5N, 74.4W at 12Z. Ship highlights: 35 kt NE and 996 mb at 37.6N, 76.1W at 0Z (COADS); 45 kt S and 991 mb at 36.8N, 74.5W at 06Z (COADS); 25 kt SSE and 989 mb at 37.3N, 73.3W at 12Z (micro), and 50 kt WSW and 989 mb at 37.0N, 72.5W at 18Z (COADS). Land highlights: 986 mb at Norfolk (no time given) (CLIMO); 15 kt SE and 979 mb at Elizabeth City at 03Z (micro); 25 kt NE and 987 mb at Norfolk at 06Z (micro), and 25 kt NW and 996 mb at Elizabeth City at 12Z (micro). Aircraft highlights: Penetration center fix measured surface winds of 95 kt and a central pressure of 982 mb and an eye of a 30 mile diameter at 37.0N, 73.0W at 15Z (ATSR/micro); Penetration center fix at 37.7N, 72.4W at 16Z (ATSR); Penetration center fix at 38.7N, 70.9W at 20Z (ATSR); Penetration center fix at 38.7N, 71.2W at 2015Z (ATSR), and penetration center fix measured a central pressure of 976 mb at 39.2N, 69.6W at 2245Z (ATSR/micro). "On the 20th of September, movement out to sea was followed by regeneration with attendant increase in intensity" (ATSR).

September 21:

HWM shows a closed area of low pressure of at most 970 mb centered near 45.5N, 58.8W with a warm front to the east and a cold front to the south at 12Z. HURDAT lists this as a 50 knot extratropical cyclone at 45.0N, 59.4W at 12Z. Microfilm shows a closed low pressure of at most 972 mb centered near 45.0N, 59.0W with a cold front to the south at 12Z. MWR shows a low pressure of 972 mb at 45.9N, 59.1W at 12Z. Ship highlights: 65 kt W and 987 mb at 38.0N, 70.0W at 0Z (micro); 40 kt S and 972 mb

at 41.5N, 68.9W at 06Z (micro); 65 kt S and 982 mb at 41.0N, 62.0W at 06Z (micro); 50 kt SW and 973 mb at 44.0N, 58.0W at 12Z (micro), and 50 kt SW and 979 mb at 46.5N, 54.1W at 18Z (micro). Land highlights: 10 kt SE and 992 mb at Sable Island at 06Z (micro); 50 kt NW and 974 mb at Sable Island at 12Z (micro), and 15 kt SSW and 957 mb Garner, Canada at 18Z (micro). Aircraft highlight: Radar center fix measured an eye of a 32 mile diameter at 39.3N, 68.1W at 0015Z (ATSR/micro); Radar center fix measured an eye of a 30 mile diameter at 39.3N, 67.8W at 0045Z (ATSR/micro), and radar center fix measured a central pressure of 976 mb at 40.2N, 66.2W at 0245Z (ATSR/micro).

September 22:

HWM shows a closed area of low pressure of at most 970 mb centered near 50.5N, 52.5W with a dissipating cold front to the northeast at 12Z. HURDAT lists this as a 45 knot extratropical cyclone at 51.8N, 53.0W at 12Z. Microfilm shows a closed low pressure of at most 972 mb centered near 50.5N, 53.5W at 12Z. MWR shows a low pressure of 958 mb at 45.9N, 59.1W at 12Z. Ship highlights: 70 kt E and 966 mb at 52.3N, 53.0W at 0Z (COADS); 50 kt ENE and 998 mb at 56.5N, 51.0W at 06Z (COADS); 55 kt SW and 984 mb at 47.1N, 51.4W at 12Z (COADS), and 60 kt ENE and 989 mb at 55.8N, 50.7W at 18Z (COADS). Land highlights: 20 kt SW and 972 mb at St. Johns at 0Z (micro); 30 kt S and 970 mb at Garner at 49.0N, 54.6W at 06Z (micro); 40 kt SW and 973 mb at Garner at 12Z (micro), and 45 kt SW and 990 mb at St. Johns at 18Z (micro).

September 23:

HWM shows a closed area of low pressure of at most 985 mb centered near 53.5N, 40.5W at 12Z. HURDAT lists this as a 45 knot extratropical cyclone at 53.1N, 40.6W at 12Z. Microfilm shows a closed low pressure of at most 996 mb centered near 54.0N, 48.0W at 06Z (last position available). MWR shows a low pressure of 960 mb at 53.0N, 41.0W at 12Z. Ship highlights: 50 kt E and 987 mb at 54.8N, 50.0W at 0Z (micro); 50 kt W and 987 mb at 48.6N, 43.6W at 06Z (COADS/micro); 25 kt SW and 983 mb at 52.8N, 37.6W at 12Z (COADS), and 45 kt NE and 998 mb at 58.2N, 43.2W at 18Z (COADS).

September 24:

HWM shows a closed area of low pressure of at most 985 mb centered near 62.5N, 14.0W with a stationary front to the east and southeast at 12Z. HURDAT lists this as a 45 knot extratropical cyclone at 57.2N, 29.3W at 0Z (last position). Microfilm and MWR are not available on this date. Ship highlights: 40 kt WSW and 1001 mb at 51.4N, 29.2W at 0Z (COADS); 35 kt WSW and 1000 mb at 53.1N, 21.6W at 06Z (COADS); 25

kt NE and 980 mb at 63.0N, 16.0W at 12Z (COADS), 35 kt WSW and 1007 mb at 55.2N, 17.0W at 18Z (COADS), and 20 kt W and 979 mb at 63.0N, 16.0W at 18Z (COADS).

September 25:

HWM shows a closed area of low pressure of at most 980 mb centered near 70.0N, 8.0W with a stationary front to the northeast at 12Z. HURDAT, microfilm and MWR are not available on this date. Ship highlights: 25 kt S and 993 mb at 62.8N, 2.0W at 0Z (COADS); 35 kt SSW and 993 mb at 63.7N, 1.0W at 06Z (COADS); 10 kt SW and 979 mb at 68.7N, 4.4W at 12Z (COADS), and 30 kt SW and 985 mb at 70.5N, 1.7W at 18Z (COADS). Land highlights: 10 kt ESE and 980 mb at Dan Mayen Island at 12Z (micro).

September 26:

HWM shows a closed area of low pressure of at most 990 mb centered near 72.5N, 7.0W at 12Z. HURDAT, microfilm and MWR are not available on this date. Ship highlights: 25 kt S and 989 mb at 68.3N, 4.8W at 03Z (COADS).

MWR: “Ione developed in an easterly wave which passed through the Cape Verdes on September 6 and the circulation was still quite weak on the 11th, but Ione began to develop on this date and reached hurricane intensity during the night of September 14-15 in about Latitude 19.5N and Longitude 62.6W. Ione then pursued a general northwesterly course toward the North Carolina coast. It reached greatest intensity on the 17th when a central pressure of 938 mb (27.70 inches) was reported with maximum winds of 125 mph. By the time the hurricane reached the North Carolina coastline on the 19th, the central pressure had filled to about 28.35 inches and the maximum winds had decreased slightly. Ione was the third hurricane to pass through eastern North Carolina within six weeks and the fourth within eleven months. Not within the known meteorological history of this section have so many hurricanes affected the area within so short a period. Total storm damage, mostly to crops in eastern North Carolina, is estimated at $88,035,000. There were 7 fatalities directly or indirectly attributable to the hurricane. The lack of any deaths from Connie and Diane in North Carolina and only 7 in Ione and the comparatively small property damage, excluding crop damage, in this area, is a tribute to the effectiveness of the warnings and precautionary measures taken by governmental and private agencies such as the Red Cross.”

NC CLIMO: “The center of Hurricane “Ione” entered the North Carolina coast near Salter Path, about 10 miles west of Morehead City, at about 0500E on September 19. Meandering slowly northward, the center passed west of Cherry Point, east of New Bern

and Aurora, west of Belhaven, east of Plymouth and Elizabeth City, and thence off the coast of Currituck County. Ocean tides rose to seven to ten feet above normal at the beaches around Morehead City and three to five feet above normal elsewhere along the ocean front. The western portion of the inland sounds and their estuaries had tides from six to ten feet above normal. Water rose into forty city blocks of New Bern, while considerable areas of Washington, Belhaven, Aurora, Oriental and Arapahoe were flooded deep water to enter the first floor of buildings. Thousands of acres of low-lying farm land were also inundated."

The genesis of Ione is retained at 06Z on September 10 as a 25 kt tropical depression as originally shown in HURDAT. Data on this day is sparse but if a closed low level circulation was present, it must have been located substantially farther southeast of the position originally in HURDAT. There are no other major changes to the track while the system was a tropical cyclone. However, major track alterations were introduced on the 21st when the cyclone was extratropical. Intensification to a tropical storm is retained at 12Z on the 10th, but there is no data to support it. Ione moved generally westward to west-northwestward during the next following days. At 1545Z on the 11th, microfilm indicates that an Air Force (GULL) airplane reported an "eye" near 15.7N, 45.5W. No other information was available about this mission either on the Monthly Weather Review or the Navy reconnaissance book; therefore, it has been ignored for the reanalysis. Ship and Lesser Antilles stations data on the 12th and 13th suggests that the low level circulation of Ione was poorly-defined and it is possible that it may have not been closed. A reconnaissance mission arrived late on the 12th to investigate the cyclone, but it did not go south enough to sample the center and only sampled the northern portion of the circulation. The mission measured 10 kt and 1008 mb at 1629Z on the 12th. This allows computing a central pressure of about 1007 mb, which has been added to HURDAT at 18Z on the 12th. A central pressure of 1007 mb yields 32 kt according to Brown et al. southern pressure-wind relationship. Thus, an intensity of 35 kt is analyzed for 18Z on the 12th, down from 40 kt originally in HURDAT. A ship named "Franca" passed close to the cyclone on the 12th and early on the 13th. The wind direction and intensity reported by the ship appear to be correct, but the pressure reported was a few millibars below the actual value based upon intercomparing Franca's subsequent observations against other nearby ships. Another reconnaissance mission investigated the cyclone at around 1145Z on the 14th measuring a central pressure of 1001 mb and estimated surface winds of 60 kt. A central pressure of 1001 mb yields 45 kt from the south of 25N pressure-wind relationship. An intensity of 50 kt has been selected for 12Z on the 14th, down from 60 kt originally in HURDAT. A central pressure of 1001 mb has been added to 12Z on the 14th. The final reconnaissance mission of the day arrived at 1830Z measuring a central pressure of 1000 mb and an eye of 30 mile diameter. An intensity of 55 kt is selected for 18Z and a central pressure of 1000 mb has been added.

Late on the 14th, Ione made its closest approach to the Leeward Islands passing about 55 nm from Barbuda at 18Z. Tropical storm force winds are likely to have affected the northernmost of the Leeward Islands. The circulation of Ione continued to become better organized as it moved away from the Leeward Islands on the 15th reaching hurricane intensity at 06Z, six hours later than originally shown in HURDAT. A central pressure of 990 mb was in HURDAT at 12Z on the 15th and although there is no data to directly support it, it is a reasonable value and is retained. A central pressure of 990 mb yields 64 kt from the south of 25N pressure-wind relationship. A ship named "BA CANADA" reported 70 kt E and 1007 mb at 12Z on the 15th. This wind value appears reasonable but the ship continued to report the same wind value at 15Z and 18Z as the storm moved away, which begs into question the validity of the report. A reconnaissance airplane at 1052Z reported estimated maximum surface winds of 66 kt. Thus, an intensity of 70 kt at 12Z is retained as originally shown in HURDAT.

Ione continued to gain strength on the 16th reaching category 2 at 18Z. A reconnaissance aircraft reached the hurricane at 1317Z reporting estimated surface winds of 80 kt and at 14Z reporting a 50 mile eye diameter. The Navy reconnaissance book indicates that a central pressure of 985 mb was reported on this day, but does not specify the time. It is likely that this central pressure was measured on the aforementioned center fixes and a 985 mb central pressure has been added to 12Z on the 16th. A central pressure of 985 mb yields 71 kt from the south of 25N pressure-wind relationship. Thus, an intensity of 80 kt is retained as originally shown in HURDAT. Intensification continued on the 17th and a central pressure of 971 mb and an eye of a 15 mile diameter were measured by a reconnaissance aircraft at 0745Z. This central pressure yields 89 kt from the south of 25N and 83 kt from the north of 25N (87 kt from north 25N and intensifying subset) pressure-wind relationships. The 15 mile eye diameter allows computing an RMW of about 12 nm and climatology suggests an RMW of 18 nm. Therefore, in part due to the small size an intensity of 90 kt is selected for 06Z on the 17th, down from 95 kt originally shown in HURDAT. A central pressure of 971 mb has been added to HURDAT at 06Z on the 17th. A 950 mb central pressure is present in the original HURDAT at 12Z and while there were no specific observations to corroborate it, this value is retained as it is reasonable based on the rapid intensification the hurricane was going through on this day. A central pressure of 950 mb yields 105 kt from the north of 25N and 110 kt from the north of 25N intensifying subset of the pressure-wind relationships. An intensity of 105 mb has been selected for 12Z, up from 100 kt originally shown in HURDAT. Another reconnaissance aircraft made a center fix at 20Z measuring estimated surface winds of 100 kt, a central pressure of 938 mb and an eye with a 15 mile diameter. A central pressure of 938 mb yields 116 kt north of 25N and 122 kt north of 25N intensifying subset from the pressure-wind relationships. An RMW of about 12 nm was computed from the available eye diameter information and climatology suggests 17 nm. Therefore, an intensity of 120 kt is

selected for 18Z on the 17th and 00Z on the 18th, up from 100 kt originally shown in HURDAT, a major change. 120 kt is also the revised peak intensity for this hurricane, up from 105 kt originally in HURDAT. Ione remained a major hurricane on the 18th, but its intensity began to decrease as it moved toward the East Coast. Another reconnaissance mission reached the cyclone at 1340Z on the 18th measuring estimated surface winds of 95 kt and a central pressure of 943 mb. A central pressure of 943 mb yields 112 kt from the north of 25N and 107 kt from the north of 25N weakening subset of the pressure-wind relationships. An intensity of 110 kt has been selected for 12Z on the 17th, up from 100 kt originally shown in HURDAT. A central pressure of 943 mb has been added to 12Z on the 18th.

Ione reached the North Carolina coast around 11Z on the 19th making landfall just west of Morehead City. The center of Ione passed about 5-10 nm from Morehead City where a minimum pressure of 960 mb was reported. Given that Ho et al.'s RMW estimate of the RMW of 20-25 nm appears reasonable, 960 mb can be considered a central pressure. This pressure yields 91 kt north of 25N weakening and 90 kt north of 35N according to the Brown et al. and Landsea et al. pressure-wind relationships. The estimated RMW of 20-25 nm is slightly smaller than the 27 nm from climatology. An intensity of 90 kt is selected at landfall and 12Z, up from 65 kt originally shown in HURDAT, a major change. This makes Ione a Category 2 impact in North Carolina, which is down from Category 3 originally assessed by Taylor and Hebert. The hurricane moved northward to northeast across eastern North Carolina reaching the Atlantic Ocean again around 06Z on the 20th. The only reports of sustained hurricane-force winds were on the Frying Pan and Diamond Shoals lighthouses. Cherry Point reported a 93 kt gust. Ione remained a hurricane while moving across North Carolina weakening to 65 kt as it made oceanfall. Elizabeth City reported 15 kt SE and 979 mb at 03Z on the 20th, which allows computing a central pressure of about 976 mb. A central pressure of 976 mb has been added to 00Z on the 20th. It is estimated that no hurricane-force winds affected Virginia, but tropical storm force winds impacted the southeast portion of the state.

Over the open Atlantic, Ione began to regain strength while accelerating to the northeast. A reconnaissance plane reached the hurricane on the 20th at 15Z measuring estimated surface winds of 95 kt, a central pressure of 982 mb and an eye of 30 mile diameter. A central pressure of 982 mb yields 71 kt from the north of 35N pressure-wind relationship. The eye diameter information permits computing an RMW of about 20-25 nm and climatology suggests 30 nm. An intensity of 75 kt is selected for 18Z on the 20th due to the small RMW, down from the 85 kt intensity originally shown in HURDAT. At 0245Z on the 21st, a reconnaissance mission reported a central pressure of 976 mb. A central pressure of 976 mb suggests 77 kt from the north of 35N pressure-wind relationship. An intensity of 80 kt is selected for 00Z on the 21st, up from 75 kt originally shown in

HURDAT. A central pressure of 976 mb has been added to 00Z on the 21th. Transition to a powerful extratropical cyclone is retained at 06Z on the 21st. Ione passed just west of Sable Island around 11Z on 21st and made landfall in Newfoundland around 17Z. Reports from ships and land stations in Newfoundland indicate that Ione remained a very strong extratropical cyclone late on the 21st and 22nd. The motion of the cyclone came to an almost standstill late on the 21st into the 22nd while located near the northern coast of Newfoundland. Late on the 22nd, Ione began to accelerate east-northeastward. Weakening below hurricane-force intensity occurred at 00Z on the 23rd. The system continued to weaken on the 24th passing over eastern Iceland around 18Z and dissipating late on the next day near Jan Mayen Island. HURDAT originally dissipated the system after 00Z on the 24th, so an additional 42 hours is included now before dissipation after 18Z on the 25th.

Hurricane Hilda [September 11–20, 1955]

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38995 09/10/1955 M=11  8 SNBR= 853 HILDA       XING=0 SSS=0
38995 09/11/1955 M=10  9 SNBR= 853 HILDA       XING=0 SSS=0
         **        **  *

39000 09/10*  0   0   0    0*  0   0   0    0*  0   0   0    0*168 613  30    0*
39000 09/10*  0   0   0    0*  0   0   0    0*  0   0   0    0*  0   0   0    0*
                                                          *   *   *

39005 09/11*174 617  30    0*180 623  30    0*186 629  35    0*189 641  40    0*
39005 09/11*  0   0   0    0*  0   0   0    0*  0   0   0    0*189 652  35    0*
               *   *   *        *   *   *        *   *   *          ***  **

39010 09/12*192 656  45    0*195 668  50    0*198 680  65 1007*201 691  75    0*
39010 09/12*192 661  40    0*195 670  45    0*198 680  55  996*201 691  65    0*
               ***  **          ***  **                **  ***          **

39015 09/13*204 702  80    0*204 713  85    0*203 725  85    0*202 736  70    0*
39015 09/13*203 702  70    0*205 713  70    0*204 725  70    0*202 736  70 986*
           ***       **      ***       **      ***       **                   ***

39020 09/14*201 747  65    0*201 762  60    0*201 777  60    0*199 792  65    0*
39020 09/14*201 748  60    0*201 762  55    0*201 777  50    0*199 792  50    0*
               ***  **                **                **                **

39025 09/15*196 806  75    0*194 821  85    0*192 834  90  980*191 844 100    0*
39025 09/15*195 806  60  995*192 821  75    0*191 834  90  980*191 844 100    0*
           ***       **  *** ***       **      ***

39030 09/16*192 854 100  963*194 864  95    0*196 874  95    0*199 884  90    0*
39030 09/16*192 854 105  963*194 864 105    0*196 874 105    0*199 884  75    0*
                   ***               ***               ***               **

39035 09/17*202 893  85    0*206 902  85    0*209 910  90    0*211 920  90    0*
39035 09/17*202 893  55    0*205 902  50    0*208 911  55    0*210 920  65  985*
                   **        ***       **      *** ***  **      ***       **  ***

39040 09/18*213 929  95    0*214 936 100    0*216 942 105    0*218 950 110    0*
39040 09/18*211 928  75    0*213 935  80    0*215 942  85  970*218 949  95    0*
           *** ***  **        *** ***  **      ***       **  ***      ***  **
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39045 09/19*220 959 105    0*222 970  85    0*223 981  60  952*222 988  45    0*
39045 09/19*220 959 105    0*221 970 105    0*223 981 105  952*222 988  50    0*
                             ***     ***              ***                 **

39050 09/20*220 991  40    0*218 995  35    0*  0   0   0    0*  0   0   0    0*
39050 09/20*220 991  30    0*218 995  25    0*  0   0   0    0*  0   0   0    0*
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39055 HR
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Evidence for these alterations comes from the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Monthly Weather Review, Mexican synoptic maps, Perez et al., and the Navy aircraft reconnaissance book.

September 9:

HWM shows a spot low centered near 13.0N, 64.0W at 12Z. HURDAT and Microfilm do not list an organized system on this date. MWR is not available on this date. Ship highlights: No gales or low pressures. “The synoptic analysis of the tropical regions to the east of the Lesser Antilles on the 9th and 10th of September indicated a moderately strong easterly flow in which were embedded two easterly waves approximately 1000 miles apart and believed to be of moderate intensity” (ATSR).

September 10:

HWM shows a spot low centered near 14.5N, 64.0W at 12Z. HURDAT lists a 30 kt tropical depression near 16.8N, 61.3W (first position) at 18Z. Microfilm does not show an organized system on this date. MWR is not available on this date. Ship highlights: No gales or low pressures.

September 11:

HWM shows a spot low centered near 16.0N, 64.0W at 12Z. HURDAT lists a 30 kt tropical depression near 18.6N, 62.9W at 12Z. Microfilm shows a NE-SW extending tropical wave or trough across the Virgin Islands from 22N, 61W to 13N, 67W at 12Z. MWR is not available on this date. Ship highlights: No gales or low pressures. “Easterly wave defined by shifting winds weather pattern and pressure pattern in vicinity of Saint Thomas oriented NNE-SSW, moderate rain with max wind 40 kt” (micro). “The first of these waves was verified on the “time cross-section” as being of moderate intensity upon passing Guadaloupe Island at 110000Z and was labeled locally as “September #1.” As this wave moved westward, the development of a very weak vortex became evident at 110900Z. This vortex moved northward up in the wave increased in intensity slightly by 111830Z was centered over Culebra Island” (ATSR).

September 12:

HWM shows a tropical storm of at most 1005 mb centered near 20.0N, 67.4W at 12Z. HURDAT lists a 65 kt hurricane near 19.8N, 68.0W at 12Z. Microfilm shows a closed low pressure of at most 1005 mb near 20.0N, 69.0W at 12Z. MWR shows a low pressure of 1000 mb near 20.7N, 67.9W at 12Z. Ship highlights: 25 kt S and 1005 mb at 19.7N, 66.4W at 06Z (COADS); 40 kt ENE at 20.3N, 68.7W at 1430Z (micro), and 996 mb near 20.3N, 68.7W at 1445Z (micro). Aircraft highlights: Penetration center fix measured a central pressure of 1007 mb and an eye of a 50 mile diameter at 19.8N, 68.7W at 1345Z (ATSR/micro). “the Air Force reconnaissance flight on easterly wave “September #1,” at 121345Z reported a “small” storm with an eye poorly defined centered at 19-48N 68-42W with maximum winds of 70 knots near the center and 40 knot winds extending 65 miles north of the center. The minimum pressure was 1007 mb as determined by dropsonde” (ATSR).

September 13:

HWM shows a hurricane of at most 1010 mb centered near 20.3N, 72.1W at 12Z. HURDAT lists an 85 kt hurricane near 20.3N, 72.5W at 12Z. Microfilm shows a closed low pressure of at most 1011 mb near 20.0N, 73.0W at 12Z. MWR shows a low pressure of 996 mb near 20.7N, 72.5W at 12Z. Ship highlights: 35 kt E and 1011 mb at 21.0N, 68.2W at 0Z (micro). Land highlights: 40 kt E and 1014 mb at Mayaguana, Bahamas at 12Z. Aircraft highlights: Penetration center fix measured a central pressure of 986 mb, maximum sustained winds of 85 kt, and an eye of a 20 mile diameter at 20.1N, 73.7W at 1737Z (ATSR/micro), and a penetration center fix at 20.0N, 73.9W at 1955Z (ATSR). “Sep 13-14, Category 1, 65 kt, landfall 9/13, deaths 4, damage $2,000,000” (Perez et al.) “During the next 24 hours, “Hilda” moved west to west-northwest at 8 to 12 knots. The track paralleled Hispaniola at about 55 miles north of the eastern end of the island then dipped southwest to within 20 miles of the western end. The Navy low level penetration center fix at 131530Z reported a well-defined horseshoe shaped eye 20 miles in diameter. The minimum surface pressure had decreased to 986 mb and the maximum winds were reported as 85 knots in a small area near the center. Severe turbulence and mountainous seas were reported near the center by the flight aerologist. Although the center of “Hilda” at this time was only approximately 25 miles from the western end of Hispaniola, little damage was reported because of the very small diameter of destructive winds of “Hurricane Hilda”” (ATSR).

September 14:

HWM shows a tropical storm of at most 1010 mb centered near 20.8N, 77.5W at 12Z. HURDAT lists a 60 kt tropical storm near 20.1N, 77.7W at 12Z. Microfilm shows a closed low pressure of at most 1008 mb near 19.7N, 78.5W at 12Z. MWR shows a low pressure of 996 mb near 20.4N, 78.2W at 12Z. Ship highlights: No gales or low

pressures. Aircraft highlights: Radar center fix measured a central pressure of 1004 mb and an eye of a 15 mile diameter at 20.1N, 77.2W at 1645Z (ATSR/micro). “The circulation aloft showed moderately strong easterly flow across the Bahamas Islands just north of the “small” circulation of “Hilda” at both the 700 mb and 500 mb level. The course of “Hilda” was, therefore, expected to continue nearly westward for the near future. In making a slight dip to the southwest, “Hilda” made transit through the Windward Passage and then encroached upon the eastern tip of Cuba passing approximately 15 miles north of Guantanamo Bay. In crossing southeastern Cuba at a speed of 14 knots, “Hilda” decreased in intensity to barely hurricane force in squalls, and also lost some of her characteristic cloud patterns. The small cyclonic circulation of “Hilda,” being rather obscure in the strong easterly flow even caused considerable confusion to reconnaissance radar tracking crews as it moved west-southwest from Cape Cruz” (ATSR).

September 15:

HWM shows a hurricane of at most 1005 mb centered near 19.5N, 83.8W at 12Z. HURDAT lists a 90 kt hurricane near 19.2N, 83.4W at 12Z. Microfilm shows a closed low pressure of at most 999 mb near 19.0N, 83.5W at 12Z. MWR indicates the system was located near 19.0N, 83.7W at 12Z. Ship highlights: 20 kt SSE and 1004 mb at 18.4N, 81.4W at 12Z (micro), and 50 kt N and 1004 mb at 19.5N, 86.1W at 21Z (micro). Land highlights: 48 kt NNW at Grand Cayman at 0230Z (micro), 5 kt SSE and 995 mb at Grand Cayman after 0230Z (micro), 15 kt W and 1005 mb at Swan Island at 12Z (micro), and 10 kt S and 1004 mb at Swan Island at 21Z (micro). Aircraft highlights: Penetration center fix measured a central pressure of 980 mb and an eye of a 8-10 mile diameter at 19.0N, 83.5W at 1130Z (ATSR/micro), penetration center fix at 19.1N, 83.5W at 12Z (ATSR), and penetration center fiz measured a central pressure of 963 mb and an eye of a 9 mile diameter at 2230Z (ATSR/micro). “A slight increase in intensity was noted as “Hilda” moved over the open water of the Caribbean. The center passed directly over Grand Cayman Island at 050300Z, and a considerable increase in intensity was noted by the Navy reconnaissance flight establishing a center fix at 151200Z. The maximum winds had now reached 100 knots with the minimum surface pressure at 980 mb” (ATSR).

September 16:

HWM shows a hurricane of at most 995 mb centered near 20.0N, 87.7W at 12Z. HURDAT lists a 95 kt hurricane near 19.6N, 87.4W at 12Z. Microfilm shows a closed low pressure of at most 1002 mb near 19.5N, 87.5W at 12Z. MWR shows a low pressure of 988 mb near 19.4N, 87.5W at 12Z. Ship highlights: 30 kt E and 993 mb at 19.3N, 84.9W at 00Z (micro); 10 kt W and 1005 mb at 16.6N, 86.9W at 0Z (COADS), and 20 kt SSW and 1004 mb at 17.3N, 86.2W at 06Z (COADS). Land highlights: 5 kt S and 1004

mb at Swan Island at 0Z (micro); 5 kt SW and 1005 mb at Belize City at 12Z (micro), and 15 kt SW and 1003 mb at Chetumal at 18Z (micro). ""Hilda" continued at the same intensity on westward at about 10 knots until entering the Yucatan Peninsula, then a slight decrease in intensity was observed while crossing the Yucatan Peninsula" (ATSR).

September 17:

HWM shows a hurricane of at most 1000 mb centered near 21.0N, 91.1W at 12Z. HURDAT lists a 90 kt hurricane near 20.9N, 91.0W at 12Z. Microfilm shows a closed low pressure of at most 1002 mb near 20.5N, 91.5W at 12Z. MWR shows a low pressure of 992 mb near 20.7N, 91.1W at 12Z. Ship highlights: 35 kt E and 1014 mb at 23.5N, 91.5W at 18Z (micro). Land highlights: 10 kt SE and 1000 mb at Cozumel at 0Z (micro); 35 kt NE and 998 mb at Merida at 03Z (micro); 25 kt E and 999 mb at Merida at 06Z (micro); 40 kt SSE and 1001 mb at Campeche at 12Z (micro), and 10 kt S and 1004 mb at Ciudad del Carmen at 21Z (micro). Aircraft highlights: Penetration center fix measured a central pressure of 987 mb and an eye of a 40 mile diameter at 21.0N, 91.8W at 1515Z (ATSR/micro), penetration center fix measured an eye of a 35 mile diameter at 21.0N, 92.0W at 1630Z (ATSR/micro), penetration center fix at 21.0N, 92.1W at 1845Z (ATSR), and penetration center fix measured a central pressure of 982 mb and an eye of a 30 mile diameter at 21.0N, 89.6W at 2045Z (ATSR/micro). "Upon moving out into the Gulf of Campeche on the 17th of September, "Hilda" began increasing gradually to a maximum intensity of 100 knots in a small area near the center" (ATSR).

September 18:

HWM shows a hurricane of at most 990 mb centered near 21.5N, 94.5W at 12Z. HURDAT lists a 90 kt hurricane near 21.6N, 94.2W at 12Z. Microfilm shows a closed low pressure of at most 990 mb near 21.5N, 94.7W at 12Z. MWR shows a low pressure of 992 mb near 21.5N, 94.8W at 12Z. Ship highlights: No gales or low pressures. Aircraft highlights: Radar center fix at 20.8N, 92.5W at 0130Z (ATSR); radar center fix at 21.1N, 93.7W at 0625Z (ATSR), and penetration center fix measured a central pressure of 970 mb and an eye of a 40 mile diameter at 21.6N, 94.5W at 1422Z (ATSR/micro).

September 19:

HWM shows a hurricane of at most 995 mb centered near 22.0N, 98.0W at 12Z. HURDAT lists a 60 kt tropical storm near 22.3N, 98.1W at 12Z. Microfilm shows a closed low pressure of at most 993 mb near 22.3N, 98.5W at 12Z. MWR shows a low pressure of 988 mb near 22.5N, 98.0W at 12Z. Ship highlights: No gales or low pressures. Land highlights: 10 kt NW and 995 mb at Tampico at 06Z (micro); calm and 952 mb at Tampico (no time given but likely around 12Z) (MWR); 979 mb at Ciudad Victoria at 1630Z (micro), and 15 kt NE and 998 mb at Ciudad Victoria at 18Z (micro).

““Hilda” moved inland just north of Tampico and degenerated into an area of squalls in the Sierra Madre Oriental Mountains of Mexico” (ATSR).

September 20:

HWM shows a closed low pressure of at most 1005 mb at 23.0N, 102.0W at 12Z. HURDAT lists a 35 kt tropical storm at 21.8N, 99.8W (last position) at 06Z. Microfilm shows a closed low pressure of at most 1008 mb near 21.0N, 99.0W at 12Z. MWR is not available on this date at 12Z.

MWR: “Hilda formed in an easterly wave and reached hurricane intensity at Latitude 20.0N and Longitude 69.1W on the 12th. It remained very small with a very narrow ring of strong winds around the eye of several days. It passed over the southeastern tip of Cuba where 4 persons were killed and there was moderate damage. By 1730 EST on the 15th, in the northwestern Caribbean, the central pressure had dropped to 963 mb (28.44 inches). On the 16th, Hilda crossed the Yucatan peninsula midway between Chetumal and Cozumel, an area very sparsely populated. Hilda reached its greatest intensity in the Gulf of Campeche. The center moved inland early on the 19th at Tampico which experienced calm for 45 minutes. The lowest pressure at Tampico was 952 mb (28.11 inches). Highest wind recorded before anemometer blew away was 105 mph and the maximum winds were estimated at 150 mph. Newspaper reports indicate 300 deaths and $120,000,000 damage, largely from floods.”

Genesis for this tropical cyclone has been delayed 24 hours to September 11th at 18Z as a 35 kt tropical storm. HURDAT originally had genesis at 18Z on the 10th as a 30 kt tropical depression. Delaying genesis is based on data from ships and land stations in and around the northeast Caribbean on the 10th and 11th of September that indicate that a closed low level circulation was not present until late on the 11th. Furthermore, a reconnaissance airplane late on the 11th was unable to locate a closed low level circulation and found a tropical wave in the vicinity of longitude 65ºW. The basis to start the cyclone as a 35 kt tropical storm is on a 40 kt surface estimated report from the reconnaissance airplane at 19Z on the 11th and a 30 kt ship report at 18Z. Hilda continued to intensify on the 12th as it moved westward north of Puerto Rico and the Dominican Republic. A ship at 1430Z on the 12th passed through the center of the storm measuring a central pressure of 996 mb and 15 minutes later, measured sustained surface winds of force 9 or about 40 kt. A central pressure of 996 mb yields 54 kt according to Brown et al. southern pressure-wind relationship. Thus, an intensity of 55 kt is analyzed for 12Z on the 12th, down from 65 kt originally in HURDAT. A reconnaissance airplane reached Hilda at 1345Z measuring a central pressure reportedly of 1007 mb. It is likely that the dropsonde did not land in the center based on a couple ships around this time reporting lower pressures. Therefore, the central pressure of 1007 mb originally in HURDAT at

12Z on the 12th has been replaced by 996 mb measured by the aforementioned ship. Hilda is analyzed to have reached hurricane intensity at 18Z on the 12th, 6 hours later than originally in HURDAT. At 1530Z on the 13th, a reconnaissance mission reported a central pressure of 986 mb and an eye of a 20 mile diameter. A central pressure of 986 mb yields 70 kt south of 25N, according to the pressure-wind relationship. A 20 mile diameter eye allows calculating roughly a 15 nm RMW and climatology suggests around 16 nm. Thus, a 70 kt intensity is analyzed at 18Z on the 13th, same as originally in HURDAT. A central pressure of 986 mb has been added to 18Z. Hilda was a small cyclone and gale reports were sparse, but 40 kt were measured in the SE Bahamas at 12Z on the 13th.

Hilda made its first landfall in eastern Cuba at 21Z on the 13th near 20.2N, 74.2W with maximum sustained winds of 70 kt. This intensity is consistent with the Perez et al. assessment. The hurricane moved westward over the entire length of eastern Cuba, entering the waters of the Caribbean Sea around 11Z on the 14th. A reconnaissance aircraft on the 14th had trouble locating the center of Hilda due to the mountainous terrain. The center locations from the reconnaissance aircraft are inconsistent with the reports from the land stations. The aircraft even reported a central pressure of 1004 mb overland at 1645Z on the 14th although the land station reports indicate that the storm was already over the Caribbean Sea. Because of the uncertainty, this information is not being used in the reanalysis. Hilda is analyzed to have weakened to a tropical storm at 0Z on the 14th, 6 hours before than originally in HURDAT. After moving over the Caribbean Sea, Hilda began to rapidly reorganize making landfall in the Cayman Islands (19.3N, 81.2W) at 03Z on the 15th as a 65 kt hurricane. A central pressure of 995 mb was measured in Grand Cayman. A central pressure of 995 mb yields 56 kt S25N according to the pressure-wind relationship. A central pressure of 995 mb has been added to 00Z on the 15th. A reconnaissance aircraft reached Hilda on the 15th of September at 12Z measuring a central pressure of 980 mb, estimated surface winds of 90 kt, and an eye of an 8-10 nm diameter. A central pressure of 980 mb yields 78 kt S25N according to the pressure-wind relationship. An 8-10 nm eye diameter allows calculating an RMW of about 7 nm and climatology suggests about 15 nm. Thus, an intensity of 90 kt has been selected for 12Z on the 15th, same as originally shown in HURDAT. An intensity of 60 kt is selected at 00Z, and 75 kt at 06Z. HURDAT originally showed 75 kt at 00Z, 85 kt at 06Z, and 90 kt at 12Z. Another reconnaissance airplane reached Hilda on the 15th at 2230Z measuring a central pressure of 963 mb and an eye diameter of 9 miles. A central pressure of 963 mb yields 98 kt S25N, according to the pressure-wind relationship. A 9 mile eye diameter allows calculating an RMW of about 7 nm and climatology suggests about 14 nm. Thus, an intensity of 105 kt has been selected for 0Z on the 16th, up from 100 kt originally in HURDAT. Hilda is analyzed to have reached major hurricane intensity at 18Z on the 15th, same as originally in HURDAT. Ships remained away from

the hurricane and due to the small size of Hilda, no gales were reported on the 15th and 16th of September.

Over the northwest Caribbean, this cyclone moved west-northwest reaching the Yucatan eastern coast (19.7N, 87.7W) around 14Z with an intensity of 105 kt. HURDAT originally showed a decrease in intensity below major hurricane intensity before Hilda made landfall in Yucatan. There is no data to justify this weakening, and it is very likely that Hilda continued to intensify after the reconnaissance airplane left late on the 15th. The hurricane made landfall in a very sparsely populated area and no inner core data is available during its crossing of the Yucatan Peninsula. The Kaplan and DeMaria model was run for 18Z on the 16th, and 00Z, and 06Z on the 17th yielding 74 kt, 51 kt and 48 kt, respectively. An intensity of 75 kt is selected for 18Z on the 16th, 55 kt at 00Z and 50 kt at 06Z on the 17th (down from 90 kt, 65 kt and 60 kt, respectively, originally in HURDAT), a major change at 00Z and 06Z on the 17th. Hilda entered the Gulf of Mexico around 08Z on the 17th as a tropical storm. Two reconnaissance airplanes investigated the cyclone on the 17th, measuring a central pressure of 987 mb at 1515Z and 982 mb at 2045Z. Since the missions occurred at around three hours before and after 18Z, a central pressure of 985 mb has been added to 18Z on the 17th. A central pressure of 985 mb yields 71 kt south of 25N according to the pressure-wind relationship. The aircrafts also reported an eye diameter of 40 nm at 1515Z and 30 nm at 2045Z, which is larger than climatology suggests. Therefore, an intensity of 65 kt is selected for 18Z on the 17th, bringing Hilda back to hurricane status for the 3rd time. HURDAT originally showed 90 kt at 18Z on the 17th. Major downward changes were then made for all the intensities on the 17th.

Hilda continued to intensify on the 18th while moving on a west-northwest heading over the southern Gulf of Mexico. At 1422Z on September 18th, a reconnaissance aircraft reported a central pressure of 970 mb and an eye of a 40 mile diameter. A central pressure of 970 mb yields 90 kt south of 25N according to the pressure-wind relationship. A 40 nm diameter allows calculating an RMW of about 30 nm and climatology suggests near 15 nm. Thus, an intensify of 85 kt is selected for 12Z on the 18th, down from 105 kt originally shown in HURDAT, a major change. A central pressure of 970 mb has been added to 12Z on the 18th. Major downward changes are also introduced at 00Z, and 06Z. HURDAT originally showed 95 kt and 100 kt, respectively, and our reanalysis shows 75 kt and 80 kt, respectively. Hilda made its 4th and final landfall at 11Z on the 19th near Tampico where a central pressure of 952 mb was measured and MWR indicates that a calm was experienced for 45 minutes. A central pressure of 952 mb yields 109 kt south of 25N and 111 kt south of 25N intensifying, according to the pressure-wind relationship. An intensity of 105 kt is selected for 12Z on the 19th due to the size of the hurricane. Major upward changes in intensity are analyzed at 06Z and 12Z, as HURDAT originally

showed 85 kt and 60 kt, respectively. The cyclone is analyzed to have reached major hurricane intensity for a 2nd time at 00Z on the 19th, 18 hours later than shown originally in HURDAT. There is no data to justify weakening Hilda before it makes landfall in Tamaulipas. After moving inland, Hilda weakened rapidly becoming a tropical depression at 0Z on the 20th and dissipating after 06Z. HURDAT originally kept Hilda as a 35 kt tropical storm at the last position on September 20th at 06Z.

New Tropical Storm [September 19-28, 1955]

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37265 09/19/1955 M=10 10 SNBR= 820 UNNAMED       XING=0 SSS=0
37265 09/19*  0   0   0    0*130 200  30    0*130 215  35    0*130 230  40    0*
37265 09/20*130 245  40    0*130 260  40    0*130 275  40    0*131 290  40    0*
37265 09/21*133 305  40    0*136 320  40    0*140 335  40    0*144 350  40    0*
37265 09/22*149 365  40    0*156 380  40    0*165 395  40    0*174 410  40    0*
37265 09/23*183 425  40    0*192 440  40    0*200 455  40    0*206 470  35    0*
37265 09/24*211 485  30    0*216 503  30    0*220 510  30    0*228 516  30    0*
37265 09/25*241 522  30    0*256 526  30    0*270 530  30    0*283 532  30    0*
37265 09/26*296 534  30    0*308 535  30    0*320 535  35    0*331 530  40    0*
37265 09/27*342 515  40    0*354 495  35    0E370 470  35    0E405 455  45    0*
37265 09/28E440 410  45    0E470 375  40    0E500 340  35    0E535 300  30    0*
37285 TS
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A new tropical storm has been added to HURDAT, not previously shown in McAdie et al. (2009). Evidence for its existence comes from the Historical Weather Map series, Microfilm, Monthly Weather Reviews, COADS ship database, and Jack Beven's suspect list.

September 18:

HWM and microfilm do not analyze an organized system at 12Z. HURDAT and MWR do not list this system at 12Z. Ship highlights: No gale force winds or equivalent low pressures.

September 19:

HWM shows a closed low pressure of at most 1010 mb at 14.0N, 21.0W at 12Z. Microfilm does not analyze an organized system at 12Z. HURDAT and MWR do not list this system at 12Z. Ship highlights: 15 kt NW and 1004 mb at 12.7N, 24.0W at 18Z (COADS).

September 20:

HWM shows a closed low pressure of at most 1010 mb at 11.0N, 25.0W at 12Z. Microfilm analyses a spot low pressure near 13.5N, 28.5W at 12Z. HURDAT and MWR do not list this system at 12Z. Ship highlights: No gale force winds or equivalent low pressures.

September 21:

HWM shows a closed low pressure of at most 1010 mb at 12.0N, 33.0W at 12Z. Microfilm does not analyze an organized system at 12Z. HURDAT and MWR do not list this system at 12Z. Ship highlights: No gale force winds or equivalent low pressures.

September 22:

HWM shows a closed low pressure of at most 1010 mb at 14.5N, 39.0W at 12Z. Microfilm does not analyze an organized system at 12Z. HURDAT and MWR do not list this system at 12Z. Ship highlights: No gale force winds or equivalent low pressures.

September 23:

HWM shows a closed low pressure of at most 1005 mb at 19.5N, 45.0W at 12Z. Microfilm analyses a closed low pressure of at most 1011 mb at 20.0N, 45.0W at 12Z. HURDAT and MWR do not list this system at 12Z. Ship highlights: No gale force winds or equivalent low pressures.

September 24:

HWM shows a closed low pressure of at most 1010 mb at 21.5N, 49.0W at 12Z. Microfilm does not analyze an organized system at 12Z. HURDAT and MWR do not list this system at 12Z. Ship highlights: No gale force winds or equivalent low pressures.

September 25:

HWM shows a spot low pressure near 26.0N, 54.0W with trough extending from 21-31N, 52-54W at 12Z. Microfilm analyses a closed low pressure of at most 1011 mb at 29.0N, 54.0W at 18Z. HURDAT and MWR do not list this system at 12Z. Ship highlights: No gale force winds or equivalent low pressures.

September 26:

HWM shows a spot low pressure at 31.0N, 53.0W at 12Z. Microfilm analyses a closed low pressure of at most 1014 mb at 32.0N, 54.0W at 12Z. HURDAT does not list this system at 12Z. MWR analyses a low pressure of 1008 mb at 31.8N, 54.0W at 12Z. Ship highlights: 35 kt SE and 1015 mb at 32.1N, 52.0W at 12Z (micro). 40 kt SSE and 1012 mb at 33.0N, 51.3W at 18Z (micro).

September 27:

HWM shows a frontal boundary over the central north Atlantic extending from an extratropical cyclone near 60.0N, 43.0W at 12Z. Microfilm analyses a closed low

pressure of at most 1011 mb at 38.0N, 48.0W and a frontal boundary extending through the system at 12Z. HURDAT does not list this system at 12Z. MWR analyses a low pressure of 1010 mb at 37.5N, 46.8W at 12Z. Ship highlights: 35 kt SE and 1016 mb at 34.0N, 49.6W at 0Z (micro). 45 kt NNW and 1009 mb at 40.3N, 46.7W at 18Z (micro).

September 28:

HWM shows a closed low pressure of at most 1010 mb at 49.0N, 36.0W with a cold front extending through the system at 12Z. Microfilm analyses a closed low pressure of at most 1011 mb at 44.0N, 37.0W at 06Z. HURDAT does not list this system at 12Z. MWR analyses a low pressure of 1006 mb at 50.7N, 33.8W at 12Z. Ship highlights: 35 kt SW and 1008 mb at 46.5N, 36.5W at 0Z (micro).

A tropical wave left the African coast on September 18 rapidly organizing into a tropical cyclone. Ship data at 18Z on the 19th indicate that the cyclone had already reached tropical storm intensity. The ship 309 8235 reported 15 kt NW and 1004 mb at 12.7N, 24.0W. This is also a 5 mb drop from 12Z. A peripheral pressure of 1004 mb suggests maximum winds greater than 39 kt south of 25N from the Brown et al. pressure-wind relationship. An intensity of 40 kt is selected for 18Z on the 19th. Genesis is begun on September 19th at 06Z as a 30 kt tropical depression. The cyclone is analyzed to have reached tropical storm intensity at 12Z on the 19th, six hours after genesis. Data becomes very sparse between September 20th and 23rd. During this period, it is believed that the tropical storm moved on a general northwest course and the intensity is kept at 40 kt based almost entirely upon persistence. The analyzed track agrees with the daily Historical Weather Maps, but the intensity is speculative and could in fact be much stronger or somewhat weaker.

Another ship passed close to the tropical cyclone on September 23rd at 12Z reporting 30 kt ENE and 1007 mb at 21.2N, 45.0W. Data on the 24th indicate that the circulation was not well organized, and it is possible that the tropical cyclone had degenerated into a tropical wave. Therefore, the intensity is decreased to 30 kt at 0Z on the 24th. At this time, a cold front was approaching and the system began to track toward the north. On the 25th, ship data shows that the system became better organized although no gale-force winds were reported, and the analyzed intensity is kept at 30 kt. On the 26th, the tropical depression turns to the northeast and begins to gain in forward speed. At 12Z on the 26th, the ship “Richelien” reported 35 kt SE and 1015 mb at 32.1N, 52.0W. At this time it is estimated that the tropical cyclone regained tropical storm intensity. The intensity is increased to 40 kt at 18Z based on the report of the ship “GCTF” (40 kt SSE and 1012 mb). 40 kt is also the estimated intensity at 0Z on the 27th and it is the peak intensity for the lifetime of this tropical cyclone. Extratropical transition occurred around 12Z on the 27th as the system continued to increase in forward speed over the north-central Atlantic.

The system also strengthened as an extratropical cyclone reaching 45 kt from 18Z on the 27th to 06Z on the 28th. This is also the peak intensity as an extratropical storm. Weakening occurred thereafter and the storm dissipated or was absorbed by a larger extratropical cyclone to the north late on the 28th while located southeast of Iceland.

Hurricane Janet [September 21–30, 1955]

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39145 09/21/1955 M=10 10 SNBR= 855 JANET       XING=0 SSS=0
39145 09/21/1955 M=10 11 SNBR= 855 JANET       XING=0 SSS=0
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39150 09/21*  0   0   0    0*  0   0   0    0*  0   0   0    0*132 543  35    0*
39150 09/21*  0   0   0    0*  0   0   0    0*132 526  40    0*132 543  50    0*
                                             *** ***  **                 **

39155 09/22*133 560  50    0*131 576  50    0*129 592 105    0*125 604 105  979*
39155 09/22*132 560  60    0*131 575  70    0*129 589  80  979*126 602  90    0*
                     **          ***  **          ***  **      *** ***  **

39160 09/23*123 614 100    0*125 625  85    0*127 636  80  996*129 648  80  996*
39160 09/23*125 614  90    0*125 625  80    0*127 636  70    0*130 648  60  996*
           ***       **                **                **    * ***       **

39165 09/24*130 660  85    0*135 669  95    0*140 679 100  996*139 693 110  995*
39165 09/24*132 659  60    0*135 670  55    0*138 682  55  996*138 695  50  999*
           *** ***  **          ***  **      *** ***  **      *** ***  **  ***

39170 09/25*137 707 115    0*138 718 115    0*139 729 115  993*143 743 115  988*
39170 09/25*138 707  50    0*138 718  55    0*139 729  60  993*142 742  65  988*
           ***       **                **                **      *** ***  **

39175 09/26*147 755 120    0*148 763 120    0*150 771 125  970*154 780 125    0*
39175 09/26*145 754  70    0*147 764  80    0*150 772  90  970*153 780 100    0*
           *** ***  **      *** ***  **          ***  **      ***       ***

39180 09/27*159 789 130    0*165 802 135  914*170 820 140  938*175 841 145    0*
39180 09/27*158 789 110    0*164 802 120    0*170 821 130  938*175 841 140    0*
           ***       ***      ***       ***    *     *** ***                ***

39185 09/28*180 861 150    0*185 882 130    0*190 902  95  950*193 919  90    0*
39185 09/28*180 861 150    0*185 882 150  914*189 902  95  950*192 917  90    0*
                                    ***  *** ***              *** ***

39190 09/29*195 931  90    0*197 942  95    0*199 953  95  950*200 963  85    0*
39190 09/29*195 931  90    0*197 942  95    0*198 953  95    0*198 964  95    0*
                                             ***              * *** ***  **

39195 09/30*200 977  60    0*203 988  50    0*  0   0   0    0*  0   0   0    0*
39195 09/30*200 977  60    0*203 991  35    0*2051005  25    0*  0   0   0    0*
                           ***  **      *******  **

39200 HR
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Minor changes to the track and major changes to the intensity shown in McAdie et al. (2009). Evidence for these alterations comes from the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Monthly Weather Review, Mexican synoptic maps and the Navy aircraft reconnaissance book.

September 14:

HWM, microfilm and HURDAT does not show an organized system at 12Z. MWR is not available on this date. Ship highlights: No gales or low pressures.

September 15:

HWM analyzes a closed low pressure of at most 1010 mb at 13.2N, 22.3W at 12Z. Microfilm and HURDAT does not show an organized system at 12Z. MWR is not available on this date. Ship highlights: No gales or low pressures.

September 16:

HWM, microfilm and HURDAT does not show an organized system at 12Z. MWR is not available on this date. Ship highlights: No gales or low pressures.

September 17:

HWM, microfilm and HURDAT does not show an organized system at 12Z. MWR is not available on this date. Ship highlights: No gales or low pressures.

September 18:

HWM, microfilm and HURDAT does not show an organized system at 12Z. MWR is not available on this date. Ship highlights: No gales or low pressures.

September 19:

HWM, microfilm and HURDAT does not show an organized system at 12Z. MWR is not available on this date. Ship highlights: No gales or low pressures.

September 20:

HWM analyzes a closed low pressure of at most 1010 mb centered near 12.0N, 51.5W at 12Z. Microfilm and HURDAT does not show an organized system. MWR is not available on this date. Ship highlights: No gales or low pressures.

September 21:

HWM shows a closed low pressure of at most 1010 mb centered near 13.7N, 55.6W at 12Z. HURDAT lists this as a 35 knot tropical storm at 13.2N, 54.3W at 18Z. Microfilm analyzes a closed low pressure of at most 1014 mb centered near 15.5N, 55.3W at 12Z. MWR is not available on this date. Ship highlights: 10 kt W and 1010 mb at 11.9N, 56.0W at 12Z. 10 kt and 1009 mb at 10.8N, 54.5W at 18Z. All reports from COADS. MWR: “Early on the 21st, pilot reports from the airlines Air France and Iberia

indicated the presence of a weak tropical disturbance at about latitude 13.5N and longitude 53.0W … it is believed that Janet was just attaining hurricane intensity when encountered by the SS Mormacdale in latitude 13.6N and longitude 55.2W at 1900 EST on September 21 when it reported winds of 63 mph." ATSR: "Hurricane Janet," rightfully designated the "killer" hurricane of 1955, came into existence on September 22nd about 200 miles east of the Lesser Antilles. Several days earlier, on the 18th, an easterly wave of weak to moderate intensity that was eventually to bear "Janet" passed over the ship ROBIN HOOD near 38W. During the next few days the easterly wave was tracked westward at 12.5 knots although hardly any reports were received to verify its existence or reveal its intensity. On the 21st, the ship SS DEL NORTE in the vicinity of 11N 55W reported a light west wind with surface pressures of 1010.2 mb abd 1009.1 mb at 1230Z and 1830Z respectively, thus verifying the easterly wave and revealing the development of a vortex, then estimated to be centered near 14N 55W."

September 22:

HWM shows a tropical storm of at most 1005 mb centered near 14.1N, 57.9W at 12Z. HURDAT lists this as a 105 kt hurricane at 12.9N, 59.2W at 12Z. Microfilm analyzes a closed low pressure of at most 1005 mb centered near 13.0N, 59.0W at 12Z. MWR is not available on this date. Ship highlights: 55 kt S and 1003 mb at 13.5N, 55.3W at 00Z. 35 kt W and 998 mb at 12.6N, 56.1W at 00Z. 40 kt W and 1007 mb at 11.5N, 62.0W at 21Z. All reports from microfilm. Aircraft highlights: Penetration center fix measured a central pressure of 979 mb at 12.8N, 59.4W at 1425Z (ATSR/MWR). Land highlights: 30 kt N (gusts to 50 kt) and 1003 mb at Barbados at 15Z (micro). 85+ kt ESE (maybe estimated) and 989 mb at Barbados around 1610Z (MWR). MWR: "The eye of hurricane Janet passed just south of the island of Barbados shortly after 1100 EST on the 22nd. It was an immature hurricane at this time with a very small ring of hurricane winds around the 20-mile eye. The reconnaissance plane reported the wall cloud around the eye only 5 miles wide but turbulence was very severe. Maximum winds were estimated by an observer on the south side of the island at 110 to 120 mph, dropping off very rapidly 20 miles out from the edge of the eye … the hurricane was moving at 11 mph at this time so it can be seen the ring of hurricane winds was very narrow. The lowest pressure reported by plane in the eye just to the south of the island was 979 mb. This was the first hurricane in Barbados in 57 years." ATSR: "Due to the lack of any other information, the vortex was believed to be only of moderate intensity, however, subsequent data from the ship SS MORMAC DALE at 220030Z, reporting south wind 50 to 55 knots and surface pressure of 1003.1 mb, confirmed the development of "Janet." Warning Number One was issued at 220200Z after coordination accomplished with the Weather Bureau Office at San Juan, Puerto Rico. Navy aircraft reconnoiter the storm area located a small but intense hurricane centered near Barbados islands. Surface winds were reported in excess of 100

knots and the minimum surface pressure was reported as 979 mb. Further evidence of the severity of “Hurricane Janet” was exemplified by the wake of destruction left on Barbados Islands followed about 12 hours later with similar conditions wrought at Grenada Island.”

September 23:

HWM shows a hurricane of at most 1000 mb centered near 12.8N, 63.1W at 12Z. HURDAT lists this as an 80 kt hurricane at 12.7N, 63.6W at 12Z. Microfilm analyzes a closed low pressure of at most 996 mb centered near 12.8N, 64.5W at 12Z. MWR is not available on this date. Ship highlights: 30 kt SW and 1002 mb at 12.5N, 65.4W at 18Z (micro). 20 kt NW and 1002 mb at 13.5N, 68.2W at 20Z (micro). 25 kt SW and 1003 mb at 12.2N, 65.3W at 21Z (micro). Aircraft highlights: Radar center fix measured an eye of a 25 mile diameter at 12.4N, 62.1W at 0454Z (ATSR/micro). Radar center fix measured an eye of a 45 mile diameter at 12.9N, 63.1W at 09Z (ATSR/micro). Radar center fix measured an eye of a 37 mile diameter near 12.5N, 63.9W at 1432Z (ATSR/micro). Penetration center fix measured a central pressure of 996 mb, maximum sustained winds of 80 kt and an eye of a 40 mile diameter at 13.0N, 64.7W at 1815Z (ATSR/micro). Land highlights: 10 kt NW and 1004 mb at 0Z at Grenada (micro). MWR: “During the next several days in the eastern Caribbean, Janet pursued a course generally toward the west with some actual decrease in intensity. The center was located at 3 pm on September 23 at latitude 13.2N and longitude 64.8W with central pressure 996 mb and wind 92 mph, radar eye 40 miles in diameter and wind eye 20 miles N-S, 27 E-W. Turbulence was moderate, sea high, no weather bands in northern semicircle but some in the southern semicircle.” ATSR: “During “Janet’s” transit across the Caribbean almost constant aircraft surveillance was maintained; therefore an accurate account was maintained of the movement and changing intensity of the storm. On a westward course describing a sinusoidal track, “Janet” moved at an average rate of speed of about 12 knots from Barbados Island to the 76th Meridian.”

September 24:

HWM shows a hurricane of at most 1000 mb centered near 13.9N, 68.4W at 12Z. HURDAT lists this as a 100 kt hurricane at 14.0N, 67.9W at 12Z. Microfilm analyzes a closed low pressure of at most 1005 mb centered near 13.5N, 69.1W at 12Z. MWR shows an area of low pressure of at most 996 mb near 13.5N, 68.7W at 12Z. Ship highlights: 15 kt SW and 1005 mb at 11.5N, 67.5W at 06Z (micro). 35 kt SE and 1004 mb at 15.5N, 69.2W at 21Z (micro). Land highlights: Aircraft highlights: 30 kt SW and 1004 at Aruba at 18Z (micro). 15 kt SW and 1005 mb at Curazao at 18Z (micro). 10 kt SW and 1004 at Aruba at 21Z (micro). Penetration center fix measured a central pressure of 996 mb and maximum sustained winds of 55 kt at 14.0N, 68.3W at 1345Z (ATSR).

Penetration center fix at 14.3N, 68.6W at 1454Z (ATSR). Penetration center fix measured a central pressure of 996 mb and an eye of a 20 mile diameter at 14.1N, 68.6W at 1520Z (ATSR/micro). Penetration center fix measured a central pressure of 995 mb and an eye of a 15-20 mile diameter at 14.3N, 68.6W at 1545Z (micro). Penetration center fix measured a central pressure of 999 mb and maximum sustained winds of 100 kt at 13.5N, 69.8W at 1745Z (micro). Penetration center fix at 13.9N, 68.7W at 1645Z (ATSR). Penetration center fix at 13.8N, 69.5W at 1815Z (ATSR). Penetration center fix at 13.8N, 69.9W at 2002Z (ATSR). MWR: "During the early hours on the 24th, according to the NAVY reconnaissance plane, Janet never presented good center definition and it is not certain the center was found. Weather targets consisted of large areas of diffuse targets with no spiral relationship. All center fixes were taken on strongest, most promising targets and the plane stated the fixes were of unknown accuracy. The radar bands were so disorganized, radar coverage was not considered feasible. Late in the afternoon, one very strong spiral weather band was found although the central pressure remained about the same. The reconnaissance plane reported: Eye centered Lat 13.8N and Long 69.9W at 3:02 pm EST circular eye with well defined cloud and wind eye approximately 20 miles in diameter. Minimum pressure 995 mb, maximum wind 127 mph … in weather band 40 miles from eye in southwest quadrant, wind shifted in weather band from 240 to 330, band approximately 25 miles thick, section we went through showed up weakest on radar, maximum winds northwest through southwest 52 mph, turbulence light to none except in weather band where it was moderate to heavy, precipitation light to none, navigation good, radar coverage not considered feasible for eye positions, however, weather band to west presents good picture."

September 25:

HWM shows a hurricane of at most 1000 mb centered near 13.9N, 72.9W at 12Z. HURDAT lists this as a 115 kt hurricane at 13.9N, 72.9W at 12Z. Microfilm analyzes a closed low pressure of at most 996 mb centered near 13.8N, 73.0W at 12Z. MWR shows an area of low pressure of at most 992 mb near 13.9N, 72.9W. Ship highlights: 30 kt S and 1005 mb at 14.9N, 69.5W at 0Z (micro). 35 kt ESE and 1009 mb at 14.5N, 70.4W at 18Z (ATSR). 25 kt S and 1005 mb at 13.2N, 74.0W at 21Z (micro). Aircraft highlights: Penetration center fix at 13.9N, 73.2W at 1345Z (ATSR). Penetration center fix measured a central pressure of 988 mb, maximum sustained winds of 85 kt and an eye of a 20 mile diameter at 14.3N, 74.2W at 19Z (ATSR/MWR/micro). MWR: "On the 25th the eye was located at 1400 EST at latitude 14.3N and longitude 74.2W with a maximum wind at 98 mph, central pressure 987.7 mb. The eye was described as well defined but there was evidence it was very changeable – hoop-shaped on one occasion, a figure "6" on another. One obtains the impression of a slowly but definitely intensifying storm. The reconnaissance flight on the night of September 25-26 summarizes its observations as

follows: Eye completely closed circle after 9:15 pm, average diameter 22 miles, storm presented symmetrical pattern of intense weather bands which extended 120 miles south, 140 east, 130 north and 170 west, high overcast throughout area, low scattered to broken stratocumulus with tops near 6000, thunderstorms generally oriental in spiral bands throughout area, frequent lighting. Rapid intensification was evident." "For the next 150 miles "Janet" moved at a slower speed of 9 knots,this was followed by gradual acceleration to 17 knots at the 80th meridian and 20 knots at the 86th meridian."

September 26:

HWM shows a hurricane of at most 995 mb centered near 14.7N, 76.5W at 12Z. HURDAT lists this as a 125 kt hurricane at 15.0N, 77.1W at 12Z. Microfilm analyzes a closed low pressure of at most 999 mb centered near 14.6N, 77.2W at 12Z. MWR is not available on this date. Ship highlights: 40 kt SW and 1004 mb at 13.1N, 78.1W at 6Z (micro). 35 kt ESE and 1008 mb at 17.6N, 77.7W at 18Z (micro). 40 kt ESE and 1008 mb at 17.4N, 77.5W at 21Z (micro). Aircraft highlights: Radar center fix at 14.3N, 76.3W at 0115Z (ATSR). Radar center fix measured an eye of a 25 mile diameter at 14.6N, 76.6W at 0615Z (ATSR/micro). Radar center fix measured an eye of a 22 mile diameter at 14.7N, 76.3W AT 09Z (ATSR/micro). Radar center fix at 14.8N, 77.1W at 12Z (ATSR). Radar center fix at 15.2N, 78.8W at 22Z (ATSR). MWR: "At 0830 EST of the 26th, Lt. Comdr. Windham with crew of 8 and 2 newspapermen reported in latitude 15.4N and longitude 78.2W that they were about to begin penetration of the main core of the storm. No further report was ever received from this plane. Janet had become a very severe hurricane."

September 27:

HWM shows a hurricane of at most 995 mb centered near 16.5N, 81.5W at 12Z. HURDAT lists this as a 140 kt hurricane at 17.0N, 82.0W at 12Z. Microfilm analyzes a closed low pressure of at most 996 mb centered near 16.8N, 82.5W at 12Z. MWR is not available on this date. Ship highlights: 40 kt ESE and 1008 mb at 17.5N, 77.3W at 0Z (micro). 50 kt NE and 1001 mb at 18.0N, 81.0W at 09Z (micro). 50 kt S at 16.6N, 81.8W at 12Z (micro). 50 kt ENE and 1001 mb at 18.0N, 80.8W at 18Z (ATSR). Land highlight: 10 kt SW and 1003 mb at Cabo Gracias a Dios at 12Z (micro). 30 kt N and 1000 mb at Swan Island at 15Z (micro). 15 kt SW and 1004 mb at Cabo Gracias a Dios at 18Z (micro). Aircraft highlight: Radar center fix at 15.6N, 78.8W at 01Z (ATSR). Radar center fix at 16.5N, 80.2W at 0630Z (ATSR). Radar center fix at 16.9N, 82.8W at 13Z (ATSR). Penetration center fix measured a central pressure of 938 mb at 16.9N, 82.7W at 1540Z (ATSR/MWR). Penetration center fix at 17.0N, 82.7W at 1615Z (ATSR). MWR: "The NAVY reconnaissance plane at 1040 EST on the 27th reported the center at latitude 16.9N and longitude 82.7W with lowest pressure 938 mb, and maximum winds in excess

of 115 mph by a large and incalculable amount. Janet passed over Swan Island during midday with winds estimated at 200 mph."

September 28:

HWM shows a hurricane of at most 990 mb centered near 19.2N, 89.6W at 12Z. HURDAT lists this as a 95 kt hurricane at 19.0N, 90.2W at 12Z. Microfilm analyzes a closed low pressure of at most 993 mb centered near 19.4N, 90.3W at 12Z. MWR is not available on this date. Ship highlights: 20 kt WSW and 1003 mb at 16.5N, 87.5W at 0Z (micro). Land highlights: 25 kt SW and 1002 mb at Belize City at 03Z (micro). 994 mb at Corozal at 04Z (MWR). 50 kt SW and 994 mb at Belize City at 6Z (micro). 152 kt (before collapsing) and 914 mb (southern edge of the eye) at Chetumal (no time given but likely around 06Z) (MWR). 918 mb at 0610Z at Corozal (MWR). 55 kt S and 998 mb at Belize City at 09Z (micro). 40 kt N (gusts to 70 kt) and 1009 mb at Campeche, Mexico at 12Z (micro). 10 kt WSW and 990 mb at Ciudad del Carmen at 18Z (micro). Aircraft highlights: Radar center fix measured an eye of a 10 mile diameter at 19.0N, 91.9W at 1945Z (ATSR/micro). MWR: "The hurricane center reached Corozal, British Honduras, and Chetumal, Mexico, about 1 am, local time, September 28. It was still a very concentrated storm with winds reaching hurricane force only about 2 hours before the arrival of the eye. In Corozal the barometer read 29.34 inches [994 mb] at 2300 EST and 27.10 inches [918 mb] at 0110 EST, falling 2.24 inches in 2 hours and 10 minutes with most of the fall occurring after 2330 EST. The official minimum barometer reading in Corozal was 27.10 inches [918 mb] (aneroid) and another aneroid in the house of a clergyman read 27.05 inches [916 mb]. In Chetumal the radio operator of the Mexican Aviation Company read 920.1 mb (27.17 inches) on the mercurial barometer some minutes before the eye arrived. The original barograph trace (fig. 6) at Chetumal was furnisged vy Mr. S.B Lizama Frias, Flight Dispatch Superintendent, CIA, Mexicana de Aviation, S.A. The pen passed off the trace at 27.94 inches. A barometer reading of 27.00 inches [914 mb] in the eye at Chetumal was forwarded by Mr. D.N.A. Fairweather, the meteorological observer at Corozal. Corozal was in the southern edge of the eye and since the eye passed directly over Chetumal, it is believed the reading of 27.00 inches can be accepted. Therefore on the inset in figure 6 we have constructed a continuation of the trace below 28.00 inches based on this reading and the length of the period of calm at Chetumal. The anemometer at the airport terminal building at Chetumal registered 152 knots or 175 mph before it collapsed. The wind continued to increase and the maximum is estimated in excess of 200 mph. In British Honduras 16 persons were killed and total damage is estimated at about $5,000,000. In Chetumal, a town of about 2,500 people, only 4 badly battered buildings were left standing. Sea water reached a height of 6½ feet some 1,600 feet inland. The area is rather well protected from the Caribbean Sea by a sizable peninsula but there was one report of a hurricane wave south of Corozal. In

Chetumal approximately 120 bodies were found in and about the ruins but the sea dragged away an unknown number. Altogether in the Mexican state of Quintana Roo, the death toll is estimated at about 500 with $40,000,000 damage." ""Janet" maintained this fast rate of movement even in crossing the Yucatan Peninsula. This speed was a result of the intensification of the subtropical ridge over the Gulf of Mexico and southeastern United States."

September 29:

HWM shows a hurricane of at most 1000 mb centered near 20.2N, 95.5W at 12Z. HURDAT lists this as a 95 kt hurricane at 19.9N, 95.3W at 12Z. Microfilm analyzes a closed low pressure of at most 990 mb centered near 20.0N, 94.5W at 12Z. MWR is not available on this date. Ship highlights: 30 ENE and 1007 mb at 0Z near 23.8N, 93.0W. Land highlights: 15 SSW and 999 mb at Coatzacoalcos, Mexico at 12Z (micro). Aircraft highlights: Radar center fix near 19.8N, 96.4W at 1745Z (ATSR). ATSR: "After "Janet" moved in to the Gulf of Campeche the circulation became distorted and partially disrupted by the surrounding land masses. This being an area of sparse upper air reports it is difficult to say why "Janet" decelerated to 14 knots and finally to 8 knots before entering the coast of Mexico."

September 30:

HWM and Microfilm does not show an organized system at 12Z. HURDAT lists this as a 50 kt tropical storm at 20.3N, 98.8W at 6Z (last position). MWR is not available on this date. Land highlights: 10 kt E and 1002 mb at Veracruz at 0Z (micro). 10 kt SW and 1004 mb at Mexico City at 06Z (micro).

MWR: "Hurricane Janet passed into the Gulf of Campeche and moved inland between Veracruz and Nautla. The circulation aloft continued its westward movement across Mexico and a squally disturbed area developed off the west coast of Mexico under this circulation late on the first of October. Floods were already occurring in the Tampico area from the rains of Gladys and Hilda when the torrential rains of this hurricane were added. Little information is available on fatalities and damage which should be attributed to Janet in this area, but according to the Weather Bureau Office at New Orleans, the floods in the Tampico area from the tropical storms of 1955 were probably one of the greatest natural disasters ever to occur in that country."

Hurricane Janet developed from a tropical wave that left the African coast around mid-September. The tropical wave traveled westward organizing into a tropical cyclone east of the Lesser Antilles. The time of genesis is uncertain as data east of 55W is very sparse and by the time Janet was detected on September 21st, it was already a well-organized tropical storm. The data at 12Z on the 21st does suggest that a well-defined center was

present and this is the first entry into HURDAT (not genesis) of our analysis, six hours earlier than originally in HURDAT. At 0Z on the 22nd, two separate ships reported gale-force winds and pressures below 1005 mb. The ship Mormac Dale located at 13.5N, 55.3W reported sustained winds of 55 kt S and 1003 mb, while another ship near 12.6N, 56.1W reported 35 kt W and 998 mb. A peripheral pressure of 998 mb suggests maximum sustained winds greater than 51 kt from the south of 25N Brown et al. pressure-wind relationship. An intensity of 60 kt is selected for 0Z on September 22nd, a minor upward change from original HURDAT. Also, an intensity of 40 kt is selected for 12Z and 50 kt for 18Z on the 21st, the latter is a minor change as originally HURDAT had 35 kt. Janet approached Barbados late on the 22nd passing just south of the island. Winds over 100 mph (possibly an estimate) were reported by an observer on the island. An aircraft reconnaissance mission reached Janet at 1425Z measuring a central pressure of 979 mb. A central pressure of 979 mb suggests maximum sustained winds of 79 kt the south of pressure-wind relationship. At this point Janet was a small hurricane, with a RMW of about 8 nmi and climatology suggests about 12 nmi. Therefore, an intensify of 80 kt is selected for 12Z on the 22nd and 90 kt at 18Z, down from 105 kt at both times originally in HURDAT. Janet did not make landfall in Barbados but category 1 force winds, and possibly category 2 force winds, did impact the island causing significant damage to houses and other structures.

The hurricane continued on a west-southwest path toward the Lesser Antilles maintaining 90 kt winds at 00Z on the 23rd. Around this time, the center of Janet moved over Grenada also causing significant damage to the Caribbean nation. Weakening began thereafter as Janet began to move west and west-northwest over the eastern Caribbean. A reconnaissance aircraft reached the cyclone at 1815Z on the 23rd measuring a central pressure of 996 mb, estimated maximum surface winds of 80 kt, and an eye diameter of 40 nm. A central pressure of 996 mb yields maximum sustained winds of 54 kt south of 25N according to the south of 25N pressure-wind relationship. The large eye diameter suggests an RMW of ~30 nm compared with climatology of ~13 nm, which would usually indicate winds weaker than that from the pressure-wind relationship. Putting some weight on the visual estimate of the winds, an intensity of 60 kt is selected for 18Z on the 23rd. This is a major change as originally HURDAT indicated 80 kt at this time. A central pressure of 996 mb was originally in HURDAT at 12Z on the 23rd but it has been removed as there is no evidence that it was an actual measurement and that the cyclone substantially filling during the day, not steady state. The shipping presence was scarce over the southeast Caribbean as Janet moved across the area. Around mid-day on the 24th, the tropical storm passed about 80 nmi north of the ABC islands. It is possible that tropical storm force winds on the southern portion of the circulation affected the islands. At 1345Z, a reconnaissance aircraft reached the cyclone measuring a central pressure of 996 mb and estimated maximum surface winds of 55 kt. As stated before, a central

pressure of 996 mb yields 54 kt according to the south of 25N pressure-wind relationship. An intensity of 55 kt is selected for 12Z on the 24th, a major change from 100 kt originally in HURDAT. 60 kt is selected for 00Z and 55 kt for 06Z on the 24th, both major changes to HURDAT (85 kt and 95 kt, respectively). Another reconnaissance mission reached the storm at 1520Z measuring a central pressure of 996 mb, estimated maximum surface of 45 kt and an eye diameter of 20 nm. At 1745Z, the last aircraft mission for the day reported a central pressure of 999 mb and estimated maximum surface winds of 100 kt. A central pressure of 999 mb suggests maximum sustained winds of 49 kt according to the south of 25N pressure-wind relationship. An intensity of 50 kt is selected for 18Z on the 24th, a major change as originally HURDAT indicated 110 kt. A central pressure of 999 mb is added to 18Z on the 24th, replacing the existing 995 mb.

On September 25th, Janet was moving westward entering the central Caribbean Sea and like many other cyclones before and since, the storm began to strengthen. A reconnaissance aircraft reached the cyclone at 19Z on the 25th measuring a central pressure of 988 mb, estimated maximum surface winds of 85 kt and an eye diameter of 20 miles. A central pressure of 988 mb suggests maximum sustained winds of 67 kt according to the south of 25N pressure-wind relationship. The diameter data indicates a RWM of about 15 nm and climatology suggests 13 nm. Therefore, an intensity of 65 kt is selected for 18Z on the 25th, a major change in HURDAT as it indicates 115 kt for this time. At 18Z on the 25th, Janet is analyzed to have regained hurricane intensity. A central pressure of 993 mb was present in the original HURDAT at 12Z on the 25th, and although there is no data to verify it, it looks reasonable and it is retained. An intensity of 50 kt is selected for 0Z on the 25th, 55 kt at 06Z, and 60 kt at 12Z. Major changes to HURDAT as at these times it indicates 115 kt. No inner core pressure or wind data was received on the 26th as this was the day of the fateful flight that never made it back. But Janet likely continued to intensify reaching major hurricane status at 18Z on the 26th. An intensity of 100 kt is selected for 18Z, a major change to HURDAT as it indicates 125 kt. A central pressure of 970 mb is in the original HURDAT at 12Z and although this appears to be an interpretation and not a measurement, it looks reasonable and it is retained. An intensity of 70 kt is selected for 0Z on the 26th, 80 kt at 06Z and 90 kt at 12Z. All of these are major downward changes to HURDAT as it shows 120 kt at 00Z and 06Z and 125 kt at 12Z on the 26th.

On September 27th, Janet continued to intensify while moving on a west-northwest course entering the western Caribbean Sea. Around 18Z, the system devastated Swan Island after making a direct landfall. No direct wind measurements were made at Swan Island,

just estimates that placed the wind at over 200 mph. Certainly it is possible that wind gusts could have approached or reached that velocity but very likely not maximum sustained winds. Gale-force winds also affected Grand Cayman as Janet passed about 165 nmi to the southwest. A reconnaissance aircraft reached the hurricane at 1540Z measuring a central pressure of 938 mb. A central pressure of 938 mb suggests maximum sustained winds of 123 kt and 125 kt intensifying, according to the south of 25N pressure-wind relationships. An intensity of 130 kt is selected for 12Z and 140 kt for 18Z, as the hurricane was traveling at about 20 kt. It is analyzed that at 18Z on the 27th, Janet reached category 5. Originally HURDAT had a central pressure of 914 at 06Z on the 27th, but this was measured at 06Z on the 28th, and therefore, it is moved to its correct time slot. Only 12 hours after devastating Swan Island, Janet was moving over the Yucatan Peninsula with an even stronger intensity. Janet moved over Chetumal, Mexico, where a central pressure of 914 mb was measured around 06Z on the 28th. The nearby city of Corozal, Belize, measured a pressure of 916 mb at 0610Z. A central pressure of 914 mb suggests 144 kt and 146 kt intensifying, according to the south of 25N pressure-wind relationships. An intensity of 150 kt is selected at 06Z on the 28th, a major change to HURDAT as it originally had 130 kt. 150 kt is also selected for 00Z on the 28th, matching original HURDAT. A central pressure of 950 mb is in the original HURDAT at 12Z on the 28th while the hurricane was still over land, appears to be an estimate but it is kept as it is reasonable. Weakening occurred over the Yucatan Peninsula although the data is very sparse. The Kaplan-DeMaria model was run for 12Z on the 28th suggesting maximum sustained winds of 88 kt. Janet weakened below major hurricane status at 12Z as the intensity of 95 kt is kept from original HURDAT. Around 15Z on the 28th, Janet reached the Bay of Campeche and a reconnaissance aircraft reached the hurricane at 1945Z measuring an eye diameter of 10 miles but no information is provided on the central pressure or estimated maximum surface winds. Therefore, no changes are made to HURDAT's intensities late on the 28th and 29th. At 12Z on the 29th, HURDAT shows a central pressure of 950 mb. This appears to be a (rather dubious) estimate and it is removed because of the lack of inner-core data on this day and the rest of the lifetime of Janet. The hurricane made its final landfall around 18Z on the 29th on the Mexican state of Veracruz with maximum sustained winds of 95 kt. It is possible that Janet had regained major hurricane status by the time it made its final landfall but there is no data to show this. Weakening rapidly occurred over the mountainous terrain and it is analyzed that Janet was a depression by 12Z on the 30th and dissipated shortly after.

New Tropical Storm Linda [September 23-24, 1955]

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37265 09/23/1955 M=12 2 SNBR= 820 LINDA       XING=0 SSS=0

37265 09/23*  0   0   0    0*140 195  40    0*140 203  40    0*140 225  40    0*
37265 09/24*140 240  35    0*143 253  35    0*150 260  35    0*  0   0   0    0*
37275 TS
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A new tropical storm has been added to HURDAT, not previously shown in McAdie et al. (2009). Evidence for its existence comes from the Historical Weather Map series, Microfilm, and COADS ship database.

September 22:

HWM shows a closed low pressure of at most 1010 mb at 13.5N, 18.8W at 12Z. Microfilm does not analyze an organized system at 12Z. HURDAT and MWR do not list this system at 12Z. Ship highlights: No gale force winds or equivalent low pressures.

September 23:

HWM shows a closed low pressure of at most 1010 mb at 14.0N, 20.0W at 12Z. Microfilm does not analyze an organized system at 12Z. HURDAT and MWR do not list this system at 12Z. Ship highlights: 40 kt SE and 1004 mb (likely ~1009 mb) at 14.3N, 18.0W at 06Z (COADS). 15 kt NE and 1005 mb at 15.6N, 22.5W at 18Z (COADS). Land highlights: 10 kt N and 1005 mb at 14.9N, 23.5W at Praia, Cape Verde Islands at 18Z (micro).

September 24:

HWM shows a closed low pressure of at most 1010 mb at 16.5N, 24.7W at 12Z. Microfilm does not analyze an organized system at 12Z. HURDAT and MWR do not list this system at 12Z. Ship highlights: No gale force winds or equivalent low pressures.

September 25:

HWM shows a closed low pressure of at most 1010 mb at 18.2N, 31.8W at 12Z. Microfilm does not analyze an organized system at 12Z. HURDAT and MWR do not list this system at 12Z. Ship highlights: No gale force winds or equivalent low pressures.

September 26:

HWM shows a spot low at 18.2N, 35.3W at 12Z. Microfilm does not analyze an organized system at 12Z. HURDAT and MWR do not list this system at 12Z. Ship highlights: No gale force winds or equivalent low pressures.

September 27:

HWM shows a spot low at 18.0N, 41.5W at 12Z. Microfilm does not analyze an organized system at 12Z. HURDAT and MWR do not list this system at 12Z. Ship highlights: No gale force winds or equivalent low pressures.

September 28:

HWM and microfilm do not analyze an organized system at 12Z. HURDAT and MWR do not list this system at 12Z. Ship highlights: No gale force winds or equivalent low pressures.

A tropical wave left the African coast on late on September 22nd rapidly organizing into a tropical cyclone. Ship data at 06Z on the 23rd indicate that the cyclone had already reached tropical storm intensity. A ship located at 14.3N, 18.0W reported 40 kt SE and 1004 mb at 06Z on the 23rd. The pressure appears to have about a 5 mb low bias. An intensity of 40 kt is selected for 06Z on the 23rd. Genesis is begun on September 23rd at 06Z as a 40 kt tropical storm. Tropical Storm Linda moved generally westward during the first 24 hours after formation. The pressure at Praia, Cape Verde Islands decreased from 1008.3 mb at 12Z on the 23rd to 1004.8mb at 18Z as Linda passed close to the station. A peripheral pressure of 1005 mb suggests maximum sustained winds of at least 37 kt south of 25N from the Brown et al. pressure-wind relationship. The intensity is kept at 40 kt at 18Z. 40 kt is also the peak intensity for this tropical cyclone, but this is highly speculative since no inner-core data was ever received from this system. Data on September 24th becomes very sparse as Linda moves away from the African continent. Data from the Cape Verde Islands indicates that the track of the cyclone turned to the northwest on the 24th and after 12Z, there is no data to locate Linda anymore. Therefore, it was decided to make 12Z on the 24th the last position but it is very likely that the storm continued toward the central Atlantic dissipating on a later date. The low pressure associated with Linda is tracked by HWM until September 27th but there is no data to indicate that it was a tropical cyclone on these days. The name “Linda” was given to the low pressure system in 1955 and appears on the microfilm data. The track of Linda is reminiscent to the track of Tropical Storm Melissa in 2007, a system that became a tropical cyclone close to the Cape Verde Islands only to dissipate as it entered the central Atlantic.

Unnamed Tropical Storm 11 [October 10-14, 1955]

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39210 10/10*  0   0   0    0*284 414  30    0*284 420  45    0*284 427  45    0*
39210 10/10*  0   0   0    0*288 422  50    0*288 426  50    0*288 430  50    0*
                             *** ***  **       *** ***  **       *** ***  **
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39215 10/11*284 433  45    0*286 438  55    0*288 442  50    0*291 444  50    0*
39215 10/11*288 434  50    0*288 438  55    0*288 442  55    0*290 444  50    0*
           *** ***  **      ***       **                ** 

39220 10/12*294 444  50    0*297 444  50    0*300 442  50    0*306 435  50    0*
39220 10/12*294 444  50    0*297 442  50    0*300 438  50    0*303 431  50    0*
                             ***             ***             *** ***

39225 10/13*312 426  50    0*318 416  50    0*324 405  50    0*337 394  50    0*
39225 10/13*306 420  50    0*311 410  50    0*319 400  50    0*329 390  50    0*
           *** ***           *** ***           *** ***           *** ***

39230 10/14E358 380  50    0E378 366  45    0E400 351  40    0*  0   0   0    0*
39230 10/14*350 380  50    0*372 370  50    0*  0   0   0    0*  0   0   0    0*
           ****              **** ***  **        *   *   *

39235 TS
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Minor changes to the track but major revision to the intensity shown in McAdie et al. (2009). Evidence for these alterations comes from the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, and Monthly Weather Review. Additionally, the reanalysis indicates that the cyclone did not undergo an extratropical transition.

October 9:

HWM shows a cold front over the northeast Atlantic extending to the southwest to 30N, 40W at 12Z. HURDAT and Microfilm do not analyze an organized system on this date. MWR is not available in this date. Ship highlights: No gales or low pressures.

October 10:

HWM shows a weakening cold front over the northeast Atlantic extending to a spot low located at 25.5N, 40.5W at 12Z. HURDAT lists this as a 45 knot tropical storm at 28.4N, 42.0W at 12Z. Microfilm analyzes a closed low pressure of at most 1005 mb centered at 28.5N, 42.W at 18Z. MWR is not available in this date. Ship highlights: 45 kt SW and 1002 mb at 28.7N, 42.8W at 16Z (micro). 45 kt SW and 1002 mb at 28.6N, 42.8W at 18Z (micro).

October 11:

HWM shows a closed low pressure of at most 1015 mb located at 27.5N, 44.5W at 12Z. HURDAT lists this as a 50 knot tropical storm at 28.8N, 44.2W at 12Z. Microfilm analyzes a closed low pressure of at most 1008 mb centered at 29.0N, 45.0W at 12Z. MWR is not available in this date. Ship highlights: 35 kt SW and 1007 mb at 27.7N, 44.5W at 18Z (micro).

October 12:

HWM shows a closed low pressure of at most 1005 mb located at 30.0N, 45.0W at 12Z. HURDAT lists this as a 50 knot tropical storm at 30.0N, 44.2W at 12Z. Microfilm analyzes a closed low pressure of at most 1008 mb centered at 30.0N, 44.0W at 12Z. MWR is not available in this date. Ship highlights: 35 kt SSW and 1007 mb at 29.3N, 41.5W at 18Z (micro).

October 13:

HWM shows a closed low pressure of at most 1005 mb located at 30.3N, 40.8W and an approaching cold front to the north near 40N at 12Z. HURDAT lists this as a 50 knot tropical storm at 32.4N, 40.5W at 12Z. Microfilm analyzes a closed low pressure of at most 1008 mb centered at 32.0N, 40.0W at 12Z. MWR is not available in this date. Ship highlights: 35 kt S and 1006 mb at 31.3N, 38.7W at 06Z (COADS). 25 kt SSE and 1003 mb at 32.6N, 38.0W at 18Z (COADS).

October 14:

HWM shows a closed low pressure of at most 990 mb located at 41.5N, 37.0W with a cold front extending to the southwest and a warm front to the northeast 12Z. HURDAT lists this as a 40 knot extratropical cyclone at 40.4N, 40.5W (last position) at 12Z. Microfilm analyzes a closed low pressure of at most 996 mb centered at 43.0N, 39.0W at 12Z. MWR is not available in this date. Ship highlights: 1000 mb at 35.0N, 48.3W at 0Z (micro). 50 kt SW and 1008 mb at 34.0N, 34.3W at 06Z (micro).

MWR: “A small vortex apparently developed in an easterly wave which passed through the Cape Verde islands on October 4. It was first reported by two passing ships on October 10 at approximately Latitude 28.5ºN and Longitude 42.8ºW. The storm recurved to the northeast on the 11th and merged with an extra-tropical storm on the 14th. The combined storm was quite severe with one ship reporting 979 mb (28.91 inches). The lowest reported pressure in the tropical storm was 1000 mb (29.53 inches) and highest winds were about 55 mph.”

This unnamed tropical storm developed from the remnants of a frontal boundary over the central Atlantic during the second week of October. The genesis remains unchanged from 06Z on the 10th of October, although it is very probable that the system developed earlier. Very minor alterations were made to the positions of the cyclone for all five days of its existance. The first ship to encounter the tropical system was ELBJ reporting sustained winds of 45 kt SW and a barometric pressure of 1002 mb at 16Z on the 10th. A peripheral pressure of 1002 mb suggests maximum winds greater than 42 kt from the north of 25N Brown et al. pressure-wind relationship. An intensity of 50 kt is selected for 06Z on the 10th, up from 30 kt originally in HURDAT, as the system was already well-developed when it was first encountered. During the next 24 hours, the storm moved slowly

westward while slightly intensifying to 55 kt. This intensification was present in the original HURDAT but there is no data to justify or change it. The intensity is decreased to 50 kt at 18Z on the 11th of October, as it is originally in HURDAT. On the 12th, the track changed to the northeast while accelerating as a cold front approached from the west. A reconnaissance aircraft reached the tropical storm late on the 12th reporting a squall area between 30-32N, 44-45W, and maximum sustained winds of only 20 kt. Based on the ship data at the time, it is analyzed that the reconnaissance aircraft visited the northwest portion of the circulation, never reaching the center of the cyclone. Late on the 13th, the tropical storm began to interact with the frontal boundary, and the large circulation began to become elongated N-S at 18Z. Another ship (S.S. Mateo) passed close to the center at 00Z on the 14th measuring a peripheral pressure of 1000 mb. A pressure of 1000 mb yields maximum sustained winds greater than 45 kt north of 25N and 49 kt north of 35N according to the Brown et al. and Landsea et al. pressure-wind relationships, respectively. The intensity is kept at 50 kt at 00Z, unchanged from original HURDAT. By 12Z on the 14th, the tropical storm had been absorbed by a larger extratropical cyclone, making 06Z the last position. Originally in HURDAT, the tropical cyclone became extratropical at 00Z on the 14th and the last position was at 12Z. The reanalysis keeps the system tropical for 12 hours longer but ends the cyclone's lifetime six hours earlier than the original HURDAT. The extratropical cyclone moved northwest over the next few days toward Newfoundland, dissipating on the 17th.

Hurricane Katie [October 14-20, 1955]

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39240 10/14/1955 M= 7 12 SNBR= 857 KATIE       XING=0 SSS=0                    L
39240 10/14/1955 M= 6 14 SNBR= 857 KATIE       XING=0 SSS=0                    L
                     * **

39245 10/14*  0   0   0    0*  0   0   0    0*  0   0   0    0*117 779  30    0*
39245 10/14*  0   0   0    0*  0   0   0    0*  0   0   0    0*125 793  25    0*
                                                            *** ***  **

39250 10/15*121 777  35    0*126 772  45    0*132 767  50    0*138 761  60    0*
39250 10/15*127 787  30    0*129 780  35    0*132 772  40    0*137 764  45    0*
           *** ***  **      *** ***  **          ***  **      *** ***  **

39255 10/16*143 753  70    0*148 745  80    0*153 737  90    0*161 729 100  984*
39255 10/16*143 753  50    0*148 745  55    0*154 737  60    0*162 729  70  984*
                     **                **      ***      **      ***      **

39260 10/17*171 722 100    0*181 718  55    0*193 713  50    0*207 705  60    0*
39260 10/17*171 723  80    0*181 717  90    0*193 711  50    0*205 706  45    0*
                ***  **          ***  **          ***          ***  ***  **

39265 10/18*221 698  60    0*233 690  60    0*247 683  60    0*269 671  50    0*
39265 10/18*219 700  50 1000*233 692  50    0*247 683  50    0*269 671  50  999*
           *** ***  ** ****     ***  **                **                    ***

39270 10/19*295 654  40    0*320 633  40    0*345 605  35    0E371 569  35    0*
39270 10/19*295 654  45    0*320 633  40    0*  0   0   0    0*  0   0   0    0*
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39275 10/20E397 524  35    0E419 471  35    0*  0   0   0    0*  0   0   0    0*
39275 10/20*  0   0   0    0*  0   0   0    0*  0   0   0    0*  0   0   0    0*

39280 HR
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Minor changes to the track, but major alterations to the intensity shown in McAdie et al. (2009). Another major change is to show dissipation a day earlier than originally indicated. Evidence for these alterations comes from the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, and Monthly Weather Review. Additionally, the reanalysis indicates that the cyclone did not undergo an extratropical transition.

October 13:

HWM, HURDAT and Microfilm do not analyze an organized system on this date. MWR is not available in this date. Ship highlights: No gales or low pressures.

October 14:

HWM shows a spot low located at 12.0N, 80.5W at 12Z. HURDAT lists this as a 30 kt tropical depression at 11.7N, 77.9W at 18Z. Microfilm does not analyze an organized system on this date. MWR is not available in this date. Ship highlights: No gales or low pressures.

October 15:

HWM shows a tropical storm of at most 1005 mb located at 14.7N, 77.1W at 12Z. HURDAT lists this as a 50 kt tropical storm at 13.2N, 76.7W at 12Z. Microfilm analyses a closed low pressure of at most 1005 mb at 13.5N, 76.8W at 12Z. MWR is not available in this date. Ship highlights: 20 kt NNE and 1005 mb at 13.2N, 77.7W at 12Z (COADS).

October 16:

HWM shows a hurricane of at most 1000 mb located at 15.5N, 73.1W at 12Z. HURDAT lists this as a 90 kt hurricane at 15.3N, 73.7W at 12Z. Microfilm analyses a closed low pressure of at most 1005 mb at 15.0N, 74.0W at 12Z. MWR is not available in this date. Ship highlights: 50 kt NW and 1001 mb at 14.9N, 74.1W at 12Z (COADS). Aircraft highlights: Penetration center fix at 16.4N, 72.9W at 2010Z (ATSR). Radar center fix measured a central pressure of 984 mb, an eye diameter of 20 miles and maximum surface winds of 100 kt at 16.9N, 72.3W at 23Z (ATSR/micro).

October 17:

HWM shows a hurricane of at most 1005 mb located at 19.1N, 70.5W at 12Z. HURDAT lists this as a 50 kt tropical storm at 19.3N, 71.3W at 12Z. Microfilm analyses

a closed low pressure of at most 1008 mb at 18.5N, 70.5W at 12Z. MWR is not available in this date. Ship highlights: 25 kt E and 1005 mb at 20.0N, 70.7W at 12Z (COADS). Aircraft highlights: Radar center fix at 17.7N, 72.0W at 04Z (ATSR). Penetration center fix at 21.3N, 70.4W at 22Z (ATSR). Radar center fix measured a central pressure of 1000 mb and maximum surface winds of 65 kt at 21.5N, 70.3W at 22Z (ATSR/micro).

October 18:

HWM shows a tropical storm of at most 1000 mb located at 24.9N, 68.8W with an approaching cold front to the northwest at 12Z. HURDAT lists this as a 60 kt tropical storm at 24.7N, 68.3W at 12Z. Microfilm analyses a closed low pressure of at most 1008 mb at 24.5N, 68.0W at 12Z. MWR is not available in this date. Ship highlights: 35 kt SW and 1004 mb at 22.0N, 69.0W at 03Z (micro). 35 kt SSE and 1014 mb at 24.5N, 66.0W at 12Z (micro). 45 kt SSE and 1009 mb at 27.0N, 66.9W at 18Z (micro). Aircraft highlights: Penetration center fix measured a central pressure of 999 mb, an eye of a 40 mile diameter and maximum surface winds of 50 kt at 25.8N, 66.7W at 1630Z (micro). Penetration center fix at 27.3N, 67.3W at 2010Z (micro).

October 19:

HWM shows an extratropical cyclone of at most 1000 mb located at 40.0N, 67.0W, which may indicate that the tropical cyclone has been absorbed, at 12Z. HURDAT lists this as a 35 kt tropical storm at 34.5N, 60.5W at 12Z. Microfilm analyses a closed low pressure of at most 1008 mb at 34.5N, 60.5W at 12Z. MWR is not available in this date. Ship highlights: No gales or low pressures.

October 20:

HWM shows an extratropical cyclone of at most 985 mb located at 51.0N, 50.0W at 12Z. HURDAT lists this as a 35 kt extratropical cyclone at 41.9N, 47.1W at 06Z. Microfilm analyses an extratropical cyclone of at most 993 mb at 50.0N, 52.0W at 12Z. MWR is not available in this date. Ship highlights: 30 kt W and 1003 mb at 41.5N, 47.0W at 06Z (micro).

ATSR: “Hurricane Katie,” the final storm of the 1955 season, had a life span of a short duration before becoming extratropical after crossing the island of Hispaniola. “Katie” came into existence in the Caribbean south of Hispaniola from a weak vortex on the Intertropical Convergence Zone and developed to full hurricane intensity rapidly after being detected as a tropical storm. The first indication of the vortex as on the 15th of October when a weak vortex could be drawn at 0030Z. There was no indication of intensification at 151230Z, and as late as 160630Z there were no reports in the area to indicate intensification. A weak to moderate cold front was moving southeast into the

Caribbean. The vortex was not considered potentially suspicious since the charts for the previous few days and current charts revealed an orderly procession of vortices moving westward along the Intertropical Convergence Zone which is normal in this area during the summer and early fall months. However, at 161200Z a report from the ship SS POSEIDON was received, giving a west wind of 50 knots and a low surface pressure of 1001.3 mb, confirming the development of "Katie" near 15N 74W. A Navy aircraft was ordered immediately from San Juan to reconnoiter the suspicious area and verify the report from the SS POSEIDON. A small intense hurricane with winds of 100 knots and minimum surface pressure of 984 mb centered at 16-23N 72-52W at 162010Z was reported by the reconnaissance aircraft. Warning Number One for "Hurricane Katie" was coordinated with the Weather Bureau Office of San Juan and issued at 162200Z. As reported by the Navy Reconnaissance aircraft, rapid intensification of "Katie" was taking place. The eye, reported to be well defined both visually and by radar by the reconnaissance aircraft was 20 miles in diameter with spiral squall bands extending from the storm center. With the rapid intensification and the north-northeast movement the island of Hispaniola was in line for the full force of "Katie" in a matter of hours. In moving across the island of Hispaniola, "Katie" lost some of her intensity, but later regained hurricane intensity over the water north of the island for a few hours before becoming extratropical. On the 18th of October the final aircraft reconnaissance into "Katie" reported maximum winds of 55 knots, no definite eye, flat pressure pattern and that the storm consisted of a line of isolated cumulonimbus oriented east-west. In view of this information, verifying the belief that "Katie" had become extratropical, the final warning was issued at 182200Z."

MWR: "Hurricane Katie probably developed from a wave on the intratropical convergence zone in the vicinity of Panama. The first definite evidence was a ship report from the Dutch motor vessel Poseidon on the morning of the 16th. A Navy reconnaissance plane the same afternoon located the center with a pressure of 984 mb (29.06 inches) and winds up to 115 mph. The center crossed the coastline of Hispaniola near the border between Haiti and the Dominican Republic about midnight that night. This area is thinly populated but the small border towns of Anse-a-Pitre and Pedernales were badly damaged with highest winds estimated at 115 mph. On the basis of incomplete reports, total damage is estimated at between $200,000 and $300,000 with 7 deaths. Katie became almost completely disorganized in crossing the high mountains of Hispaniola but briefly intensified to near hurricane intensity after passing out into the Atlantic. However, it shortly reached an area containing the remains of an old cold front and again lost intensity. The vortex was probably last encountered by SS Amsterdam at 0130 EST on the 20th in Latitude 37.3ºN and Longitude 56.4ºW."

Hurricane Katie developed in the central Caribbean Sea at 18Z on the 14th of October, unchanged from HURDAT. It is analyzed at genesis as a 25 kt tropical depression, down from 30 kt in HURDAT. The time of genesis is somewhat uncertain as the data is sparse. Minor track changes were introduced on all days of this system except the 19th, with the most significant change made at genesis with a new position 100 nm WNW of the original one. Intensification to a tropical storm occurred at 06Z on the 15th, 6 hours later than originally shown in HURDAT. Katie generally moved northeastward and the first report of tropical storm force winds occurred at 12Z on the 16th when the ship Poseidon reported 50 kt W and 1001 mb, about 40 nm from the center of the system. Intensification to a hurricane occurred at 18Z on the 16th, 18 hours later than originally shown in HURDAT. A reconnaissance aircraft reached Katie at 2010Z on the 16th measuring a central pressure of 984 mb and an eye diameter of 20 miles. A central pressure of 984 mb suggests maximum winds of 72 kt south of 25N from the Brown et al. pressure-wind relationship. The eye diameter information suggests an RMW of around 15 nm, which is close to climatology. An intensity of 70 kt is selected for 18Z on the 16th and 80 kt for 0Z on the 17th, down from 100 kt at both times originally in HURDAT, a major change.

Katie was a small hurricane that continued to intensify until landfall occurred around 06Z on the 17th on the Dominican Republic, near the city of Pedernales (18.0N, 71.8W). Landfall intensity is estimated at 90 kt, a category 2 hurricane. It is possible that Katie was even stronger as the aircraft left the hurricane 8 hours before landfall as it was intensifying. But there is no data to suggest that Katie was a major hurricane. Weakening occurred after landfall and Katie reached the north coast of Hispaniola around 15Z on the 17th. The intensity decreased to 45 kt at 18Z and slight intensification ensued after. Another aircraft investigated Katie at 22Z on the 17th measuring a central pressure of 1000 mb and estimated maximum surface winds of 65 kt. A central pressure of 1000 mb yields 47 kt south of 25N according to the pressure-wind relationship. An intensity of 50 kt is selected at 0Z on the 18th (down from 60 kt originally in HURDAT) as the system was starting to accelerating toward the north-northeast. A central pressure of 1000 mb is added to 00Z on the 18th. A second reconnaissance mission reached Katie at 1630Z measuring a central pressure of 999 mb, estimated maximum sustained winds of 50 kt and an eye diameter of 40 miles. A central pressure of 999 mb yields 45 kt north of 25N according to the pressure-wind relationship. A central pressure of 999 mb has been added to 18Z on the 18th. An intensity of 50 kt is selected at 18Z on the 18th due in part to the fast motion of the storm. Early on the 19th, Katie began to interact with an approaching frontal boundary and the storm became absorbed by 12Z. This is supported by the synoptic maps of 12Z on the 19th and 0Z on the 20th. The analyzed last position is 06Z on the 19th, 24 hours earlier than originally shown in HURDAT. The ship AMST at 06Z on the 20th reported 30 kt W and 1003 mb at 41.5N, 47.0W indicating an extratropical cyclone development along this frontal boundary at that time. Also, unlike HURDAT, the

reanalysis does not show Katie becoming extratropical. The extratropical cyclone continued moving northeastward for several days, eventually passing east of Greenland on the 22nd of October.

1955 - Additional Notes

1) February 18-27: A low pressure developed along the tail-end of a frontal boundary over the western Atlantic on the 19th. It moved eastward reaching the central Atlantic on the 21st according to the Historical Weather Maps and Microfilm. The system became an occluded low pressure on the 22nd and gale-force winds were present on the 23rd but far to the north (~300 nm) of the center. The low pressure remained over the area for a couple more days while producing gale-force winds. The system persisted as a large, occluded low until it was absorbed by a cold front on the 27th. Therefore, it is not added to HURDAT. This disturbance was in Beven's and Roth's List of Suspects.

Day	LAT	LONG	STATUS
February 18	13-29N	75-79W	Trough
February 19	27N	71W	Extratropical
February 20	27N	68W	Extratropical
February 21	28N	60W	Extratropical
February 22	26N	52W	Occluded
February 23	30N	51W	Occluded
February 24	26N	52W	Occluded
February 25	28N	53W	Occluded
February 26	28N	50W	Occluded
February 27			Absorbed by front

2) April 21-26: A low pressure system formed over the central Atlantic on the 21st of April according to the Historical Weather Maps. It moved generally northward for about five days before weakening to a trough and becoming absorbed by a cold front on April 26th over the north Atlantic. No gale-force winds were found in COADS or HWM associated with this disturbance. Therefore, it is not added to HURDAT.

Day	LAT	LONG	STATUS
April 21	23N	57W	Tropical Depression?
April 22	25N	47W	Tropical Depression?
April 23	28N	48W	Tropical Depression?
April 24	32N	49W	Tropical Depression?
April 25	42-34N	44W	Trough
April 26			Absorbed by front

3) May 1-7: A weakening cold front over the western Atlantic spawned a non-tropical low pressure between the United States East Coast and Bermuda on May 1st according to the Historical Weather Maps and Microfilm. The system was producing gale-force winds to the west and northeast of its center on May 1st, 2nd and 3rd. The disturbance moved generally southwestward becoming an occluded low on the 2nd and degenerating into a trough of low pressure on the 5th. On May 7th, the system had dissipated. Because it only had gale force winds while it was occluded, it is not added to HURDAT. This disturbance was in Roth's List of Suspects.

Day	LAT	LONG	STATUS
May 1	32N	69W	Extratropical
May 2	30N	72W	Occluded
May 3	28N	73W	Occluded
May 4	28N	70W	Occluded
May 5	20-30N	65-68W	Trough
May 6	19-34N	62-66W	Trough
May 7			Dissipated

4) September 5-8: A trough of low pressure was present over the northwest Gulf of Mexico at the same time that Hurricane Gladys churned over the Bay of Campeche according to the Monthly Weather Review, Microfilm and Annual Tropical Storm Report. The disturbance produced tropical storm force conditions across southern Texas but it moved inland before developing a well-defined circulation. Therefore, it is not added to HURDAT. MWR: "At the same time an area of heavy squalls developed off the middle Texas coast on September 5 and moved inland on the 6th. Highest winds reported were 45 mph in the Corpus Christi-Port O'Connor area, and an oil rig 15 miles east of Port Aransas, Tex., reported gusts of 55 to 65 mph. The Naval Air Station at Corpus Christi received 12.23 inches of rain in 24 hours and a high tide of 4.5 feet was reported in the Bay. Damage was estimated at $500,000 in the Corpus Christi area. It is reported that radar observations during this period indicated briefly the presence of a cyclonic circulation, consequently this may have been a separate tropical storm." ATSR: "Between 050300Z and 06300Z, the westward movement of "Gladys" trough was arrested by the westerly trough and it began an oscillation westward and eastward all the while oriented north-south along the Texas and Mexican Gulf Coast. The two troughs met and merged in northeastern Texas resulting in heavy rain and extremely squally weather along the trough axis. ... However, the stagnant trough along the Texas Gulf coast continued to give heavy rains to the Galveston-Brownsville area. By request two additional recoinnaissance aircraft flights were ordered into the Western Gulf to investigate the area along the Texas coast for possible tropical storm existence or development. None was expected and none was found." This disturbance was in Beven's List of Suspects.

Day	LAT	LONG	STATUS
September 5	25-29N	96W	Trough
September 6	25-28N	97W	Trough
September 7	25-28N	99W	Trough
September 8			Dissipated

5) October 25-28: A low pressure developed on October 25th over the central Atlantic along the tail-end of a weakening cold front according to the Historical Weather Maps and Microfilm. The disturbance became better organized on the 26th and a ship near 28.5N, 57.5W reported gale-force winds. The disturbance generally moved northeast and an approaching cold front absorbed the low pressure late on the 27th. It is possible the system may have been a short-lived tropical storm but the data is not enough to justify such an assestment with only one gale-force report. Therefore, it is not added to HURDAT.

Day	LAT	LONG	STATUS
October 25	23N	57W	Tropical Depression?
October 26	28N	56W	Tropical Storm?
October 27	28N	53W	Tropical Storm?
October 28			Absorbed by front

6) November 2-5: A non-tropical low pressure developed on November 2nd to the southeast of Nova Scotia according to the Historical Weather Maps and Microfilm. The system moved eastward becoming a large, occluded cyclone on the 3rd with gale-force winds to the west and northeast of the its center. An approaching cold front absorbed the cyclone on the 5th. Because gale force winds were recorded only while the system was an occluded low, it is not added to HURDAT. This disturbance was in Roth's List of Suspects.

Day	LAT	LONG	STATUS
November 2	40N	60W	Extratropical
November 3	38N	58W	Occluded
November 4	40N	53W	Occluded
November 5			Dissipated

7) November 5-8: A trough of low pressure formed over the central Atlantic during the first week of November according to the Historical Weather Maps. A low pressure developed on the 6th as it moved generally on an eastward course. Dissipation occurred around the 9th over the eastern Atlantic. No gale-force winds were found in COADS or HWM associated with this disturbance. Therefore, it is not added to HURDAT.

Day	LAT	LONG	STATUS
November 5	20-30N	48-58W	Trough
November 6	28N	42W	Tropical Depression?
November 7	28N	31W	Tropical Depression?
November 8	28N	24W	Tropical Depression?
November 9			Dissipated

1956 hurricane season

New Tropical Storm [June 7-10, 1956]

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37265 06/07/1956 M= 4 1 SNBR= 820 UNNAMED       XING=0 SSS=0

37265 06/07*0   0    0     0*340 751  35    0*337 756  40 1002*333 760  40    0*
37265 06/08*326 762  40    0*316 763  45    0*312 762  45    0*314 758  40    0*
37265 06/09*316 749  35    0*318 737  35    0*327 726  30    0*338 715  30    0*
37265 06/10E348 700  30    0E358 682  30    0E370 664  30    0*  0   0   0    0*
37285 TS
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A new tropical storm has been added to HURDAT, not previously shown in McAdie et al. (2009). Evidence for its existence comes from the Historical Weather Map series, Microfilm, Monthly Weather Review, COADS ship database, and Jack Beven's and David Roth's suspect lists.

June 5:

HWM shows a stationary front over the eastern United States at 12Z. Microfilm analyses a frontal boundary east of the United States at 12Z. Ship highlights: No gale force winds or equivalent low pressures.

June 6:

HWM shows a closed low pressure of at most 1010 mb at 28.0N, 75.0W at 12Z. Microfilm analyses a closed low pressure of at most 1011 mb at 29.0N, 76.0W and another closed low pressure of at most 1011 mb at 23.5N, 76.5W at 12Z. Neither analysis indicates a frontal boundary near the low(s). MWR shows a low pressure of 1011 mb located near 26.9N, 77.0W at 12Z. Ship highlights: No gale force winds or equivalent low pressures.

June 7:

HWM shows a closed low pressure of at most 1005 mb at 34.0N, 73.8W with a weakening front to its northeast at 12Z. Microfilm analyses a closed low pressure of at most 1008 mb at 34.0N, 74.0W at 12Z. MWR shows a low pressure of 1002 mb located near 34.8N, 74.3W at 12Z. Ship highlights: 30 kt N and 1005 mb at 33.8N, 76.1W at 12Z (COADS). 20 kt SE and 1004 mb at 33.5N, 75.6W at 12Z (COADS). 35 kt NE and 1006 mb at 34.5N, 75.6W at 18Z (COADS).

June 8:

HWM shows a closed low pressure of at most 1005 mb at 31.3N, 75.0W at 12Z. Microfilm analyses a closed low pressure of at most 1008 mb at 32.0N, 76.0W at 12Z. MWR shows a low pressure of 1003 mb located near 32.7N, 76.7W at 12Z. Ship

highlights: 35 kt NE and 1007 mb at 32.8N, 77.0W at 12Z (COADS). 30 kt SSW and 1001 mb at 31.3N, 76.2W at 06Z (micro). 30 kt SW and 1004 mb at 31.3N, 76.9W at 09Z (micro). 35 kt WNW and 1009 mb at 30.9N, 76.5W at 18Z (micro).

June 9:

HWM shows a closed low pressure of at most 1010 mb at 32.5N, 72.5W and a frontal boundary to the north at 12Z. Microfilm analyses a closed low pressure of at most 1011 mb at 32.5N, 72.5W and a frontal boundary to the north at 12Z. MWR shows a low pressure of 1008 mb located near 32.5N, 72.0W at 12Z. Ship highlights: No gale force winds or equivalent low pressures.

June 10:

HWM shows a closed low pressure of at most 1015 mb at 37.0N, 66.0W with a frontal boundary going through the system at 12Z. Microfilm analyses a closed low pressure of at most 1017 mb at 37.0N, 66.0W with a frontal boundary going through the system at 12Z. MWR shows a low pressure of 1014 mb located near 37.0N, 66.0W at 12Z. Ship highlights: No gale force winds or equivalent low pressures.

June 11:

HWM shows an extratropical cyclone of at most 1010 mb at 41.0N, 58.0W at 12Z. Microfilm analyses an extratropical cyclone of at most 1008 mb at 43.0N, 61.0W at 12Z. MWR shows a low pressure of 1008 mb located near 42.5N, 60.0W at 12Z. Ship highlights: No gale force winds or equivalent low pressures.

June 12:

HWM shows an extratropical cyclone of at most 1005 mb at 43.5N, 53.2W at 12Z. Microfilm analyses an extratropical cyclone of at most 1008 mb at 43.0N, 61.0W at 12Z. MWR shows a low pressure of 1005 mb located near 53.5N, 62.0W and a frontal boundary south of Newfoundland, Canada at 12Z. Ship highlights: No gale force winds or equivalent low pressures.

A low pressure developed off the southeast coast of the United States from a weakening frontal boundary during the first week of June. Ship data indicates that a trough of low pressure was present north of the Bahamas along longitude 76W on June 6th and it was slowly moving northward. The frontal boundary dissipated by the 6th. By early June 7th, pressures had decreased about 3-5 mb near the disturbance compared to the previous day and a closed circulation is analyzed to have developed around 06Z on June 7th. Several ships reported 30 kt early on the 7th and the intensity of the first position is analyzed at 35 kt on June 7th at 06Z. A ship close to the center at 12Z reported 20 kt

and 1004 mb, which suggests a central pressure of about 1002 mb and has been added to HURDAT. A peripheral pressure of 1004 mb suggests maximum sustained winds of at least 36 kt north of 25N from the Brown et al. pressure-wind relationship. An intensity of 40 kt is selected for 12Z on June 7th. On June 7th and early on the 8th, the tropical storm moved generally southward, near the warm waters of the Gulf Stream.

Gale force winds were also reported on June 8th by a couple of ships near the tropical cyclone. At 06Z on the 8th, a ship reported 30 kt and 1001 mb. A peripheral pressure of 1001 mb suggests maximum sustained winds of at least 42 kt north of the 25N pressure-wind relationship. An intensity of 45 kt is selected for 06Z and 12Z on the 8th. 45 kt is the peak intensity for the lifetime of this tropical cyclone. Late on the 8th and into the 9th, the forward speed increased to the northeast ahead of a deepening frontal boundary. Weakening is analyzed to have started late on the 8th and by 12Z on the 9th; the cyclone had diminished to a tropical depression. Late on the 9th, ship data indicates that the circulation of the tropical depression began to interact with the frontal boundary. It is analyzed that by 00Z on June 10th, the tropical depression became an extratropical cyclone. Its duration as an extratropical cyclone was short-lived as the system continued to weaken, becoming a trough of low pressure between Bermuda and Nova Scotia after 12Z on the 10th.

Unnamed Tropical Storm 1 [June 12-15, 1956]

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39285 06/12/1956 M= 4  1 SNBR= 858 NOT NAMED   XING=1 SSS=0
39285 06/12/1956 M= 4  2 SNBR= 858 NOT NAMED   XING=1 SSS=0
                       *

39290 06/12*220 915  25    0*225 913  30    0*231 912  30 1009*240 910  35    0*
39290 06/12*200 915  25    0*203 915  25    0*207 915  30 1007*212 915  35    0*
            ***              *** ***  **      *** ***     **** *** ***

39295 06/13*253 907  40    0*264 907  50    0*275 909  50 1004*290 908  45    0*
39295 06/13*230 915  40    0*251 913  45    0*275 909  50 1004*294 906  50 1002*
            *** ***          *** ***  **                     *** ***  ** ****

39300 06/14*306 905  40    0*322 910  35    0*338 917  25 1006*347 928  25    0*
39300 06/14*310 906  35    0*324 910  30    0*338 917  25 1006*345 928  25    0*
            *** ***  **      ***       **                     ***

39305 06/15*349 933  25    0*352 938  20    0*  0   0   0    0*  0   0   0    0*

39310 TS
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U.S. Tropical Storm Landfall

06/13 17Z 29.1N 90.7W 50 kt LA

Major changes to the track and minor changes to the intensity shown in McAdie et al. (2009). Evidence for these alterations comes from the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Monthly Weather Review, the Local Climatological Data, Surface Weather Observations, Connor (1956) and Mexican synoptic maps.

June 11:

HWM, HURDAT and MWR does not analyze an organized system at 12Z. Microfilm shows a low pressure over eastern Mexico and a tropical wave/trough along 92W at 12Z. No gales or low pressures.

June 12:

HWM does not analyze an organized system over the Gulf of Mexico at 12Z. HURDAT lists this as a 30 knot tropical depression at 23.1N, 91.2W at 12Z. Microfilm analyzes a low pressure of at most 1011 mb centered near 20.2N, 92.5W at 12Z. MWR shows a low pressure of 1009 mb located near 20.3N, 91.8W at 12Z. No gales or low pressures. "This was the second tropical storm to occur in June in 10 years. On June 9, a fracture occurred in the polar trough lying just off the Atlantic coast, and the southern section began moving westward across Florida into the Gulf of Mexico while the northern portion continued eastward over the western Atlantic. The westward moving southern section apparently induced an easterly wave which moved across the extreme western Caribbean, western Cuba, southern Florida, and the Yucatan Peninsula, and on the 12th formed a depression in the Bay of Campeche under the mid-tropospheric trough." (MWR)

June 13:

HWM shows a closed low pressure of at most 1010 mb centered near 28.3N, 91.5W at 12Z. HURDAT lists this as a 50 knot tropical storm at 27.5N, 90.9W at 12Z. Microfilm analyzes a closed low pressure of at most 1005 mb centered near 28.2N, 90.9W at 12Z. MWR shows a low pressure of 1004 mb located near 27.8N, 91.2W at 12Z. Ship highlights: 40 kt SE and 1013 mb near 24.0N, 87.4W at 06Z (micro). 35 kt SE and 1008 mb near 28.2N, 90.1W at 12Z (micro). 40 kt SSE and 1008 mb near 28.7N, 89.3W at 18Z (COADS). Land highlights: 40 kt SE and 1011 mb at SW Pass Lighthouse, LA at 12Z (micro). 48 kt E at Grand Isle, LA at 1315Z (MWR). 1004 mb at New Orleans (no time given) (MWR). 40 kt at Golden Meadow, LA (no time given) (CONNOR). "The disturbance moved northward, acquiring tropical storm intensity and the center crossed the Louisiana coast a short distance west of Grand Isle during the late afternoon of the 13th. According to the report from the hurricane forecast center at New Orleans, "The storm had both tropical and extratropical characteristics. Rainfall was tropical in nature

but never formed in bands characteristics of tropical storm and there was never any definite center or eye. The temperature aloft over the surface Low remained as cold as or colder than the surrounding air." The situation in the high troposphere was also markedly different from that usually observed during hurricane formation." "The highest wind reported ashore was 55 mph from the east at Grand Isle, at 0715 CST on the 13th. A boat 5 miles south of Pilottown, La, reported gusts to 60 mph from the south-southeast. The lowest observed pressure was 29.66 inches at Moissant Airpor, New Orleans, and at McComb, Miss. The highest measured tide was 4.7 feet above mean sea level at Biloxi, Miss. The heaviest rainfall was within 100 miles of and to the east of the storm track and decreased from 6.13 inches at Grand Isle, La., to 5.60 inches at Monticello, Miss., 3.17 inches at Jackson, Miss., and 1.60 inches at Greenwood, Miss. The benefit to crops from these rains, which ended a drought at least temporarily, exceeded property loses from wind and water on the coast. Four persons were drowned, three of them when a tug sank off the Mississippi coast and the other, a truck driver, when his truck skidded on the bridge over Lake Pontchartrain and plunged into the lake. The bridge was damaged by the truck but more seriously by a loose barge. The total damage to the bridge was estimated at $12,000. Tides generally ranged from 1 to 4 feet above normal along the Louisiana and Mississippi coasts. The Freeport Sulphur Co. suffered some damage to their sulphur mines near the coast south of Houma, La, where the tide was 4.5 feet above mean sea level. Minor damage to the beaches, small boats, and piers occurred along the Mississippi coast in places where tides were said to have reached as much as 5 feet above mean sea level. The total damage from this storm is estimated at $50,000." (MWR)

June 14:

HWM shows a closed low pressure of at most 1010 mb centered near 34.0N, 92.5W at 12Z. HURDAT lists this as a 25 knot tropical depression at 33.8N, 91.7W at 12Z. Microfilm analyzes a closed low pressure of at most 1008 mb centered near 34.0N, 92.0W at 12Z. MWR shows a low pressure of 1006 mb located near 33.5N, 91.5W at 12Z. Land highlights: 1004 mb at McComb, MS (no time given) (CONNOR). 5 kt N and 1005 mb at Liberty, MS at 0Z (micro). "At 250 mb, at 0300 GMT on the 12th, an intense cyclonic circulation was centered southwest of Fort Worth and at 0300 GMT on the 14th this center had moved almost over the tropical storm in Louisiana." (MWR)

June 15:

HWM shows a low pressure system over SW Wyoming with a cold front to the south and a warm front to the east stretching over the north of the US. The tropical cyclone appears to have dissipated. HURDAT lists this as a 20 kt tropical depression at 35.2N, 93.8W at 06Z (last position). Microfilm does not analyze an organized system at 12Z. No gales or low pressures.

The first tropical cyclone of the 1956 hurricane season developed in the Bay of Campeche during the second week of June as a tropical wave moved into the region. Genesis of this tropical storm is kept at 00Z on the 12th of June, but ship and land stations data on this day indicate that the center was located about 120 nm south than originally shown in HURDAT, a major change. Only minor changes to the track were subsequently introduced on the 13th, and 14th, with no alterations on the 15th. The cyclone is initialized as a 25 kt tropical depression, as originally shown in HURDAT. The depression moved northward, initially slow but gaining forward speed later in the day. A central pressure of 1009 mb was in original HURDAT at 12Z and appears to be an estimate, not an actual measurement. A ship within the RMW reported 20 kt E and 1009 mb, suggesting a possible central pressure of 1007 mb. Therefore, the 1009 mb at 12Z has been replaced by 1007 mb. Intensification to a tropical storm occurred at 18Z on the 12th in agreement with the original HURDAT. The first gales were observed early on the 13th as various ships reported 35-40 kt about 150-300 nm away from the center. At this time the system was moving at about 22 kt to the north with an elongated N-S structure and most of the rainbands and winds concentrated on the eastern quadrant. The structure, as mentioned by the Monthly Weather Review summary, exhibited subtropical characteristics and it is possible that during this time this system was a subtropical cyclone. Note, however, that formally designating systems as "subtropical" is not feasible until the advent of satellite imagery to assess the convective distribution. Nonetheless, intensification continued and by 12Z on the 13th it had reached a peak intensity of 50 kt as originally shown in HURDAT. At this time, the cyclone became more symmetric and the circulation became more concentrated although the winds remained stronger on the eastern quadrant. Another reason for the winds to be stronger on the eastern semi-circle was the presence of an intense high pressure system over the Ohio Valley causing a strong pressure gradient on that side of the storm.

Landfall occurred around 17Z on the 13th on southeast Louisiana near 29.1N, 90.7W with maximum winds of 50 kt, no changes from original HURDAT. The highest wind report over land was 48 kt at Grand Isle, LA. A central pressure of 1004 mb was on the original HURDAT at 12Z on the 13th and appears to be an estimate, but it looks to be reasonable and is retained. The tropical storm passed at about 30 miles west of New Orleans where the pressure dropped to 1004 mb at the airport (unknown time, but likely soon after 18Z) and the winds at the time were at about 10 kt from the south. Therefore, this suggests that the central pressure of the system was around 1002 mb. A central pressure of 1002 mb is selected for 18Z on the 13th and added to HURDAT. Weakening began after landfall and the system is analyzed to have become a tropical depression at 06Z on June 14th, six hours earlier than originally shown in HURDAT. At this time the track of the cyclone changed to the northwest and its forward speed began to decrease. A central pressure of 1006 mb was present on the original HURDAT at 12Z on the 14th and

although it appears to be an estimate, it looks to be reasonable and is retained. Dissipation occurred after 06Z on June 15th as originally shown in HURDAT.

Hurricane Anna [July 25-27, 1956]

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39315 07/25/1956 M= 3  2 SNBR= 859 ANNA        XING=0 SSS=0
39315 07/25/1956 M= 3  3 SNBR= 859 ANNA        XING=0 SSS=0
                       *

39320 07/25*  0   0   0    0*  0   0   0    0*  0   0   0    0*206 927  30    0*
39320 07/25*  0   0   0    0*  0   0   0    0*  0   0   0    0*208 925  30    0*
                                                          *** ***

39325 07/26*208 935  35 1006*210 945  45    0*212 955  50  991*215 967  65    0*
39325 07/26*210 933  35 1006*212 944  50    0*214 956  65  991*216 969  75    0*
           *** ***          *** ***  **      *** ***  **      *** ***  **

39330 07/27*219 984  70 1002*220 989  60    0*  0   0   0    0*  0   0   0    0*
39330 07/27*218 981  60    0*220 989  35    0*221 995  25    0*  0   0   0    0*
           *** ***  **    *           **      *** ***  **

39335 HR
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Minor changes to the track and major changes to the intensity shown in McAdie et al. (2009). Evidence for these alterations comes from the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Monthly Weather Review, Connor (1956), Navy reconnaissance book and Mexican synoptic maps.

July 24:

HWR and microfilm do not analyze an organized system at 12Z. HURDAT does not list a tropical cyclone on this day. No gales or low pressures. “The easterly wave in which Anna developed passed through the Lesser Antilles on July 20 and continued westward through the Caribbean. Instability of the wave began to increase on the 23rd as the wave, extending on the surface from central Cuba to Panama, passed under a very well developed anticyclone in the middle and upper troposphere. A weak circulation may have developed as it moved over the Yucatan Peninsula on the night of the 24th but all surface winds were under 20 mph.” (MWR) ““Tropical Storm Anna formed from an easterly wave, locally numbered “July #1,” which moved into the Antilles from the Atlantic on 20 July. “July #1” was a wave of moderate intensity while moving across the Caribbean but exhibited no signs of vortex development. The first indications of vortex development came late on the 24th of July. Previously the easterly wave had not been capped with divergent flow at higher levels but, beginning on the 24th, the easterly moved under divergent flow of the 200 mb level. The perturbation of the pressure pattern shortly became more accentuated and a weak vortex developed.” (ATSR)

July 25:

HWM shows a closed low pressure of at most 1010 mb centered near 20.5N, 91.0W at 12Z. HURDAT lists this as a 30 knot tropical depression at 20.6N, 92.7W at 18Z. Microfilm analyzes a closed low pressure of at most 1008 mb centered near 20.5N, 92.5W at 12Z. No gales or low pressures. Aircraft highlights: Penetration center fix measured a central pressure of 1006 mb and maximum surface winds of 35 kt at 20.9N, 93.0W at 2225Z (ATSR). "Intensification was steady after the center passed into the Bay of Campeche and the depression intensified to storm intensity on the afternoon of the 25th." (MWR) "Moving westward at about 10 knots, the vortex and associated wave moved over the warm waters of the Gulf of Campeche on the 25th of July, meanwhile the intensity was slowly increasing. The first weather reconnaissance flight was ordered out of Jacksonville on the 25th. Late that afternoon the Navy flight reported a center of light wind circulation, minimum surface pressure of 1006 mb and maximum winds of 35 knots at some distance from the center. Spiral bands, although evident, did not define the center. It was decided not to issue warnings on this vortex until the wind force and circulation increased." (ATSR)

July 26:

HWM shows a closed low pressure of at most 1005 mb centered near 21.3N, 95.9W at 12Z. HURDAT lists this as a 50 knot tropical storm at 21.2N, 95.5W at 12Z. Microfilm analyzes a closed low pressure of at most 1002 mb centered near 20.6N, 91.0W at 12Z. Ship highlights: 20 kt N and 1005 mb at 22.0N, 97.1W at 12Z (COADS). Land highlights: 70 kt, 1002 mb measured at Tampico (no time given) (MWR). Aircraft highlights: Penetration center fix measured a central pressure of 991 mb, maximum surface winds of 50 kt, and an eye diameter of 4 miles at 21.3N, 96.3W at 1442Z (ATSR). Penetration center fix at 21.6N, 96.6W at 1530Z (ATSR). "On the morning of the 26th, Navy reconnaissance located the center with lowest pressure 991 mb (29.26 in.) and found maximum winds of 50 knots in the northern semicircle. Early that evening the center moved inland south of Tampico, Mexico where a maximum wind of 70 knots (81 mph) was reported that winds of hurricane force existed only for about three hours as the center approached and crossed the coastline. Many houses in the poorer sections of Tampico were blown down and some roofs of the better homes were blown off. Although only 2.5 inches of rain were reported, downtown streets in Tampico were flooded. There were no reports of deaths and injuries. Damage has been estimated at around $50,000." (MWR) "During the night of the 25th and the morning of the 26th, the vortex and wave moved westward at 11 to 12 knots intensifying very slowly. Another reconnaissance flight was flown early on the 26th. This flight reported a very small center of wind circulation of 4 nm diameter, a minimum pressure of 991 mb and maximum winds of 50 knots in the north quadrant. These facts prompted the issue of warning number ONE of Tropical Storm Anna at 261600Z. The past movement of Anna had been west to west-

northwest at 11 to 12 knots. Anna had been moving along the south and southwest periphery of the 700 mb and 500 mb ridge. At the time Anna was expected to continue to move west-northwest at about 11 knots. Actually, Anna moved almost due west after 261600Z. The third and last reconnaissance flight was ordered into the storm area late on the 26th on a radar tracking mission. The only fix placed the "eye" inland west of Cape Rojo and about half way between Tampico and Tuxpan. Thus "eye" fix, at 262235Z, was followed by a report at 262300Z indicating that the "eye" was no longer discernible, The final warning had been issued at 262200Z when it became apparent from land station reports that the center was moving overland. The maximum wind velocity report from aircraft and ship reports was 50 knots. Tampico reported a maximum wind of 42 knots with occasional gusts to 60 knots when Anna was passing south of the city. After passing overland Anna rapidly degenerated into an area of squalls. Except for some flooding damage, no reports of damage were received." (ATSR)

July 27:

HWM and Microfilm do not analyze an organized system at 12Z. HURDAT lists this as a 60 kt tropical storm at 22.0N, 98.9W at 06Z (last position). Land highlights: 40 kt ESE and 1006 mb at Tampico at 00Z (micro).

Hurricane Anna formed over the central Bay of Campeche from a tropical wave that likely entered the area late on July 24th. The pressure at Ciudad del Carmen, Mexico [18.6N, 91.8W] decreased from 1011.3 mb on July 24 at 12Z to 1006.8 mb on the 25th at 12Z, a drop of 4.5 mb in 24 hours. The data on the Bay of Campeche is sparse but it indicates the possibility that this tropical cyclone developed earlier on the 25th than shown. Very minor track changes were introduced for the duration of this system. Because of the lack of data, the genesis of this tropical cyclone is retained from original HURDAT at 18Z on the 25th as a 30 kt tropical depression. The first aircraft reconnaissance reached the system at 2225Z measuring estimated surface winds of 35 kt and a central pressure of 1006 mb. A central pressure of 1006 mb suggests maximum winds of 35 kt south of 25N from the Brown et al. pressure-wind relationship. Therefore, an intensity of 35 kt is selected for 00Z on the 26th, which agrees with the original HURDAT. A central pressure of 1006 mb was present in HURDAT at 00Z on the 26th and it has been kept. At this time it is analyzed that the tropical depression had become a tropical storm. Anna moved generally on a west-northwest course and another aircraft mission at 1442Z on the 26th found that the system had rapidly intensified. The plane measured a central pressure of 991 mb, estimated maximum surface winds of 50 kt and an eye diameter of just 4 nm. A central pressure of 991 mb suggests maximum sustained winds of 62 kt south of 25N according to the pressure-wind relationship. The eye diameter 4 nm suggests an RMW of about 3 nm, while climatology suggests an RMW of

about 16 nm. Due to the small size of Anna, an intensity of 65 kt is selected for 12Z on the 26th, up from 50 kt on HURDAT. At this time it is analyzed that Anna became a hurricane, six hours earlier than originally shown in HURDAT. A central pressure of 991 mb appears in HURDAT at 12Z on the 26th and it has been kept.

Late on July 26, the hurricane continued to intensify making landfall around 21Z near 21.7N, 97.5W between Tampico and Tuxpan in the Mexican state of Veracruz. The intensity at landfall is estimated at 75 kt but it is possible that Anna was stronger, possibly a category 2 hurricane when it crossed the coast as there is no data from the core between 15Z and 21Z on the 26th. The last aircraft reconnaissance mission reached Anna at 2235Z on the 26th finding that the cyclone had already made landfall, and thus the plane only provided a radar fix position. MWR reports that Tampico experienced winds of 70 kt causing damage to numerous houses, yet the reports from the Annual Tropical Storm Report on Anna contradicts this information indicating that the city only experienced maximum winds of 42 kt and no damage was reported. Anna continued inland weakening to a tropical storm at 00Z on the 27th, six hours earlier than originally shown in HURDAT. Furthermore, a 1002 mb central pressure was present in the original HURDAT at 00Z on the 27th but this is very likely to be from the lowest pressure reported by Tampico. Since Anna passed about 60 nm south of the city, this is not a central pressure and has been removed. The mountainous terrain continued to take its toll on the cyclone and by 12Z on the 27th it is analyzed to have weakened to a tropical depression. Dissipation occurred after 12Z, six hours later than originally shown in HURDAT which has the last position of Anna unrealistically listed as a 60 kt tropical storm.

Hurricane Betsy [August 9-21, 1956]

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39780 08/09/1956 M=12  3 SNBR= 866 BETSY       XING=0 SSS=0
39780 08/09/1956 M=13  4 SNBR= 866 BETSY       XING=0 SSS=0
                    **  *

39785 08/09*  0   0   0    0*135 472  50    0*137 488  50    0*139 502  50    0*
39785 08/09*  0   0   0    0*135 472  50    0*137 488  60    0*139 502  70    0*
                                            **                **

39790 08/10*140 516  60    0*141 530 105    0*142 543 105    0*144 560 105  979*
39790 08/10*140 516  80    0*141 530  85    0*143 545  90    0*147 560  90  979*
                    **                **      *** ***  **      ***       **

39795 08/11*147 578 105    0*149 591 100    0*153 603  95    0*160 618  80  991*
39795 08/11*150 576  90    0*152 591  90    0*155 604  90    0*160 618  90  979*
           *** ***  **      ***       **      *** ***  **                **  ***

39800 08/12*165 632  80    0*170 644  80    0*178 657  80    0*188 672  80    0*
39800 08/12*165 632  85    0*171 645  85    0*179 659  85  981*188 673  80    0*
                    **      *** ***  **      *** ***  **  ***     ***
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39805 08/13*198 687  85    0*209 700  95    0*219 713  95  974*228 725  95    0*
39805 08/13*198 687  85    0*209 700  95    0*220 714 100  972*230 727 100    0*
                                            *** *** ***  *** *** *** ***

39810 08/14*237 736  95    0*246 748  95    0*256 760  95    0*265 767  95    0*
39810 08/14*240 739 100    0*249 750 105    0*257 760 105  960*265 767 100    0*
           *** *** ***      *** *** ***      ***     ***  ***         ***

39815 08/15*272 768  90  968*278 768  85    0*283 766  85  963*288 761  85    0*
39815 08/15*272 769  90  968*278 770  90    0*283 767  95  963*288 762  95    0*
                ***              ***  **          ***  **          ***  **

39820 08/16*293 756  85    0*298 750  85    0*307 743  85    0*322 733  85    0*
39820 08/16*293 757  90    0*299 752  80  973*308 743  85    0*322 734  95    0*
                ***  **      *** ***  **  *** ***                ***  **

39825 08/17*337 722  80  954*351 709  75    0*366 696  70    0*380 681  70    0*
39825 08/17*337 724 100  954*351 712  95    0*366 698  85    0*380 684  75    0*
                *** ***          ***  **          ***  **          ***

39830 08/18*395 664  65    0*408 647  50    0E417 621  50    0E424 586  50    0*
39830 08/18*395 667  70    0*408 647  65    0*417 621  60    0*424 586  55    0*
                ***  **                **     *          **     *          **

39835 08/19E428 550  50    0E431 517  45    0E432 486  45    0E431 451  45    0*
39835 08/19E428 550  55    0E431 517  55    0E432 486  55    0E431 451  50    0*
                     **                **                **                **

39840 08/20E431 416  40    0*  0   0   0    0*  0   0   0    0*  0   0   0    0*
39840 08/20E429 416  45    0E425 385  40    0E421 365  35    0E420 340  30    0*
           ***       **     **** ***  **     **** ***  **     **** ***  **

(September 21st is new to HURDAT)
39843 08/21E420 320  25    0E420 310  25    0*  0   0   0    0*  0   0   0    0*
           **** ***  **     **** ***  **

39845 HR
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Minor track changes and major intensity changes shown in McAdie et al. (2009). A major alteration is to add one additional day at the end of the cyclone's lifetime. Evidence for these alterations comes from the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Navy reconnaissance book, Monthly Weather Review 1956 (MWR), MWR Weather Notes (MWR-WN), Monthly Weather Review 1959 (MWR-1959), Notes on the Tropical Cyclones of Puerto Rico (Perez), and Puerto Rico and Virgin Islands State Climatological Data (CLIMO).

August 8:

HWM analyzes a spot low near 10.6N, 50.8W at 12Z. Microfilm and HURDAT does not show an organized system on this date. Ship highlights: No gales or low pressures.

August 9:

HWM analyzes a closed low pressure of at most 1015 mb at 13.2N, 54.5W at 12Z. HURDAT lists this as a 50 knot tropical storm at 13.7N, 48.8W at 12Z. Microfilm shows a closed low pressure of at most 1008 mb at 13.5N, 49.0W at 12Z. Ship highlights: 50 kt and 1008 mb at 14.1N, 49.1W at 1218Z (micro). 40 kt NE and 1011 mb at 15.7N, 50.8W at 18Z (micro).

MWR: "Around August 9, when the development of Betsy was first suspected, the anticyclone had reached maximum intensity and immediately began to subside and to return to its previous position south of its north track. Lack of reports in the eastern Atlantic makes it impossible to arrive at a detailed analysis for the period preceding the first indications of this storm but there was some evidence of an easterly wave near longitude 33W on August 6. Extrapolation at a normal rate of movement would have brought it to the vicinity of 50W on the 9th. On that date the following report was received from the M/T Marisa: "At 1218 GMT passed through trough of tropical storm in position 14.05N, 55.25W. At 1200 GMT 1008 mb, winds force 10, very high wild sea, heavy squalls." It was not possible to fit this report into any logical analysis and consequently efforts were made to verify the ship's position. At 1730 GMT a corrected position of 14.05N, 49.05W was obtained. This was only a short distance from the routine Gull Papa reconnaissance track but the developing storm was too small to alert the reconnaissance observer and there was no diversion from the scheduled track."
CLIMO: "An easterly wave appeared on the surface chart at 1800Z on August 6 at the longitude of 33ºW. Its orientation was almost North and South while its amplitude at that time was slight. This easterly wave was followed across the Atlantic until on August 9 the SS Marisa radioed in a report that gave cause to suspect possible intensification in the easterly wave."

August 10:

HWM analyzes a hurricane of at most 1005 mb at 14.0N, 54.9W at 12Z. HURDAT lists this as a 105 knot hurricane at 14.2N, 54.3W at 12Z. Microfilm shows a closed low pressure of at most 1008 mb at 13.5N, 54.5W at 12Z. Ship highlights: 30 kt NE and 1004 mb at 14.6N, 54.2W at 06Z (micro). 60-65 kt and 1005 mb at 14.6N, 54.2W at 0930Z (micro). 35 kt NE and 1012 mb at 15.7N, 55.8W at 12Z (COADS). 50 kt NW and 1004 mb at 14.6N, 56.6W at 18Z (COADS). Aircraft highlights: Penetration center fix at 14.2N, 54.5W at 1455Z (ATSR). Penetration center fix estimated maximum surface winds of 100 kt, measured a central pressure of 979 mb and an eye diameter of 10 nm at 1955Z (ATSR).

MWR: "A special reconnaissance flight was made on August 10, but confirmation of storm development was received through surface ship reports before the plane reached the area. The M/S Sagaland at 1200 GMT reported: "Lat. 14.35N, Long. 54.10W, at 0400

GMT, wind 035 GMT northeast force 5, barometer 1008 mb. At 0930 GMT, northeast force 11/12, barometer 1004, violent sea, heavy rain, no visibility. At 1200 GMT wind east force 6, barometer 1009, heavy seas, rain, decreasing sea." The 1200 GMT observations from the SS Mormac Lark and SS Willamstadt on the outskirts of the storm, were also helpful in the location of the storm and evaluation of its intensity. The first advisory was issued at 1100 EST, August 10, at which time a hurricane watch was issued for the Leeward and Windward Islands from Antigua to Barbados. When reconnaissance aircraft reached the storm later in the day, it was found to be a very small hurricane but with winds of 120 mph near the center and central pressure 979 mb. The eye was defined by a very tightly closed pattern on the radar as only 10 miles in diameter." CLIMO: "During the 10th further ship reports confirmed the presence of a tropical storm and at 1600Z on the 10th the first advisory on tropical storm Betsy was issued. Hurricane intensity was reached later on the 10th."

August 11:

HWM analyzes a hurricane of at most 1005 mb at 15.5N, 59.9W at 12Z. HURDAT lists this as a 95 knot hurricane at 15.3N, 60.3W at 12Z. Microfilm shows a closed low pressure of at most 1008 mb at 15.5N, 60.5W at 12Z. Ship highlights: 35 kt E and 1014 mb at 17.3N, 58.0W at 06Z (COADS). 35 kt E and 1014 mb at 18.3N, 58.0W at 12Z (COADS). 45 kt NE and 1011 mb at 16.8N, 60.5W at 18Z (micro). 15 kt NNE and 989 mb at 14.4N, 62.9W at 21Z (micro). Land highlights: 50 kt NNW and 1009 mb at 1010 mb at Dubuc, Dominica at 15Z (micro). 991 mb at Point-au-Pitre, Guadaloupe at 18Z (MWR-1959). 85-105 kt (estimated) at Guadaloupe (no time given) (MWR). Aircraft highlights: Radar center fix at 15.1N, 59.3W at 07Z (ATSR). Radar center fix at 15.6N, 60.4W at 12Z (ATSR). Radar center fix at 16.3N, 61.9W at 19Z (ATSR).

MWR: "The hurricane moved on a west-northwest course at about 17 mph during the next 24 hours and passed through the central Lesser Antilles about midday August 11. It crossed over the islands of Marie Galante and between Isle des Saintes and the extreme south portion of Basse Terre, Guadaloupe. Reports indicate 18 lives lost and severe damage. On Guadaloupe, 1000 dwellings were extensively damaged, all communications disrupted, and about 50 to 60 percent of the banana, breadfruit, coconut, and papaya trees destroyed, a serious blow to the economy of the island. The banana crop loss was estimated at $3.5 million and preliminary estimates give $10 million for the total damage figure. Winds were estimated at 100 to 120 mph on Guadeloupe and the lowest pressure was 991 mb." CLIMO: "Betsy crossed through the Central Antilles between noon and 2 pm on August 11, passing over the south portion of the Island of Marie Galente and between Les Saintes and the extreme south portion of Basseterre, Guadaloupe. By 4 pm August 11 Betsy had entered the northeastern Caribbean Sea."

August 12:

HWM analyzes a hurricane of at most 1000 mb at 18.1N, 65.2W at 12Z. HURDAT lists this as an 80 knot hurricane at 17.8N, 65.7W at 12Z. Microfilm shows a closed low pressure of at most 1008 mb at 18.0N, 66.0W at 12Z. Ship highlights: 35 kt ENE and 1012 mb at 19.4N, 64.3W at 00Z (COADS/micro). 35 kt E at 20.0N, 63.0W at 06Z (COADS). 45 kt ENE and 1017 mb at 19.6N, 65.3W at 12Z (micro). 50 kt ENE and 1013 mb at 19.6N, 65.2W at 14Z (micro). Land highlights: 55 kt SE, gusts to 75 kt and 1004 mb at St. Croix at 09Z (micro). 983 mb at Guayama, PR at 1230Z (MWR-1959). 65 kt, gusts to 80 kt at San Juan, PR at 1235Z(MWR-1959). 75 kt, gusts to 100 kt at Ramsey Air Force Base, PR near 16Z (MWR-1959). 60 kt WSW, gusts to 85 kt at Arecibo, PR at 17Z (micro). Aircraft highlights: Radar center fix at 16.4N, 63.2W at 00Z (ATSR). Radar center fix at 17.1N, 64.5W at 06Z (ATSR). Radar center fix at 17.9N, 65.9W at 12Z (ATSR).

MWR: “After moving through the Leeward Islands, the hurricane began a more northwesterly course, passing about 30 miles south of St. Croix, Virgin Islands, and reaching the southeastern tip of Puerto Rico in the early morning of August 12. Prior to reaching Puerto Rico the storm displayed a small but apparently real oscillatory motion about the mean track with an amplitude of a little less than ½ degree and a period on the order of one day. The oscillation was sufficiently definite that, some forecast use could be made of it, on an extrapolation basis. Following the turn to a more northwesterly direction, this oscillation was not present or was obscured. A hurricane watch had been ordered for Puerto Rico and the Virgin Islands on the evening of August 10. As the hurricane continued to move toward Puerto Rico, the watch was changed to hurricane warnings on the afternoon of August 11. The eye of the storm crossed Puerto Rico between 1200 and 1530 GMT, August 12, on an erratic coarse between northwest and west-northwest at about 17 mph, emerging on the north coast near Camuy with only slight and temporary weakening of its circulation. According to reports, all of Puerto Rico, except the south-western portion which was protected by the mountain backbone of the island, experienced winds of 75 m. p. h. or higher in gusts. Maximum sustained winds at San Juan were 73 mph, with gusts to 92 mph. Rainfall totaled 3.19 inches. Ramey Air Force Base, on the northeastern tip of the island, recorded wind gusts to 115 mph. Nine deaths were reported in Puerto Rico and the property damage totaled $25,500,000 or more.” CLIMO: “Betsy passed about 30 miles south of St. Croix, VI between 4 and 4:30 am Sunday morning with winds from ESE at 86 mph in gusts and entered the SE coastal area of Puerto Rico in the vicinity of Maunabo between 1147Z and 12Z on August 12 on a WNW course at about 20 mph and passed out to sea in the Atlantic near Camuy (west of Arecibo) at 1515Z on the same day. According to reports all of Puerto Rico except the

southwestern portion experienced winds of 75 mph or higher in extreme gusts. West Ponce to Mayagüez maximum velocities reached 45 to 50 knots."

August 13:

HWM analyzes a closed low pressure of at most 1010 mb at 22.0N, 71.3W at 12Z. HURDAT lists this as a 95 knot hurricane at 21.9N, 71.3W at 12Z. Microfilm shows a closed low pressure of at most 1008 mb at 21.7N, 71.6W at 12Z. Ship highlights: No gales or low pressures. Land highlights: 30 kt W and 1011 mb at Turks and Caicos at 18Z (micro). 35 kt NE and 1012 mb at San Salvador, Bahamas at 24.1N, 74.5W at 23Z (micro). Aircraft highlights: Radar center fix at 20.8N, 69.9W at 06Z (ATSR). Radar center fix at 22.2N, 71.5W at 12Z (ATSR). Penetration center fix measured a central pressure of 972 mb at 22.2N, 71.8W at 1350Z (ATSR/MWR). Penetration center fix at 23.3N, 73.1W at 1940Z (ATSR).

MWR: "Hurricane Betsy continued at a speed of about 17 mph to near Turks Island early on August 13 and, with some acceleration, reached the vicinity of San Salvador in the Bahamas about 2000 EST on that date. Winds at San Salvador reached 132 mph. in gusts. Sustained winds were 100 mph or more. Approximately 5 inches of rain fell in 5 hours. Several houses were demolished and most of the churches, which are generally better constructed, lost their roofs. Aircraft reconnaissance on August 13 had shown a slight increase in size of the storm but little change in central pressure or maximum winds. Gale winds were reported as extending 125 miles north and 60 miles south of the center. Lack of important increase in size or intensity was compatible with the fact that turbulence and rain in all quadrants were predominantly light with only intermittent bursts of heavy rain and moderate turbulence."

August 14:

HWM analyzes a hurricane of at most 1010 mb at 26.0N, 76.0W at 12Z. HURDAT lists this as a 95 knot hurricane at 25.6N, 76.0W at 12Z. Microfilm shows a closed low pressure of at most 1011 mb at 25.8N, 76.1W at 12Z. Ship highlights: 65 kt NE and 1012 mb at 24.6N, 74.7W at 00Z (COADS). 65 kt E and 1014 mb at 25.2N, 74.8W at 03Z (micro). 40 kt S and 1015 mb at 24.1N, 74.0W at 06Z (COADS). 35 kt SE and 1017 mb at 25.9N, 74.0W at 12Z (COADS). Land highlights: 85 kt, gusts to 115 kt at San Salvador, Bahamas (no time given) (MWR). 80 kt NW, gusts to 104 kt and 985 mb at San Salvador, Bahamas at 02Z (micro). 45 kt SW and 1011 mb at San Salvador, Bahamas at 06Z (micro). 50 kt NNW and 1002 mb at Hope Town, Bahamas at 26.5N, 77.0W at 18Z (micro). Aircraft highlights: Radar center fix at 24.2N, 74.6W at 0234Z (ATSR). Radar center fix at 24.9N, 74.8W at 0604Z (ATSR). Penetration center fix at 26.2N, 76.2W at 14Z (ATSR). Penetration center fix at 26.2N, 76.2W at 1430Z (ATSR).

Penetration center fix at 26.6N, 76.6W at 1930Z (ATSR). Penetration center fix at 26.7N, 76.6W at 20Z (ATSR).

MWR: “On the 14th, central pressure was reported as 960 mb., the eye was 12 miles in diameter and well formed, and associated clouds extended 250 miles north and 200 miles to the east. On August 14 and 15, Betsy began recurvature with sharp deceleration in forward movement.”

August 15:

HWM analyzes a hurricane of at most 995 mb at 28.5N, 76.9W at 12Z. HURDAT lists this as an 85 knot hurricane at 28.3N, 76.6W at 12Z. Microfilm shows a closed low pressure of at most 1008 mb at 28.2N, 76.5W at 12Z. Ship highlights: 50 kt SW and 1003 mb at 27.5N, 76.6W at 12Z (COADS). 45 kt NW and 1004 mb at 28.0N, 78.0W at 18Z (COADS). Aircraft highlights: Radar center fix at 27.0N, 76.8W at 0130Z (ATSR). Radar center fix at 27.7N, 77.0W at 06Z (ATSR). Radar center fix at 28.1N, 76.5W at 1030Z (ATSR). Radar center fix at 28.6N, 76.8W at 18Z (ATSR). Penetration center fix at 28.7N, 76.2W at 1940Z (ATSR).

August 16:

HWM analyzes a hurricane of at most 995 mb at 31.0N, 73.6W at 12Z. HURDAT lists this as an 85 knot hurricane at 30.7N, 74.3W at 12Z. Microfilm shows a closed low pressure of at most 996 mb at 30.0N, 74.7W at 12Z. Ship highlights: 45 kt S and 1009 mb at 27.7N, 74.5W at 00Z (COADS). 35 kt SW and 1003 mb at 28.7N, 73.7W at 06Z (micro). 40 kt S and 1016 mb at 28.0N, 71.2W at 12Z (COADS). 40 kt S and 1014 mb at 29.7N, 71.0W at 15Z (micro). Aircraft highlights: Radar center fix at 29.4N, 75.4W at 03Z (ATSR). Radar center fix at 29.7N, 75.3W at 06Z (ATSR). Penetration center fix measured a central pressure of 973 mb at 0735Z (ATSR). Radar center fix at 30.8N, 74.1W at 12Z (ATSR). Penetration center fix at 31.1N, 73.7W at 14Z (ATSR). Penetration center fix at 33.7N, 72.6W at 2349Z (ATSR).

MWR: “Between the 13th when the storm was near Turks Island, and the 16th, when a dropsonde was released in the eye near 30N., 75W., temperatures in the eye between the surface and 700 mb. fell about 2C. The normal sea-surface temperature difference between these areas is less than 1' and, while some anomaly may have existed, it' seems likely that the cooling was an indication of the beginning, even at this time, of some other factors interfering with the efficiency of the storm engine. By the 16th it was moving toward the northeast and had increased its forward speed to about 20 mph. Maximum winds began to decrease on the 16th.”

August 17:

HWM analyzes a hurricane of at most 1000 mb at 37.0N, 69.8W at 12Z. HURDAT lists this as a 70 knot hurricane at 36.6N, 69.6W at 12Z. Microfilm shows a closed low pressure of at most 1005 mb at 37.0N, 70.0W at 12Z. Ship highlights: 35 kt SW and 1018 mb at 31.3N, 71.1W at 00Z (micro). 45 kt NE and 1002 mb at 35.2N, 72.6W at 03Z (COADS). 35 kt ENE and 1009 mb at 38.3N, 71.0W at 12Z (micro). 55 kt SSE and 985 mb at 38.0N, 69.0W at 15Z (micro). 50 kt SE and 1011 mb at 38.2N, 66.5W at 18Z (micro). Aircraft highlights: Penetration center fix at 34.6N, 71.6W at 0230Z (ATSR). Penetration center fix at 37.3N, 69.5W at 14Z (ATSR). Penetration center fix at 38.8N, 68.1W at 20Z (ATSR).

MWR: "and by late August 17th had dropped to 80 mph. Reconnaissance at this time reported the eye was becoming poorly defined as the hurricane moved northeastward at about 23 mph past the latitude of Nantucket."

August 18:

HWM analyzes a closed low pressure of at most 1000 mb at 42.0N, 62.0W with a frontal boundary about 300 nm to the north at 12Z. HURDAT lists this as a 50 knot extratropical cyclone at 41.7N, 62.1W at 12Z. Microfilm shows a closed low pressure of at most 999 mb at 42.5N, 62.3W with a frontal boundary just to the north at 12Z. Ship highlights: 50 kt S and 1007 mb at 38.0N, 65.5W at 00Z (micro). 65 kt S and 990 mb at 40.1N, 64.3W at 06Z (COADS). 40 kt W and 999 mb at 40.0N, 65.0W at 09Z (micro). 50 kt SW and 1013 mb at 40.0N, 56.0W at 18Z (COADS). Aircraft highlights: Penetration center fix at 40.7N, 65.3W at 0422Z (ATSR). Penetration center fix at 41.3N, 64.0W at 08Z (ATSR).

MWR: "The last advisory was issued on the morning of August 18 as the storm assumed more extratropical characteristics."

August 19:

HWM analyzes a closed low pressure of at most 995 mb at 43.0N, 48.5W with a dissipating warm front to the north and east at 12Z. HURDAT lists this as a 45 knot extratropical cyclone at 43.2N, 48.6W at 12Z. Microfilm shows a closed low pressure of at most 1002 mb at 43.0N, 48.0W at 12Z. Ship highlights: 45 kt SSW and 998 mb at 41.3N, 54.7W at 00Z (COADS). 45 kt SW and 999 mb at 41.0N, 50.8W at 06Z (COADS). 55 kt W and 1004 mb at 40.9N, 51.1W at 12Z (COADS). 35 kt ESE and 990 mb at 43.7N, 44.2W at 18Z (COADS).

MWR: "It moved due east on the 19th and 20th, gradually losing its identity."

August 20:

HWM analyzes a closed low pressure of at most 995 mb at 41.5N, 37.0W at 12Z. HURDAT lists this as a 40 knot extratropical cyclone at 43.1N, 41.6W at 0Z (last position). Microfilm shows a closed low pressure of at most 1005 mb at 43.0N, 39.0W at 06Z. Ship highlights: 45 kt E and 999 mb at 43.3N, 41.1W at 00Z (COADS). 30 kt SSW and 1001 mb at 41.0N, 36.5W at 06Z (COADS). 25 kt W and 1000 mb at 40.1N, 38.0W at 12Z (COADS).

August 21:

HWM analyzes a closed low pressure of at most 995 mb at 48.8N, 12.7W with a trough extending to the south and southwest at 12Z. HURDAT is not available on this date. Microfilm shows a low pressure at 44.5N, 31.0W with a frontal boundary extending to the north, southwest and southeast at 0Z. Ship highlights: No gales or low pressures.

Hurricane Betsy developed from a tropical wave that left the west coast of Africa at the beginning of August. On August 9th at 1218Z, a ship located at 14.1N, 49.1W reported sustained winds of 50 kt and 1008 mb. This was the first indication that a tropical cyclone had developed. The time of genesis is uncertain because ship data between Africa and the Lesser Antilles was very sparse. COADS were acquired for the previous days to see if it was possible to detect the exact time of formation but the lack of data gave no results. Therefore, the first entry into HURDAT (not genesis) remains unchanged on August 9th at 06Z as a 50 kt tropical storm. No changes are made to the track on the 9th and 19th, and minor track changes are introduced on the other days. Betsy was a small and fast-moving tropical cyclone. Intensification to hurricane is analyzed at 18Z on the 9th and an intensity of 70 kt is selected, up from 50 kt originally in HURDAT, a major change. Intensification to hurricane is analyzed 12 hours earlier than originally shown in HURDAT. HURDAT indicated an unrealistic increase in intensity from 60 kt at 0Z on the 10th to 105 kt at 06Z. Major intensity changes are also introduced on those times as our analysis suggests 80 kt at 0Z and 85 kt at 06Z on the 10th. Betsy is not assessed to have reached major hurricane status east of the Lesser Antilles. At 0930Z on the 10th, a ship reports winds of 60 to 65 kt and 1005 mb. At 1955Z on the 10th, the first reconnaissance aircraft reached the hurricane estimating sustained surface winds of 100 kt, measuring a central pressure of 979 mb and an eye diameter of 10 nm. A central pressure of 979 mb suggests maximum sustained winds of 79 kt from the south of 25N Brown et al. pressure-wind relationship. An eye diameter of 10 nm suggests an RMW of about 8 nm and climatology suggests about 13 nm. An intensity of 90 kt is selected at 18Z on the 10th because Betsy was moving at about 15 kt and its RMW was smaller than the climatological value. This is a minor intensity change to HURDAT. On August 11th, Betsy continued moving toward the Lesser Antilles while its intensity remained at 90 kt. Crossing the chain of islands occurred late in the day. The tropical cyclone made landfall in the southern end of the

island of Guadeloupe near 16.0N, 61.7W around 1730Z with an intensity of 90 kt. HURDAT originally had a central pressure of 991 mb at 18Z on the 11th but this was not a central pressure as there was never a report of calm by the station. Furthermore, the report of José Colón in 1959 titled "Meteorological Conditions over Puerto Rico during Hurricane Betsy, 1956" indicates that the center of the hurricane passed about 12 miles from the station that reported 991 mb and provides an estimate of 979 mb for the real central pressure at the time of landfall. Therefore, a central pressure of 979 mb is added to 18Z on the 11th. According to the MWR, the damage in Guadeloupe was very severe and winds in the island were estimated between 85 and 105 kt. A ship at 18Z located at 16.8N, 60.5W reported 45kt NE and 1011 mb.

Hurricane Betsy entered the northeast Caribbean Sea late on the 11th while its track turned to the northwest. Moving rapidly, the center of the cyclone passed south of St. Croix early on the 12Z producing gusts of hurricane intensity. Landfall in Puerto Rico occurred near the town of Arroyo at 18.0N, 66.0W around 1230Z. According to the report by José Colón, the town of Guayama recorded a minimum pressure of 983 mb and it was located about 1-2 miles from the point of landfall. José Colón estimated that Betsy had a central pressure near 981 mb at the time of landfall and this central pressure has been added to HURDAT at 12Z on the 12th. A central pressure of 981 mb suggests winds of 76 kt south of 25N according to the pressure-wind relationship. Due to the small size of Betsy and that it was moving at about 21 miles, an intensity of 85 kt is selected for 12Z on the 12th, up from 80 kt in the original HURDAT, a minor change. Minor intensity changes are also introduced at 0Z and 06Z on the 12th. Sustained hurricane-force winds affected a great portion of Puerto Rico. San Juan, on the northeast side of the island, reported sustained winds of 65 kt with gusts to 80 kt at 1235Z. The Ramey Air Force Base, on the northwest side of the island, reported sustained winds of 75 kt with gusts to 100 kt around 16Z on the 12th. The hurricane warnings for Hurricane Betsy were the first to be televised in Puerto Rico. Betsy crossed Puerto Rico diagonally in about 2 and half hours. Late on the 12th, Betsy moved back to the Atlantic en route to the Bahamas. The hurricane passed north of Hispaniola early on the 13th and just north of the Turks and Caicos late on the day. Hurricane Betsy remained under the surveillance of reconnaissance aircraft during its crossing of the northeast Caribbean but only radar fixes were made. At 1350Z on the 13th, a penetration fix measured a central pressure of 972 mb, indicating that Betsy had intensified after leaving Puerto Rico. A central pressure of 972 mb suggests maximum sustained winds of 88 kt south of 25N according to the pressure-wind relationship. Due to the small size of the hurricane, fast forward speed and relatively high environmental pressures, an intensity of 100 kt is selected for 12Z on the 13th, which is a minor change from the original 95 kt in HURDAT. At this time it is analyzed that Betsy reached major hurricane status. Originally HURDAT had a central pressure of 974 mb at 12Z on the 13th, but the report of José Colón indicates that the

central pressure was 972 mb. Therefore, a central pressure of 972 mb is added at 12Z on the 13th. All ships remained away from Betsy on the 13th and no gale-force winds or low pressures were reported on this date. On the 14th, Betsy began to slow down as it approached the western end of the ridge. A ship at 24.6N, 74.7W at 0Z on the 14th reported 65 kt NE and 1012 mb. At 02Z, the island of San Salvador in the Bahamas reported sustained winds of 80 kt with gusts to 104 kt and 985 mb. MWR indicates that the island registered gusts up to 115 kt. MWR also indicates that a central pressure of 960 mb and an eye diameter of 12 nm were measured on August 14th. The Navy book shows that penetration fixes were made on this date at 14Z, 1430Z, 1930Z and 20Z. We don't know which of these fixes made the measurements but for this analysis it will be attributed to the fix at 14Z and a central pressure of 960 mb is added to HURDAT at 12Z. A central pressure of 960 mb suggests maximum sustained winds of 101 kt south of 25N and 102 kt south of 25N intensifying, and 95 kt north of 25N and 100 kt north of 25N intensifying. An eye diameter of 12 nm suggests an RMW of about 10 nm and climatology indicates about 22 nm. Due to the small size of Betsy, an intensity of 105 kt is selected for 12Z on the 14th, up from 95 kt in HURDAT, a minor change in intensity. 100 kt are selected for 0Z and 18Z, and 105 kt for 06Z, all up from 95 kt, a minor intensity change. 105 kt is the peak intensity for the lifetime of this tropical cyclone.

A central pressure of 968 mb is present in HURDAT at 00Z on the 15th and although it was not in the MWR report or the Navy book, it appears to be accurate and it is retained. A central pressure of 968 mb suggests maximum sustained winds of 87 kt north of 25N according to the pressure-wind relationship. HURDAT has 90 kt at 0Z on the 15th and this intensity is retained. At this time is analyzed that Betsy weakened below major hurricane intensity. On the 15th, the track of Betsy turned to the north and later to the northeast. Another central pressure of 963 mb is present in HURDAT at 12Z on the 15th and appears to be accurate, so it is retained. A central pressure of 963 mb suggests maximum sustained winds of 92 kt north of 25N according to the pressure-wind relationship. An intensity of 95 kt is selected for 12Z on the 15th, up from 85 kt originally in HURDAT, a minor intensity change. Various ships got close to Betsy on this date reporting winds up to 50 kt. On the 16th, Betsy began to accelerate to the northeast. Another reconnaissance aircraft reached the storm at 0735Z measuring a central pressure of 973 mb. A central pressure of 973 mb suggests maximum sustained winds of 81 kt north of 25N and 77 kt north of 25N weakening according to the pressure-wind relationship. An intensity of 80 kt is selected for 06Z on the 16th, down from 85 kt originally in HURDAT, a minor change. A central pressure of 973 mb is added to 06Z on the 16th. Minor intensity changes are also introduced at 0Z and 18Z on this date. Ships remained away from the center of Betsy on the 16th. A central pressure of 954 mb appears on HURDAT at 00Z on the 17th and although there was a penetration fix late on the 16th and early on the 17th, there is no report of a central pressure around 00Z on the 17th in

MWR or the Navy book. Nonetheless, it appears to be accurate and it is retained. A central pressure of 954 mb suggests maximum sustained winds of 101 kt south of 25N according to the pressure-wind relationship. An intensity of 100 kt is selected for 00Z on the 17th, making Betsy a major hurricane for the second time. This is also a major change as HURDAT originally had 80 kt at this time. Betsy is analyzed to have weakened below major hurricane intensity at 06Z. No other central pressures were reported and HURDAT suggests that Betsy weakened later on the 17th. The ship data on the 17th suggests that although Betsy increased in size, it remained a small tropical cyclone passing about 250 nm east of North Carolina early on this day. A ship at 15Z passed close to the hurricane measuring 55 kt SE. On the 18th, the track of Betsy turned to the east-northeast and is analyzed to have weakened below hurricane intensity at 12Z. This is six hours later than originally shown in HURDAT. Furthermore, HURDAT has Betsy transitioning to extratropical at 12Z on the 18th but the analysis of the ship data and the symmetry of the storm suggests that Betsy did not become extratropical until 0Z on the 19th, twelve hours later than shown in HURDAT. The last aircraft reconnaissance to reach Betsy occurred at 08Z on the 18th when the hurricane was north of 40N. Betsy moved generally eastward on the 19th and remained an intense and small extratropical cyclone with ships reporting winds up to 55 kt. At the same time, another extratropical cyclone was gaining strength north of Betsy. Betsy is analyzed to have weakened below gale force at 18Z on the 20th and dissipated after 06Z on the 21st becoming absorbed by the larger and intense extratropical cyclone to the northeast.

Tropical Storm Carla [September 7-16, 1956]

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39850 09/05/1956 M= 7  4 SNBR= 867 CARLA       XING=0 SSS=0
39850 09/07/1956 M=10  5 SNBR= 867 CARLA       XING=0 SSS=0
         **        **  *

39855 09/05*  0   0   0    0*210 748  30    0*215 749  35    0*220 751  35    0*
39855 09/05*  0   0   0    0*  0   0   0    0*  0   0   0    0*  0   0   0    0*
                             *   *   *        *   *   *        *   *   *

39860 09/06*225 753  35    0*231 754  35    0*237 754  35    0*242 754  35    0*
39860 09/06*  0   0   0    0*  0   0   0    0*  0   0   0    0*  0   0   0    0*
               *   *   *        *   *   *        *   *   *        *   *   *

39865 09/07*248 753  35    0*254 750  35    0*260 748  35    0*266 745  40    0*
39865 09/07*248 750  30    0*253 750  30    0*260 748  30    0*270 744  30    0*
                ***  **      ***      **                **      ***  ***  **

39870 09/08*273 743  45    0*281 739  45    0*290 733  45    0*299 726  45    0*
39870 09/08*279 740  30    0*287 736  30    0*293 733  35    0*300 730  35    0*
             *** ***  **      ***  ***  **      ***      **      ***  ***  **

39875 09/09*308 719  40    0*316 710  35    0*323 700  35    0*330 688  35    0*
39875 09/09*307 725  40 1003*314 720  40 1002*320 708  45 1000*325 692  55    0*
             *** ***     **** ***  ***  ** **** ***  ***  ** **** ***  ***  **
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39880 09/10*338 670  35  998*347 642  35    0*360 612  35  996*377 587  35    0*
39880 09/10E332 670  55  998E343 642  55    0E356 612  60    0E377 587  60    0*
           ***       **     ****       **     ****       **    **         **

39885 09/11*397 561  30    0*418 530  25    0*440 500  25    0*  0   0   0    0*
39885 09/11E397 561  60    0E418 530  60    0E455 500  55    0E500 450  50    0*
                     **     *          **     ****       **      *** ***  **

(September 12th through 16th are new to HURDAT)
39886 09/12E530 410  50    0E535 380  50    0E545 340  50    0E561 300  50    0*
39887 09/13E578 265  55    0E590 230  60    0E595 190  60    0E605 145  60    0*
39888 09/14E620 095  55    0E640 040  55    0E6603585  55    0E6753530  50    0*
39889 09/15E6853500  50    0E6933470  50    0E7023453  50    0E7103443  45    0*
39890 09/16E7203440  40    0E7303440  35    0*  0   0   0    0*  0   0   0    0*

39895 TS
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Minor changes to the track and major changes to the intensity shown in McAdie et al. (2009). Two additional major changes are to remove the first two days of its existence and adding an extratropical stage seven days (with five of those being new to HURDAT). Evidence for these alterations comes from the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Navy reconnaissance book and Monthly Weather Review.

September 4:

HWM analyzes a trough of low pressure at 75W at 12Z. Microfilm does not show an organized system at 12Z. HURDAT does not list a tropical cyclone on this day. No gales or low pressures. “A brief review of the history of Carla indicates that this storm was of tropical origin, but acquired gale and storm intensity. However, because of the rapid increase in intensity to storm force on the 9th, it was agreed upon by the members of the Joint Hurricane Warning Service to issue numbered warnings as Tropical Storm Carla, even though the true characteristics of the storm were debatable at this time. Only three numbered warnings were issued, the first at 092230Z and the final warning at 101000Z.” (ATSR)

September 5:

HWM analyzes a trough of low pressure at 78W at 12Z. Microfilm does not show an organized system at 12Z. HURDAT lists this as a 35 kt tropical storm at 21.5N, 74.9W at 12Z. No gales or low pressures. “The first indication of Carla appeared on September 5 when a weak circulation showed up in an easterly wave which was moving into the southeastern Bahamas.” (MWR)

September 6:

HWM does not analyze an organized system at 12Z. HURDAT lists this as a 35 knot tropical storm at 23.7N, 75.4W at 12Z. Microfilm shows a closed low pressure of at most 1011 mb centered near 24.5N, 75.5W at 12Z. No gales or low pressures. “As early as the 6th of September, it was noted that an incipient tropical depression was located over the Bahamas, with the formation taking place in semi-stationary weak low pressure trough extending aloft through the 200 mb level.” (ATSR)

September 7:

HWM analyzes a spot low centered near 25.7N, 74.5W at 12Z. HURDAT lists this as a 35 kt tropical storm at 26.0N, 74.8W at 12Z. Microfilm shows a closed low pressure of at most 1008 mb centered near 26.0N, 76.0W at 12Z. No gales or low pressures. “During the next several days it moved on a parabolic course and on the 7th recurved northeastward with some deepening and the area of strong winds expanded to cover an area 300 to 400 miles in diameter. A strong southeastward outbreak of polar air was taking place in the eastern and central United States and the accompanying cold front passed off the coast during the morning of the 7th.” (MWR) “Early movement of the weak depression along an oscillatory northerly track at 7 to 10 kt followed by a recurvature to the northeast after 071010Z. Continues northeast to east-northeast movement with a gradual acceleration to 25 to 30 kt was observed iin the latter potion of the life cycle of Carla. This northeastward movement and accelerated speed was produced by the upper level trough in the westerlies moving eastward across the track of Carla. An important synoptic feature, which was later to affect the development of Carla into a storm was the cold front moving off the southeastern coast of the United States on the 7th of September.” (ATSR)

September 8:

HWM analyzes a closed low pressure of at most 1010 mb centered near 31.0N, 73.0W at 12Z. HURDAT lists this as a 45 kt tropical storm at 29.0N, 73.3W at 12Z. Microfilm shows a closed low pressure of at most 1008 mb centered near 29.0N, 73.5W at 12Z. Ship highlights: 35 kt SE and 1012 mb at 31.2N, 70.8W at 12Z (COADS). 35 kt SE and 1012 mb at 30.6N, 70.2W at 18Z (micro). “On the 8th interaction between the high with central pressure 1034 mb over the Lakes Region and the tropical Low off the southeastern United States coast was causing strong northeast winds from the central Florida coast northward along and off Georgia and Carolina coasts.” (MWR) “The exact time in which the front moved into Carla and changed her characteristics to extratropical is difficult to determine, but it is believed that it took place sometimes between late on

the 8th and early on the 9th of September. This coincided with the increase in intensity to gale force." (ATSR)

September 9:

HWM analyzes a closed low pressure of at most 1000 mb centered near 32.0N, 71.0W at 12Z. HURDAT lists this as a 35 kt tropical storm at 32.3N, 70.0W at 12Z. Microfilm shows a closed low pressure of at most 1005 mb centered near 32.0N, 70.0W at 12Z. Ship highlights: 20 kt NE and 1005 mb at 31.2N, 72.6W at 00Z (COADS). 10 kt WSW and 1003 mb at 31.0N, 71.8W at 06Z (COADS). 15 kt S and 1001 mb at 31.9N, 70.5W at 12Z (COADS). 40 kt SSW and 996 mb at 32.3N, 69.1W at 16Z (micro). 50 kt N and 1000 mb at 32.3N, 70.0W at 18Z (micro). Aircraft highlights: Penetration fix measured 40 kt at 32.1N, 69.5W at 1445Z (ATSR). Penetration fix at 33.1N, 68.6W at 20Z (ATSR). "Gales spread to the New England coast as the Low moved to a position near Lat. 32.5º N., Long. 70º W. by the morning of the 9th. Reconnaissance aircraft on the morning of the 9th located an ill-defined center but reported no eye existed and no spiral bands were in evidence. Highest surface winds near the center were estimated at 30 knots. However, 40 to 50 mph winds were found extending 200 miles to the west and northwest and 40 mph winds some distance to the east and south. During the period of greatest intensity, the storm was probably not a true tropical storm." (MWR) "Further intensification to storm force followed later on the 9th as deepening took place. With respect to determining the true characteristics of Carla it is interesting to note the remarks of the Air Force weather reconnaissance reports on the 9th and 10th of September. The track of Carla was entirely over the open water of the Atlantic when storm intensity was reached and no damage was reported." (ATSR)

September 10:

HWM analyzes a tropical storm of at most 1000 mb centered near 39.8N, 58.2W with a warm front extending to the northeast and another low pressure of at most 1000 mb centered at 35.0N, 63.5W with a cold front extending to the south at 12Z. HURDAT lists this as a 35 kt tropical storm at 36.0N, 61.2W at 12Z. Microfilm shows a closed low pressure of at most 993 mb centered near 36.0N, 62.0W with a cold front extending to the southwest at 12Z. Ship highlights: 35 kt NE and 1004 mb at 34.6N, 67.0W at 0Z (COADS). 20 kt N and 997 mb at 33.3N, 65.5W at 6Z (COADS). 60 kt SSW and 992 mb at 35.3N, 61.1W at 12Z (micro). 50 kt NNE and 1000 mb at 40.0N, 57.0W at 18Z (micro). Aircraft highlights: Penetration fix at 35.3N, 61.7W at 1230Z (ATSR). Penetration fix at 36.4N, 61.5W at 1530Z (ATSR). "It has definitely taken on extratropical characteristics by the forenoon of the 10th and only three advisories were issued." (MWR)

September 11:

HWM analyzes an extratropical system of at most 990 mb centered near 47.0N, 49.0W with a warm front extending to the northeast and a cold front extending to the south at 12Z. HURDAT lists this as a 25 kt tropical depression at 44.0N, 50.0W at 12Z (last position). Microfilm shows a closed low pressure of at most 1002 mb centered near 45.0N, 50.0W with a cold front extending to the southwest at 12Z. Ship highlights: 60 kt SE at 39.9N, 55.5W at 0Z (micro). 60 kt S and 998 mb at 39.5N, 53.0W at 06Z (micro). 40 kt NNE and 993 mb at 47.4N, 50.4W at 12Z (COADS). 40 kt N and 997 mb at 48.0N, 48.7W at 18Z (COADS).

September 12:

HWM analyzes an extratropical system of at most 1000 mb centered near 53.5N, 37.0W with a warm front extending to the northeast and a cold front extending to the south at 12Z. Microfilm shows a closed low pressure of at most 1011 mb centered near 54.5N, 35.0W with a cold front extending to the south at 12Z. HURDAT does not list this system on this date. Ship highlights: 35 kt NNW and 1002 mb at 48.5N, 46.8W at 00Z (COADS). 45 kt SW and 1015 mb at 47.9N, 33.3W at 18Z (COADS).

September 13:

HWM analyzes an extratropical system of at most 985 mb centered near 60.0N, 19.0W with a warm front extending to the northeast and a cold front extending to the south at 12Z. HURDAT does not list this system on this date. Microfilm is not available on this date. Ship highlights: 20 kt SSW and 996 mb at 59.0N, 19.7W at 0Z (COADS). 35 kt SW and 1013 mb at 52.6N, 19.2W at 09Z (COADS). 10 kt S and 986 mb at 59.1N, 19.7W at 12Z (COADS). 60 kt NW and 992 mb at 59.0N, 19.5W at 15Z (COADS). 50 kt W and 1000 mb at 57.6N, 15.4W at 18Z (COADS).

September 14:

HWM analyzes an extratropical system of at most 985 mb centered near 65.0N, 2.0E with a warm front extending to the northeast and a cold front extending to the south at 12Z. HURDAT does not list this system on this date. Microfilm is not available on this date. Ship highlights: 35 kt ESE and 995 mb at 65.9N, 2.1E at 03Z (COADS). 45 kt W and 1010 mb at 58.0N, 0.0W at 07Z (COADS). 15 kt SSE and 982 mb at 66.0N, 2.3E at 12Z (COADS). 50 kt NW and 990 mb at 66.0N, 1.8E at 17Z (COADS). 50 kt W and 1005 mb at 64.0N, 6.0E at 21Z (COADS). Land highlights: 35 kt SW and 995 mb at Hustad, Norway [63.0N, 7.1E] at 12Z (micro). 35 kt NW and 1013 mb at Shetland Island, England [60.3N, 1.3W] at 12Z (micro).

September 15:

HWM analyzes an extratropical system of at most 990 mb centered near 70.0N, 13.0E with a dissipating front to the east and southeast at 12Z. HURDAT does not list this system on this date. Microfilm is not available on this date. Ship highlights: 50 kt NW and 990 mb at 65.0N, 8.0E at 0Z (COADS). 10 kt SE and 988 mb at 68.0N, 13.0E at 06Z (COADS). 50 kt WNW and 998 mb at 67.0N, 9.0E at 12Z (COADS). 35 kt WW and 1003 mb at 67.0N, 10.0E at 18Z (COADS). Land highlights: 10 kt SW and 993 mb at Tromso, Norway [69.7N, 18.9E] at 12Z (micro). 35 kt W and 992 mb at Rost, Norway [67.5N, 12.1E] at 12Z (micro).

September 16:

HWM analyzes a closed low pressure of at most 1000 mb centered near 74.5N, 10.0E at 12Z. HURDAT does not list this system on this date. Microfilm is not available on this date. Ship highlights: 15 kt E and 996 mb at 73.0N, 17.0E at 0Z (COADS). 10 kt SE and 997 mb at 74.0N, 16.0E at 12Z (COADS). Land highlights: 10 kt SE and 998 mb at Bear Island, Norway [74.5N, 19.0E] at 12Z (micro).

September 17:

HWM analyzes a closed low pressure of at most 1000 mb centered near 78.0N, 20.0E at 12Z. HURDAT does not list this system on this date. Microfilm is not available on this date. Ship highlights: 25 kt W and 1004 mb at 74.1N, 15.9E at 08Z (COADS). Land highlights: 10 kt WNW and 998 mb at Svalbard, Norway [78.0N, 16.0E] at 12Z (micro).

September 18:

HWM analyzes a closed low pressure of at most 990 mb centered near 78.0N, 12.0E at 12Z. HURDAT does not list this system on this date. Microfilm is not available on this date. Ship highlights: 35 kt SW and 1005 mb at 71.0N, 27.0E at 10Z (COADS). Land highlights: 10 kt SE and 990 mb at Svalbard, Norway [78.0N, 16.0E] at 12Z (micro).

September 19:

HWM analyzes a closed low pressure of at most 995 mb centered near 75.0N, 37.0E at 12Z. HURDAT does not list this system on this date. Microfilm is not available on this date. Ship highlights: 35 kt W and 1005 mb at 70.0N, 32.0E at 09Z (COADS). Land highlights: 10 kt SE and 998 mb at Hopen, Norway [76.6N, 25.1E] at 12Z (micro).

September 20:

HWM analyzes a closed low pressure of at most 995 mb centered near 70.0N, 51.0E at 12Z. HURDAT does not list this system on this date. Microfilm is not available on this date. Ship highlights: 30 kt NW and 994 mb at 70.8N, 45.0E at 12Z (COADS). Land highlights: 10 kt SE and 998 mb at Hopen, Norway [76.6N, 25.1E] at 12Z (micro).

A tropical disturbance reached the Bahamas during the first days of September while moving slowly toward the northwest. A well-defined center slowly became better organized and a 30 kt tropical depression developed at 00Z on September 7th just north of the central Bahamas. This time of genesis is 42 hours later than originally shown in HURDAT. Data from the Bahamas and ships indicate that a well-defined center was not present on September 5th and 6th. Furthermore, no low pressures or gales were reported on these days, but the environmental pressure did decrease about two mb in the 24 hours before genesis. Minor track changes were introduced for the duration of this system. The depression moved north-northeast after formation while becoming better organized.

Intensification to a tropical storm is analyzed at 12Z on September 8th, 72 hours later than originally shown in HURDAT. The first gale was reported at 12Z on the 8th, a ship located at 31.2N, 70.8W reported 35 kt. On September 9th, Carla began to feel the effects of an approaching frontal boundary from the west and its track turned to the northeast while gaining in forward speed. A ship located at 31.2N, 72.6W at 00Z on the 9th reported 20 kt NE and 1005 mb. It is analyzed that this ship was inside the RMW of the tropical storm, resulting in an estimated central pressure of 1003 mb. A central pressure of 1003 mb has been added to 00Z on September 9th. A central pressure of 1003 mb suggests maximum sustained winds of 38 kt north of 25N from the Brown et al. pressure-wind relationship. An intensity of 40 kt is selected for 00Z on the 9th. Another ship located at 31.0N, 71.8W at 06Z on the 9th reported 10 kt WSW and 1003 mb, resulting in an estimated central pressure of 1002 mb. A central pressure of 1002 mb has been added to 06Z on September 9th. An intensity of 40 kt has been selected for 06Z on the 9th. At 12Z on the 9th, a ship reported 15 kt S and 1001 mb at 31.9N, 70.5W, resulting in an estimated central pressure of 1000 mb. A central pressure of 1000 mb has been added to 12Z on September 9th. A central pressure of 1000 mb suggests maximum sustained winds of 44 kt north of 25N according to the pressure-wind relationship. An intensity of 45 kt has been selected for 12Z on the 9th, up from 35 kt originally in HURDAT. The first aircraft reconnaissance to reach Carla occurred on September 9th at 1445Z measuring estimated surface winds of 40 kt and making a center fix at 32.1N, 69.5W. At 18Z, a ship located at 32.3N, 70.0W reported 50 kt N and 1000 mb. An intensity of 55 kt has been selected for 18Z on the 9th, up from 35 kt originally in HURDAT, a major intensity change. This is also the peak intensity for Carla as a tropical cyclone, up from 45 kt

originally in HURDAT. (HURDAT indicated that the peak intensity of this tropical cyclone occurred between 00Z to 18Z on September 8th.)

HURDAT indicates that Carla remained a tropical cyclone for all of its lifetime, but ship data indicates that the Carla became an extratropical cyclone around 00Z on the 10th. At this time, the circulation became elongated NE-SW with a warm front to the northeast and a cold front to the southwest of the center. A prominent temperature gradient is noticeable on the ship data on the 10th and the strongest winds are located about 250 nm from the center, mainly to the north and west. A central pressure of 998 mb is present in HURDAT at 00Z on the 10th, and although there is no data to confirm it was an observation, it appears reasonable and it is retained. Two aircraft reconnaissance reported center fixes at 35.3N, 61.7W at 1230Z and 36.4N, 61.5W at 1530Z on the 10th. A central pressure of 996 mb is present in HURDAT at 12Z on the 10th and it has been removed because ship data indicates that the central pressure was lower at this time, likely in the 980s mb range. A ship reported 60 kt SSW and 992 mb at 12Z on the 10th. An intensity of 60 kt has been selected for 12Z on the 10th, up from 35 kt in HURDAT, a major intensity change to HURDAT. Major changes in intensity are also analyzed at 06Z and 18Z on the 10th. 55 kt and 60 kt, respectively are analyzed, while HURDAT has 35 kt for both times. Around midday on the 11th, Carla passed about 200 nm east of Newfoundland while heading on a northeast course. HURDAT weakens Carla to a 30 kt tropical depression at 00Z on the 11th but ship data suggests that the system was a powerful extratropical cyclone at this time with winds around 60 kt. A major change in intensity to HURDAT. The last position in HURDAT is at 12Z on September 11th as a 25 kt tropical depression at 44N, 50W. Ship data indicates that Carla was a 55 kt extratropical cyclone at this time and this is a major change in intensity to HURDAT. Over the next five days, Carla continued toward the northeast passing southeast of Iceland on September 13th. On September 16th at 06Z, while located north of Norway near 73.0N, 16.0E, Carla dissipated as it merged with another extratropical low pressure system.

Tropical Storm Dora [September 10-13, 1956]

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39895 09/10/1956 M= 3  5 SNBR= 868 DORA        XING=0 SSS=0
39895 09/10/1956 M= 4  6 SNBR= 868 DORA        XING=0 SSS=0
                     *  *

39900 09/10*  0   0   0    0*205 911  35    0*208 921  45    0*211 930  50    0*
39900 09/10*  0   0   0    0*205 911  30    0*208 921  35    0*211 930  35 1010*
                                      **                **                ** ****

39905 09/11*213 938  55    0*215 944  55    0*216 950  60 1001*215 955  60 1004*
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39905 09/11*213 938  40    0*215 944  40    0*217 950  45    0*217 955  45 1004*
                     **                 **      ***      **     * ***      **

39910 09/12*214 960  60 1004*213 964  60    0*211 968  50 1004*208 974  30 1002*
39910 09/12*215 959  45    0*213 963  50    0*211 968  50 1004*209 973  50 1000*
            *** ***  **    *     ***  **                        *** ***  ** ****

(September 13th is new to HURDAT)
39911 09/13*207 978  25    0*  0   0   0    0*  0   0   0    0*  0   0   0    0*
            *** ***  **

39915 TS
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Minor changes to the track and major changes to the intensity shown in McAdie et al. (2009). Evidence for these alterations comes from the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Monthly Weather Review, Connor (1956) and Mexican synoptic maps.

September 9:

HWM analyzes a closed low pressure of at most 1015 mb at 18.5N, 88.5W at 12Z. HURDAT does not list an organized system on this date. Microfilm shows a closed low pressure of at most 1011 mb at 18.5N, 93.0W at 12Z. Ship highlights: No gales or low pressures. “As early as 071230Z a weak vortex was detected over the Yucatan Peninsula. By 9 September the vortex, moving in a westerly direction, had moved off the west coast of the Yucatan Peninsula over the warm waters of the Gulf of Campeche. A low level investigative flight was ordered for the afternoon of the 9th of September to investigate the Gulf of Campeche. The Navy post-flight summary from the 9 September flight showed minimum pressure of 1011 mb, maximum observed surface winds of seven knots, and evidence of a wind circulation but inability to determine the exact center due to the large calm central area. (ATSR)

September 10:

HWM analyzes a closed low pressure of at most 1010 mb at 21.5N, 96.5W at 12Z. HURDAT lists this as a 45 knot tropical storm at 20.8N, 92.1W at 12Z. Microfilm shows a closed low pressure of at most 1011 mb at 21.2N, 94.1W at 12Z. Ship highlights: No gales or low pressures. “Navy reconnaissance during the previous afternoon [Sep 10] found a rather large area in the Bay of Campeche with scattered squalls. The lowest pressure was 1010 mb and the maximum wind 35 knots.” (MWR) “As is frequent in this area, few ship reports were received. A second low level flight was flown on 10 September. The reports showed a minimum surface pressure of 1010 mb, maximum surface winds of 35 knots in squalls and the area characterized by isolated squalls and low stratiform clouds. No “eye” was discernible at this time.” (ATSR)

September 11:

HWM analyzes a closed low pressure of at most 1010 mb at 22.5N, 95.5W at 12Z. HURDAT lists this as a 60 knot tropical storm at 21.6N, 95.0W at 12Z. Microfilm shows a closed low pressure of at most 1011 mb at 22.0N, 94.5W at 12Z. Ship highlights: No gales or low pressures. Aircraft highlights: Penetration fix at 22.1N, 95.4W at 1627Z (ATSR). Penetration fix estimated surface winds of 65 kt and a central pressure of 1004 mb at 21.6N, 95.8W at 1950Z (ATSR/micro). "A tropical storm formed during the afternoon of September 11 in the southwest Gulf of Mexico in a depression that has been drifting westward. On the 11th, aircraft reconnaissance found the lowest pressure to be 1004 mb and the maximum wind 65 knots. This storm has not been classified as a hurricane since the 65-knot wind was an estimate and not a measurement, and it is not believed that the required pressure gradient for this speed existed." (MWR) "Two flights were flown on the 11th of September; one by the Navy and the other by an Air Force Research aircraft. At 111950Z the Navy low level flight located the center of the wind circulation. The minimum surface winds were 60 knots in the northeast quadrant. The center of circulation could not be defined by the weather bands. The Air Force Research flight at higher levels located a wind circulation and again the radar bands showed a strong cyclonic curvature but did not define an "eye." From the wind reports it was decided to issue Warning Number ONE of Tropical Storm Dora at 112200Z." Dora, upon leaving the Yucatan Peninsula, had maintained a west to west-northwest course and accelerated until it reached its most northward position of 21.7N, maximum speed of 9 knots and maximum intensity of 60 knots at about 111900Z. Until this time, Dora had been under the influence of the anticyclonic circulation at the 200 mb level but a trough at 200 mb oriented northeast-southwest over Mexico and central United States moving eastward forced the high cell over Dora to move eastward. As the trough approached, Dora reached maximum intensity and moved more northwestward. With the passage of the trough, Dora was under the convergent and more northeastly flow, causing a decrease in intensity and a movement toward the southwest to west-southwest." (ATSR)

September 12:

HWM analyzes a tropical storm of at most 1005 mb at 21.2N, 96.5W at 12Z. HURDAT lists this as a 50 knot tropical storm at 21.1N, 96.8W at 12Z. Microfilm shows a closed low pressure of at most 1002 mb at 20.8N, 97.0W at 12Z. Ship highlights: 35 kt N and 1010 mb at 21.7N, 97.1W at 00Z (micro). 30 kt NE and 1003 mb at 21.1N, 96.5W at 06Z (micro). 40 kt SW and 1005 mb at 20.7N, 96.2W at 09Z (micro). Land highlights: 10 kt W and 1005 mb at Tuxpan, Mexico [21.0N, 97.4W] at 12Z (micro). 10 kt N and 1002 mb at Tuxpan, Mexico [21.0N, 97.4W] at 18Z (micro).Aircraft highlights: Penetration fix estimated surface winds of 50 kt, central pressure of 1004 mb, and an eye diameter of 8 nm at 21.6N, 95.8W at 1235Z (ATSR/micro). "The next morning the minimum pressure was the same and maximum winds were 50 knots. The center moved

inland around noon near Tuxpan, Mexico with lowest pressure 1002 mb and highest wind 30 knots." (MWR) "A fifth flight was ordered 12 September before Dora entered the Mexican coast. The Navy flight at low level located and reported the center of the wind circulation 32 miles east-northeast of Tuxpan, Mexico, with a minimum surface pressure of 1004 mb and maximum wind of 50 knots. Warning Number FOUR at 121600Z was the final warning issued. At 121700Z, Dora entered the Mexican coast just south of Tuxpan where maximum winds of 30 knots ans slight flooding was reported." (ATSR)

September 13:

HWM analyzes a spot low at 21.2N, 102.0W at 12Z. HURDAT does not list an organized system on this date (last position at 18Z on the 12th). Microfilm shows a spot low at 19.5N, 99.0W at 12Z. Ship highlights: No gales or low pressures.

Tropical Storm Dora formed over the eastern Bay of Campeche on the 10th of September likely from a tropical wave. The genesis of this cyclone is unchanged from the original HURDAT at 06Z on the 10th of September, but the intensity is decreased from 35 to 30 knots, a minor change. The reason for this is because the system started about 40 nm from the western Yucatan coast and the strongest winds would have been located on the eastern quadrant, which was partially over land and is consistent with the few available observations. Ship and land reports were sparse over the Bay of Campeche and the genesis time is bit uncertain. Intensification to tropical storm is delayed six hours from the original HURDAT to 12Z on the 10th. A reconnaissance aircraft reached Dora in the afternoon of the 11th measuring a central pressure of 1010 mb and estimated surface winds of 35 knots. No center position was reported but the data from the plane at 18Z on the 11th on the microfilm map does suggest that a closed circulation was present. A 1010 mb central pressure has been added to 18Z on the 10th based on the reconnaissance report. The intensity at 12Z and 18Z on the 10th is analyzed at 35 kt, down from 45 kt and 50 kt, respectively, originally in HURDAT. Both changes are minor. No track changes are introduced on the 10th of September as Dora was moving on a west-northwest course and slowly decreasing in speed.

On September 11th, a reconnaissance aircraft reached Dora at 1627Z but only reported a fix position. The next fix at 1950Z on this day reported a central pressure of 1004 mb and estimated surface winds of 65 knots. A central pressure of 1004 mb suggests maximum winds of 39 kt south of 25N from the Brown et al. pressure-wind relationship. An intensity of 45 kt was selected for 18Z on the 11th because Dora was a small system with 30 kt winds only extending about 50-60 nm away from the center according to the reconnaissance report. A central pressure of 1001 mb was present at 12Z on the original HURDAT and has been removed since there is no evidence to suggest it was an actual observation and is not consistent with what was observed a few hours later. The intensity

at 00Z, 06Z and 12Z on the 11th is selected to be 40 kt, 40 kt and 45 kt, respectively (down from 55 kt, 55 kt, and 60 kt, respectively, originally in HURDAT, a minor change). Minor track changes are introduced at 12Z and 18Z on the 11th based on the center fixes made by the reconnaissance missions. The only ship to report tropical storm force winds was the S.S Atzacapotzalco early on the 12th of September as it was moving away from the western coast of the Bay of Campeche. At 06Z on the 12th it reported 30kt NE and 1003 mb. A peripheral pressure of 1003 mb suggests winds greater than 41 kt south of 25N according to the pressure-wind relationship. If we assume that the ship was inside the RMW of Dora, this would suggest a central pressure of 1000 mb (but not certain enough to add this value in to HURDAT). A central pressure of 1000 mb yields maximum winds at or greater than 47 kt south of 25N according to the pressure-wind relationship. An intensity of 50 kt is selected for 06Z on the 12th based on this data and on the small size of the cyclone. HURDAT originally had 60 kt at 06Z, thus the reduction is a minor change. A central pressure of 1004 mb is present at 00Z on the 12th but there is no data to suggest that this is a measurement and it is not consistent with the ship measurements, so it has been removed. The intensity at 00Z on the 12th is analyzed at 45 kt, down from 60 kt in the original HURDAT, a minor change. The final aircraft reconnaissance reached Dora at 1235Z on the 12th measuring a central pressure of 1004 mb, estimated surface winds of 50 kt, and reported a tiny eye diameter of 8 nm. A central pressure of 1004 mb suggests maximum sustained winds of 39 kt south of 25N according to the pressure-wind relationship. The eye diameter suggests an RMW of about 6 nm and climatology suggests about 16 nm. Due to the small size of the storm, the intensity is kept at 50 kt for 12Z on the 12th, down from 60 kt originally in HURDAT. Dora moved generally west-southwest on the 12th and the analyzed track on this day shows minor changes. Landfall occurred around 18Z on the 12th around 5 nm south of Tuxpan, Mexico as a 50 kt tropical storm, up from 30 kt originally in HURDAT, a major change. A central pressure of 1002 mb was in HURDAT at 18Z on the 12th but Tuxpan at this time reported 10 kt N and 1002 mb, suggesting that the measurement was not in the center and that the central pressure of the cyclone was likely around 1000 mb. Therefore, a central pressure of 1000 mb had been added at 18Z on the 12th replacing the original 1002 mb in HURDAT. Dora quickly lost organization over the mountainous terrain of Mexico but a circulation was still present at 00Z on the 13th extending its lifetime six hours from original HURDAT. At this time it is analyzed that the system had weakened to a 25 kt tropical depression. Dissipation occurred after 00Z on the 13th.

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39920 09/11/1956 M= 4  6 SNBR= 869 ETHEL       XING=0 SSS=0
39920 09/11/1956 M= 4  7 SNBR= 869 ETHEL       XING=0 SSS=0
                       *

39925 09/11*  0   0   0    0*  0   0   0    0*  0   0   0    0*229 750  25    0*
39925 09/11*  0   0   0    0*  0   0   0    0*  0   0   0    0*235 757  25    0*
                                                          *** ***

39930 09/12*237 750  30    0*245 747  30    0*254 743  40    0*264 736  60    0*
39930 09/12*240 755  30    0*248 749  35    0*257 741  40    0*266 732  50  999*
           *** ***          *** ***  **      *** ***          *** ***  **

39935 09/13*273 727  60  999*278 723  55    0*283 718  50 1007*289 711  40    0*
39935 09/13*273 727  50    0*278 723  45    0*282 720  35 1007*286 718  35    0*
                  **                 **      *** ***  **       *** ***  **

39940 09/14*296 700  35    0*  0   0   0    0*  0   0   0    0*  0   0   0    0*
39940 09/14*290 717  30    0*294 717  25    0*  0   0   0    0*  0   0   0    0*
           *** ***  **       *** ***  **

39945 TS
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Minor track and intensity changes shown in McAdie et al. (2009). Evidence for these alterations comes from the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Navy reconnaissance book and Monthly Weather Review.

September 10:

HWM analyzes a stationary cold front over the central Bahamas at 12Z. HURDAT does not list an organized system on this date. Microfilm does not show an organized system on this date. Ship highlights: No gales or low pressures. “Tropical Storm Ethel is another storm pecular to the 1956 season in that its tropical characteristics were not clearly defined. In the frontal trough left in the wake of Carla, a very small and weak vortex or wave formation was noticed on the 10th of September over the Bahamas. During the next two days the low moved northeasterly only slight to moderate intensification as indicated by the synoptic reports.” (ATSR)

September 11:

HWM analyzes a weakening frontal boundary over the central Bahamas at 12Z. HURDAT lists this as a 25 knot tropical depression at 22.9N, 75.0W at 18Z (first advisory). Microfilm shows a closed low pressure of at most 1011 mb at 23.5N, 77.0W at 12Z. Ship highlights: No gales or low pressures. “At 1330 EST September 11, a weak circulation was noted over Great Exuma Island is the Bahamas, about 100 miles south of a quasi-stationary front.” (MWR)

September 12:

HWM analyzes a closed low pressure of at most 1010 mb at 25.5N, 74.0W at 12Z. HURDAT lists this as a 40 knot tropical storm at 25.4N, 74.3W at 12Z. Microfilm shows a closed low pressure of at most 1008 mb at 25.5N, 74.5W at 12Z. Ship highlights: 40 kt NE and 1001 mb at 26.7N, 73.3W at 18Z (micro). Aircraft highlight: Penetration center fix estimated surface winds of 66 kt, central pressure of 999 mb, and an eye diameter of 20 nm at 27.2N, 73.2W at 2030Z (ATSR). "During the next 24 hours the tropical depression moved north-northeastward and gradually intensified. On the afternoon of the 12th, research aircraft reconnaissance entered the storm and found a well-developed eye about 20 miles in diameter and entirely surrounded by a typical wall could extending upward about 30,000 feet. A maximum wind of 66 knots was encountered while entering the eye over a distance of some 3 miles in the northeastern quadrant. Thirty-knot winds extended outward 30 to 100 miles in all directions but no hurricane winds were found in any other quadrant." (MWR) "Unlike Carla, Ethel was of extratropical origin but possibly gained and then lost her tropical characteristics on the 12th of September. An Air Force Research reconnaissance aircraft departed West Palm Beach, Florida, on the 12th of September to investigate the low which was then just north of the Bahamas. The aircraft reported locating an "eye" with a diameter of 20 miles, minimum surface pressure of 999 mb, and maximum winds of 66 knots in a squall band within three miles of the center (by post-analysis it is believed that this wind was measured at the flight level of the aircraft which was near 700 mb). The small and comparatively weak surface wind field reported by ship and island reports did not indicate that the storm had winds of much more than forty knots in squalls and no more than twenty-five knots of wind as a rule. The night reconnaissance reports received from the Navy reconnaissance aircraft indicated that Ethel was evidently rapidly filling and losing any possible tropical characteristics." (ATSR)

September 13:

HWM analyzes a closed low pressure of at most 1010 mb at 29.0N, 70.0W with a stationary cold front extending to the northeast at 12Z. HURDAT lists this as a 50 knot tropical storm at 28.3N, 71.8W at 12Z. Microfilm shows a closed low pressure of at most 1008 mb at 28.2N, 72.3W at 12Z. Ship highlights: 35 kt E and 1008 mb at 27.7N, 73.4W at 00Z (micro). 35 kt NW and 1007 mb at 27.9N, 72.4W at 18Z (micro). Penetration center fix estimated surface winds of 40 kt, central pressure of 1007 mb, and an eye diameter of 30 nm at 28.5N, 71.9W at 1110Z (ATSR). Penetration center fix at 28.1N, 72.2W at 1433Z (ATSR). "By late on the 13th, the storm had assumed extratropical characteristics and lost intensity. It is thought that the storm may have developed strongly for a short time as a new source of energy in the form of cold air entered the system. If the research plane had not flown into the storm on the 12th, no advisories would have been issued and it would not have been listed as a tropical storm." (MWR) "Based on the

reports from the reconnaissance aircraft, Warning Number ONE was 130100Z on Tropical Storm Ethel. After a 700 mb level penetration of the center during the early morning of the 13th of September, the Navy reconnaissance aircraft descended to 500 feet in the center and observed a minimum surface pressure of 1007 mb, a 30 mile diameter of the wind circulation and maximum surface winds of 40 knots. Warning Number THREE was the final warning issued on Ethel at 131000Z. All information available revealed that further weakening was taking place." (ATSR)

September 14:

HWM analyzes a closed low pressure of at most 1015 mb at 31.0N, 70.0W with a stationary cold front extending to the northeast at 12Z. HURDAT lists this as a 35 knot tropical storm at 29.6N, 70.0W at 00Z (last advisory). Microfilm shows a closed low pressure of at most 1014 mb at 29.5N, 72.0W at 06Z. Ship highlights: No gales or low pressures.

September 15:

HWM analyzes a trough over the northwest Bahamas extending northeast toward a weakening cold front, no organized system is depicted at 12Z. HURDAT do not list an organized system on this date. Microfilm shows a closed low pressure of 1014 mb at 29.5N, 72.8W at 00Z. Ship highlights: No gales or low pressures.

A frontal boundary moved off the eastern seaboard of the United States during the first week of September absorbing Tropical Storm Carla. The tail-end of the frontal system reached the Bahamas where a low pressure developed around September 11. A 25-kt tropical depression formed around 18Z on September 11, this is the time of genesis and in agreement with the original HURDAT. Minor track changes were introduced for the duration of this system with the most significant change made early on the 14th to west-southwest near the end of the system's lifetime. The tropical depression started moving north-northeast to northeast while increasing in forward speed. Intensification to tropical storm is analyzed to have occurred at 06Z on the 12th, six hours earlier than originally shown in HURDAT. No gales were reported early on the 12th but HURDAT shows an intensification from 30 kt at 06Z to 40 kt at 12Z on the 12th and there is no data to support this rapid increase in intensity. Thus, the reanalysis shows a gradual increase in intensity. The first gale-force wind is reported at 18Z on the 12th. 40 kt and 1001 mb were reported by a ship located at 26.7N, 73.3W. A peripheral central pressure of 1001 mb suggests maximum sustained winds greater than 42 kt south of 25N from the Brown et al. pressure-wind relationship. Also, the first aircraft reconnaissance to reach the storm occurred at 2030Z on the 12th measuring a central pressure of 999 mb, estimated surface winds of 66 kt and a 20 nm eye diameter. A central pressure of 999 mb suggests

maximum sustained winds of 45 kt south of 25N according to the pressure-wind relationship. An eye diameter of 20 nm suggests an RMW of about 15 nm and climatology indicates 22 nm. Due to the small size of Ethel and based on the data from the ship and reconnaissance aircraft, an intensity of 50 kt is selected for 18Z on the 12th, down from 60 kt originally in HURDAT. A central pressure of 999 mb was present in HURDAT at 00Z on the 13th and has been moved to 18Z on the 12th in agreement with the reconnaissance report. An intensity of 50 kt is also analyzed at 00Z on the 13th, down from 60 kt originally in HURDAT. 50 kt is analyzed as the peak intensity for the lifetime of Tropical Storm Ethel, down from 60 kt originally in HURDAT.

On September 13th, Ethel began to weaken while moving at a slower speed. A reconnaissance aircraft reached the storm at 1110Z on the 13th measuring a central pressure of only 1007 mb, estimated surface winds of 40 kt and a 30 nm diameter of the wind circulation (~15 nm RMW). A central pressure of 1007 mb suggests 30 kt north of 25N according to the pressure-wind relationship. An intensity of 35 kt is selected for 12Z on the 14th, down from 50 kt originally in HURDAT. The last gale was reported at 18Z on the 14th. Ethel is analyzed to have weakened to a tropical depression at 00Z on the 14th. HURDAT originally does not show Ethel weakening to a tropical depression and the intensity is 35 kt in the last position at 00Z on the 14th. The system continued to lose intensity on the 14th and weakened to a trough of low pressure after 06Z. Dissipation is six hours later than originally shown in HURDAT. The trough of low pressure continued over the western Atlantic for another 48 hours, finally dissipating on September 16. HWM and microfilm depict a weakening frontal boundary on these days but there is no temperature gradient to suggest that a frontal system was present. Furthermore, there is no indication that the system redeveloped.

Hurricane Flossy [September 20 – October 3, 1956]

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39950 09/21/1956 M=10  7 SNBR= 870 FLOSSY      XING=1 SSS=2
39950 09/20/1956 M=14  8 SNBR= 870 FLOSSY      XING=1 SSS=2
                    **  *
(September 20th is new to HURDAT)
39953 09/20*  0   0   0    0*  0   0   0    0*  0   0   0    0*180 865  25    0*

39955 09/21*  0   0   0    0*174 875  25    0*180 880  25    0*189 884  25    0*
39955 09/21*181 870  25    0*183 877  25    0*185 884  25    0*189 891  25    0*
                             *** ***          *** ***              ***
39960 09/22*199 889  25    0*211 893  30    0*222 898  35    0*231 902  40    0*
39960 09/22*195 897  25    0*204 901  30    0*215 904  35    0*226 907  40    0*
            *** ***          *** ***          *** ***          *** ***
39965 09/23*240 906  50 1007*249 909  55    0*257 910  60    0*269 910  65    0*
39965 09/23*238 909  50    0*250 911  55  994*262 913  60    0*271 913  70    0*
            *** ***          * *** ***      *** *** ***          *** ***  **
39970 09/24*281 906  70    0*289 898  75  983*295 887  80    0*300 875  80    0*
39970 09/24*280 909  75  984*287 901  75    0*294 889  80  983*299 876  85    0*
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            *** ***  **  *** *** ***        * *** ***      *** *** ***  **
39975 09/25*304 864  65  980*307 856  45    0*312 844  40    0E320 830  35    0*
39975 09/25*304 864  85  974*308 854  50    0*312 844  40  996E319 832  35  998*
                     **  *** *** ***  **                   *** *** ***      ***
39980 09/26E328 816  35    0E336 801  35    0E344 789  30    0E348 784  30    0*
39980 09/26E326 818  35  999E334 803  40  999E341 791  40 1001E345 784  45 1001*
            *** ***  **  *** *** ***  **  *** *** ***  ** **** ***      ** ****
39985 09/27E350 780  30    0E351 776  30    0E353 772  35    0E358 765  35    0*
39985 09/27E348 780  45 1002E350 776  50 1005E353 772  50 1008E356 766  50 1009*
            ***      ** **** ***      ** ****          ** **** *** ***  ** ****
39990 09/28E367 752  35    0E382 725  40    0E396 696  40    0E401 681  40    0*
39990 09/28E363 757  50 1011E374 745  50    0E385 730  45    0E395 715  40    0*
            *** ***  ** **** *** ***  **      *** ***  **      *** ***
39995 09/29E401 667  40    0E399 645  40    0E397 627  40    0E392 618  40    0*
39995 09/29E401 695  35    0E403 675  30    0E405 640  30    0E403 610  30    0*
                ***  **      *** ***  **      *** ***  **      *** ***  **
40000 09/30E389 609  40    0E388 600  40    0E387 591  35    0E389 582  35    0*
40000 09/30E398 595  30    0E385 585  30    0E375 575  30    0E367 560  30    0*
            *** ***  **      *** ***  **      *** ***  **      *** ***  **

(October 1st through 3rd are new to HURDAT)
40001 10/01E360 555  30    0E360 558  35    0E370 560  35    0E385 560  40    0*
40002 10/02E400 562  45    0E415 565  50    0E430 565  50    0E445 565  45    0*
40003 10/03E460 565  40    0E475 565  40    0*  0   0   0    0*  0   0   0    0*

40010 HR LA2AFL1
40010 HR LA1AFL2
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U.S. Hurricane:
Sep 24th – 10Z – 29.1N 89.4W – 80 kt – Category 1 – 983 mb – 1010 mb OCI – 300 nm ROCI

Sep 25th – 00Z – 30.4N 86.4W – 85 kt – Category 2 – 974 mb – 1010 mb OCI – 300 nm ROCI

Major track and intensity changes shown in McAdie et al. (2009). Also, a major alteration is to add four additional days to the cyclone's lifetime. Evidence for these alterations comes from the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Navy reconnaissance book, Connor (1956), Surface Weather Observations, Monthly Weather Review, Mexican synoptic maps, Schwardt et al. (1979), Ho et al. (1987), and Jarrell et al. (1992).

September 20:

HWM analyzes a trough or tropical wave extending from South Florida to Swan Island along longitude 84W to a spot low at 15.8N, 84.8W at 12Z. HURDAT does not list an organized system on this date. Microfilm shows a closed low pressure of at most 1008 mb at 18.0N, 86.0W at 18Z. Ship highlights: No gales or low pressures. MWR: "The origin of this hurricane – the only one to reach the coast of the United States in 1956 – is the rather obscure. Hurricane squalls were reported in the Pacific south of Guatemala on the 20th, and the initial impulse may have moved northward from there or from the

Caribbean." ATSR: "During the period 18-20 September the ITC was oriented across the Yucatan Peninsula-Lower Mexico area with several small active vortices in evidence. By 1830Z on the 20th, a closed vortex began to break away from the ITC over the Yucatan Peninsula, which was the beginning of subsequent Hurricane Flossy."

September 21:

HWM analyzes a trough or tropical wave extending from Central Florida to the north of the Yucatan Peninsula to a spot low at 20.5N, 88.5W at 12Z. HURDAT lists this as a 25 knot tropical depression at 18.0N, 88.0W at 12Z. Microfilm shows a spot low pressure over the Yucatan Peninsula at 18.5N, 89.0W at 12Z. Ship highlights: No gales or low pressures. MWR: "The first well-developed circulation was noted over the Yucatan Peninsula at 1330 EST on the 21st, passing into the Gulf of Mexico near Merida."

September 22:

HWM analyzes a tropical storm of at most 1005 mb at 23.0N, 88.8W at 12Z. HURDAT lists this as a 35 knot tropical storm at 22.2N, 89.8W at 12Z. Microfilm shows a closed low pressure of at most 1005 mb at 22.0N, 90.0W at 12Z. Ship highlights: 40 kt ESE and 1009 mb at 24.8N, 89.5W at 18Z (COADS). 45 kt SE and 1011 mb at 23.0N, 87.0W at 21Z (COADS). Land highlights: 1004 mb at Campeche, Mexico at 00Z (micro). MWR: "According to the report of the hurricane forecast center at New Orleans, the circulation intensified gradually while moving northward over the Gulf and reached storm intensity on the afternoon of the 22nd. After this time the size of the storm increased considerably but the pressure gradient around the center intensified only slowly." ATSR: "The vortex moved across the Yucatan Peninsula in a northwesterly direction at about 8 knots during the period from 1830z, 20 September, to 1000z, 22 September. During this time, winds from reporting stations on the peninsula were gradually increasing from 10 knots to 30 knots. A low-level reconnaissance flight was ordered for 22 September. The flight estimated the center of circulation at 23.8N 90.9W at 2300Z [table lists 0000Z on 23rd] on 22 September, with maximum winds of 45 knots in the northeast quadrant and a minimum observed surface pressure of 1007 mbs. Coordination was established with the Weather Bureau, New Orleans, and Warning Number ONE on Tropical Storm Flossy was issued at 2300Z on 22 September. After departing the land area near Merida at 0600Z on the 22nd, Flossy moved almost straight north at 12 knots for the next 24-hour period. Flossy was held on the northerly course during that time due to intensification of the subtropical high over the East Gulf of Mexico and Florida."

September 23:

HWM analyzes a tropical storm of at most 1000 mb at 27.2N, 91.0W with a stationary cold front extending to the northeast at 12Z. HURDAT lists this as a 60 knot

tropical storm at 25.7N, 91.0W at 12Z. Microfilm shows a closed low pressure of at most 999 mb at 27.2N, 90.6W at 12Z. Ship highlights: 45 kt SE and 1011 mb at 23.0N, 88.0W at 00Z (COADS). 35 kt ESE and 1006 mb at 26.0N, 88.5W at 06Z (COADS). 65 kt SSW and 1007 mb at 25.9N, 89.2W at 12Z (micro). 65 kt S and 1006 mb at 25.7N, 89.0W at 15Z (micro). 60 kt SSW and 1004 mb at 28.4N, 91.2W at 18Z (COADS). Land highlights: 35 kt SE and 1011 mb at Grand Isle, LA at 09Z (micro). Aircraft highlights: Penetration center fix estimated maximum surface winds of 45 kt at 23.8N, 90.9W at 00Z (ATSR). Penetration center fix at 26.0N, 90.9W at 1830Z (ATSR). Penetration center fix measured a central pressure of 984 mb, maximum surface winds of 45 kt and an eye diameter of 10 nm at 27.4N, 91.2W at 2105Z (ATSR). MWR: "The tropical storm reached hurricane force near or somewhat before noon on the 23rd when the center was about 125 miles off the southeastern Louisiana coast." ATSR: "Flossy first attained winds of hurricane force during the 23rd."

September 24:

HWM analyzes a closed low pressure of at most 985 mb at 28.5N, 89.1W at 12Z. HURDAT lists this as an 80 knot hurricane at 29.5N, 88.7W at 12Z. Microfilm shows a closed low pressure of at most 981 mb at 29.0N, 88.9W at 12Z. Ship highlights: 45 kt S and 1001 mb at 27.6N, 89.0W at 00Z (COADS). 50 kt N and 1001 mb at 28.6N, 91.5W at 06Z (micro). 65 kt SSW and 984 mb at 28.1N, 89.0W at 12Z (COADS). 60 kt SSE and 982 mb at 29.5N, 87.2W at 00Z (micro). Land highlights: 72 kt, gusts to 82 kt at an Oil Rig at 29.1N, 90.5W at 0505Z (CONNOR/MWR). 80 kt NW, gusts to 85 kt, 989 mb at Grande Isle, LA at 09Z-10Z (CONNOR). 983 mb at Burrwood, LA at 1010Z (CONNOR). 983 mb at Venice, LA (calm between 0950Z-1155Z) (CONNOR). 73 kt N or NW at Burrwood, LA at 1228Z (CONNOR). 980 mb at Pensacola, FL at 2023Z (CONNOR). 50 kt NE, gusts to 68 kt at Pensacola, FL at 2235Z (CONNOR). Aircraft highlights: Penetration center fix at 30.2N, 87.1W at 2142Z (ATSR). Penetration center fix measured a central pressure of 974 mb, maximum surface winds of 80 kt and an eye diameter of 30 nm at 30.3N, 86.9W at 2230Z (ATSR). Penetration center fix at 30.4N, 86.3W at 2330Z (ATSR). "29.2N, 89.6W – 974 mb – 1013 mb Penv – RMW 22 nmi – speed 10 kt – 70 kt est max sustained 10m, 10-min wind" (Schwardt et al. (1979)).(973.9 mb) central pressure measured by land barometer at Destin, FL and RECON – RMW 18 nmi – 10 kt forward speed – landfall pt 30.4N, 86.4W" (Ho et al. (1987). "Sep – LA2, FL1 – Cat 2 – 975 mb" (Jarrell et al. (1992). MWR: "During the afternoon the hurricane turned rather sharply toward the east-northeast, crossing the Mississippi delta a little north Burrwood near Pilottown early on the 24th. Here it seems to have reached maximum intensity with the highest wind at Burrwood 84 m.p.h and lowest pressure 29.03 inches. An oil rig a little west of Grande Isle reported a maximum wind of 83 m.p.h and gust to 95. The center passed a little south of Pensacola, Florida, during the afternoon

and later about over Fort Walton. The storm became extra-tropical shortly after the center passed out of Florida but it moved northeastward inside the coastlines as an energetic storm until it passed out to sea near the Virginia Capes. As far as known, no hurricane winds were reported at any Florida point although winds were near hurricane force eastward along the coast to Panama City. The lowest pressure reported during the storm was 28.93 inches at the Pensacola Naval Air Station. The highest storm tide was 7.4 feet m.s.l at Laguna Beach, Florida. Some higher values were reported along the eastern side of the Mississippi delta but have not been verified. Tides flooded portions of Norfolk, Va., and water stood 2.5 feet deep in several of the principal street. Beach erosion occurred as far north as Delaware. The heaviest rainfall reported was 16.70 inches at Golden Meadow, La., and 16.30 inches at Gulf Shore, Ala. The rainfall intensity decreased gradually as the storm moved northeastward but 1 to 3 inches fell as far north as Virginia. Three tornados were reported in advance of the storm in northeastern Florida and another at Hilton Head Island near Savannah, Ga., but each caused only minor damage. Total damage in the States of Louisiana, Florida, Alabama, and Mississippi was 424,774,000 of which 415,204,00 was to crops. Damage in other States such as Georgia, the Carolinas, and Virginia was $100,000 or less and was greatly outweighed by the beneficial rains which relieved drought conditions. Deaths, mainly from plane and automobile accidents attributed to the storm, totaled 15. Warnings throughout the storm were timely and accurate." ATSR: "Flossy entered the Mississippi Delta 10 miles north of Burwood, Louisiana, at 1100Z on the 24th and continued on the northeast course until passing into the Atlantic at Elizabeth City, North Carolina, on the 27th." "... and continued increasing to a maximum of 105 knots while passing south of Mobile, Alabama, on the 24th. No sustained winds greater than 40 knots existed after Flossy passed Dothan, Alabama."

September 25:

HWM analyzes a tropical storm of at most 1005 mb at 31.5N, 84.1W at 12Z. HURDAT lists this as a 40 knot tropical storm at 31.2N, 84.4W at 12Z. Microfilm shows a closed low pressure of at most 999 mb at 31.0N, 84.5W at 12Z. Ship highlights: 40 kt SW and 1006 mb at 27.9N, 85.2W at 00Z (micro). 35 kt WSW and 1006 mb at 27.2N, 85.4W at 06Z (COADS). 35 kt W and 1006 mb at 27.9N, 86.0W at 12Z (COADS). 35 kt S and 1000 mb at 29.9N, 80.7W at 18Z (COADS). Land highlights: 50 kt NNE at Crestview, FL at 00Z (SWO). 15 kt N and 982 mb at Fort Walton Beach, FL at 00Z (micro). 20 kt SW and 995 mb at Marianna, FL at 06Z (micro). 30 kt NE and 1001 mb at Montgomery, AL at 0728Z (SWO). 10 kt SE and 998 mb at Albany, GA at 12Z (micro). 10 kt NW and 998 mb at Albany, GA at 18Z (micro). ATSR: "Definite extra-tropical characteristics were evident by 1830Z on the 25th. Numbered warnings were continued

only due to the Weather Bureau's request. Such advisories were requested because of expected torrential rains in the South Atlantic coastal states."

September 26:

HWM analyzes a tropical storm of at most 1005 mb at 34.0N, 79.3W with a trough extending to the south and a warm front to the northeast at 12Z. HURDAT lists this as a 30 knot extratropical cyclone at 34.4N, 78.9W at 12Z. Microfilm shows a closed low pressure of at most 1002 mb at 34.1N, 78.8W with a warm front to the east and a cold front to the south at 12Z. Ship highlights: 35 kt S and 1003 mb at 32.2N, 79.1W at 00Z (COADS). 40 kt SE and 1004 mb at 34.2N, 75.8W at 06Z (COADS). 35 kt SW and 1004 mb at 31.5N, 79.3W at 12Z (COADS). 45 kt ENE and 1010 mb at 36.2N, 72.3W at 18Z (COADS). Land highlights: 10 kt SW and 1001 mb at Savannah, GA at 00Z (micro). 10 kt SSE and 1001 mb at Edisto Beach, SC at 06Z (micro). 40 kt ENE and 1011 mb at Diamond Shoals, NC at 12Z (micro). 37 kt E at Atlantic City, NJ at 18Z (SWO). ATSR: "Commencing with Warning Number FIFTEEN at 0400Z on 26 September all warnings were issued at Storm Flossy, since no evidence of a tropical nature existed within the storm."

September 27:

HWM analyzes a closed low pressure of at most 1010 mb at 35.5N, 76.5W with a cold front extending to the south and a warm front to the northeast at 12Z. HURDAT lists this as a 35 knot extratropical cyclone at 35.3N, 77.2W at 12Z. Microfilm shows a closed low pressure of at most 1008 mb at 36.0N, 76.2W with a warm front to the east and a cold front to the south at 12Z. Ship highlights: 35 kt ENE and 1007 mb at 35.6N, 74.9W at 00Z (COADS). 50 kt NE and 1016 mb at 37.9N, 70.7W at 06Z (COADS). 50 kt NE and 1016 mb at 38.2N, 70.3W at 12Z (COADS). 45 kt E and 1016 mb at 38.1N, 69.9W at 18Z (COADS). Land highlights: 40 kt NE and 1017 mb at Ocean City, NJ at 00Z (SWO). 45 kt NE and 1018 mb at Ocean City, NJ at 00Z (SWO). 42 kt E at Atlantic City, NJ at 12Z (SWO). 47 kt E, gusts to 60 kt at Atlantic City, NJ at 18Z (SWO). ATSR: "The final warning was issued at 1600Z, 27 September. Minor damage to small craft and coastal installations in the Mississippi Delta and Gulf Coast from New Orleans to Apalachicola was reported. Minor damage from heavy rains was also reported in the Carolinas and Georgia."

September 28:

HWM analyzes a closed low pressure of at most 1015 mb at 38.5N, 73.5W with a cold front extending to the south and a warm front to the northeast at 12Z. HURDAT lists this as a 40 knot extratropical cyclone at 39.6N, 69.6W at 12Z. Microfilm shows a closed low pressure of at most 1014 mb at 40.0N, 69.5W with a warm front to the east and a

cold front to the south at 12Z. Ship highlights: 45 kt NE and 1021 mb at 40.5N, 71.0W at 00Z (COADS). 60 kt E and 1020 mb at 40.2N, 72.1W at 06Z (COADS). Land highlights: 36 kt E at Atlantic City, NJ at 00Z (SWO).

September 29:

HWM analyzes a closed low pressure of at most 1015 mb at 40.0N, 60.0W with a stationary front extending through the system and to the southeast and a cold front to the south at 12Z. HURDAT lists this as a 40 knot extratropical cyclone at 39.7N, 62.7W at 12Z. Microfilm shows a closed low pressure of at most 1014 mb at 40.0N, 63.0W with a warm front to the east and a cold front to the southwest at 12Z. Ship highlights: No gales or low pressures.

September 30:

HWM analyzes a closed low pressure of at most 1015 mb at 37.0N, 58.0W with a weakening cold front to the west and south, and a warm front to the southeast at 12Z. HURDAT lists this as a 35 knot extratropical cyclone at 38.7N, 59.1W at 12Z. Microfilm shows a closed low pressure of at most 1014 mb at 37.5N, 58.8W with a warm front to the east and a cold front to the southwest at 12Z. Ship highlights: No gales or low pressures.

October 1:

HWM analyzes a closed low pressure of at most 1005 mb at 37.5N, 55.5W with a warm front to the northeast at 12Z. HURDAT does not list an organized cyclone on this date (last position at 18Z on the 30th). Microfilm shows a closed low pressure of at most 1008 mb at 36.5N, 57.5W at 12Z. Ship highlights: 35 kt ENE and 1010 mb at 40.0N, 55.0W at 08Z (COADS). 35 kt E and 1010 mb at 40.0N, 54.0W at 12Z (COADS). 35 kt E and 1010 mb at 40.0N, 53.0W at 16Z (COADS). 35 kt E and 1002 mb at 39.5N, 55.9W at 18Z (COADS).

October 2:

HWM analyzes a closed low pressure of at most 1000 mb at 43.0N, 57.0W with a warm front to the northeast and a cold front to the southeast at 12Z. HURDAT does not list an organized cyclone on this date. Microfilm shows a closed low pressure of at most 1002 mb at 42.0N, 56.2W with a warm front to the southeast and a cold front to the south at 12Z. Ship highlights: 45 kt SE and 1007 mb at 40.5N, 52.8W at 00Z (COADS). 45 kt SE and 997 mb at 42.2N, 54.4W at 06Z (COADS). 45 kt E and 1000 mb at 44.7N, 52.5W at 12Z (COADS). 40 kt E and 997 mb at 46.2N, 56.6W at 18Z (COADS).

October 3:

HWM analyzes a closed low pressure of at most 1000 mb at 49.0N, 58.0W with a stationary front to the east and southeast at 12Z. HURDAT does not list an organized cyclone on this date. Microfilm shows a closed low pressure of at most 999 mb at 49.5N, 64.5W with a cold front to the south at 12Z. Ship highlights: 20 kt SSW and 1001 mb at 40.6N, 57.6W at 00Z (COADS). 15 kt SW and 1000 mb at 41.5N, 54.0W at 06Z (COADS). 15 kt S and 1001 mb at 44.5N, 51.4W at 12Z (COADS). 30 kt SSE and 1000 mb at 49.6N, 47.2W at 18Z (micro). Land highlights: 10 kt SW and 997 mb at St. Pierre and Miquelon at 06Z (micro). 20 kt SSW and 994 mb at CFB Gander, Canada at 18Z (micro).

October 4:

HWM analyzes a closed low pressure of at most 990 mb at 55.5N, 54.0W with a stationary front to the east and southeast, and another closed low pressure of at most 990 mb at 50.0N, 48.0W with a stationary front to the south at 12Z. HURDAT does not list an organized cyclone on this date. Microfilm shows a closed low pressure of at most 990 mb at 56.5N, 53.0W with a warm front to the southeast and a cold front to the south at 12Z. Ship highlights: 30 kt SSE and 1003 mb at 53.3N, 43.7W at 00Z (COADS). 20 kt SSW and 1001 mb at 40.6N, 57.6W at 00Z (COADS). 30 kt SSW and 993 mb at 53.0N, 47.0W at 06Z (COADS). 10 kt SW and 989 mb at 54.5N, 55.0W at 12Z (COADS). 15 kt SW and 991 mb at 56.5N, 51.0W at 18Z (COADS).

October 5:

HWM analyzes a closed low pressure of at most 985 mb at 57.0N, 47.0W with a stationary front to the southeast and a dissipating front to the north at 12Z. HURDAT does not list an organized cyclone on this date. Microfilm shows a closed low pressure of at most 993 mb at 57.5N, 50.0W with a cold front to the southeast at 06Z. Ship highlights: 35 kt NW and 998 mb at 53.0N, 51.1W at 00Z (COADS). 15 kt NNW and 993 mb at 56.5N, 51.0W at 06Z (COADS). 35 kt W and 998 mb at 53.5N, 48.6W at 12Z (COADS). 40 kt NNE and 994 mb at 59.5N, 43.2W at 18Z (micro). Land highlights: 45 kt NE and 1001 mb at Aluk Island, Greenland at 12Z (micro).

October 6:

HWM analyzes a closed low pressure of at most 985 mb at 71.5N, 62.0W at 12Z. HURDAT does not list an organized cyclone on this date. Microfilm is not available on this date. Ship highlights: No gales or low pressures.

The only hurricane to hit the United States during the 1956 Atlantic Hurricane Season started as a tropical wave that entered the Caribbean Sea during the third week of September. The disturbance became better organized over the western Caribbean Sea and a 25 kt tropical depression is analyzed to have formed at 18Z on September 20th, twelve hours earlier than originally shown in HURDAT, based on data from ships and land stations. Minor track changes are introduced between September 20th and 27th; and major track changes are introduced between September 28th and 30th. Early on September 21st, while on a west-northwest course, the tropical depression moved over the Yucatan peninsula. On September 22nd, the tropical depression changed course and began moving to the north-northwest entering the Gulf of Mexico after 09Z. Various ships reported winds up to 45 kt at 18Z and 21Z on the 22nd. Intensification to a tropical storm is analyzed at 12Z on September 22nd, same as it appears in HURDAT. The first reconnaissance aircraft to reach Flossy occurred at 0Z on September 23nd and estimated maximum surface winds of 45 kt and observed a minimum surface pressure of 1007 mb. A central pressure of 1007 mb is present in HURDAT at 00Z on September 23rd and it has been removed based on observation by various ships of lower pressures and also because the reconnaissance report does not indicate that the measurement was a central pressure. The tropical cyclone rapidly grew in strength on September 23rd as it moved generally northward toward the Louisiana coast. At 0650Z on the 23rd, the ship "SS Tasculus" located at 26.3N, 90.2W reported a central pressure of 994 mb. The position of the ship appears to be wrong but the pressure looks to be correct and has been added to HURDAT at 06Z. A central pressure of 994 mb suggests maximum winds of 58 kt south of 25N and 53 kt north of 25N from the Brown et al. pressure-wind relationship. An intensity of 55 kt has been selected for 12Z on the 23rd, same as in HURDAT. The ship "Lima" reported 65 kt S and 1006 mb at 15Z on the 23rd, while other ships reported winds of 55 and 60 kt late on the day. Intensification to hurricane is retained at 18Z on September 23rd, but an intensity of 70 kt is analyzed at this time, up from 65 kt originally in HURDAT, a minor intensity change. Another reconnaissance aircraft reached Flossy at 2105Z measuring a central pressure of 984 mb, a 10 nm eye diameter and estimating surface winds of 45 kt. A central pressure of 984 mb suggests maximum surface winds of 68 kt north of 25N according to the pressure-wind relationship. The 10 nm eye diameter suggests an RMW of about 8 nm, which is smaller than the climatological value of about 20 nm. An intensity of 75 kt is analyzed at 00Z on September 24th, up from 70 kt originally in HURDAT, a minor intensity change. A central pressure of 984 mb has been added to HURDAT at 00Z on the 24th.

Early on September 24th, Hurricane Flossy turned to the northeast making landfall in the delta region of southeast Louisiana around 10Z with maximum sustained winds of 80 kt. Landfall occurred between the towns of Burrwood and Venice, with both registering a central pressure of 983 mb. Venice reported calm conditions between 0950Z and 1150Z.

It is plausible that the central pressure of Flossy was slightly lower than measured by these towns. Nonetheless, a central pressure of 983 mb was present in HURDAT at 06Z on the 24th and has been moved to 12Z. Grand Isle registered sustained winds of 80 kt with gusts up to 85 kt. Flossy continued to deepen after leaving Lousiana and a reconnaissance airplane at 2230Z on the 24th measured a central pressure of 974 mb, estimated maximum surface winds of 80 kt and a 30 nm eye diameter. A central pressure of 974 mb suggests maximum surface winds of 80 kt north of 25N and 83 kt north of 25N intensifying, according to the pressure-wind relationship. An intensity of 85 kt is selected at 18Z on the 24th and 00Z on the 25th. The original HURDAT shows 80 kt and 65 kt, respectively, which is a minor and major intensity change, respectively. A central pressure of 974 mb has been added to HURDAT at 00Z on the 25th, replacing the existing 980 mb, which was measured at Pensacola and the hurricane passed about 10 nm south of the city. Hurricane Flossy is analyzed to have made landfall in Florida around 00Z on September 25th near 30.4N, 86.4W, about 5 nm east of Destin, with an intensity of 85 kt. 85 kt is also the peak intensity for the lifetime of Flossy, up from 80 kt in HURDAT, a minor intensity change. Pensacola reported 56 kt N at 2058Z on the 24th and gusts up to 72 kt. Crestview reported 50 kt at 00Z on the 25th. Flossy rapidly weakened over land while moving to the northeast. The hurricane weakened to tropical storm intensity at 06Z on the 25th, same as in HURDAT. The Kaplan and DeMaria model was run for 06Z, 12Z and 18Z on the 25th, yielding 56 kt, 41 kt and 31 kt, respectively. The only gales during these times were from ships. An intensity of 50 kt is selected for 06Z, 40 kt at 12Z and 35 kt at 18Z on the 25th. Albany, GA reported 10 kt SE and 998 mb at 12Z on the 25th, suggesting a central pressure of 996 mb, which has been added to HURDAT. Late on September 25th, the structure of Flossy became less symmetric and dry continental air entered the center causing the storm to become extratropical around 18Z, same as shown by HURDAT. Albany, GA reported 10 kt NW and 998 mb at 18Z on the 25th, and a central pressure of 998 mb has been added to HURDAT at this time.

Early on September 26th, Flossy crossed into South Carolina while continuing its course to the northeast. HURDAT shows that the storm weakens to an extratropical depression at 12Z on the 26th, but ship data indicates that the storm retained gale-force winds. An intensity of 35 kt is selected for 00Z, 40 kt for 06Z, 12Z and 18Z. HURDAT shows 35 kt at 00Z and 06Z and 30 kt for 12Z and 18Z, minor intensity changes. Savannah measured 10 kt SW and 1001 mb at 00Z, suggesting a central pressure of 999 mb, which has been added to HURDAT. Edisto Beach, SC measured 10 kt SSE and 1001 mb at 06Z, suggesting a central pressure of 999 mb, which has been added to HURDAT. Myrtle Beach, SC measured 10 kt SW and 1003 mb at 12Z, suggesting a central pressure of 1001 mb, which has been added to HURDAT. New Bern, NC measured 10 kt SW and 1003 mb at 1931Z, suggesting a central pressure of 1001 mb, which has been added to HURDAT at 18Z. A strong pressure gradient between Flossy and a high pressure to the

north produced strong winds along the Mid-Atlantic. Ocean City, MD reported 46 kt NE at 18Z on the 26th. Flossy entered North Carolina around 12Z on the 26th and its forward speed slowed late on the day and into the 27th. At 06Z on the 27th, an intensity of 50 kt is analyzed, up from 30 kt in HURDAT, a major intensity change. 50 kt is also the peak intensity Flossy is analyzed to have reached as an extratropical cyclone. Cherry Point, NC measured 6 kt E and 1003 mb at 2330Z on the 26th, suggesting a central pressure of 1002 mb, which has been added to HURDAT at 00Z on the 27th. New Bern, NC measured 6 kt ESE and 1006 mb at 0530Z, suggesting a central pressure of 1005 mb, which has been added to HURDAT at 06Z. New Bern, NC reported calm conditions and 1008 mb at 1130Z, suggesting a central pressure of 1008 mb, which has been added to HURDAT at 12Z. New Bern, NC measured 10 kt SSW and 1011 mb at 18Z, suggesting a central pressure of 1009 mb, which has been added to HURDAT. Early on September 28th, Flossy moved back into the Atlantic Ocean but the organization of the system continued to degrade, potentially becoming a trough based on ship data. The intensity of the extratropical cyclone is analyzed to have decreased to 45 kt at 12Z and 40 kt at 18Z on the 28th. Elizabeth City, NC measured 7 kt SSW and 1012 mb at 2332Z on the 27th, suggesting a central pressure of 1011 mb, which has been added to HURDAT at 00Z on the 28th. Flossy turned to the east on the 29th weakening to a 30 kt extratropical depression at 06Z, down from 40 kt originally in HURDAT, a minor intensity change. On September 30th, the system moved to the southeast slowing its forward speed. A small clockwise loop was completed early on October 1st and its forward speed increased to the north. Flossy regained gale-force winds around 06Z on October 1st and continued to intensify until reaching 50 kt on October 2nd at 06Z. Early on October 3rd, Flossy began to interact with another extratropical cyclone to its west. It is analyzed that Flossy merged with the other cyclone after 06Z on October 3rd. October 3rd at 06Z is the last position for Flossy. It is also analyzed that Flossy lasted 60 hours more than originally shown in HURDAT, a major change.

New Storm [October 9-12, 1956]

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37265 10/09/1956 M=9 4 SNBR= 820 UNNAMED       XING=0 SSS=0
37265 10/09*  0   0   0    0*153 460  40    0*153 468  40    0*153 476  40    0*
37265 10/10*155 484  40    0*160 492  35    0*170 495  30    0*178 495  30    0*
37265 10/11*184 492  30    0*187 489  30    0*190 485  30    0*193 478  30    0*
37265 10/12*197 465  30    0*  0   0   0    0*  0   0   0    0*  0   0   0    0*
37285 TS
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A new tropical storm has been added to HURDAT, not previously shown in McAdie et al. (2009). Evidence for its existence comes from the Historical Weather Map series, Microfilm, COADS ship database, Mariners Weather Log and Jack Beven's suspect list.

October 4:

HWM shows a spot low pressure at 12.0N, 36.0W at 12Z. Microfilm does not analyze an organized system at 12Z. Ship highlights: No gale force winds or equivalent low pressures.

October 5:

HWM shows a closed low pressure of at most 1010 mb at 8.0N, 39.5W at 12Z. Microfilm does not analyze an organized system at 12Z. Ship highlights: No gale force winds or equivalent low pressures.

October 6:

HWM shows a closed low pressure of at most 1010 mb at 9.0N, 40.5W at 12Z. Microfilm analyses a closed low pressure of at most 1011 mb at 12.5N, 43.0W at 12Z. Ship highlights: 35 kt E and 1011 mb at 15.0N, 41.1W at 18Z (micro).

October 7:

HWM shows a closed low pressure of at most 1010 mb at 12.0N, 44.5W at 12Z. Microfilm analyses a closed low pressure of at most 1011 mb at 12.0N, 47.5W at 12Z. Ship highlights: 45 kt NNE and 1011 mb at 14.1N, 47.8W at 00Z (micro).

October 8:

HWM shows a closed low pressure of at most 1010 mb at 14.0N, 46.0W at 12Z. Microfilm does not analyze an organized system at 12Z. Ship highlights: No gale force winds or equivalent low pressures.

October 9:

HWM shows a closed low pressure of at most 1010 mb at 15.5N, 46.0W at 12Z. Microfilm analyses a closed low pressure of at most 1011 mb at 15.5N, 46.5W at 12Z. Ship highlights: 40 kt ENE and 1004 mb at 16.4N, 46.4W at 09Z (MWL). MWR: “Some 1,300 miles east of Puerto Rico on this date, ships reported squalls of 40 to 45 mph and there was evidence of at least a quasi-circulation. It was completely damped out within 24 hours.”

October 10:

HWM shows a spot low pressure at 18.5N, 46.5W and another spot low pressure at 25.5N, 49.5W at 12Z. Microfilm does not analyze an organized system at 12Z. Ship highlights: No gale force winds or equivalent low pressures.

October 11:

HWM shows a spot low pressure at 18.5N, 46.5W and another spot low pressure at 25.5N, 49.5W at 12Z. Microfilm does not analyze an organized system at 12Z. Ship highlights: No gale force winds or equivalent low pressures.

October 12:

HWM shows a spot low pressure at 20.0N, 50.0W at 12Z. Microfilm does not analyze an organized system at 12Z. Ship highlights: No gale force winds or equivalent low pressures.

A strong tropical wave moved off the African coast in early October. The disturbance gained strength and by the 6th, a ship reported 35 kt E and 1011 mb at 15.0N, 41.1W. Unfortunately, the data in the southern quadrant was sparse and is not possible to determine whether a closed circulation was present. Early on the 7th, another ship reported gale force winds but once again, the ship data is too sparse to show a closed circulation was present. The system continued slowly westward and early on the 9th, the ship SS ANTONIA reported 11 kt N (not that microfilm had a comment that they were unclear whether "11" meant "kt" or "force 11" (60 kt)) and 989 mb. Data from nearby ships indicate that the pressure reported by the SS ANTONIA likely had a significant low bias or the cyclone was extremely small. At 09Z on October 9th, the ship DEL SOL reported 40 kt E and 1004 mb. The pressure reported by the ship DEL SOL dropped 10 mb in 21 hours between 12Z on the 8th and 09Z on the 9th. A peripheral pressure of 1004 mb suggests maximum sustained winds of at least 39 kt south of 25N from the Brown et al. pressure-wind relationship. Ship data on the 9th indicates that a closed low level circulation was present. The first position is analyzed at 06Z on October 9th as a 40 kt tropical storm given the slow motion of the cyclone. This is not the genesis of the tropical cyclone as it likely formed a day to even a few days earlier. The tropical storm moved slowly westward and early on the 10th turned to the north. Weakening to a tropical depression is analyzed at 12Z on the 10th. No other ships reported gales or equivalent pressures. Early on the 11th, the tropical depression turned to the northeast and it is analyzed that it dissipated after 00Z on the 12th.

New Tropical Storm [October 14-18, 1956]

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37265 10/14/1956 M=10 6 SNBR= 820 UNNAMED       XING=0 SSS=0
37265 10/14*  0   0   0    0*  0   0   0    0*226 798  35    0*229 800  40    0*
37265 10/15*232 801  40    0*237 802  40    0*242 803  40    0*248 805  45    0*
37265 10/16*256 806  50    0*269 807  50    0*282 807  50  999*292 806  45  997*
37265 10/17*301 803  50  997*311 798  50  996E323 789  50    0E337 779  50    0*
37265 10/18E352 770  45    0E364 759  45  999E375 745  45    0E385 720  45    0*
37285 TS
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U.S. Tropical Storm Landfall

10/15 21Z 25.2N 80.6W 50 kt FL

A new tropical storm has been added to HURDAT, not previously shown in McAdie et al. (2009). Evidence for its existence comes from the Historical Weather Map series, Microfilm, Monthly Weather Review, COADS ship database, and Jack Beven's and David Roth's suspect lists.

October 13:

HWM shows a stationary cold front over Cuba and eastern Bahamas at 12Z. Microfilm analyses frontal boundary over the Bahamas, a closed low pressure of at most 1008 mb at 21.5N, 77.5W and another closed low pressure of at most 1008 mb at 14.5N, 81.5W at 12Z. Ship highlights: 35 kt NE and 1008 mb at 22.9N, 79.2W at 18Z (COADS).

October 14:

HWM shows spot a low pressure at 20.5N, 80.0W and a warm front over the Bahamas to the northeast of the low at 12Z. Microfilm analyses a closed low pressure of at most 1005 mb at 23.3N, 80.0W at 12Z. MWR shows a low pressure of 1006 mb located near 21.5N, 79.8W at 12Z. Ship highlights: 35 kt NE and 1013 mb at 24.6N, 83.0W at 12Z (micro). 40 kt N and 1011 mb at 24.3N, 82.5W at 18Z (COADS). Land highlights: 20 kt E and 1004 mb at Caibarien, Cuba at 00Z (micro). 35 kt N and 1003 mb at Matanzas, Cuba at 18Z (micro).

October 15:

HWM shows a closed low pressure of at most 1005 mb at 23.5N, 79.5W and a warm front extending from the low to the northeast at 12Z. Microfilm analyses a closed low pressure of at most 1005 mb at 24.0N, 80.5W with a frontal boundary to the north at 12Z. MWR shows a low pressure of 1004 mb located near 24.5N, 80.1W at 12Z. Ship highlights: 40 kt NNE and 1006 mb at 24.1N, 79.8W at 00Z (micro). 40 kt NNE and 1009 mb at 23.6N, 82.8W at 06Z (micro). 35 kt NNE and 1009 mb at 24.6N, 83.7W at 12Z (COADS). 35 kt NE and 1009 mb at 27.5N, 79.8W at 12Z (COADS). Land highlights: 16 kt NE and 1004 mb at Key West, FL at 0930Z (SWO). 12 kt NE and 1002 mb at Miami, FL at 2025Z (SWO).

October 16:

HWM shows a closed low pressure of at most 1005 mb at 28.0N, 79.0W and a warm front extends from the low to the northeast at 12Z. Microfilm analyses a closed low pressure of at most 1002 mb at 28.0N, 80.0W with a frontal boundary to the north of the low at 12Z. MWR shows a low pressure of 1002 mb located near 28.5N, 80.0W at 12Z. Ship highlights: 40 kt NE and 1008 mb at 28.3N, 79.7W at 00Z (COADS). 40 kt NE and 1011 mb at 31.2N, 74.4W at 06Z (COADS). 35 kt S and 1009 mb at 25.3N, 47.4W at 12Z (COADS). 40 kt S and 1004 mb at 28.5N, 78.7W at 18Z (COADS). 20 kt SSE and 999 mb at 29.0N, 79.8W at 18Z (SWO). Land highlights: 10 kt SSW and 1002 mb at West Palm Beach, FL at 0728Z (SWO). 11 kt NE and 1001 mb at Patrick AFB, FL at 1028Z (SWO). 33 kt SSW and 998 mb at Cape Canaveral, FL at 1938Z (SWO). 47 kt N and 1002 mb at Mayport, FL at 23Z (SWO).

October 17:

HWM shows a closed low pressure of at most 1005 mb at 31.5N, 78.3W and a warm front extending from the low to the northeast at 12Z. Microfilm analyses a closed low pressure of at most 1002 mb at 32.5N, 78.5W with a frontal boundary extending from the low to the northeast at 12Z. MWR shows a low pressure of 998 mb located near 32.5N, 78.9W at 12Z. Ship highlights: 10 kt SE and 998 mb at 30.1N, 80.3W at 00Z (COADS). 40 kt S and 1003 mb at 29.4N, 78.0W at 00Z (COADS). 50 kt WSW and 1001 mb at 29.5N, 79.7W at 05Z (micro). 10 kt WNW and 999 mb at 30.6N, 80.1W at 06Z (COADS). 30 kt SW and 997 mb at 30.3N, 79.7W at 06Z (COADS). 45 kt E and 996 mb at 32.4N, 78.7W at 12Z (COADS). 50 kt S and 996 mb at 33.1N, 78.3W at 15Z (micro). 35 kt SSE and 1008 mb at 34.0N, 74.9W at 18Z (COADS). Land highlights: 16 kt NNW and 1004 mb at Brunswick, GA at 0428Z (SWO). 16 kt N and 1003 mb at Hunter AFB, GA at 0728Z (SWO). 30 kt S and 999 mb at Frying Pan Shoals, SC at 33.5N, 77.6W at 17Z (micro). 8 kt E and 998 mb at New Bern, NC at 2234Z (SWO).

October 18:

HWM shows a closed low pressure of at most 1005 mb at 38.0N, 74.0W and a weakening warm front extending to its northeast and a cold front extending to its north at 12Z. Microfilm analyses a closed low pressure of at most 1002 mb at 37.5N, 74.4W with a frontal boundary extending to its northeast at 12Z. MWR shows a low pressure of 1000 mb located near 38.0N, 80.1W at 12Z. Ship highlights: 40 kt SSW and 1009 mb at 32.5N, 76.0W at 00Z (COADS). 35 kt SSW and 1010 mb at 33.1N, 75.1W at 06Z (COADS). 35 kt SW and 1003 mb at 36.3N, 74.0W at 12Z (COADS). 40 kt N and 1006 mb at 37.9N, 74.6W at 18Z (COADS). Land highlights: 5 kt SSW and 1000 mb at Elizabeth City, NC at 0730Z (SWO).

October 19:

HWM shows a frontal boundary over the northwest Atlantic at 12Z. Microfilm analyses a closed low pressure of at most 1002 mb at 40.0N, 55.0W along a frontal boundary at 12Z. MWR shows a low pressure of 998 mb located near 39.2N, 56.1W at 12Z. Ship highlights: 40 kt SW and 1003 mb at 37.5N, 68.0W at 00Z (micro). 50 kt NE and 1004 mb at 39.2N, 64.5W at 06Z (COADS). 35 kt S and 1009 mb at 25.3N, 47.4W at 12Z (COADS).

MWR: "This Low formed as a wave on a dissipating polar front north of Hispaniola on the 12th and moved west-northwestward to the extreme southeastern Florida coast south of Miami on the 15th, when it turned north and north-northeastward passing over the North Carolina Capes west of Cape Hatteras. Rainfall was excessive in portions of Florida ranging from 6 to 20 inches over a 50-mile wide belt from the northeastern corner of Lake Okeechobee to Jacksonville. This storm never became wholly tropical, and maximum winds and most of the precipitation occurred well in advance of the low pressure center. Highest winds reported were gusts of 60 to 65 mph and probably some sustained winds of near 60 mph at sea. Damage from flooding in Florida, particularly around Kissimmee, totaled about $3,000,000. Two persons were drowned in the surf during the storm."

A broad area of low pressure was present over the western Caribbean Sea during the second week of October while a weakening cold front moved into the Bahamas. A well-defined low pressure developed on October 14th and genesis is analyzed at 12Z on the 14th as a 35 kt tropical storm. A strong pressure gradient was present to the north of the tropical cyclone, generating gale-force winds over 300 nm from the center, which was not directly due to this system. Microfilm and Historical Weather Maps indicate that a frontal boundary was present to the northeast of the center while ship data showed a very moist environment around the storm. Data does suggests that this system may have been a subtropical storm but without satellite images to determine the convective structure of the cyclone, it is analyzed as a tropical cyclone. The tropical storm moved generally northward increasing in strength. An intensity of 40 kt is analyzed at 18Z on the 14th and increasing to 45 kt at 18Z on the 15th. Early on the 15th, several ships reported gale-force winds within 120 nm of the center. A ship reported 55 kt NNW at 00Z on the 15th but the measurement appears to be too high compared to nearby ship data. Ship data on October 15th continued to indicate that a warm front may have been present to the northeast of the center although the temperature gradient across the cyclone was almost non-existent. The northward forward motion brought the storm to South Florida making landfall at 21Z on the 15th near 25.2N, 80.6W over extreme southern Miami-Dade with an intensity of 50 kt.

Early on October 16th, the strongest winds were reported about 350 nm away from the center. A ship reported 55 kt at 00Z on the 16th and the intensity is analyzed at 50 kt at this time. 50 kt is also the peak intensity for this tropical cyclone. The tropical storm moved back into the Atlantic Ocean around 15Z on October 16th and started moving on a northeast course. No change in intensity is analyzed for the 16th and 17th. At 1027Z on the 16th, Patrick AFB, FL reported 11 NE and 1001 mb, suggesting a central pressure of 999 mb, which has been added to HURDAT at 12Z. At 18Z on the 16th, a ship reported 20 kt SSE and 999 mb suggesting a central pressure of 997 mb, which has been added to HURDAT. 47 kt N were measured at Mayport, FL at 23Z on October 16th. Late on the 16th, the structure of the storm again became more symmetric with gale-force winds reported just 120 nm to the east and southeast of the center. Furthermore, dew points across the southeast United States and ship data continued to indicate that a moist environment was present around the tropical cyclone. At 00Z on October 17th, a ship reported 10 kt SE and 998 mb, suggesting a central pressure of 997 mb, which has been added to HURDAT. At 06Z on the 17th, a ship reported 10 kt NW and 999 mb and another reported 30 kt SW and 997 mb, suggesting a central pressure of around 996 mb (given the uncertainties in the accuracy of the two ships' barometers), which has been added to HURDAT. At 12Z on the 17th, several ships near the center reported winds up to 45 kt while lighter winds were being reported in the periphery. Still, the system had become elongated NE-SW with a clear warm front present extending northeast from the center and continental dry air likely entraining into the circulation. It is analyzed that at 12Z on October 17th, the tropical cyclone became an extratropical cyclone. A ship near the center reported 50 kt S at 15Z on the 17th. The extratropical cyclone made landfall in North Carolina around 21Z on the 17th. Early on October 18th, the extratropical cyclone turned to the east-northeast ahead of a deepening frontal boundary. At 0730Z on the 18th, Elizabeth City, NC reported 5 kt SSW and 1000 mb, suggesting a central pressure of 999 mb, which has been added to 06Z on the 18th in HURDAT. Early on the 19th, ship data suggests that the extratropical cyclone became less organized and likely was absorbed by a frontal boundary. Therefore, the last position is at 18Z on October 18. The development and characteristics of this tropical cyclone bear similarities to Tropical Storm Leslie in 2000 and Tropical Storm Nicole in 2010.

Hurricane Greta [October 31 - November 7, 1956]

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40010 10/30/1956 M= 9  8 SNBR= 871 GRETA       XING=0 SSS=0
40010 10/31/1956 M= 8 11 SNBR= 871 GRETA       XING=0 SSS=0
         **          * **

40015 10/30*  0   0   0    0*178 755  25    0*172 753  25    0*175 751  25    0*
40015 10/30*  0   0   0    0*  0   0   0    0*  0   0   0    0*  0   0   0    0*
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                                  *   *   *       *   *   *       *   *   *
40020 10/31*182 749  25    0*192 747  25    0*204 745  25    0*217 744  25    0*
40020 10/31*  0   0   0    0*  0   0   0    0*208 750  25    0*219 753  30 1003*
                *   *   *       *   *   *      *** ***          *** ***  ** ****

40025 11/01*231 743  30    0*245 735  30    0*259 725  30    0*276 722  30    0*
40025 11/01*230 750  30    0*242 742  35    0*257 730  45    0*272 722  50    0*
            *** ***          *** ***  **      *** ***  **      ***       **

40030 11/02*290 723  30  992*294 737  30    0*281 735  35    0*273 729  35    0*
40030 11/02*285 723  50  992*284 728  50    0*278 727  50    0*273 725  55    0*
            ***      **      *** ***  **      *** ***  **          ***  **

40035 11/03*265 723  40    0*258 721  45    0*252 718  55  982*246 714  55    0*
40035 11/03*270 723  55    0*265 722  60    0*257 721  60  982*246 716  60    0*
            ***      **      *** ***  **      *** ***  **          ***  **

40040 11/04*240 707  60    0*233 696  65    0*226 683  75    0*219 669  95  970*
40040 11/04*238 707  65    0*231 696  70    0*226 684  80    0*222 671  85  970*
            ***      **      ***      **          ***  **      *** ***  **

40045 11/05*222 653 110    0*237 632 115    0*253 610 120  970*268 591 120    0*
40045 11/05*222 657  85    0*235 639  85    0*253 617  85  970*271 595  85    0*
                ***  **      *** ***  **          ***  **      *** ***  **

40050 11/06*283 571 110    0*295 545 100    0*306 512  85  985*319 476  70    0*
40050 11/06*282 575  85    0E293 558  85    0E304 530  85    0E314 502  75    0*
            *** ***  **     **** ***  **     **** ***         ***** ***  **

40055 11/07E333 426  55    0E345 377  45    0*  0   0   0    0*  0   0   0    0*
40055 11/07E325 470  65    0E337 420  55    0*  0   0   0    0*  0   0   0    0*
            *** ***  **      *** ***  **

40060 HR
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Major changes to the track and intensity shown in McAdie et al. (2009). Another major change is to indicate tropical storm intensity 30 hour earlier. Evidence for these alterations comes from the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Monthly Weather Review, and Navy reconnaissance book.

October 28:

HWM analyzes a closed low pressure of at most 1010 mb at 14N, 76.5W at 12Z. HURDAT does not list an organized system on this date. Microfilm shows a closed low pressure of at most 1008 mb at 11N, 80.5W at 18Z. Ship highlights: No gales or low pressures.

ATSR: “On 28 October a large low pressure area was observed in the western Caribbean between Cuba and Panama. This area, a large vortex of the ITC, remained static near 14N and 77W for the next few days.”

October 29:

HWM analyzes a closed low pressure of at most 1010 mb at 14.5N, 79.5W at 12Z. HURDAT does not list an organized system on this date. Microfilm shows a closed low pressure of at most 1011 mb at 14.0N, 78.5W at 12Z. Ship highlights: No gales or low pressures.

October 30:

HWM analyzes a closed low pressure of at most 1010 mb at 17.0N, 79.5W at 12Z. HURDAT lists this as a 25 knot tropical depression at 17.2N, 75.3W at 12Z. Microfilm shows a spot low pressure at 14.5N, 76.8W at 12Z. Ship highlights: No gales or low pressures.

MWR: "A tropical depression, which is believed to have had its origin along the intertropical convergence zone over the southern Caribbean, was first noted southeast of Jamaica on October 30 when a Navy reconnaissance flight observed 35 mph southeasterly winds. Numerous showers and a large area of relative calm near the location of lowest pressure were also observed." ATSR: "On the 30 October, a second center was observed forming near the eastern tip of Cuba within the large low pressure area. The circulation was evident as high as 500 mb level and was under the southwesterly and divergent flow of a 200 mb trough in the westerlies. A high pressure area moving off the northeast coast of the United States was tightening the gradient to the north of the low pressure center causing high winds over the broad area."

October 31:

HWM analyzes a closed low pressure of at most 1005 mb at 21.2N, 75.5W at 12Z. HURDAT lists this as a 25 knot tropical depression at 20.4N, 74.5W at 12Z. Microfilm shows a closed low pressure of at most 1005 mb at 21.0N, 76.0W at 12Z. Ship highlights: 5 kt NW and 1005 mb at 19.6N, 75.0W at 12Z (micro). 20 kt NW and 1004 mb at 22.0N, 77.3W at 18Z (COADS). Land highlights: 10 kt N and 1005 kt at Santiago de Cuba at 12Z (micro). 1003 mb at Ragged Island, Bahamas at 18Z (micro).

MWR: "The Woods Hole Oceanographic Institution research vessel Crawford, on a weather mission in the Caribbean, was very near the circulation center during the afternoon and evening of the 30th and encountered 25 mph southeasterly winds and a minimum pressure near 1005 mb (29.68 in). A radiosonde observation taken by the Crawford shortly after their winds shifted from the southeast to northwest indicated the Low was definitely cold-core as opposed to the warm core associated with hurricanes."

November 1:

HWM analyzes a tropical storm of at most 1000 mb at 25.0N, 72.3W at 12Z. HURDAT lists this as a 30 knot tropical depression at 25.9N, 72.5W at 12Z. Microfilm shows a closed low pressure of at most 1002 mb at 27.0N, 72.0W at 12Z. Ship highlights: 10 kt WSW and 1004 mb at 22.4N, 74.6W at 00Z (micro). 35 kt E and 1010 mb at 28.1N, 72.2W at 06Z (micro). 40 kt SE and 1001 mb at 27.2N, 71.0W at 12Z (micro). 45 kt E and 1002 mb at 27.6N, 71.3W at 18Z (micro). Land highlights: 20 kt WSW and 1004 mb at Mayaguana, Bahamas at 00Z (micro). 5 kt WSW and 1003 mb at San Salvador, Bahamas at 06Z (micro). 10 kt N and 1005 mb at North Eleuthera at 12Z (micro). 5 kt SW and 1003 mb at Ragged Island, Bahamas at 18Z (micro).

MWR: “The Low continued northward at about 15 mph with a gradual intensification and by November 1 the lowest pressure had decreased to 998 mb (29.47 in). Winds of 30 to 40 mph were reported over a large area surrounding the center, but gentle variable winds and calm still covered an extensive area near the center. A large high pressure system, which had stagnated some distance off the middle Atlantic coast during the last few days of October, blocked further northwest movement so that during the night of November 1, the storm looped and took a southeastward course with a somewhat slower speed. It was during this period, as shown by data received from planes of the National Hurricane Research Project, that Greta assumed tropical storm characteristics with a minimum pressure of 992 mb (29.29 in).” ATSR: “Between 1 and 2 November the new low pressure area increased greatly in area of circulation. The central pressure had decreased as expected under the divergent flow aloft. Future intensification was expected, not in the form of hurricane formation, but rather as a large North Atlantic extratropical storm. On 2 November the storm became nearly stationary within an area of a radius of 30 miles from 26.8N and 72.3W. Southerly movement at about 11 knots then became apparent.”

November 2:

HWM analyzes a tropical storm of at most 990 mb at 27.5N, 72.0W at 12Z. HURDAT lists this as a 35 knot tropical storm at 28.1N, 73.5W at 12Z. Microfilm shows a closed low pressure of at most 996 mb at 27.5N, 72.0W at 12Z. Ship highlights: 40 kt E and 1002 mb at 30.0N, 71.9W at 00Z (COADS). 40 kt NE and 1003 mb at 30.3N, 72.6W at 06Z (COADS). 45 kt E and 1003 mb at 30.2N, 72.4W at 12Z (COADS). 45 kt E and 1002 mb at 30.5N, 72.7W at 18Z (COADS). 55 kt NE and 1001 mb at 29.8N, 74.1W at 21Z (micro). Land highlights: 10 kt WNW and 1002 mb at Cat Island, Bahamas at 00Z (micro). 20 kt WNW and 1002 mb at San Salvador, Bahamas at 06Z (micro). 25 kt NNE

and 1001 mb at Abaco Island at 12Z (micro). 30 kt N and 1000 mb at Abaco Island at 18Z (micro). Aircraft highlight: 992 mb central pressure around 0Z (MWR).

November 3:

HWM analyzes a tropical storm of at most 990 mb at 25.3N, 72.3W at 12Z. HURDAT lists this as a 55 knot tropical storm at 25.2N, 71.8W at 12Z. Microfilm shows a closed low pressure of at most 990 mb at 25.5N, 71.5W at 12Z. Ship highlights: 45 kt ENE and 1004 mb at 30.5N, 72.7W at 00Z (COADS). 45 kt NE and 1000 mb at 28.3N, 71.4W at 06Z (COADS). 35 kt ENE and 989 mb at 26.8, 71.8W at 12Z (micro). 55 kt NE and 1005 mb at 30.1N, 72.0W at 18Z (COADS). Land highlights: 30 kt N and 1000 mb at Abaco Island at 00Z (micro). 25 kt W and 996 mb at San Salvador at 06Z (micro). 15 kt NW and 991 mb at Mayaguana, Bahamas at 12Z (micro). 35 kt NNE and 1002 mb at Abaco Island, Bahamas at 18Z (micro). 40 kt W and 992 mb at Grand Turk and Caicos at 21Z (micro).

MWR: “It is believed that Greta reached hurricane intensity on the afternoon of November 3 or early on the 4th.” ATSR: “Air Force reconnaissance on 2 and 3 November reported intensification and the 3 November flight reports indicated the center of circulation had become a warm core circulation. The surface wind field still exhibited extratropical characteristics, therefore hurricane or tropical storm warnings were not issued since a warning of this type would indicate to the users of the information that the maximum winds were near the center and such was not the case at this time.”

November 4:

HWM analyzes a hurricane of at most 985 mb at 23.3N, 69.7W at 12Z. HURDAT lists this as a 75 knot hurricane at 22.6N, 68.3W at 12Z. Microfilm shows a closed low pressure of at most 984 mb at 22.5N, 68.5W at 12Z. Ship highlights: 40 kt W and 987 mb at 23.2N, 70.7W at 00Z (COADS). 70 kt E and 1005 mb at 26.7N, 68.5W at 03Z (micro). 50 kt NE and 994 mb at 24.0N, 71.0W at 06Z (COADS). 40 kt SE and 982 mb at 22.5N, 67.7W at 12Z (micro). 80 kt SSW and 991 mb at 22.7N, 65.9W at 15Z (micro). 25 kt W and 975 mb at 22.0N, 67.2W at 18Z (micro). 70 kt SSW and 985 mb at 21.9N, 65.8W at 21Z (micro). Land highlights: 35 kt ENE and 1006 mb at Abaco Island at 00Z (micro). 15 kt SW and 994 mb at Puerto Plata, Dominican Republic at 06Z (micro). 10 kt N and 998 mb at Grand Turk and Caicos at 12Z (micro). 20 kt SW and 996 mb at Aguadilla, Puerto Rico at 18Z (micro). Aircraft highlights: Penetration center fix estimated maximum surface winds of 60 kt and an eye diameter of 40 nm at 22.6N, 66.4W at 1915Z (ATSR/climo). Penetration center fix at 22.6N, 66.2W at 2020Z (ATSR).

ATSR: “By 4 November the 200 mb chart indicated a more east to northeasterly trend and continued intensification due to divergent flow aloft and the warm waters over which

the storm was now passing. High level Air Force reconnaissance on 4 November reported an “eye” centered at 22.6N and 66.4W at 1915Z and maximum surface winds estimated at 60 kt. The wind field estimated from ship and reconnaissance reports now indicated intensification near the center. At 2200Z, 4 November, coordinated Warning Number One Hurricane Greta was issued.”

November 5:

HWM analyzes a hurricane of at most 970 mb at 25.8N, 60.7W with a warm front extending to the east at 12Z. HURDAT lists this as a 120 knot hurricane at 25.3N, 61.0W at 12Z. Microfilm shows a closed low pressure of at most 975 mb at 26.2N, 61.2W at 12Z. Ship highlights: 50 kt N and 978 mb at 22.6N, 66.3W at 00Z (COADS). 55 kt N and 997 mb at 22.5N, 66.0W at 03Z (micro). 45 kt SSW and 987 mb at 22.4N, 62.0W at 06Z (COADS). 50 kt NNE and 997 mb at 27.0N, 63.0W at 12Z (COADS). 35 kt NE and 969 mb at 28.5N, 63.5W (longitude appears too far west)(no time given but likely around 18Z). Land highlights: 30 kt SW and 1001 mb at St. Martin at 00Z (micro). Aircraft highlights: Penetration center fix estimated maximum surface winds of 120 kt and a central pressure of 970 mb at 26.1N, 61.1W at 1320Z (ATSR). Penetration center fix estimated maximum surface winds of 70 kt at 27.4N, 58.5W at 2220Z (ATSR).

MWR: “Continued to intensify until November 5 when winds in excess of 100 mph and a minimum pressure of 970 mb (28.64 in) were reported by reconnaissance aircraft. During this period the forward motion became east-northeast at 20-25 mph.” ATSR: “On 5 November, Navy low level reconnaissance reported the “eye” centered by radar precipitation echoes and wind circulation at 26-03N and 61-03W at 1320Z with a minimum surface pressure of 970 mb, maximum surface winds of 120 knots to the north and east quadrants. At 2220Z, 5 November, Air Force reconnaissance penetrated after dark at the 500 mb level and reported the center at 27-25N and 58-27W with maximum winds of 70 knots east and south of the storm at that level. It was also reported that much of the cloudiness surrounding the “eye” could be topped at 10,000 to 14,000 feet.”

November 6:

HWM analyzes a hurricane of at most 980 mb at 29.9N, 53.5W with a cold front about 120 nm miles to the northwest at 12Z. HURDAT lists this as an 85 knot hurricane at 30.6N, 51.2W at 12Z. Microfilm shows a closed low pressure of at most 990 mb at 30.5N, 53.5W at 12Z. Ship highlights: 60 kt N and 1004 mb at 28.7N, 63.5W at 00Z (micro). 60 kt E and 992 mb at 31.2N, 53.8W at 06Z (COADS). 40 kt SE and 984 mb at 31.0N, 52.6W at 12Z (COADS). 80 kt NNE and 999 mb at 31.0N, 53.0W at 15Z (micro). 60 kt SW and 996 mb at 30.2N, 50.6W at 18Z (COADS). Aircraft highlights: Penetration

center fix at 28.3N, 56.8W at 0245Z (ATSR). Penetration center fix at 29.5N, 55.5W at 0720Z (ATSR).

MWR: “On November 6 and 7 the storm continued east-northeastward at an accelerated speed, gradually assuming extratropical characteristics due to much colder ocean temperatures and an influx of cold air.” ATSR: “Hurricane Greta continued on a northeasterly course reaching a speed of 22 knots by 1000Z, 6 November. By this time, a combination of effects was beginning to limit Greta’s life span. The increased forward speed and the course over cooler water had decreased the maximum surface winds from 120 knots to about 85 to 90 knots by 1000Z, 6 November. By 2200Z, 6 November, Hurricane Greta had become extratropical with maximum surface winds of 55 to 60 knots and the final warning was issued.”

November 7:

HWM analyzes a closed low pressure of at most 1000 mb at 35.0N, 36.0W with a cold front extending through the system northeast to southwest at 12Z. HURDAT lists this as a 45 knot extratropical cyclone at 34.5N, 37.7W at 06Z (last position). Microfilm shows a closed low pressure of at most 996 mb at 33.5N, 46.0W at 00Z. Ship highlights: 35 kt NE and 998 mb at 33.5N, 48.0W at 00Z (micro). 40 kt NW and 1006 mb at 32.5N, 47.2W at 06Z (COADS). 40 kt SW and 1009 mb at 32.6N, 35.0W at 12Z (COADS).

A broad area of low pressure was present over the central Caribbean Sea late in October, possibly associated with the eastern Pacific monsoon trough. The low pressure started to become better organized around October 30 south of Jamaica while slowly moving northward. A 25 kt tropical depression is analyzed to have developed at 12Z on October 31st just north of eastern Cuba. Genesis is delayed 30 hours compared to the original HURDAT, a major change. Ship and land observations indicate that a well-defined low level circulation was not present on October 30th or early on the 31st. Minor track changes are analyzed from October 31st to November 6th at 12Z, and major track changes are analyzed on November 6th at 18Z and November 7th at 00Z and 06Z. The depression continued moving northward and later northeastward. At 18Z on the 31st, calm conditions and 1003 mb were reported at Ragged Island, Bahamas. A central pressure of 1003 mb is added to HURDAT at 18Z on the 31st. A central pressure of 1003 mb suggests maximum sustained winds of 41 kt from the south of 25N Brown et al. pressure-wind relationship. Due to the large size of the cyclone, low environmental pressures and no reports of gale-force winds, an intensity of 30 kt is selected at 18Z on the 31st. At 00Z on November 1st, the depression crossed Long Island, Bahamas, on its way to the Atlantic. Two ships reported 35 kt at 06Z and it is analyzed that at this time, the depression reached tropical storm intensity. Intensification to a tropical storm is analyzed 30 hours earlier than originally shown in HURDAT, a major change. More gales were reported by ships on the

1st, reaching up to 45 kt at 18Z. At 18Z, an intensity of 50 kt is selected, up from 30 kt in HURDAT, a major intensity change. Late on November 1st, the northward progression of Greta stopped and the storm turned to the west. Shortly after, Greta turned to the southeast completing a counter-clockwise loop early on the 3rd.

At 00Z on November 2nd, HURDAT shows a central pressure of 992 mb. According to the MWR, the National Hurricane Research Project made this measurement and the central pressure is retained. A central pressure of 992 mb suggests maximum sustained winds of 56 kt from the north of 25N pressure-wind relationship and 59 kt N25N intensifying. Due to the large size of the tropical storm and slow forward speed, an intensity of 50 kt is selected. Major intensity changes are introduced at 00Z, 06Z and 18Z on the 2nd. It is analyzed that Greta had an intensity of 50 kt at 00Z and 06Z and 55 kt at 18Z, while HURDAT indicates 30 kt, 30 kt and 35 kt, respectively. Numerous ships reported gale-force winds on the 2nd, including 55 kt at 21Z. On November 3rd, Greta started to gain forward speed while moving southeastward and passing over 100 nm northeast of the eastern Bahamas. The tropical cyclone slowly intensified on the 3rd reaching 60 kt at 06Z on the 3rd, up from 45 kt in HURDAT, a minor intensity change. The cyclone continued to grow in size and on the 3rd at 12Z, the 34 kt wind radii of Greta extended to about 500 nm to the northwest quadrant. A central pressure of 982 mb is present in HURDAT at 12Z on the 3rd and although it is not in the MWR or Navy book, reconnaissance aircraft was present around this time and it is retained. A central pressure of 982 mb suggests maximum sustained winds of 70 kt from the north of 25N and 75 kt south of 25N pressure-wind relationship. Due to the large size of Greta and low environmental pressures, an intensity of 60 kt is selected for 12Z on the 3rd, up from 55 kt in HURDAT, a minor change. Gale-force winds continued to be reported by ships on the 3rd, reaching up to 45 kt. Gale-force winds were also reported by land stations late on the 3rd over the eastern Bahamas. Tropical Storm Greta turned to the east late on the 4th and then to the northeast on the 5th while gaining in forward speed. Intensification to hurricane is analyzed at 00Z on the 4th, six hours earlier than HURDAT. A ship at 00Z on the 4th reported 40 kt W and 986 mb. A pressure of 986 yields maximum sustained winds greater than 70 kt south of 25N according to the pressure-wind relationship. An intensity of 65 kt is selected at 00Z on the 4th, bringing Greta to hurricane intensity. Winds of hurricane intensity were reported by ships on the 4th, including 80 kt at 15Z and 70 kt at 21Z. The 34 kt wind radii at 12Z on the 4th is analyzed to have been about 550 nm to the northwest.

A reconnaissance aircraft estimated maximum surface winds of 60 kt and an eye diameter of 40 nm at 1915Z on the 4th. At 18Z, a central pressure of 970 mb is present and it appears likely that it was from the same reconnaissance mission. A central pressure of 970 mb suggests maximum sustained winds of 90 kt from the south of 25N pressure-wind

relationship. An eye diameter of 40 nm suggests an RMW of about 30 nm and climatology for this central pressure and latitude 17 nm. Due to the large size of Greta and forward speed of about 15 knots, an intensity of 85 kt is selected at 18Z on the 4th, down from 95 kt originally in HURDAT, a minor change. Hurricane Greta continued to move rapidly to the northeast on the 5th while moving away from the northeastern Caribbean where the swells from the hurricane caused damage. A reconnaissance aircraft measured a central pressure of 970 mb and estimated maximum surface winds of 120 kt (which were used verbatim in HURDAT) at 1312Z. A central pressure of 970 mb suggests maximum sustained winds of 84 kt north of 25N and 90 kt south of 25N, according to the pressure-wind relationship. Greta was still a very large hurricane, the ROCI at 12Z is estimated at 500 nm, but it was moving at a pace of about 25 kt, thus an intensity of 85 kt is selected for 12Z on the 5th, down from 120 kt originally in HURDAT, a major intensity change. Major intensity changes are also introduced at 00Z, 06Z, and 18Z. 85 kt is selected for those times and HURDAT has 110 kt, 115 kt and 120 kt, respectively. 85 kt is also the peak intensity for Greta, down from 120 kt originally shown in HURDAT, a major intensity change. The reanalysis indicates that Greta never reached major hurricane status. Gale-force winds were reported by numerous ships on the 5th, including 50 kt with 978 mb at 00Z. Transition to an extratropical cyclone is analyzed at 06Z on the 6th, 18 hours earlier than originally shown in HURDAT. Data analysis at 06Z on the 6th indicates that a warm front had developed to the northeast of the center and a temperature gradient was clearly visible between the eastern and northern quadrants. Furthermore, the microfilm data suggests that the circulation was becoming elongated northeast-southwest. A central pressure of 985 mb is present in HURDAT at 12Z on the 6th. It has been removed because a ship at 12Z located at 31.0N, 52.0W reported 40 kt SE and 984 mb. At 12Z on the 6th, a ship reported 80 kt and the intensity has been kept at 85 kt. Late on the 6th and early on the 7th, Greta continued northeastward becoming embedded within a frontal boundary. After 06Z on the 7th, the circulation had dissipated (unchanged from HURDAT). Microfilm data clearly indicates that major track changes are necessary at 18Z on the 6th and 00Z and 06Z on the 7th as the extratropical cyclone was not moving as fast as shown in HURDAT. The extratropical cyclone is analyzed to have weakened below hurricane intensity at 06Z on the 7th. The largest 34 kt wind radii of Hurricane Sandy, analyzed at 00Z on October 28, 2012, reached 480 nm. The ROCI of Hurricane Sandy on October 28th at 18Z was also estimated to be 500 nm.

New Tropical Storm [November 19-21, 1956]

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37265 11/19/1956 M=12 3 SNBR= 820 UNNAMED       XING=0 SSS=0                    L

37265 11/19*250 470  25    0*250 473  30    0*250 478  35    0*251 483  40    0*
37265 11/20*253 487  40    0*255 491  40    0*256 490  40    0*253 487  40    0*
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37265 11/21*250 490  35    0*251 497  35    0*255 505  30    0*0   0    0     0*
37285 TS
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A new tropical storm has been added to HURDAT, not previously shown in McAdie et al. (2009). Evidence for its existence comes from the Historical Weather Map series, COADS ship database, and Jack Beven's suspect list.

November 18:

HWM shows a spot low pressure at 23.5N, 43.5W at 12Z. Ship highlights: No gale force winds or equivalent low pressures.

November 19:

HWM shows a closed low pressure of at most 1010 mb at 25.0N, 48.0W at 12Z. Ship highlights: No gale force winds or equivalent low pressures.

November 20:

HWM shows a closed low pressure of at most 1010 mb at 25.5N, 48.0W and a stationary frontal boundary to the north at 12Z. Ship highlights: 30 kt SSW and 1002 mb at 25.0N, 48.7W at 00Z (COADS). 30 kt W and 1005 mb at 25.2N, 49.5W at 06Z (COADS). 35 kt S and 1009 mb at 25.3N, 47.4W at 12Z (COADS).

November 21:

HWM shows a trough of low pressure along 22N-30N, 51W at 12Z. Ship highlights: No gale force winds or equivalent low pressures.

November 22:

HWM does not show an organized system at 12Z. Ship highlights: No gale force winds or equivalent low pressures.

A small area of low pressure developed as a frontal boundary weakened over the central Atlantic during the third week of November. Ship data indicates that it became better organized and a 25 kt tropical depression is analyzed to have developed at 00Z on November 19th. It is certainly possible that the tropical cyclone developed late on the 18th but the data is too scarce on this day. The tropical depression moved slowly to the west becoming a tropical storm at 12Z on November 19th. A ship reported 30 kt SSW and 1002 mb at 06Z on November 20th. A peripheral pressure of 1002 mb suggests maximum

sustained winds of at least 43 kt south of 25N and 40 kt north of the 25N from the Brown et al. pressure-wind relationship. An intensity of 40 kt is selected for 06z on November 20th due to the slow forward motion of the storm. 40 kt is the peak intensity of this tropical storm. At 12Z on the 20th, a ship reported 35 kt S and 1009 mb and the ship mentioned previously was reporting 30 kt W and 1005 mb. The tropical cyclone began weakening early om November 21st, diminishing to a tropical depression at 12Z and degenerating later on the day into a trough of low pressure.

1956 - Additional Notes

1) January 4-8: A low pressure developed along the tail-end of a frontal boundary over the central Atlantic on January 5th. The disturbance remained nearly stationary over the next few days according to the Historical Weather Map. A strong pressure gradient to the north resulted in gale-force winds 400 nm north of the center. On the 6th, numerous ships near the center reported low pressures (below 1000 mb) but no gale-force winds, which is likely an indication that the system was never a tropical cyclone or subtropical cyclone. The disturbance started weakening on the 7th and was absorbed by a cold front on the 8th. Therefore, because it likely remained as an extratropical low, it is not added to HURDAT.

Day	LAT	LONG	STATUS
January 4	Central	Atlantic	Cold front
January 5	25N	44W	Extratropical
January 6	26N	45W	Extratropical
January 7	27N	45W	Extratropical
January 8	33N	46W	Absorbed by front

2) May 22-25: A trough of low pressure was located north of Hispaniola on May 22nd. The disturbance moved generally northeastward ahead of a frontal boundary, while becoming slighly better organized on the 23rd and 24th. The system weakened back to a trough on the 25th over the central Atlantic and was absorbed by the cold front soon after. No gale-force winds were found in COADS or HWM associated with this disturbance. Therefore, it is not added to HURDAT. This disturbance was in Beven's and Roth's List of Suspects.

Day	LAT	LONG	STATUS
May 22	20-25N	69W	Trough
May 23	27N	64W	Tropical Depression?
May 24	27N	60W	Tropical Depression?
May 25	24-34N	53-60W	Trough

3) June 18-20: A non-frontal low pressure developed east of the Bahamas on the 18th and moved northward. Two ships reported gale-force winds east of the disturbance on the 18th. The disturbance was also monitored by a reconnaissance aircraft on the 18th. The reconnaissance mission did not find a closed low-level circulation, just a minimum pressure of 1014 mb. The system continued northward on the 19th and by the 20th it was absorbed by a frontal boundary. Therefore, without a closed circulation when gale force winds were observed, it is not added to HURDAT. This disturbance was in Beven's and Roth's List of Suspects.

Day	LAT	LONG	STATUS
June 18	25N	71W	Trough
June 19	30N	69W	Trough
June 20	33N	59W	Absorbed by front

4) July 5-7: A low pressure developed over the northeast Gulf of Mexico on July 5th producing gusty conditions over the western Florida panhandle. Panama City reported a gust to 38 kt on the 6th. No gales or equivalent low pressures were found in COADS, Microfilm, or Surface Weather Observations. By the 7th, the system had moved inland and dissipated soon thereafter. MWR: "A complete although very weak circulation was noted at 1930 EST on July 4, at Lat. 26.2N., Long. 86.2W., developing under a cold trough in the mid-troposphere. It moved north-northwestward and northwestward on the 6th causing gusts of 38 knots at Panama City and moved inland near Pensacola late on the 6th where the lowest barometer noted was 1011 mb. Whatley, Ala., reported 14.22 inches of rain during the storm and 10.85 inches in 24 hours. Property damage was estimated at $400,000 from the heavy rains, plus $1OO,OOO crop and $3,000 livestock damage. Many highway and railroad bridges were washed out and erosion of roads was extensive." Therefore, it is not added to HURDAT. Because this system did not have observed gale force sustained winds, disturbance was in Beven's List of Suspects.

Day	LAT	LONG	STATUS
July 5	28N	85W	Tropical Depression?
July 6	29N	87W	Tropical Depression?
July 7	30N	88W	Dissipated

5) August 14-17: A strong tropical wave followed Hurricane Betsy to the Caribbean Sea during the middle of August. The vigorous disturbance produced gale-force winds on the 15th as it approached the Lesser Antilles but a reconnaissance aircraft found that the circulation was poorly-organized with no west-winds on the southern quadrant. The disturbance continued westward and became less organized over the eastern Caribbean Sea as it interacted with the Greater Antilles. Therefore, because it did not have a closed circulation, it is not added to HURDAT.

Day	LAT	LONG	STATUS
August 14	15N	53W	Tropical Wave
August 15	15N	56W	Tropical Wave
August 16	18N	64W	Tropical Wave
August 17	18N	66W	Tropical Wave

6) August 29 - September 7: A strong tropical wave left the African coast on August 28. The system gradually moved westward and on August 31st, the pressure at Santa Maria in the Cape Verde Islands dropped to 1004 mb, a drop of six millibars from the previous day. The ship and land data is sparse to suggest a closed low level circulation was present. During the next few days, the strong disturbance moved away from the Cape Verde Islands into the central Atlantic where the ship data is even more sparse. By September 6th, ships northeast of the Lesser Antilles indicate that the tropical wave did not have a closed low level circulation. On the 7th, the disturbance continued to lose organization as it moved toward the Lesser Antilles. MWR: "On August 28 an unusually strong wave on the intertropical convergence zone began approaching the Cape Verde Islands and soon developed considerable intensity. Station SAL in the Cape Verdes on the 31st observed a barometer reading of 1004 mb. Several ships in the area reported winds of 35 to 40 knots. After leaving the Cape Verde area the storm apparently gradually decreased in intensity and finally dissipated northeast of the Leeward Islands on the 6th." Therefore, because it unknown whether the system had a closed low on the 31st when the low pressure and gales were reported, it is not added to HURDAT. This disturbance was in Beven's List of Suspects.

Day	LAT	LONG	STATUS
August 29	14N	19W	Tropical Wave
August 30	14N	20W	Tropical Depression?
August 31	15N	24W	Tropical Storm?
September 1	14N	27W	Tropical Storm?
September 2	15N	32W	Tropical Storm?
September 3	15N	36W	Tropical Storm?
September 4	15N	40W	Tropical Storm?
September 5	18N	46W	Tropical Depression?
September 6	17N	50W	Tropical Wave
September 7	17N	55W	Tropical Wave

7) September 11-13: A strong tropical wave left the African coast on September 10th. The disturbance moved westward passing by the Cape Verde Islands on the 12th. On this day, a ship just north of the islands reported a pressure of 1005 mb but the data is very sparse to suggest a closed low level circulation was present. The tropical wave continued westward into the central Atlantic where the ship data is even sparser. No gales were

found associated with this disturbance. MWR: "A vigorous depression passed through the Cape Verdes on the 13th, attended by squalls. Maximum winds are unknown. The depression was completely damped out before reaching the Antilles." Therefore, without any gale force winds or indications of a closed low, it is not added to HURDAT. This disturbance was in Beven's List of Suspects.

Day	LAT	LONG	STATUS
September 11	15N	20W	Tropical Wave
September 12	13N	22W	Tropical Depression?
September 13	12N	27W	Tropical Depression?

8) September 29-30: A low pressure developed over the Gulf of Mexico on September 29 and moved to the northwest making landfall in Texas on the 30th. No gale-force winds were found in microfilm or HWM associated with this disturbance. Therefore, without any gale force winds, it is not added to HURDAT.

Day	LAT	LONG	STATUS
September 29	23N	92W	Tropical Depression?
September 30	26N	94W	Dissipated

9) October 10-12: A low pressure developed over the central Atlantic on October 10th, possibly in the northern portion of a tropical wave. The disturbance drifted northward and was absorbed by a cold front on October 13. No gale-force winds were found in COADS or HWM associated with this disturbance. MWR: "Probably developing from the same easterly wave but farther to the north, a tropical depression formed on October 10 and moved in a general northerly direction for several days without further development. It was not the same depression noted on the 9th (new storm)." Therefore, without any gale force winds, it is not added to HURDAT. This disturbance was in Beven's List of Suspects.

Day	LAT	LONG	STATUS
October 10	25N	50W	Tropical Depression?
October 11	29N	52W	Tropical Depression?
October 12	29N	54W	Tropical Depression?
October 13			Absorbed by front

10) October 22-26: A low pressure developed on the tail-end of a frontal boundary over the eastern Atlantic on October 22nd. The system moved southwestward on the 23rd and became an occluded low pressure. As another frontal boundary approached, the disturbance turned northward and by October 25th, gale-force winds were being reported about 150 nm north of the center. Nonetheless, data suggests that the disturbance never

became a tropical or subtropical cyclone before being absorbed by the frontal boundary. Therefore, it is not added to HURDAT. This disturbance was in Roth's List of Suspects.

Day	LAT	LONG	STATUS
October 22	32N	31W	Extratropical
October 23	30N	35W	Extratropical
October 24	34N	37W	Extratropical
October 25	36N	41W	Extratropical
October 26	45N	41W	Absorbed by front

11) October 28-30: An extratropical cyclone was located east of North Carolina on October 28 and slowly moved southwestward becoming occluded the next day. Gale-force winds were reported about 200 nm from the center but data suggests it never acquired tropical characteristics. The disturbance made landfall on October 30th and dissipated a day later. Therefore, it is not added to HURDAT.

Day	LAT	LONG	STATUS
October 28	34N	73W	Extratropical
October 29	31N	76W	Extratropical
October 30	33N	78W	Extratropical
October 31			Dissipated

12) November 3-5: Microfilm shows that a non-frontal low pressure developed east of Hurricane Greta early on November 3rd. The disturbance moved rapidly to the northeast on the 4th with gale-force winds near the center and low pressures (below 1000 mb) according to ships in the area. At the same time, there was a powerful extratropical cyclone over the north Atlantic and ship data suggests that there may have been a trough connecting both systems as winds north of the non-frontal low pressure were responding to the larger extratropical cyclone. On November 5th, the disturbance was absorbed by the extratropical cyclone. The environment around the disturbance was moist and temperatures were warm, suggesting the system was likely tropical or subtropical, but the data suggests that the low level circulation was probably not closed. Therefore, it is not added to HURDAT.

Day	LAT	LONG	STATUS
November 3	23N	57W	Trough
November 4	29N	48W	Trough
November 5			Absorbed by an extratropical cyclone

1957 hurricane season

New Tropical Storm [April 30-May 4, 1957]

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37265 04/30/1957 M= 5 1 SNBR= 820 UNNAMED       XING=0 SSS=0

37265 04/30*  0   0   0    0*  0   0   0    0*293 924  30    0*294 928  30    0*
37265 05/01*295 932  30    0*296 934  30    0*297 931  35 1001*298 927  35 1001*
37265 05/02*300 923  30 1000*303 919  30  999*305 915  25 1000*307 911  25    0*
37265 05/03*309 906  25 1000*311 900  20 1001*313 889  20 1001*315 876  25  999*
37265 05/04*316 863  25  999E316 849  25  998E316 835  30  998*  0   0   0    0*
37285 TS
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U.S. Tropical Storm Landfall

05/01 14Z 29.7N 93.0W 35 kt LA

A new tropical storm has been added to HURDAT, not previously shown in McAdie et al. (2009). Evidence for its existence comes from the Historical Weather Map series, Microfilm, COADS ship database and Surface Weather Observations.

April 29:

HWM analyzes a warm front over the central United States at 12Z. Microfilm shows a frontal boundary over the northwest Gulf of Mexico at 12Z. Ship highlights: No gale force winds or equivalent low pressures.

April 30:

HWM analyzes a closed low pressure of at most 1010 at 27.5N, 91.5W at 12Z. Microfilm shows a closed low pressure of at most 1008 at 29.0N, 92.0W at 12Z. Ship highlights: 30 kt ENE and 1007 mb at 29.5N, 92.5W at 12Z (micro).

May 1:

HWM analyzes a closed low pressure of at most 1010 at 29.0N, 93.5W at 12Z. Microfilm shows a closed low pressure of at most 1005 at 29.5N, 93.0W at 12Z. The MWR Track of Centers shows a low pressure of 1004 mb at 29.5N, 93.2W at 12Z. Ship highlights: 30 kt W and 1003 mb at 29.5N, 92.5W at 00Z (micro). 35 kt WSW and 1004 mb at 28.9N, 92.6W at 12Z (micro). 20 kt SSE and 1003 mb at 29.5N, 92.5W at 12Z (micro). 30 kt WSW and 1005 mb at 28.8N, 92.7W at 12Z (micro). Land highlights: 14 kt ESE and 1004 mb at LaFayette, LA at 1828Z (SWO).

May 2:

HWM analyzes a closed low pressure of at most 1005 at 29.5N, 91.5W with a trough extending to another closed low pressure of at most 1005 mb at 31.5N, 78.5W at

12Z. Microfilm shows a closed low pressure of at most 1005 at 30.0N, 91.5W at 12Z. The MWR Track of Centers shows a low pressure of 1002 mb at 30.5N, 91.5W at 12Z. Ship highlights: 20 kt WNW and 1004 mb at 29.1N, 92.4W at 12Z (COADS). Land highlights: 14 kt E and 1003 mb at LaFayette, LA at 0028Z (SWO). 15 kt W and 1002 mb at LaFayette, LA at 0628Z (SWO). 17 kt SSE and 1002 mb at Baton Rouge, LA at 1128Z (SWO). 8 kt WSW and 1004 mb at Baton Rouge, LA at 1828Z (SWO). 6 kt ENE and 1001 mb at McComb, MS at 2328Z (SWO.

May 3:

HWM analyzes a closed and E-W elongated low pressure of at most 1005 at 31.0N, 90.0W with a trough extending to another closed low pressure off the US east coast and a cold front to the north at 12Z. Microfilm shows a closed low pressure of at most 1005 at 32.0N, 88.5W with a frontal boundary to the north at 12Z. The MWR Track of Centers shows a low pressure of 1003 mb at 31.2N, 88.5W at 12Z. Ship highlights: 15 kt SW and 1005 mb at 28.8N, 91.6W at 00Z (COADS). Land highlights: 7 kt NW and 1004 mb at Baton Rouge, LA at 0028Z (SWO). 8 kt NW and 1003 mb at McComb, MS at 0528Z (SWO). 15 kt W and 1004 mb at Mobile, AL at 12Z (micro). 15 kt SW and 1001 mb at Evergreen, AL at 18Z (micro).

May 4:

HWM analyzes a frontal boundary from the northern Gulf of Mexico to the western Atlantic with an elongated area of low pressure near the SE United States at 12Z. Microfilm shows a closed low pressure of at most 1002 at 32.0N, 83.5W with a frontal boundary extending to the east and south at 12Z. The MWR Track of Centers shows a low pressure of 1000 mb at 31.8N, 83.0W at 12Z. Ship highlights: 15 kt SW and 1005 mb at 27.9N, 85.2W at 00Z (COADS). 35 kt NE and 1005 mb at 31.8N, 80.5W at 18Z (micro).Land highlights: 10 kt S and 1001 mb at Dothan, AL at 00Z (micro). 10 kt SSW and 1000 mb at Dothan, AL at 06Z (micro). 20 kt SW and 1002 mb at Valdosta, GA at 12Z (micro).

May 5:

HWM analyzes a closed low pressure of at most 1005 mb at 35.5N, 68.0W with a warm front to the east and a cold front to the southwest at 12Z. Microfilm shows a closed low pressure of at most 1005 mb at 34.0N, 70.0W with a frontal boundary to the east and southwest at 12Z. The MWR Track of Centers shows a low pressure at 31.7N, 77.8W at 00Z (last position).

The development of this off-season tropical storm appears to be associated with an upper level low that became cut-off over the southern United States and moved into the

northern Gulf of Mexico late on April. A low pressure developed at the surface and a 30 kt tropical depression is analyzed to have formed at 12Z on April 30 just off the coast of Louisiana. At 12Z, a ship close to the center reported 30 kt ENE and 1007 mb. The environment around the tropical depression was very moist with dew points in the mid to high 60s. The surface analysis on Microfilm and Historical Weather Maps do not show any type of frontal boundary associated with the tropical cyclone and the strongest winds were close to the center. The 500 mb analysis on the Historical Weather Maps shows an upper level low basically on top of the depression, thus it is likely that this cyclone was subtropical. But since we do not have satellite images to determine its structure, it is analyzed as a tropical cyclone. The system initially moved slowly to the west and later turned to the northeast on May 1st. Intensification to a tropical storm is analyzed at 12Z on the 1st. A ship at that time reported 35 kt WSW and 1004 mb. Another ship at that time reported 20 kt SSE and 1003 mb, which allows us to estimate a central pressure of 1001 mb. A central pressure of 1001 mb suggests maximum sustained winds of 42 kt north of 25N from the Brown et al. pressure-wind relationship. Due to the slow forward speed of the cyclone, an intensity of 35 kt is selected for 12Z on the 1st. A central pressure of 1001 mb is added at 12Z on the 1st. 35 kt is the peak intensity for this tropical cyclone. At 14Z on the 1st, the small tropical storm made landfall in southern Louisiana near 29.7N, 93.0W or about 20 miles southeast of Cameron, LA, with an intensity of 35 kt. At 1828Z on the 1st, LaFayette, LA reported 15 kt ESE and 1004 mb, and due to land exposure, this suggests a central pressure of 1001 mb, which has been added to 18Z. Weakening to a tropical depression is analyzed at 00Z on May 2nd over southern Louisiana. A ship near the coast reported 30 kt W and 1003 mb at this time. At 00Z on the 2nd, LaFayette, LA reported 15 kt E and 1003 mb, this suggests a central pressure of 1000 mb, which has been added. At 06Z on the 2nd, LaFayette, LA reported 15 kt W and 1002 mb, this suggests a central pressure of 999 mb, which has been added. At 12Z on the 2nd, Baton Rouge, LA reported 15 kt SW and 1003 mb, this suggests a central pressure of 1000 mb, which has been added. Reports from ships and land stations indicate the depression continued to weaken and the winds are decreased to 25 kt at 12Z on the 2nd. Late on the 2nd, the depression crossed into southern Mississippi. At 2328Z on the 2nd, McComb, MS reported 5 kt ENE and 1001 mb, this suggests a central pressure of 1000 mb, which has been added at 00Z on the 3rd. Early on the 3rd, the depression starts to accelerate to the east-northeast and the structure broadens, becoming elongated E-W, with weak winds near it. The intensity at 06Z and 12Z on the 3rd is decreased to 20 kt. At 0528Z on the 3nd, McComb, MS reported 10 kt NW and 1003 mb, this suggests a central pressure of 1001 mb, which has been added at 06Z. At 12Z on the 3nd, Meridian, MS reported 10 kt S and 1003 mb, suggesting a central pressure of 1001 mb, which has been added. Late on the 3rd, the tropical depression crossed into southern Alabama. At 18Z on the 3rd, Evergreen, AL reported 15 kt SW and 1001 mb, suggesting a central pressure of

999 mb, which has been added. Winds up to 20 kt were reported on the coast of Alabama and northwest Florida at 18Z on the 3rd, therefore the intensity is increased to 25 kt at this time. At 00Z on May 4th, the microfilm analysis included a frontal boundary that reached the system's center and also depicts another frontal boundary to the north. The observations around the system show that it was still tropical, with dew points in the mid 60s. At 00Z on the 4nd, Dothan, AL reported 10 kt S and 1001 mb, this suggests a central pressure of 999 mb, which has been added. At 06Z on the 4th, observations indicate that the depression became an extratropical cyclone over southeast Alabama. At the same time, Dothan, AL reported 10 kt SSW and 1000 mb, suggesting a central pressure of 998 mb, which has been added. At 12Z on the 4th, Valdosta, GA reported 20 kt SW and 1002 mb, this suggests a central pressure of 998 mb, which has been added. Later on the 4th, the extratropical cyclone becomes embedded with another extratropical cyclone off the US SE coast forming a large extratropical cyclone that moved into the north Atlantic over the next couple of days. The last position is analyzed at 12Z on the 4th.

Unnamed Tropical Storm 1 [June 8-15, 1957]

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40065 06/08/1957 M= 8  1 SNBR= 872 NOT NAMED   XING=1 SSS=0
40065 06/08/1957 M= 8  2 SNBR= 872 NOT NAMED   XING=1 SSS=0
                       *

40070 06/08*  0   0   0    0*255 885  20    0*262 878  35    0*282 862  35    0*
40070 06/08*  0   0   0    0*250 892  35    0*265 878  40 1002*282 862  45    0*

40075 06/09*300 843  35    0*316 823  35    0*326 802  35    0*330 782  45    0*
40075 06/09*300 843  45 1000*316 823  35 1003*321 802  35    0*323 782  45    0*

40080 06/10*331 761  55    0E332 742  60    0E330 726  60    0E325 714  60    0*
40080 06/10E324 761  55    0E326 742  65    0E328 726  65  996E324 716  65    0*

40085 06/11E320 703  55    0E315 687  55    0E310 673  50    0E309 666  45    0*
40085 06/11E319 707  60    0E314 699  55    0E308 692  50    0E309 685  50    0*

40090 06/12E311 661  45    0E317 656  40    0E322 652  35    0E330 658  35    0*
40090 06/12E310 680  45    0E311 675  40    0E314 672  40    0E318 667  40    0*

40095 06/13E322 661  35    0E321 649  35    0E321 636  35    0E327 624  35    0*
40095 06/13E322 661  40    0E322 653  40    0E323 639  40    0E327 624  40    0*

40100 06/14E334 613  35    0E340 604  35    0E346 596  35    0E356 584  35    0*
40100 06/14E332 611  40    0E337 598  40    0E341 588  40    0E345 582  40    0*

40105 06/15E370 571  35    0E387 564  35    0*  0   0   0    0*  0   0   0    0*
40105 06/15E345 580  35    0E340 585  35    0E335 595  30    0E330 605  25    0*

40110 TS
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U.S. Tropical Storm Landfall

06/09 0030Z 30.1N 84.2W 45 kt FL

Minor track and intensity changes shown in McAdie et al. (2009). Evidence for these alterations comes from the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Mexican synoptic maps, Surface Weather Observations and Monthly Weather Review.

June 7:

HWM analyzes a spot low pressure at 23.5N, 93.2W at 12Z. HURDAT and microfilm do not list an organized storm on this date. Microfilm does not show an organized system on this date. Ship highlights: No gales or low pressures.

MWR: “Pressures were abnormally low over the southwestern Gulf of Mexico and Yucatan area on June 7 but lack of upper-air wind observations from Mexico made the amount of circulation uncertain.”

June 8:

HWM analyzes a closed low pressure of at most 1005 mb at 27.5N, 87.5W at 12Z. HURDAT lists a 35 kt tropical storm at 26.2N, 87.8W at 12Z. Microfilm shows a closed low pressure of at most 1005 mb at 27.0N, 88.0W at 12Z. Ship highlights: 40 kt S and 1006 mb at 26.7N, 86.8W at 12Z (COADS). 15 kt S and 1004 mb at 25.9N, 87.4W at 12Z (COADS). 45 kt SSW and 1011 mb at 25.9N, 85.4W at 18Z (COADS). 45 kt NNE and 1003 mb at 28.7N, 88.5W at 21Z (micro). Land highlights: 5 kt NNE and 1005 mb at Panama City, FL at 21Z (micro).

MWR: “However, late on the 7th and early on the 8th it became evident that a tropical depression existed. It moved rather rapidly northeastward with some deepening but little organization and crossed the Florida coastline in Apalachee Bay during the early evening. Two ships, one about 150 to 200 miles southeast of the center and later another 100 to 150 miles west of the center, reported winds of 45 knots. However, over coastal areas all strong winds were on the east side of the storm. Exposed places along the coast from Sarasota to north of Cedar Keys, Fla., experienced winds of 40 m. p. h. or more and tides 2 to 3 feet above normal with some damage.”

June 9:

HWM analyzes a closed low pressure of at most 1005 mb at 32.0N, 80.5W at 12Z. HURDAT lists a 35 kt tropical storm at 32.6N, 80.2W and a frontal boundary just north at 12Z. Microfilm shows a closed low pressure of at most 1005 mb at 32.0N, 80.0W at 12Z. Ship highlights: 35 kt SSE and 1010 mb at 25.6N, 84.7W at 00Z (COADS). 35 kt N and 1002 mb at 32.8N, 79.3W at 15Z (micro). 35 kt W and 1005 mb at 31.7N, 78.6W at 18Z (COADS). 50 kt SW and 1003 mb at 31.8N, 76.1W at 21Z

(micro). Land highlights: 1005 mb at Panama City, FL at 00Z (micro). 1001 mb at Tallahassee, FL (likely after 01Z) (CLIMO). 30 kt S at Sarasota, Fl at 01Z (SWO). 5 kt NNW and 1004 mb at Alma, GA at 06Z (micro). 1002 mb at Savannah, GA (likely around 10Z) (CLIMO). 1005 mb at Charleston, SC (likely around 12Z) (CLIMO).

MWR: “The storm weakened as it moved inland but set off an active frontal wave after moving off the Georgia coast on the 9th.”

June 10:

HWM analyzes a closed low pressure of at most 1000 mb at 33.5N, 72.5W with a warm front to the east and a cold front to the southwest at 12Z. HURDAT lists a 60 kt extratropical cyclone at 33.0N, 72.6W at 12Z. Microfilm shows a closed low pressure of at most 1002 mb at 33.0N, 72.5W with a frontal boundary to the southeast and southwest at 12Z. Ship highlights: 45 kt SW and 1002 mb at 31.7N, 76.2W at 00Z (COADS). 65 kt NE and 1004 mb at 32.9N, 72.3W at 03Z (COADS). 60 kt NE and 1003 mb at 33.9N, 73.5W at 12Z (COADS). 65 kt ESE and 1009 mb at 33.8N, 70.5W at 18Z (COADS).

MWR: “Late on the 9th when the storm became extratropical off the Atlantic coast, ship reports indicated winds up to 65 knots.”

June 11:

HWM analyzes a closed low pressure of at most 1000 mb at 31.5N, 69.5W with a warm front to the northeast and a cold front to the east and south at 12Z. HURDAT lists a 50 kt extratropical cyclone at 31.0N, 67.3W at 12Z. Microfilm shows a closed low pressure of at most 1005 mb at 31.0N, 66.0W with a frontal boundary to the east-southeast and southwest at 12Z. Ship highlights: 50 kt ENE and 1004 mb at 32.3N, 70.3W at 00Z (COADS). 50 kt NE at 34.0N, 71.3W at 06Z (COADS). 45 kt NE and 1009 mb at 32.6N, 69.4W at 12Z (COADS). 50 kt NNE and 1003 mb at 31.7N, 70.0W at 18Z (COADS).

June 12:

HWM analyzes a closed low pressure of at most 1005 mb at 30.0N, 68.0W with a warm front to the northeast and a weakening cold front to the east and south at 12Z. HURDAT lists a 35 kt extratropical cyclone at 32.2N, 65.2W at 12Z. Microfilm shows a closed low pressure of at most 1008 mb at 32.0N, 65.5W with a frontal boundary to the east and south at 12Z. Ship highlights: 20 kt SE and 1003 mb at 31.0N, 67.2W at 00Z (COADS). 25 kt NW and 1004 mb at 30.0N, 68.5W at 12Z (micro).

June 13:

HWM analyzes a closed low pressure of at most 1010 mb at 31.5N, 64.5W at 12Z. HURDAT lists a 35 kt extratropical cyclone at 32.1N, 63.6W at 12Z. Microfilm shows a closed low pressure of at most 1008 mb at 32.0N, 64.5W at 12Z. Ship highlights: 35 kt SW and 1012 mb at 28.2N, 64.3W at 00Z (COADS). 40 kt W and 1010 mb at 30.2N, 65.3W at 12Z (COADS).

June 14:

HWM analyzes a closed low pressure of at most 1010 mb at 34.0N, 59.0W at 12Z. HURDAT lists a 35 kt extratropical cyclone at 32.1N, 63.6W at 12Z. Microfilm shows a closed low pressure of at most 1014 mb at 38.0N, 60.0W at 12Z. Ship highlights: 40 kt SW and 1012 mb at 34.2N, 56.6W at 18Z (COADS).

June 15:

HWM analyzes a spot low pressure at 34.0N, 59.0W at 12Z. HURDAT lists a 35 kt extratropical cyclone at 38.7N, 56.4W at 06Z (last position). Microfilm does not show an organized storm on this date. Ship highlights: 35 kt SSE and 1008 mb at 35.0N, 57.9W at 06Z (COADS).

June 16:

HWM analyzes a spot low pressure at 31.0N, 59.0W at 12Z. HURDAT does not show an organized system on this date. Microfilm does not show an organized storm on this date. Ship highlights: No gales or low pressures.

MWR: “Exceptionally heavy rain attended passage of this storm, particularly in Suwannee and all adjacent counties; 48-hour amounts of nearly 15 inches at official stations and some unofficial amounts as high as 19 inches. There was considerable damage to field and truck crops, particularly to tobacco and watermelons. Between 100 and 200 families were evacuated near Perry, Fla. According to the Meteorologist in Charge at Jacksonville, at least nine tornadoes or damaging wind storms were reported in northeastern Florida on the afternoon and evening of the 8th and another tornado over Jekyll Island in south-eastern Georgia. No deaths were reported from these tornadoes and the damage and injuries were small. One small craft capsized in the Gulf of Mexico and five of the seven persons aboard were apparently drowned. Damage in northwestern Florida from sea and rainfall flooding from the mouth of the Suwannee River to Port St. Joe was estimated at $30,000 and damage from tidal action along the Florida west coast mas about $10,000. Tornado damage is estimated at $12,000. Therefore, total damage from this tropical storm was around $52,000 and there were five deaths.”

The first tropical cyclone of the 1957 Atlantic hurricane season developed in the central Gulf of Mexico at the start of the second week of June. A decrease in the barometric pressure by about 3-5 mb around the Bay of Campeche was noticeable on June 7th from the previous day indicating that disturbance was organizing. The system moved rapidly to the northeast and HURDAT indicates that genesis occurred at 06Z on June 8th. Data over the western and southwest Gulf of Mexico is very sparse and the time of genesis is uncertain. Therefore, the first position (not genesis) remains unchanged from the original HURDAT. A ship reported 40 kt at 12Z and, on this basis, the tropical cyclone initiated as a 35 kt tropical storm at 06Z, which is 15 kt higher than HURDAT, a minor intensity change. Also, tropical storm intensity is analyzed six hours earlier than originally shown in HURDAT. Minor track changes are introduced for the duration of this cyclone's lifetime, except for 12Z on June 12th and 06Z on June 15th during the extratropical phase. The storm gradually intensified as it moved toward the panhandle of Florida. A ship reported 15 kt and 1004 mb at 12Z and this suggests a central pressure of around 1002 mb, which has been added to HURDAT. The intensity was gradually increased to 40 kt at 12Z, 5 kt higher than the original HURDAT, a minor intensity change. At 18Z and 21Z on the 8th, two ships reported 45 kt. An intensity of 45 kt is selected for 18Z on the 8th, 10 knots higher than the original HURDAT, a minor intensity change.

Landfall occurred around 0030Z on June 9th as a 45 kt tropical storm in the panhandle of Florida, just south of Tallahassee. Most of the winds associated with this tropical cyclone were on the eastern quadrant and Monthly Weather Review indicates that tropical storm force winds were reported between Sarasota and Cedar Key, FL. 45 kt is also the peak intensity for this storm as a tropical cyclone. This is 10 kt lower than originally shown in HURDAT, a minor intensity change. The pressure decreased to 1001 mb in Tallahassee, FL according to the Local Climatological Data and this likely happened soon after landfall. A landfall pressure of 1000 mb is estimated and has been added to HURDAT at 0Z on the 9th. Early on the 9th, the tropical cyclone moved across southeastern Georgia weakening to a minimal tropical storm. Alma, GA reported 5 kt NNW and 1004 mb at 06Z on the 9th, suggesting a central pressure around 1003 mb, which has been added to HURDAT. The storm moved over the Atlantic Ocean around 10Z on June 9th and immediately began to intensify as a cold front approached from the north and started to interact with the tropical cyclone. A ship reported 50 kt at 21Z on the 9th and an intensity of 45 kt is selected for 18Z on the 9th, same as HURDAT. Late on the 9th and early on the 10th, the structure of the storm began to resemble an extratropical cyclone with the data suggesting the circulation becoming elongated NE-SW. It is analyzed that the tropical storm became an extratropical cyclone around 00Z on June 10th, six hours earlier than originally shown in HURDAT. The intensity at 00Z on the 10th is analyzed at 55 kt, same as HURDAT. HURDAT originally indicated that at this time it was still a tropical cyclone and 55 kt was the original peak intensity. The extratropical cyclone moved

generally eastward and various ships reported winds of 65 kt on June 10th. An intensity of 65 kt is analyzed at 06Z, 12Z and 18Z on the 10th, 5 kt higher at each time than originally shown in HURDAT, a minor intensity change. A ship reported 20 kt SSE and 998 mb at 12Z on the 10th, suggesting a central pressure of 996 mb, which has been added to HURDAT.

On June 11th, the forward speed of the extratropical cyclone decreased and its intensity started to diminish. Various ships reported winds of 50 kt on the 11th. Minor intensity changes are introduced from June 11th to the 15th. On June 13th, the extratropical cyclone passed just south of Bermuda while moving northeast as a frontal boundary exited the United States. Late on June 14th and early on the 15th, the northeast motion came to a stop and the cyclone turned to the south and southwest while continuing to lose strength. It's analyzed that it weakened below gale force at 12Z on the 15th and degenerated into a trough of low pressure after 18Z. The positions at 12Z and 18Z on June 15th are new to HURDAT.

Hurricane Audrey [June 24-29, 1957]

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40115 06/25/1957 M= 5  2 SNBR= 873 AUDREY      XING=1 SSS=4
40115 06/24/1957 M= 6  3 SNBR= 873 AUDREY      XING=1 SSS=3
         **         *  *                            *

(June 24th is new to HURDAT)
40117 06/24*  0   0   0    0*  0   0   0    0*210 930  30    0*212 931  35    0*

40120 06/25*  0   0   0    0*216 933  60    0*220 934  85  989*226 935  75  979*
40120 06/25*214 932  40    0*216 933  45    0*220 934  55    0*226 935  65  989*
           *** ***  **                **                **    *          **  ***

40125 06/26*232 936  75  979*239 937  80    0*247 937  80  973*255 938  85    0*
40125 06/26*231 935  75  979*238 936  80    0*247 937  80    0*256 938  80  973*
           *** ***          *** ***                        * ***      **  ***

40130 06/27*265 938  95    0*279 938 115    0*293 938 125  946*307 935  60    0*
40130 06/27*266 938  90    0*279 938 100    0*293 938 105  950*307 935  80    0*
           ***       **                ***              ***  ***          **

40135 06/28*320 928  45  972E333 916  40    0E345 895  35    0E365 861  30    0*
40135 06/28*320 928  55    0*333 912  40    0*347 890  35    0*365 861  30    0*
                     **    **    ***         **** ***          *

40140 06/29E394 809  40    0E437 771  50    0*  0   0   0    0*  0   0   0    0*
40140 06/29E394 809  30    0*  0   0   0    0*  0   0   0    0*  0   0   0    0*
                     **     *  *   *   *

40145 HRCTX4LA4
40145 HRCTX2LA3
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U.S. Hurricane:
June 27th – 14Z – 29.8N 93.6W – 105 kt – Category 3 – 950 mb – 1003 mb OCI – 200 nm ROCI – 25 nm RMW

Minor changes to the track and major changes to the intensity shown in McAdie et al. (2009). Evidence for these alterations comes from the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Monthly Weather Review, the Local Climatological Data, Surface Weather Observations, Mexican synoptic maps, National Weather Office in Lake Charles, LA (NWSLC), Schwardt et al. (1979), Ho et al. (1987), Jarrell et al. (1992) and Jarvinen (2006).

June 21:

HWM analyzes a closed low pressure of at most 1010 mb at 16.5N, 85.5W at 12Z. HURDAT and microfilm do not list an organized storm on this date. Ship highlights: No gales or low pressures.

June 22:

HWM analyzes a spot low pressure at 18.0N, 89.0W at 12Z. HURDAT and microfilm do not list an organized storm on this date. Ship highlights: No gales or low pressures.

June 23:

HWM analyzes a spot low pressure at 20.0N, 94.0W at 12Z. HURDAT and microfilm do not list an organized storm on this date. Ship highlights: No gales or low pressures.

June 24:

HWM analyzes a tropical storm of at most 1005 mb at 21.8N, 93.8W at 12Z. HURDAT does not list an organized storm on this date. Microfilm shows a closed low pressure of at most 1011 mb at 20.0N, 93.0W at 12Z. Ship highlights: 5 kt SW and 1007 mb at 21.5N, 93.2W at 06Z (COADS). 10 kt WNW and 1006 mb at 20.7N, 94.4W at 12Z (COADS). 20 kt WW and 1007 mb at 19.8N, 95.5W at 18Z (COADS).

MWR: “Huricane Audrey, which struck the Gulf coast near the Texas-Louisiana border on June 27 with devastating effect, first became well defined over the Bay of Campeche, in the southwestern Gulf of Mexico, on June 24. A weak easterly wave which moved into the area. a day or two earlier, as evidenced by changes in the wind field across the western Caribbean and Yucatan and by increased shower activity, was probably instrumental in initiating the disturbance. The mean sea-surface temperatures for the Gulf

of Mexico for June were generally 2 to 3F. above normal. In addition, warming was evident preceding the development of Audrey with the highest temperatures (85F)in the area where the hurricane formed." ATSR: "An easterly wave located near 40ºW on 14 June moved westward until 24 June when it became stationary in the Gulf of Campeche, it was from this early wave that Audrey developed. The easterly wave was very weak throughout its life span and did not show any tendencies of tropical storm development."

June 25:

HWM analyzes a hurricane of at most 1000 mb at 22.5N, 93.2W at 12Z. HURDAT lists an 85 kt hurricane at 22.0N, 93.4W at 12Z. Microfilm shows a closed low pressure of at most 1008 mb at 23.0N, 93.0W at 12Z. Ship highlights: 35-40 kt, gusts to 55 kt and 1009 mb at 22.5N, 94.5W at 0230Z (MWR). 45 kt WNW and 998 mb at 22.3N, 93.6W at 18Z (micro). 50 kt SE and 996 mb at 23.5N, 92.8W at 21Z (micro). Aircraft highlights: Penetration center fix measured a central pressure of 989 mb, estimated maximum surface winds of 85 kt and an eye diameter of 20 nm at 22.5N, 93.5W at 17Z (ATSR). Penetration center fix measured a central pressure of 979 mb and estimated maximum surface winds of 60 kt at 23.1N, 93.4W at 2257Z (ATSR). Penetration center fix measured a central pressure of 979 mb and estimated maximum surface winds of 75 kt at 23.1N, 93.4W at 2348Z (ATSR).

MWR: "Audrey deepened during the night of June 24 while remaining nearly stationary. Aircraft reconnaissance on the morning of the 25th reported maximum winds of 85 knots and minimum pressure 989 mb. Late on the afternoon of the 25th a second flight reported that the maximum observed wind was 75 knots and the minimum pressure 979 mb." ATSR: "By 0000Z, 25 June, a definite low center had formed near 22N 93W and a Navy low level reconnaissance flight was ordered to depart Jacksonville at daylight to investigate the area. A report from a fishing boat near 22.5N 94.5W at 250230Z, reporting winds of 35 to 40 kt, was the first positive indication of a tropical storm in that area. The reconnaissance flight from Jacksonville reported the following at 251700Z: center of storm 22.5N 93.5W, maximum winds of 85 knots, minimum pressure 989 mb. After Audrey developed hurricane force she moved almost straight north and entered the Gulf Coast near Texas-Louisiana coast."

June 26:

HWM analyzes a hurricane of at most 990 mb at 24.9N, 93.7W at 12Z. HURDAT lists an 80 kt hurricane at 24.7N, 93.8W at 12Z. Microfilm shows a closed low pressure of at most 993 mb at 25.3N, 93.3W at 12Z. Ship highlights: 45 kt SE and 1003 mb at 24.6N, 91.7W at 02Z (micro). 40 kt SE and 1009 mb at 25.7N, 90.2W at 06Z (COADS). 35 kt NW and 1005 mb at 26.4N, 91.3W at 12Z (micro). 35 kt SSE and 1005

mb at 25.4N, 89.8W at 18Z (COADS). 35 kt ENE and 998 mb at 27.6N, 93.7W at 21Z (micro). Aircraft highlights: Penetration center fix measured a central pressure of 973 mb, estimated maximum surface winds of 90 kt and an eye diameter of 20 nm at 25.4N, 93.8W at 1620Z (ATSR).

MWR: “On June 26 both the size and intensity of the hurricane increased slightly. Reconnaissance showed maximum winds of 90 knots and a minimum pressure of 973 mb.”

June 27:

HWM analyzes a hurricane of at most 985 mb at 29.3N, 94.0W at 12Z. HURDAT lists a 125 kt hurricane at 29.3N, 93.8W at 12Z. Microfilm shows a closed low pressure of at most 984 mb at 29.2N, 93.8W at 12Z. Ship highlights: 45 kt NE and 995 mb at 28.5N, 93.2W at 00Z (micro). 45 kt ESE and 989 mb at 28.3N, 92.9W at 06Z (COADS). 969 mb at 28.7N, 94.0W at 0910-1025Z (MWR). 75 kt W and 981 mb at 28.6N, 94.0W at 12Z (COADS). Land highlights: 55 kt E at Port Arthur, TX at 06Z (micro). 959 mb at Cameron, LA at 1430Z (MWR). “Calm” at Orange, TX at 1530Z (MWR). 65 kt and gusts to 84 kt at Lake Charles, LA at 1630Z (NWSLC). 55 kt SW and 977 mb at Lake Charles, LA at 18Z (micro). Aircraft highlights: Radar center fix at 27.3N, 93.8W at 03Z (ATSR). Radar center fix at 28.3N, 94.1W at 07Z (ATSR). Radar center fix estimated maximum surface winds of 95 kt at 29.2N, 94.2W at 12Z (ATSR). Radar center fix at 29.6N, 94.2W and indicates landfall at 1330Z (ATSR). Radar center fix at 31.2N, 92.7W at 21Z (ATSR). “29.8N, 93.6W – 946 mb – 1007 mb Penv – RMW 19 nmi – speed 14 kt – 87 kt est max sustained 10m, 10-min wind” (Schwardt et al. (1979)) (946.5 mb, 958.4 measured at Hackberry, LA – RMW 20 nmi – 14 kt forward speed – landfall pt 29.8N, 93.6W” (Ho et al. (1987). “Jun – TX4, LA4 – Cat 4 – 945 mb” (Jarrell et al. (1992). “80 kt, 955 mb, 52 nm RMW” (Jarvinen, 2006)

MWR: “A radar tracking flight during the night of the 26th reported the precipitation field as considerably more intense than observed 24 hours previously. However, no central pressure measurement was obtained. The only additional observation of central pressure prior to the landfall of the storm was that by the Tanker Tillamook near latitude 28.7N, longitude 94.0W. from 0910 to 1025 GMT, June 27. The minimum pressure observed was 969 mb. (The barometer was subsequently calibrated and the figure of 969 mb. is the corrected value.) Indications are that the ship was in the western portion of the eye and that the pressure observed was not the absolute minimum in the center at that time. From June 26 until the center crossed the coast about 1430 GMT on the 27th, Audrey increased its forward speed from about 7 mph to 15 mph. At the same time it intensified markedly. The central pressure when it struck the coast was some 30 mb. lower than that last reported by reconnaissance and there is no doubt that there was

considerable deepening in the five hours between time of the observation of the Tillawmok and landfall. The exact minimum pressure as the center reached the coast has not been determined. The Calcasieu Coast Guard station, 20 miles east of the center, reported 960 mb. and at Port Arthur, Tex., about an equal distance west of the center, the lowest pressure was 966 mb. The lowest pressure observed was 958 mb. by the Fish and Wildlife Service at Hackberry, La." ATSR: "Although the official maximum winds and minimum pressures reported in Audrey during the forecasting periods were 95 knots and 960 mb, post-storm reports subsequently received via the Miami Weather Bureau City Office from ships and oil rigs near shore indicated winds of 125-155 knots and pressures as low as 924.5 mb. The highest winds reported by reconnaissance aircraft were 95 knots which was 110 miles from the center as Audrey was crossing the coastline."

June 28:

HWM analyzes a tropical storm of at most 995 mb at 34.5N, 89.0W with an approaching frontal boundary to the northwest at 12Z. HURDAT lists a 35 kt tropical storm at 34.5N, 89.5W at 12Z. Microfilm shows a closed low pressure of at most 996 mb at 35.0N, 89.0W at 12Z. Ship highlights: 20 kt SSW and 1004 mb at 26.8N, 93.9W at 00Z (COADS). 25 kt S and 1004 mb at 29.6N, 94.7W at 06Z (COADS). Land highlights: 20 kt S and 982 mb at Alexandria, LA at 00Z (micro). 984 mb at Monroe, LA at 03Z (NWSLC). 15 kt SE and 996 mb at Greenwood, MS at 06Z (micro). 10 kt NNW and 996 mb at Memphis, TN at 12Z (micro). 15 kt SW and 996 mb at Nashville, TN at 18Z (micro).

June 29:

HWM analyzes a large extratropical cyclone of at most 975 mb at 42.0N, 79.0W with a warm front to the east and a cold front to the southeast at 12Z. HURDAT lists a 50 kt extratropical cyclone at 43.7N, 77.1W at 06Z (last position). Microfilm shows a large closed low pressure of at most 978 mb at 42.0N, 79.0W with a frontal boundary to the southeast at 12Z. Ship highlights: No gales or low pressures. Land highlights: 15 kt SSE and 994 mb at Pittsburgh, PA at 00Z (micro). Aircraft highlights: Radar center fix at 32.9N, 92.2W at 02Z (ATSR).

MWR: "The exact number of deaths from Audrey will probably never be known. The list of known dead includes 371 in and near Cameron and 19 in other areas. To this list must be added a large number of others presumed dead from the 192 still listed as missing, although many of these may be among the 127 unidentified dead. The loss of life was the greatest in the United States since the New England hurricane of 1938 and about equal to the total for all other tropical storms in the United States in the past decade. Property damage in Audrey is estimated at $150,000,000. In the Cameron to Grand Cheniere area,

60 to 80 percent of the houses were destroyed or floated off their foundations. Inundation extended inland as much as 25 miles over the low-lying area. As the hurricane moved northeastward from Louisiana, it gradually weakened and began losing its tropical characteristics but was still attended by some damaging winds on the 28th. Re-intensification occurred due to extratropical processes as the storm moved from the Ohio Valley through the eastern Great Lakes region and there was a large amount of flood damage in States south of the Great Lakes, particularly in Illinois and Indiana, and some damage from high winds and thundersqualls from western Pennsylvania through New York. Winds were reported as high as 65 mph at Pittsburgh, Pa., and 95 to 100 mph at Jamestown, NY."

A tropical wave entered the Bay of Campeche on June 22nd causing the development of a low pressure that organized into a 30 kt tropical depression on June 24 at 12Z. This is 18 hours earlier than originally shown in HURDAT. The first position originally in HURDAT was of a 60 kt tropical storm on June 25th at 06Z. A ship moving southwest across the Bay of Campeche on June 24th reported 5 kt SW and 1007 mb at 06Z, and 10 kt NW and 1006 mb at 12Z, and although the pressure appears to be dubious compared to the coastal observations, the direction of the winds does suggest that a closed low-level circulation was present by 12Z on the 24th. Minor track changes are introduced for the duration of this system. The tropical depression moved slowly to the north on the 24th and the first gale-force winds were reported by a ship at 0230Z on June 25th while located to the northwest of the tropical cyclone. Intensification to a tropical storm is analyzed at 18Z on the 24th, twelve hours earlier than originally in HURDAT. The first reconnaissance aircraft reached the tropical cyclone at 17Z on the 25th measuring a central pressure of 989 mb, estimating surface winds of 85 kt and an eye diameter of 20 nm. A central pressure of 989 mb suggests maximum sustained winds of 65 kt south of 25N from the Brown et al. pressure-wind relationship. The 20 nm eye diameter suggests an RMW of about 15 nm and climatology suggests about 18 nm. An intensity of 65 kt is selected for 18Z on the 25th, down from 75 kt originally in HURDAT, a minor intensity change. A central pressure of 989 mb appears in HURDAT at 12Z on the 25th but it is in the wrong time slot and has been moved to 18Z on the same day. Intensification to a hurricane is analyzed at 18Z on the 25th, six hours later than HURDAT. A major intensity change is analyzed at 12Z on the 25th. HURDAT originally had 85 kt but it is analyzed that Audrey had winds of 55 kt at this time. Another center fix was made at 2257Z on the 25th measuring a central pressure of 979 mb and estimating surface winds of 60 kt. A final center fix was made on the 25th at 2348Z measuring a central pressure of 979 mb and estimating surface winds of 75 kt. A central pressure of 979 mb suggests maximum sustained winds of 79 kt south of 25N according to the pressure-wind relationship. Due to the slow motion (about 7 kt) of the hurricane and low environmental pressures (outer closed isobar of 1008 mb), an intensity of 75 kt is selected for 00Z on June 26th. A central

pressure of 979 mb was present in HURDAT at 00Z on the 26th and based on the reconnaissance observations, it has been retained. The rapid intensification observed on the 25th became more gradual on the 26th as indicated by a reconnaissance aircraft later on the day. At 1620Z on the 26th, the plane reported a central pressure of 973 mb, estimated surface winds of 90 kt and an eye diameter of 20 nm. A central pressure of 973 mb suggests maximum sustained winds of 81 kt north of 25N intensifying and 85 kt south of 25N intensifying, according to the pressure-wind relationship. Due to the slow motion of the hurricane, low environmental pressures (outer closed isobar of 1007 mb), an intensity of 80 kt is selected for 18Z on June 26th, down from 85 kt originally in HURDAT, a minor intensity change. A central pressure of 973 mb was present in HURDAT at 12Z on the 26th and has been moved to 18Z based on the reconnaissance report. No more center penetrations were made by the reconnaissance aircrafts prior to landfall.

Hurricane Audrey increased in forward speed on June 27th and another period of rapid intensification was noted. A reconnaissance mission made several radar center fixes early on the 27th. Hurricane Audrey made landfall around 14Z near 29.8N, 93.6W, just east of the Louisiana-Texas border and about 20 miles east of Port Arthur, TX. There were no measurements of the central pressure at landfall and the lowest pressure of 958 mb was recorded at Hackberry, LA at an unknown time but likely to be around 15Z on the 27th. Ho et al. analyzed that the RMW of Audrey at landfall was 20 nm, but observations by the reconnaissance aircraft before landfall and the radar images indicate that the hurricane had a larger RMW. The radar images and aircraft reconnaissance showed an eye diameter of about 40 nm, suggesting an RMW of about 30 nm. A combination between these estimates and Ho et al. gives 25 nm, which is the value selected. The center of Audrey passed about 12 nm to the west of Hackville, LA, and the environmental pressure was 1004 mb. The Schloemer equation was run three times using an RMW of 20 nm, 25 nm and 30 nm. This gave a central pressure of 949 mb, 951 mb and 953 mb, accordingly. Since the 958 mb measurement was made about one hour after landfall and a best estimate of an RMW of 25 nm, a central pressure of 950 mb is selected at landfall and added to 12Z on the 27th replacing the existing 946 mb estimate. A central pressure of 950 mb suggests maximum sustained winds of 105 kt north of 25N and 110 kt north of 25N intensifying, according to the pressure-wind relationships. Due to the low environmental pressures and relatively large RMW (climatology suggests about 20 nm), an intensity of 105 kt is selected for 12Z and at landfall at 14Z on June 26th, down from 125 kt, a major intensity change to HURDAT. 105 kt is the analyzed peak intensity for Hurricane Audrey, down from 125 kt originally in HURDAT, a major intensity change. The Schwerdt et al. parametric hurricane wind model suggests that the highest sustained winds that impacted Texas reached 92 kt. Therefore, Audrey is analyzed as a category 2 hurricane impact for Texas and category 3 hurricane impact for Louisiana.

Audrey quickly weakened as it progressed inland. The Kaplan and DeMaria model was run for 18Z on the 27th, and 00Z, and 06Z on the 28th yielding 74 kt, 48 kt and 34 kt, respectively. The highest winds recorded at these times were 60 kt, 45 kt and 32 kt, respectively. An intensity of 80 kt is selected for 18Z on the 27th, 55 kt at 00Z and 40 kt at 06Z on the 28th (up from 60 kt at 18Z on the 27th, 45 kt at 00Z on the 28th and no change at 06Z, originally in HURDAT), a major intensity change was made at 18Z on the 27th. On June 28th, Audrey turned to the northeast and noticeably increased in forward speed ahead of a frontal boundary. A central pressure of 972 mb was present originally at 00Z on the 28th. This value is not supported by observations, not is it reasonable given the system was overland 10 hours and is thus removed from HURDAT. HURDAT has Audrey transitioning to an extratropical cyclone at 06Z on the 28th but surface observations indicate that the frontal boundary was still about 300 nm northwest of the storm at that time. Transition to an extratropical cyclone is delayed until 00Z on June 29th, 18 hours later than originally in HURDAT. By 18Z on the 28th, Audrey weakened to a tropical depression, it was absorbed by a large and intense extratropical cyclone over the Great Lakes after 06Z on the 29th. Dissipation is analyzed six hours earlier than originally in HURDAT.

Tropical Storm Bertha [August 8-11, 1957]

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40150 08/08/1957 M= 4  3 SNBR= 874 BERTHA      XING=1 SSS=0
40150 08/08/1957 M= 4  4 SNBR= 874 BERTHA      XING=1 SSS=0
                       *

40155 08/08*  0   0   0    0*  0   0   0    0*  0   0   0    0*270 889  35    0*
40155 08/08*270 874  25    0*270 880  30    0*270 886  35    0*272 892  45    0*

40160 08/09*274 895  40 1000*279 904  60    0*283 913  60  998*290 923  60    0*
40160 08/09*275 899  55 1000*278 906  55    0*283 913  50    0*290 922  50 1005*

40165 08/10*297 933  60    0*302 941  45    0*306 948  30    0*311 951  25    0*
40165 08/10*295 931  55    0*297 939  60  998*301 946  40    0*308 951  30    0*

40170 08/11*318 952  25    0*327 952  25    0*336 952  25    0*347 952  25    0*
40170 08/11*317 952  25    0*327 952  25    0*  0   0   0    0*  0   0   0    0*

40175 TS
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U.S. Tropical Storm Landfall

08/10 06Z 29.7N 93.9W 60 kt TX

Minor changes to the track and intensity shown in McAdie et al. (2009). Evidence for these alterations comes from the NHC microfilm maps, Historical Weather Maps series, COADS ship database, Monthly Weather Review, the Local Climatological Data and Navy reconnaissance book.

August 6:

HWM analyzes weakening frontal boundary over the northern Gulf of Mexico at 12Z. HURDAT does not list an organized storm on this date. Ship highlights: No gales or low pressures.

MWR: “A weak extra-tropical Low entered the northeastern Gulf of Mexico on August 6 and drifted slowly westward for the next 2 days.”

August 7:

HWM analyzes a spot low pressure at 27.5N, 89.8W with a warm front to the east at 12Z. HURDAT does not list an organized storm on this date. Microfilm shows a frontal boundary over the northeast Gulf of Mexico with a trough extending from 29.0N/87.0W to 24.0N/89.0W at 12Z. Ship highlights: No gales or low pressures.

ATSR: “Bertha resulted when a frontal system moved into the Gulf of Mexico early on 7 August and became stationary with a low center forming in its trough.”

August 8:

HWM analyzes a tropical storm with a central pressure of 1000 mb at 27.7N, 89.7W with a weakening stationary front to the northeast at 12Z. HURDAT lists a 35 kt tropical storm at 27.0N, 88.9W at 18Z (first advisory). Microfilm shows a closed low pressure of at most 1011 mb at 27.5N, 89.0W at 12Z. Ship highlights: 45 kt SE and 1009 mb at 27.4N, 88.6W at 17Z (micro). 40 kt SE and 1009 mb at 27.7N, 88.9W at 21Z (COADS). Aircraft highlights: Penetration center fix estimated maximum surface winds of 60 knots and measured a central pressure of 1000 mb at 27.6N, 89.2W at 23Z (ATSR).

MWR: “It developed into a tropical storm about 100 miles south of the mouth of the Mississippi River on August 8.” ATSR: “The first positive indication of Bertha was a report received from the ship SS TELDE at 1715Z, 8 August, reporting winds from the southeast, Force 9, seas 15 feet and pressure of 1008.8 mb, near 27N 89W. Earlier (6 hours previous) the maximum winds reported in that area was 25 knots in a squall. A Navy low-level reconnaissance flight was dispatched from 2250Z with maximum winds of 60 knots and minimum pressure of 1000 mb. Radar coverage was determined to be feasible and storm eye was described as open to the west. After Bertha developed into a tropical storm she was under an easterly flow at all upper levels, due to a large high pressure system located over the east central United States.”

August 9:

HWM analyzes a tropical storm with a central pressure of 1007 mb at 28.3N, 91.5W at 12Z. HURDAT lists a 60 kt tropical storm at 28.3N, 91.3W at 12Z. Microfilm shows a trough extending along Longitude 92.0W over the north Gulf of Mexico at 12Z. Ship highlights: 55 kt E and 1010 mb at 28.0N, 89.6W at 00Z (COADS). 50 kt NE and 1012 mb at 28.7N, 91.3W at 06Z (COADS). 45 kt N and 1008 mb at 27.9N, 91.5W at 09Z (micro). 50 kt W and 1010 mb at 28.4N, 92.8W at 19Z (COADS). Aircraft highlights: Radar center fix at 27.5N, 89.8W at 0330Z (ATSR). Radar center fix at 28.5N, 91.5W at 08Z (ATSR). Penetration center fix estimated maximum surface winds of 40 knots, measured a central pressure of 1007 mb and an eye diameter of 8 nm at 28.9N, 91.8W at 1625Z (ATSR). Penetration center fix estimated maximum surface winds of 40 knots, measured a central pressure of 1005 mb and an eye diameter of 8 nm at 29.1N, 92.5W at 1755Z (ATSR).

MWR: "... then moved in a general northwesterly direction, crossing the coast near Cameron, La., late on August 9. Since it was moving toward the same portion of the coast devastated by hurricane Audrey 2 months earlier, Bertha was viewed with alarm by the population and full safety precautions and evacuations were evidently carried out promptly. Fortunately, Bertha did not develop to full hurricane intensity. Highest winds were estimated by ships and land stations at 50 to 70 m. p. h. The fastest mile at Beaumont, Tex., was measured at 44 mph with gusts to 52. Tides did not approach the disastrous proportions of those in Audrey, the highest reported being 4.7 feet at the west end of Vermilion Bay. The heaviest rainfall observed was 10.73 inches at Livingston, Tex." ATSR: "Bertha moved west-northwest just ahead of a retrograding trough at the 200 mb level until 0000Z, 9 August, when the trough overtook the storm; at this point a low center formed at 200 mb over Bertha, which is believed to have contributed to the decrease in, or failure of, Bertha's development. Of interest during the period when this low developed over the storm at 200 mb is that a night Navy radar reconnaissance aircraft was in the storm area and reported strong radar echoes and a well-defined storm center during the first 3 hours of his flight but, by the end of the flight, some ten hours later, his report was of very weak echoes, patterns diffuse and that further radar coverage was not feasible. A low-level reconnaissance flight into Bertha at daylight on 9 August reported a maximum wind of 40 knots, minimum pressure of 1005 mb, and radar coverage not feasible. Bertha entered the coast near the Texas-Louisiana border very near the place her earlier and more destructive sister, Audrey, had entered some six weeks earlier. Damages from Bertha were minor."

August 10:

HWM analyzes a closed low pressure of at most 1005 mb at 31.0N, 95.0W at 12Z. HURDAT lists a 30 kt tropical depression at 30.4N, 94.8W at 12Z. Microfilm shows a closed low pressure of at most 1008 mb at 31.0N, 94.5W at 12Z. Ship highlights: 40 kt NE and 1012 mb at 28.6N, 95.1W at 00Z (micro). Land highlights: 30 kt NNE and 1004 mb at Port Arthur, TX at 03Z (micro). 38 kt, gusts to 45 kt at Port Arthur, TX at 0344Z (CLIMO). 15 kt NNE and 1001 mb at Port Arthur, TX at 06Z (micro). 1001 mb at Port Arthur, TX at 0605Z (CLIMO).

August 11:

HWM analyzes a tropical storm of at most 1010 mb at 33.5N, 95.0W at 12Z. HURDAT lists a 25 kt tropical depression at 33.6N, 95.2W at 12Z. Microfilm shows a closed low pressure of at most 1008 mb at 34.0N, 96.5W at 06Z. Ship highlights: No gales or low pressures.

MWR: “The storm weakened and turned northward after moving inland, reaching southeastern Oklahoma on August 11. Although the storm was not identifiable as a surface circulation thereafter, it was apparent in the circulation aloft and in the accompanying heavy rains as it turned eastward across Arkansas. Two deaths resulting from Bertha were reported; property damage was slight, and the accompanying rain has been described by the Meteorologist in Charge at New Orleans Weather Bureau Office as over-all more beneficial than harmful.”

August 12:

HWM, HURDAT and micro do not analyze an organized tropical cyclone on this date. No gales or low pressures.

A frontal boundary entered the northern Gulf of Mexico on August 6th and a low pressure system developed soon thereafter. The disturbance became better organized on the 7th based on ship reports while the frontal boundary dissipated. Genesis is analyzed at 00Z on the 8th as a 25 kt tropical depression, 18 hours earlier than the original HURDAT. Minor track changes are introduced for the duration of this system. The depression intensified on the 8th reaching tropical storm status at 12Z, six hours earlier than originally shown in HURDAT. Various ships reported gales late on the 8th, including 45 kt at 17Z. An aircraft reconnaissance reached Bertha at 23Z on the 8th estimating maximum surface winds of 60 kt and a central pressure of 1000 mb. A central pressure of 1000 mb is present in HURDAT at 00Z on the 9th and it is retained.

Tropical Storm Bertha moved generally westward on the 8th but its course changed to the west-northwest on the 9th while passing south of Louisiana. At 00 and 06Z on the 9th, Bertha is analyzed to have reached an intensity of 55 kt based on various ships reporting winds of 50 kt and 55 kt. A minor intensity change to the original HURDAT. Late on the 9th, another reconnaissance mission reached Bertha and found a disorganized system. The central pressure had risen to 1005 mb, while the estimated maximum surface winds had dropped to 40 kt, but the eye diameter was just 8 nm. A central pressure of 1005 mb is added to 18Z on the 9th. A central pressure of 1005 mb suggests maximum winds of 34 kt north of 25N from the Brown et al. pressure-wind relationship. Based on the aircraft reports and ships reporting winds between 35-50 kt, the intensity of Bertha is reanalyzed at 50 kt at 12Z and 18Z, a minor intensity change to HURDAT. A central pressure of 998 mb is present in HURDAT at 12Z on the 9th and based on the reconnaissance reports, it is likely to be inaccurate and has been removed.

The tropical cyclone approached landfall early on August 10th and is analyzed to have crossed the coast near the Texas-Lousiana border, 29.7N, 93.9W, at 06Z. At this time, the barometric pressure at Port Arthur, TX, had decreased to 1001 mb and winds were 15 kt from the northeast. Based on this report, it is analyzed that Bertha made landfall with a central pressure of 998 mb, which has been added to HURDAT at 06Z on the 10th. A central pressure of 998 mb suggests maximum winds of 47 kt north of 25N according to the pressure-wind relationship. Based on the small size of the storm, an intensity of 60 kt is analyzed at 06Z on the 10th, a minor change to HURDAT. Nonetheless, HURDAT indicated an earlier landfall and an intensity of 60 kt. This is also the peak intensity of Bertha. Port Arthur, TX reported sustained winds of 38 kt and gusts to 52 kt early on the 10th. The small tropical storm weakened after landfall and became a tropical depression at 18Z on the 10th, six hours later than originally shown by HURDAT. Early on August 11th, Bertha turned to the north over eastern Texas dissipating after 06Z, 12 hours earlier than originally shown in HURDAT.

Hurricane Carrie [September 2-25, 1957]

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40180 09/02/1957 M=23  4 SNBR= 875 CARRIE      XING=0 SSS=0
40180 09/02/1957 M=24  5 SNBR= 875 CARRIE      XING=0 SSS=0
                    **  *

40185 09/02*  0   0   0    0*130 217  25    0*130 222  25    0*130 231  25 1001*
40185 09/02*  0   0   0    0*130 213  25    0*130 222  25    0*130 231  25    0*
                           ***                                              *

40190 09/03*131 240  25    0*134 250  30    0*137 259  35    0*139 268  35    0*
40195 09/04*141 277  40    0*143 286  45    0*145 296  50    0*145 306  55    0*
40200 09/05*144 315  60    0*145 326  65    0*147 337  70    0*149 346  75    0*
40200 09/05*145 316  60    0*145 326  65    0*147 336  70    0*149 346  75    0*
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40205 09/06*152 354  80    0*154 365  80    0*157 375  85    0*159 383  95    0*
40205 09/06*151 356  80    0*154 366  80    0*157 375  85    0*159 383  95    0*
          *** ***               ***

40210 09/07*162 391 100    0*164 400 105    0*167 410 110  945*170 420 115    0*
40210 09/07*161 391 100    0*164 400 105    0*167 410 110    0*170 420 115    0*
                                                  *

40215 09/08*174 429 120    0*177 439 125    0*180 450 130  945*180 457 135    0*
40215 09/08*174 429 120  945*177 437 120    0*179 445 120    0*180 452 120  945*
                    ***     *** ***      *** *** ***    *     *** ***  ***

40220 09/09*180 465 135    0*181 473 135    0*183 482 135  975*186 490 130    0*
40220 09/09*181 461 115    0*183 472 105    0*187 482  95    0*191 491  85  975*
          *** *** ***      *** *** ***      ***       **    * *** ***  **  ***

40225 09/10*190 497 125    0*192 505 115    0*195 513  95  987*199 520  85    0*
40225 09/10*194 499  80    0*197 507  75  977*199 514  70  985*201 520  65    0*
          *** ***  **      *** ***  **  *** *** ***  **  *** ***       **

40230 09/11*204 525  75    0*207 527  65    0*210 527  65  984*215 527  70    0*
40230 09/11*203 523  65    0*206 524  65  985*209 524  65  984*212 524  70  978*
          *** ***  **      *** ***      *** *** ***          *** ***      ***

40235 09/12*219 527  80    0*224 527  85    0*228 527  90  957*233 527  95    0*
40235 09/12*216 524  80    0*221 525  85    0*228 526  90  960*236 527  95  957*
          *** ***           *** ***               ***  **  *** ***       **  ***

40240 09/13*240 526  95    0*247 525  95    0*254 524 100  963*262 524 100    0*
40240 09/13*243 526 100    0*250 525 105  951*257 524 100  953*264 522  90  963*
          ***     ***       ***     ***  *** ***          *** *** ***  **  ***

40245 09/14*270 525 100    0*276 527 105    0*281 532 110  963*284 541 115    0*
40245 09/14*271 523  90    0*277 525  90  964*281 530  90  964*284 540  90  963*
          *** ***  **      *** ***  **  ***     ***  **  ***     ***  **  ***

40250 09/15*288 553 120    0*295 567 110    0*302 580 105  963*310 589 100    0*
40250 09/15*288 552  90    0*293 565  85  967*300 578  85  965*308 589  90  961*
                ***  **      *** ***  **  *** *** ***  **  *** ***       **  ***

40255 09/16*317 597  90    0*322 608  85    0*327 620  85  964*335 629  85    0*
40255 09/16*314 599  85  964*320 609  85  966*325 620  80  969*332 629  80    0*
          *** ***  **  *** *** ***      *** ***       **  *** ***       **

40260 09/17*342 636  80    0*347 641  80    0*352 638  80  972*357 629  80    0*
40260 09/17*339 636  80  970*346 643  75  974*353 642  75  975*358 633  75  978*
          ***           *** *** ***  **  *** *** ***  **  *** *** ***  **  ***

40265 09/18*361 618  80    0*362 607  75    0*359 595  75  978*355 580  75    0*
40265 09/18*360 621  70    0*360 607  70  978*359 593  70  978*355 578  70    0*
          *** ***  **      ***       **  ***     ***  **          ***  **

40270 09/19*352 564  75    0*349 552  70    0*347 539  70  970*345 522  70    0*
40270 09/19*352 562  75    0*349 548  75    0*347 534  80  970*345 519  80    0*
                ***               ***  **          ***  **          ***  **

40275 09/20*344 504  70    0*343 492  70    0*341 478  70    0*342 459  70    0*
40275 09/20*344 506  80    0*343 492  80    0*342 477  80    0*342 460  80    0*
                ***  **                **      *** ***  **          ***  **

40280 09/21*345 440  70    0*346 421  70    0*347 401  70  972*350 380  70    0*
40280 09/21*343 440  80    0*345 420  80    0*347 400  80    0*350 380  80  972*
          ***       **      *** ***  **          ***  **    *           **  ***
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40285 09/22*357 356  70    0*368 328  70    0*384 295  70    0*404 253  65    0*
40285 09/22*355 356  80    0*361 328  75    0*375 295  75    0*392 262  70    0*
           *** ***  **      ***       **      ***       **      *** ***  **

40290 09/23E423 219  65    0E440 199  65    0E456 178  60    0E475 156  60    0*
40290 09/23E415 232  70    0E440 210  70    0E460 192  65    0E480 174  60    0*
           *** ***  **          ***  **      *** ***  **      *** ***

40295 09/24E489 137  55    0E500 120  55    0E512 108  50    0E522  94  45    0*
40295 09/24E500 160  55    0E510 145  55    0E512 128  50    0E512 110  45    0*
           *** ***           *** ***             ***           *** ***

(September 25th is new to HURDAT)
40297 09/25E512 094  40    0E510 080  35    0E505 070  35    0E500 060  35    0*

40300 HR
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Major changes to the track and intensity shown in McAdie et al. (2009). Evidence for these alterations comes from the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Monthly Weather Review, Reconnaissance aircraft missions and the National Hurricane Research Project (NHRP)(Shea and Gray, 1973).

September 1:

HWM is not available on this date (system is south of 20°N). HURDAT and microfilm do not list an organized storm on this date. Ship highlights: No gales or low pressures.

September 2:

HWM is not available on this date (system is south of 20°N). HURDAT lists a 25 knot tropical depression at 13.0N, 22.2W at 12Z. Microfilm does not show an organized storm on this date. Ship highlights: No gales or low pressures.

MWR: “Observations from the Cape Verdes on September 2 showed evidence of a vortex passing just to the south of the islands, and a message from Panair do Brasil reported a tropical storm developing near latitude 11N., longitude 25W.” ATSR: “A report was received via the Recife, Brazil Office and is quoted as follows, 'Time 021741Z September. Tropical cyclonic development evident located approximately 11N 25W.' This storm is believed to have been the beginning of hurricane CARRIE.”

September 3:

HWM is not available on this date (system is south of 20°N). HURDAT lists a 35 knot tropical storm at 13.7N, 25.9W at 12Z. Microfilm does not show an organized storm on this date. Ship highlights: No gales or low pressures.

September 4:

HWM is not available on this date (system is south of 20°N). HURDAT lists a 50 knot tropical storm at 14.5N, 29.6W at 12Z. Microfilm does not show an organized storm on this date. Ship highlights: No gales or low pressures.

September 5:

HWM is not available on this date (system is south of 20°N). HURDAT lists a 70 knot hurricane at 14.7N, 33.7W at 12Z. Microfilm does not show an organized storm on this date. Ship highlights: No gales or low pressures.

September 6:

HWM is not available on this date (system is south of 20°N). HURDAT lists an 85 knot hurricane at 15.7N, 37.5W at 12Z. Microfilm shows a closed low pressure of at most 1011 mb at 14.0N, 35.0W at 12Z. Ship highlights: 35 kt NNE and 1011 mb at 16.1N, 38.5W at 12Z (COADS). 80 kt ENE and 1001 mb at 16.0N, 38.5W at 16Z (micro).

MWR: “On September 6 the SS African Star, about 700 miles west of the Cape Verde Islands, forwarded a succession of special reports showing falling pressure, increasing winds, and squalliness. The existence of hurricane Carrie was confirmed when the 1600 GMT report (somewhat delayed) showed an east-northeast wind of 92 mph and a pressure of 1,001 mb. Later analyses indicate that the vortex noted on the 2nd was the genesis stage of Carrie and that it moved west-northwestward at about 12 mph to the position at which it was encountered by the African Star.” ATSR: “No reports were received to confirm a storm in that area until 0600Z, 6 September, when the ship KATTY near 17N 40W reported a win from NNE, 20 knots, and seas of 9.5 feet with a 8-second period. The AFRICAN STAR reported again at 1600Z with 80 knots of wind, high seas and pressure of 1001.0 mb. Warning number ONE on hurricane CARRIE was promulgated, as coordinated with the San Juan Weather Bureau, at 2230Z, 6 September.”

September 7:

HWM is not available on this date (system is south of 20°N). HURDAT lists a 110 knot hurricane at 16.7N, 41.0W at 12Z. Microfilm shows a closed low pressure of at most 1005 mb at 16.0N, 45.5W at 12Z. Ship highlights: No gales or low pressures. Aircraft highlights: Penetration center fix measured a central pressure of 945 mb, estimated maximum winds of 120 kt at 700 mb, and an eye diameter of 20 nm at 17.2N, 42.5W at 2148Z (micro).

MWR: “On September 7, in an unusually long flight, the regular Air Force Gull reconnaissance plane from Bermuda was diverted to the storm area. The observer reported maximum winds of 138 mph at the 700-mb. level with a well-defined eye 20 miles in diameter and a minimum surface pressure of 945 mb.” ATSR: “No further reports were received until 072210Z when a 59th Weather Reconnaissance Squadron aircraft, which had been diverted from its normal GULL PAPA track to its maximum range, reported CARRIE at 17.2N 42.6W with flight winds of 110 knots, and a 700 mb height of 8740 feet.”

September 8:

HWM is not available on this date (system is south of 20°N). HURDAT lists a 130 knot hurricane at 18.0N, 45.0W at 12Z. Microfilm shows a closed low pressure of at most 1008 mb at 18.0N, 45.0W at 12Z. Ship highlights: 35 kt NE and 1013 mb at 19.2N, 49.7W at 15Z (micro). Aircraft highlights: Penetration center fix at 18.0N, 45.1W at 1930Z (ATSR).

September 9:

HWM is not available on this date (system is south of 20°N). HURDAT lists a 135 knot hurricane at 18.3N, 48.2W at 12Z. Microfilm shows a closed low pressure of at most 999 mb at 18.5N, 48.8W at 12Z. Ship highlights: No gales or low pressures. Aircraft highlights: Penetration center fix at 19.5N, 49.8W at 2226Z (ATSR). Penetration center fix measured a central pressure of 975 mb, estimated maximum winds of 135 kt at 700 mb and an eye diameter of 10 nm at 19.4N, 49.6W at 2021Z (micro).

ATSR: “Due to the extreme range, only one aircraft fix per day was available on CARRIE.”

September 10:

HWM is not available on this date (system is south of 20°N). HURDAT lists a 95 knot hurricane at 19.5N, 51.3W at 12Z. Microfilm shows a closed low pressure of at most 999 mb at 18.5N, 48.8W at 12Z. Ship highlights: No gales or low pressures. Aircraft highlights: Penetration center fix measured a central pressure of 977 mb and an eye diameter of 20 nm at 19.3N, 50.8W at 0815Z (micro). Penetration center fix measured a central pressure of 985 mb, estimated maximum surface winds of 75 kt, and an eye diameter of 20 nm at 19.3N, 50.9W at 0930Z (micro). Penetration center fix estimated maximum winds of 65 mb at 700 mb, and an eye diameter of 20 nm at 20.7N, 52.1W at 1930Z (micro).

ATSR: “... until 10 September when two or more fixes per day were available ...”

September 11:

HWM analyzes a hurricane with a central pressure of 985 mb at 21.0N, 52.5W at 12Z. HURDAT lists a 65 knot hurricane at 21.0N, 52.7W at 12Z. Microfilm shows a closed low pressure of at most 1005 mb at 20.5N, 52.5W at 12Z. Ship highlights: 35 kt SE and 1009 mb at 19.1N, 49.9W at 12Z (micro). 35 kt SE and 1010 mb at 18.8N, 51.7W at 15Z (micro). 35 kt SE and 1005 mb at 22.1N, 51.1W at 18Z (micro). Aircraft highlights: Penetration center fix measured a central pressure of 985 mb, estimated maximum surface winds of 50 kt, and an eye diameter of 20 nm at 20.5N, 52.4W at 09Z (ATSR). Penetration center fix measured a central pressure of 978 mb, estimated maximum winds of 60 mb at 500 mb, and an eye diameter of 25 nm at 20.9N, 52.2W at 20Z (micro).

MWR: "Reconnaissance on the next 4 days showed a gradual rise in central pressure and on the 11th, the minimum pressure was 984 mb and the highest winds were reported as about 70 mph. The weakening of the hurricane was apparently due to decreasing pressure gradient to the north as a low pressure trough formed across the subtropical High to a deepening Low near Newfoundland. This Low moved southward, reaching its most southerly position on the 11th, after which it begun a slow retreat to the north."

September 12:

HWM analyzes a hurricane with a central pressure of 960 at 22.9N, 52.7W at 12Z. HURDAT lists a 90 knot hurricane at 22.8N, 52.7W at 12Z. Microfilm shows a closed low pressure of at most 999 mb at 22.5N, 52.3W at 12Z. Ship highlights: 40 kt SE and 1007 mb at 22.0N, 50.6W at 00Z (COADS). 30 kt N and 1002 mb at 22.6N, 53.0W at 06Z (micro). 50 kt SE and 1009 mb at 23.8N, 50.9W at 21Z (COADS). Aircraft highlights: Penetration center fix measured a central pressure of 960 mb, estimated maximum surface winds of 90 kt, and an eye diameter of 25 nm at 23.5N, 52.2W at 1405Z (micro). Penetration center fix measured a central pressure of 957 mb, estimated maximum surface winds of 95 kt, and an eye diameter of 20 nm at 23.9N, 53.0W at 1930Z (micro).

MWR: "…on the 12th reconnaissance aircraft found maximum winds of 108 mph and minimum sea level pressure of 960 mb. There were heavy wall clouds in all quadrants except the southwest."

September 13:

HWM analyzes a hurricane with a central pressure of 951 mb at 25.5N, 52.1W at 12Z. HURDAT lists a 100 knot hurricane at 25.4N, 52.4W at 12Z. Microfilm shows a closed low pressure of at most 1008 mb at 25.5N, 52.8W at 12Z. Ship highlights: 70 kt

ENE and 1009 mb at 26.1N, 54.5W at 03Z (micro). 65 kt NNE and 1010 mb at 26.1N, 55.2W at 09Z (micro). Aircraft highlights: Penetration center fix measured a central pressure of 951 mb at 26.0N, 52.4W at 0839Z (micro). Penetration center fix measured a central pressure of 953 mb at 26.6N, 52.0W at 1430Z (micro). Penetration center fix measured a central pressure of 963 mb, estimated maximum surface winds of 90 kt, and an eye diameter of 20 nm at 26.5N, 52.0W at 1930Z (micro).

September 14:

HWM analyzes a hurricane with a central pressure of 968 mb at 28.5N, 53.0W at 12Z. HURDAT lists a 110 knot hurricane at 28.1N, 53.2W at 12Z. Microfilm shows a closed low pressure of at most 1005 mb at 29.0N, 53.0W at 12Z. Ship highlights: 35 kt NNE and 1010 mb at 27.7N, 55.0W at 12Z (micro). 45 kt SW and 1011 mb at 27.6N, 53.6W at 18Z (micro). Aircraft highlight: Penetration center fix measured a central pressure of 964 mb at 28.2N, 52.4W at 0735Z (micro). Penetration center fix measured a central pressure of 964 mb, estimated maximum surface winds of 75 kt, and an eye diameter of 25 nm at 28.1N, 53.8W at 1440Z (micro). Penetration center fix measured a central pressure of 963 mb, estimated maximum winds of 130 kt at 500 mb, and an eye diameter of 35 nm at 28.3N, 54.5W at 20Z (micro).

MWR: “Carrie, having curved to a northerly course at this time, continued northward at 7 to 10 mph until September 14 when rebuilding of the high pressure ridge over the north Atlantic forced it to change course toward the northwest.”

September 15:

HWM analyzes a hurricane with a central pressure of 965 mb at 30.0N, 57.5W at 12Z. HURDAT lists a 105 knot hurricane at 30.2N, 58.0W at 12Z. Microfilm shows a closed low pressure of at most 1014 mb at 30.5N, 59.0W at 12Z. Ship highlights: 35 kt SW and 1015 mb at 28.2N, 53.0W at 00Z (micro). 50 kt E at 32.2N, 58.0W at 18Z (micro). Aircraft highlight: Penetration center fix measured a central pressure of 967 mb, estimated maximum surface winds of 80 kt, and an eye diameter of 40 nm at 29.7N, 56.8W at 0740Z (micro). Penetration center fix measured a central pressure of 965 mb, estimated maximum surface winds of 72 kt, and an eye diameter of 40 nm at 30.3N, 58.2W at 1350Z (micro). Penetration center fix measured a central pressure of 963 mb, estimated maximum surface winds of 84 kt, and a RMW of about 22 nm near 30.0N, 58.0W around 19Z (NHRP). Penetration center fix measured a central pressure of 961 mb and an eye diameter of 40 nm at 31.1N, 59.2W at 1930Z (micro). Penetration center fix estimated maximum surface winds of 70 kt and an eye diameter of 40 nm at 31.8N, 60.3W at 2146Z (micro). Penetration center fix measured a central pressure of 963 mb,

estimated maximum surface winds of 80 kt, and a RMW of about 22 nm near 30.0N, 58.0W around 22Z (NHRP).

September 16:

HWM analyzes a hurricane with a central pressure of 970 mb at 33.0N, 62.0W at 12Z. HURDAT lists an 85 knot hurricane at 32.7N, 62.0W at 12Z. Microfilm shows a closed low pressure of at most 1008 mb at 32.0N, 62.6W at 12Z. Ship highlights: 35 kt NE and 1021 mb at 35.5N, 57.8W at 00Z (micro). Aircraft highlight: Penetration center fix measured a central pressure of 964 mb and an eye diameter of 40 nm at 31.8N, 60.3W at 0146Z (micro). Penetration center fix measured a central pressure of 966 mb, estimated maximum surface winds of 90 kt, and an eye diameter of 60 nm at 32.1N, 61.0W at 0557Z (micro). Penetration center fix measured a central pressure of 967 mb, estimated maximum surface winds of 60 kt, and an eye diameter of 60 nm at 32.0N, 61.2W at 07Z (micro). Penetration center fix measured a central pressure of 970 mb, estimated maximum surface winds of 90 kt, and an eye diameter of 70 nm at 32.3N, 61.7W at 0955Z (micro). Penetration center fix measured a central pressure of 969 mb and estimated maximum surface winds of 90 kt at 32.7N, 62.4W at 1351Z (micro). Penetration center fix at 33.5N, 62.2W at 2127Z (ATSR). Penetration center fix at 33.9N, 63.6W at 2352Z (ATSR).

MWR: “A continued increase in intensity and in size culminated on the 16th in what National Hurricane Research Project observers characterized as one of the most perfectly formed hurricanes they had seen. The winds of 138 mph reported on this date were the maximum surface winds observed during the life of Carrie but it is likely that higher wind speeds occurred during the period of lowest central pressure on September 7 and 8. When the hurricane passed to the northeast of Bermuda on the 16th, poor radar definition and an increase in the diameter of the eye to 40 to 70 miles indicated weakening. However, as it curved eastward in advance of a trough moving into the North Atlantic, it still maintained maximum winds of near 100 mph for the next several days.”

September 17:

HWM analyzes a hurricane of at most 1000 mb at 35.5N, 63.2W at 12Z. HURDAT lists an 80 knot hurricane at 35.2N, 63.8W at 12Z. Microfilm shows a closed low pressure of at most 999 mb at 35.5N, 64.0W at 12Z. Ship highlights: 35 kt SE and 1017 mb at 36.3N, 61.3W at 03Z (micro). 40 kt S and 1018 mb at 33.4N, 60.9W at 12Z (COADS). 50 kt S and 1001 mb at 35.8N, 62.8W at 15Z (COADS). 80 kt SE and 977 mb at 35.9N, 63.2W at 18Z (micro). Aircraft highlights: Penetration center fix measured a central pressure of 970 mb and estimated maximum surface winds of 70 kt at 34.1N, 63.7W at 0130Z (micro). Penetration center fix measured a central pressure of 974 mb

and estimated maximum surface winds of 75 kt and an eye diameter of about 65 nm at 34.8N, 64.8W at 08Z (micro). Penetration center fix measured a central pressure of 975 mb and estimated maximum surface winds of 80 kt at 35.4N, 63.9W at 1425Z (micro). Penetration center fix at 35.6N, 63.5W at 1736Z (ATSR). Penetration center fix measured a central pressure of 978 mb, estimated maximum surface winds of 84 kt, and a RMW of about 32 nm near 35.0N, 64.0W around 18Z (NHRP).

September 18:

HWM analyzes a hurricane with a central pressure of 975 mb at 36.0N, 59.9W with a cold front to the north at 12Z. HURDAT lists a 75 knot hurricane at 35.9N, 59.5W at 12Z. Microfilm shows a closed low pressure of at most 1005 mb at 36.0N, 59.0W at 12Z. Ship highlights: 40 kt SW and 1014 mb at 33.9N, 60.7W at 00Z (COADS). 65 kt S and 995 mb at 36.0N, 60.0W at 06Z (COADS). 80 kt SE and 1002 mb at 36.1N, 53.2W at 12Z (micro). 65 kt E and 1002 mb at 36.7N, 59.5W at 18Z (micro). 50 kt NNW and 999 mb at 35.2N, 57.6W at 2050Z (micro). Aircraft highlight: Penetration center fix measured a central pressure of 978 mb, estimated maximum surface winds of 80 kt, and an eye diameter of 80 nm at 35.9N, 60.4W at 07Z (micro). Penetration center fix at 36.1N, 58.9W at 1356Z (ATSR).

September 19:

HWM analyzes a hurricane with a central pressure of 985 mb at 34.5N, 54.0W with a weakening cold front to the north at 12Z. HURDAT lists a 70 knot hurricane at 34.7N, 53.9W at 12Z. Microfilm shows a closed low pressure of at most 1005 mb at 34.5N, 53.5W with a frontal boundary to the north at 12Z. Ship highlights: 65 kt NW and 985 mb at 35.0N, 56.2W at 00Z (COADS). 45 kt SSW and 1004 mb at 33.2N, 53.2W at 06Z (micro). 45 kt NW and 1007 mb at 33.1N, 54.5W at 12Z (COADS). 40 kt ENE and 1006 mb at 35.5N, 49.0W at 18Z (micro). 990 mb at 34.2N, 50.0W at 21Z (micro). Aircraft highlights: Penetration center fix at 34.7N, 52.9W at 14Z (ATSR). Penetration center fix at 34.8N, 52.1W at 1448Z (ATSR). Penetration center fix at 34.4N, 51.3W at 19Z (ATSR).

ATSR: “...until after 19 September when range again restricted fixes to one per day. CARRIE was the “greatest” hurricane of the 1957 season and set a modern report for life span, containing winds of knows hurricane force for sixteen days.”

September 20:

HWM analyzes a hurricane with a central pressure of 978 mb at 34.0N, 47.8W with a warm front to the northeast and a cold front to the west at 12Z. HURDAT lists a 70 knot hurricane at 34.1N, 47.8W at 12Z. Microfilm shows a closed low pressure of at

most 999 mb at 34.0N, 47.0W with a frontal boundary to the east at 12Z. Ship highlights: 55 kt NE and 1006 mb at 35.5N, 50.0W at 01Z (micro). 45 kt ENE and 1004 mb at 35.8N, 48.4W at 03Z (COADS). 50 kt ENE and 1002 mb at 35.8N, 48.8W at 06Z (COADS). 50 kt SE and 993 mb at 34.3N, 45.8W at 12Z (COADS). 70 kt NE and 997 mb at 34.7N, 46.2W at 16Z (COADS). 70 kt and 987 mb at 34.8N, 45.3W at 18Z (COADS). Aircraft highlights: Penetration center fix at 34.4N, 45.6W at 20Z (ATSR).

September 21:

HWM analyzes a hurricane with a central pressure of 972 mb at 34.5N, 40.0W with a weakening warm front to the northeast and a cold front to the south at 12Z. HURDAT lists a 70 knot hurricane at 34.7N, 40.1W at 12Z. Microfilm shows a closed low pressure of at most 1002 mb at 34.0N, 41.0W at 06Z. Ship highlights: 45 kt N and 1007 mb at 34.8N, 46.1W at 01Z (COADS). 45 kt NNE and 1005 mb at 35.4N, 46.4W at 06Z (COADS). 45 kt S and 1002 mb at 36.0N, 34.5W at 12Z (COADS). 90 kt SSW and 995 mb at 34.5N, 36.1W at 18Z (micro). Aircraft highlights: Penetration center fix at 35.1N, 36.9W at 1930Z (ATSR).

MWR: “Sixty-two warnings were issued by the Joint Center in Miami and an additional eight warning were issued by the U.S. Fleet Weather Central, Fort Lyautey, after CARRIE had crossed the 35th meridian. CARRIE remained at sea through her life cycle. Damages and loss of life were limited to the sinking of the German sailing vessel PAMIR on 21 September with subsequent loss of all but six of the eighty-six crew members. On the 21st the German sailing ship Pamir encountered the storm southwest of the Azores and went down with the loss of 80 of her 86 crew members.”

September 22:

HWM analyzes a hurricane of at most 985 mb at 38.0N, 29.8W with a cold front to the south at 12Z. HURDAT lists a 70 knot hurricane at 38.4N, 29.5W at 12Z. Microfilm shows a closed low pressure of at most 990 mb at 37.0N, 29.0W at 12Z. Ship highlights: 70 kt W and 980 mb at 34.5N, 34.9W at 00Z (micro). 60 kt NW and 1003 mb at 34.9N, 35.6W at 06Z (COADS). 60 kt S and 985 mb at 36.4N, 27.9W at 12Z (micro). 50 kt S and 993 mb at 39.3N, 23.4W at 18Z (COADS). Land highlights: 20 kt SE and 983 mb at Pico Island, Azores at 12Z (micro). 45 kt SW and 1000 at Sao Miguel Island, Azores at 18Z (micro).

MWR: “Insufficient reports were obtained to indicate the maximum wind and lowest pressures observed as it passed through the Azores the next day [22] but it is likely that winds of hurricane force persisted.”

September 23:

HWM analyzes a tropical storm of at most 985 mb at 45.5N, 18.7W with a stationary front to the north and a weakening cold front to the south at 12Z. HURDAT lists a 60 knot extratropical cyclone at 45.6N, 17.8W at 12Z. Microfilm is not available on this date. Ship highlights: 55 kt SSE and 1002 mb at 41.6N, 18.5W at 00Z (COADS). 70 kt WNW and 977 mb at 44.0N, 21.4W at 06Z (COADS). 65 kt SW and 987 mb at 45.5N, 17.2W at 12Z (COADS). 50 kt SW and 994 mb at 47.5N, 13.0W at 18Z (COADS).

September 24:

HWM analyzes a closed low pressure of at most 995 mb at 51.0N, 13.0W with a frontal boundary to the north and a dissipating cold front to the south at 12Z. HURDAT lists a 50 knot extratropical cyclone at 51.2N, 10.8W at 12Z. Microfilm is not available on this date. Ship highlights: 45 kt S and 976 mb at 50.0N, 15.6W at 00Z (COADS). 45 kt NE and 1000 mb at 50.0N, 16.7W at 06Z (COADS). 45 kt S and 996 mb at 50.0N, 10.7W at 12Z (COADS). 45 kt ENE and 1015 mb at 56.0N, 12.1W at 18Z (COADS). Land highlights: 25 kt SE and 997 mb at Dingle, Ireland at 12Z (HWM).

MWR: “Carrie began to assume extratropical feature thereafter and accelerated to the northeast, lashing the British Isles with high winds on the 24th and 25th and causing tremendous waves on the coast and floods over parts of the Isles. Carrie was charted over one of the longest tracks, probably the longest track, of record-approximately 6,000 miles from its origin off the African coast to near Bermuda and back across the Atlantic to the British Isles. Formal advisories were issued from September 6 to 21 and additional advices were issued through the NSS bulletin (report from Navy Radio station at Annapolis) after it passed east of longitude 35' W. on that date. Aircraft reconnaissance of Carrie was of unusual quality. The Air Force flights from Bermuda on the 7th and 21st went farther east than any previous hurricane reconnaissance flight and the initial flight on the 7th covered approximately 3,700 miles with almost 17 hours in the air.”

September 25:

HWM analyzes a closed low pressure of at most 1005 mb at 51.0N, 6.0W with a warm front to the north and cold front extending through the system to the southwest at 12Z. HURDAT does not list an organized system on this date. Microfilm is not available on this date. Ship highlights: 35 kt W and 1015 mb at 47.3N, 7.8W at 18Z (COADS). 35 kt NW and 1022 mb at 48.3N, 5.3W at 23Z (COADS). Land highlights: 15 kt SW and 1004 mb at Isles of Scilly, England at 12Z (HWM).

September 26:

HWM analyzes a frontal boundary over Western Europe and no organized low pressure system at 12Z. HURDAT does not list an organized system on this date. Microfilm is not available on this date.

A tropical wave left the African coast during the last days of August and rapidly organized into a tropical cyclone southeast of the Cape Verde Islands. Data over the eastern Atlantic is sparse and it is difficult to determine the exact time of formation but it is consistent with the presence of a low pressure system on the 2nd. A 25 kt tropical depression is analyzed to have formed at 06Z on September 2nd, no change from the original HURDAT. A central pressure of 1001 mb is present in HURDAT at 18Z on the 2nd. This value, if real, would suggest a moderate tropical storm, which is not consistent with the remaining other observations. Thus, it has been removed from HURDAT. Minor changes were made to the track on September 2nd, and 5th through the 23rd, no track changes on the 3rd and 4th and major track changes on the 24th between 00Z and 12Z. On September 3rd, the tropical depression passed south of the Cape Verde Islands. Intensification to a tropical storm is analyzed at 12Z on the 3rd. There is no data to corroborate the intensification, so we are keeping the original HURDAT. Similarly, intensification to a hurricane is analyzed at 12Z on September 5th and there are no ships or coastal stations for hundreds of miles from the center of the cyclone, thus we are retaining the original HURDAT. The first gale was observed at 12Z on September 6th when a ship northwest of the hurricane reported 35 kt NNE. Later at 16Z, another ship, very close to the hurricane, reported 80 kt ENE and 1001 mb. These data are consistent with the 85 kt at 12Z and 95 kt at 18Z on the 6th in HURDAT, so no changes are made. Intensification to a major hurricane is analyzed at 00Z on September 7th, same as the original HURDAT. The first reconnaissance aircraft to reach Carrie occurred at 2148Z on the 7th, measuring a central pressure of 945 mb, estimating flight level winds (700 mb) of 120 kt and an eye diameter of 20 nm. A central pressure of 945 mb suggests maximum sustained winds of 116 kt south of 25N and 118 kt south of 25N intensifying from the Brown et al. pressure-wind relationship. The 20 nm eye diameter suggests an RMW of about 15 nm and climatology indicates 17 nm. An intensity of 120 nm is analyzed at 00Z on September 8th, same as the original HURDAT. A central pressure of 945 mb was present in HURDAT at 12Z on the 7th and based on the reconnaissance report, it appears to be in the wrong time slot and has been moved to 00Z on the 8th.

Hurricane Carrie continued to move west-northwest on September 8th over the central Atlantic as a category 4 hurricane. A central pressure of 945 mb appears in HURDAT at 12Z on the 8th and has been moved to 18Z on this day since the reconnaissance aircraft made a center fix at 1930Z and there were no central pressure reports earlier in the day.

This central pressure of the 8th seems reasonable and it is retained but was not confirmed. 120 kt is the peak intensity for this hurricane, down from 135 kt originally in HURDAT, a major intensity change. The next reconnaissance aircraft reached Carrie at 2021Z on September 9th measuring a central pressure of 975 mb, estimating flight level winds of 135 kt at 700 mb and an eye diameter of 10 nm. A central pressure of 975 mb suggests maximum sustained winds of 83 kt south of 25N weakening according to the pressure-wind relationship. An intensity of 85 kt is selected for 18Z on the 9th, a major intensity change from the original 130 kt in HURDAT. Major intensity changes are also analyzed between 00Z and 12Z on the 9th. HURDAT originally had 135 kt for these times and the analyzed intensities are 115 kt, 105 kt and 95 kt, respectively. It is analyzed that Carrie weakened below major hurricane intensity at 12Z on the 9th, 24 hours earlier than originally shown in HURDAT. A central pressure of 975 mb was present in HURDAT at 12Z on the 9th and based on the reconnaissance reports, it has been moved to 18Z on this day. Further confirmation of the rapid weakening of Carrie occurred on September 10th when another reconnaissance mission reported a central pressure of 977 mb and an eye diameter of 20 nm at 0815Z. Later at 0930Z, another report indicated a central pressure of 985 mb, estimated surface winds of 75 kt and an eye diameter of 20 nm. A central pressure of 977 mb suggests maximum sustained winds of 80 kt south of 25N weakening according to the pressure-wind relationship. Due to the slow motion of the hurricane, an intensity of 75 kt is selected for 06Z on the 10th, down from 115 kt originally in HURDAT, a major intensity change. 80 kt is analyzed at 00Z on the 10th, a major intensity change from the 125 kt originally in HURDAT. A central pressure of 985 mb suggests maximum sustained winds of 71 kt south of 25N weakening according to the pressure-wind relationship. An intensity of 70 kt is selected for 12Z on the 10th, a major change from the original 95 kt in HURDAT. A central pressure of 985 mb was present in HURDAT at 06Z on the 10th and based on the reconnaissance report at 0815Z, has been replaced with 977 mb. At 12Z on the 10th, HURDAT has a central pressure of 987 mb and has been replaced with 985 mb based on the reconnaissance report at 0930Z. An intensity of 65 kt is analyzed at 18Z on the 10th, a major intensity change from the 85 kt originally in HURDAT.

On September 11th, Carrie stopped weakening and its track turned to the north at a very slow forward speed. The center fixes by the reconnaissance aircrafts between September 9th and the 11th show substantial inconsistencies, potentially because Carrie was far from land and moving slowly. An aircraft reconnaissance investigated the hurricane at 09Z measuring a central pressure of 985 mb, estimated surface winds of 50 kt and an eye diameter of 20 nm. A central pressure of 985 mb suggests maximum sustained winds of 71 kt south of 25N according to the pressure-wind relationship. Due to the slow motion of Carrie, an intensity of 65 kt is selected for 06Z on the 11th, same as the original HURDAT. A central pressure of 978 mb is added to 06Z on the 11th. A central pressure

of 984 mb is present in HURDAT at 12Z on the 11th, which appears reasonable and has been retained. Late on the 11th, Carrie began to re-intensify as a reconnaissance aircraft reported a central pressure of 978 mb, estimated surface winds of 60 kt and an eye diameter of 25 nm at 20Z. A central pressure of 985 mb suggests maximum sustained winds of 80 kt south of 25N according to the pressure-wind relationship. Due to the slow motion of Carrie, an intensity of 70 kt is selected for 18Z on the 11th, same as the original HURDAT. Intensification continued on September 12th and a reconnaissance aircraft reported a central pressure of 960 mb, estimated surface winds of 90 kt and an eye diameter of 25 nm at 1405Z. A central pressure of 960 mb suggests maximum sustained winds of 101 kt south of 25N according to the pressure-wind relationship. Due to the slow motion of Carrie, an intensity of 90 kt is selected for 12Z on the 12th, same as the original HURDAT. Another aircraft reported a central pressure of 957 mb at 1930Z, along with estimated surface winds of 95 kt and an eye diameter of 20 nm. A central pressure of 957 mb suggests maximum sustained winds of 104 kt south of 25N according to the pressure-wind relationship. Due to the slow forward speed of the hurricane, an intensity of 95 kt is selected for 18Z on the 12th, same as the original HURDAT. A central pressure of 957 mb is present in HURDAT at 12Z on the 12th and has been moved to 18Z based on the reconnaissance report. A central pressure of 960 mb has been added to 12Z on the 12th. On September 13th, a reconnaissance mission reported a central pressure of 951 mb at 0839Z. A central pressure of 951 mb suggests maximum sustained winds of 112 kt south of 25N intensifying and 109 kt north of 25N intensifying, according to the pressure-wind relationship. Due to the slow motion of Carrie, an intensity of 105 kt is selected for 06Z on the 13th, up from 95 kt originally in HURDAT, a minor intensity change. It is analyzed that Carrie regained major hurricane status at 00Z on the 13th, twelve hours earlier than originally in HURDAT. A reconnaissance aircraft reported a central pressure of 953 mb at 1430Z on the 13th. An intensity of 100 kt is selected for 12Z on the 13th, same as originally in HURDAT. A central pressure of 963 mb was measured by a reconnaissance aircraft at 1930Z on the 13th, along with estimated surface winds of 90 kt and an eye diameter of 20 nm. A central pressure of 963 mb suggests maximum sustained winds of 92 kt north of 25N and 88 kt north of 25N weakening, according to the pressure-wind relationship. An intensity of 90 kt is selected for 18Z on the 13th, down from 100 kt originally in HURDAT, a minor intensity change. Weakening from major hurricane status is analyzed 54 hours earlier than originally shown in HURDAT. A central pressure of 963 mb is present in HURDAT at 12Z on the 13th and based on the reconnaissance reports, has been moved to 18Z on this day. Central pressures of 951 mb and 953 mb, have been added to 06Z and 12Z, respectively, on the 13th.

On September 14th, Carrie turned to the northwest and slightly increased in forward speed. A reconnaissance aircraft measured a central pressure of 964 mb at 0735Z. A

central pressure of 964 mb suggests maximum sustained winds of 91 kt north of 25N according to the pressure-wind relationship. An intensity of 90 kt is selected for 06Z on the 14th, down from 105 kt originally in HURDAT, a minor intensity change. A central pressure of 964 mb has been added to HURDAT at 06Z on the 14th. Other center fixes measured 964 mb at 1440Z and 963 mb at 20Z. The intensity is kept at 90 kt for 12Z and 18Z on the 14th, down from the original 110 kt and 115 kt, respectively, in HURDAT, a major intensity change. On September 15th, the central pressure had minor variations from the previous day, but the eye diameter had increased to about 40 nm. A central pressure report of 967 mb was received from a reconnaissance aircraft at 0740Z and 965 mb at 1350Z. An eye diameter of 40 nm suggests an RMW of about 30 nm and climatology suggests about 23 nm. Due to the larger RMW, an intensity of 85 kt is selected for 06Z and 12Z on the 15th, down from 110 kt and 105 kt, respectively, originally in HURDAT, a major intensity change at both times. A central pressure of 967 mb has been added to HURDAT at 06Z on the 15th. On this day, the National Hurricane Research Project investigated Carrie estimating surface winds of 84 kt, measuring a central pressure of 963 mb and an RMW of about 22 nm around 19Z. Another reconnaissance mission at 1930Z reported a central pressure of 961 mb and an eye diameter of 40 nm. A central pressure of 961 mb suggests maximum sustained winds of 94 kt north of 25N according to the pressure-wind relationship. An intensity of 90 kt is selected for 18Z on the 15th, down from 100 kt originally in HURDAT, a minor intensity change. A central pressure of 961 mb is added to HURDAT at 18Z on the 15th. A central pressure of 963 mb was present in HURDAT at 12Z and, based on the reconnaissance report at 1350Z, it has been replaced with 965 mb.

Hurricane Carrie continued moving to the northwest on September 16th, slowly losing strength. The first reconnaissance reports on the 16th measured a central pressure of 964 mb at 0146Z, 966 mb at 0557Z, 967 mb at 07Z and 970 mb at 0955Z. An intensity of 85 kt is selected for 00Z and 06Z on the 16th. HURDAT originally had 90 kt at 00Z and 85 kt at 06Z, minor and no intensity change, respectively. A central pressure of 964 mb is added to HURDAT at 00Z on the 16th and 966 mb is added to 06Z. A central pressure of 969 mb and estimated surface winds of 90 kt were reported by a reconnaissance aircraft at 1351Z. A central pressure of 969 mb suggests maximum sustained winds of 86 kt north of 25N according to the pressure-wind relationship. At 0955Z, the reconnaissance aircraft estimated an eye diameter of 70 nm, suggesting an RMW of about 53 nm and climatology suggests about 25 nm. Since the RMW is larger than suggested by climatology, an intensity of 80 kt is selected at 12Z on the 16th, down from 85 kt originally in HURDAT, a minor intensity change. Early on September 17th, Carrie passed about 110 nm northeast of Bermuda. No adverse effects were reported on the island as the strongest pressure gradient was located on the northeast quadrant of the hurricane. A reconnaissance mission reported a central pressure of 970 mb and estimated surface

winds of 70 kt at 0130Z. An intensity of 80 kt is selected for 00Z on the 17th, same as originally in HURDAT. A central pressure of 970 mb is added to HURDAT at 00Z on the 17th. Another center fix at 08Z reported a central pressure of 974 mb and estimated surface winds of 75 kt and an eye diameter of about 65 nm. A central pressure of 974 mb suggests maximum sustained winds of 80 kt north of 25N and 79 kt north of 35N, according to the pressure-wind relationship. A diameter of 65 nm suggests an RMW of about 49 nm and climatology suggests about 29 nm. Since the size of the hurricane was larger than normal and it was moving at about 8 kt, an intensity of 75 kt is selected for 06Z on the 17th, down from 80 kt originally in HURDAT, a minor intensity change. A central pressure of 974 mb has been added to HURDAT at 06Z on the 17th. A central pressure of 975 mb appears in microfilm associated with a reconnaissance report at 1425Z. A central pressure of 972 mb is present in HURDAT at 12Z on the 17th and based on the reconnaissance report, has been replaced with 975 mb. An intensity of 75 kt is selected for 12Z on the 17th, down from the original 80 kt in HURDAT, a minor intensity change. Around 18Z, the National Hurricane Research Project reported a central pressure of 978 mb, estimated surface winds of 84 kt and an RMW of 32 nm. A central pressure of 978 mb suggests maximum sustained winds of 75 kt north of 25N and north of 35N, according to the pressure-wind relationship. An intensity of 75 kt is selected for 18Z on the 17th, down from 80 kt originally in HURDAT, a minor intensity change. A central pressure of 978 mb is added to HURDAT at 18Z on the 17th. A ship reported 80 kt SSE at 18Z on the 17th but based on the large size of the circulation and pressure reports by the reconnaissance aircraft, it appears to be biased slightly high. Late on the 17th, Carrie turned to the northeast and to the east on the 18th. A couple of ships reported hurricane-force winds on September 18th. A reconnaissance aircraft measured a central pressure of 978 mb, estimated surface winds of 80 kt and an eye diameter of 80 kt. An intensity of 70 kt is selected for 06Z on the 18th, down from 75 kt originally in HURDAT, a minor intensity change.

The structure of Hurricane Carrie began to be affected by an approaching frontal boundary on September 19th, causing the cyclone to become elongated E-W. A central pressure of 970 mb is present in HURDAT at 12Z on the 19th and although there is no confirmation that it was a measurement, there was a reconnaissance aircraft that made a center fix at 1356Z. Thus, it is retained. A central pressure of 970 mb suggests maximum sustained winds of 90 kt north of 25N and 82 kt north of 35N according to the pressure-wind relationship. An intensity of 80 kt is selected for 12Z on the 18th, up from 70 kt originally in HURDAT, a minor intensity change. On September 20th, Carrie continued eastward with no appreciable change in strength. Two ships reported hurricane-force winds at 18Z on the 20th and the structure of the hurricane continued to be elongated. A central pressure of 972 mb is present in HURDAT at 12Z on the 21st but the only reconnaissance mission occurred at 1930Z, thus it has been moved to 18Z on this day.

Late on the 21st, a warm front started developing northeast of the circulation but the hurricane remained tropical. A central pressure of 972 mb suggests maximum sustained winds of 88 kt north of 25N and 80 kt north of 35N according to the pressure-wind relationship. Due to the large RMW of Carrie during the last couple of days reported by the reconnaissance aircraft, an intensity of 80 kt is selected for 18Z on the 21th, up from 70 kt originally in HURDAT, a minor intensity change. A ship at 18Z on the 21st appears to be reporting 90 kt SSW on microfilm but do to the large RMW of the hurricane, the report may be biased slightly high. Carrie turned to the northeast and increased in forward speed on September 22nd passing over the central Azores as a 75 kt hurricane around 16Z. The highest winds on microfilm at the Azores were 45 kt and lowest pressure was 983 mb. Transition to an extratropical cyclone is analyzed at 00Z on September 23rd northeast of the Azores, as originally shown in HURDAT. Weakening below hurricane force is analyzed at 18Z on the 23rd, six hours later than originally in HURDAT. Further weakening occurred on September 24th as Carrie turned eastward and slowed its forward speed. Late on the 24th and 25th, Carrie affected the British Isles and continued to weaken. Dissipation is analyzed to have occurred after 18Z on the 25th. September 25th is new to HURDAT. Hurricane Carrie is tied with Hurricane #4, 1926 for the second longest duration of tropical cyclone to be re-analyzed, both lasting 23 days and 18 hours, only the San Siriaco Hurricane of 1899 lasted longer.

Tropical Storm Debbie [September 7-9, 1957]

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40305 09/07/1957 M= 3  5 SNBR= 876 DEBBIE      XING=1 SSS=0
40305 09/07/1957 M= 3  6 SNBR= 876 DEBBIE      XING=1 SSS=0
                        *
40310 09/07*  0   0   0    0*239 898  35    0*250 895  35    0*262 888  35    0*
40310 09/07*  0   0   0    0*239 898  35    0*250 895  35    0*263 890  35    0*
                                                          * ***

40315 09/08*274 881  35    0*287 874  35    0*300 868  35    0*307 860  35    0*
40315 09/08*277 885  35    0*289 879  35    0E297 870  35 1003E304 860  35    0*
           *** ***           *** ***          **** ***      ********

40320 09/09*319 851  30    0*325 844  30    0*  0   0   0    0*  0   0   0    0*
40320 09/09E316 851  30    0E331 844  25    0*  0   0   0    0*  0   0   0    0*
          ****              ****

40325 TS
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Minor changes to the track and intensity shown in McAdie et al. (2009). A major alteration is to change to extratropical the last 24 hours of this tropical cyclone's lifetime.Evidence for these alterations comes from the NHC microfilm maps, Historical Weather Maps series, COADS ship database, Monthly Weather Review, Local Climatological Data, Surface Weather Observations and Mexican synoptic maps.

September 5:

HWM analyzes a spot low pressure at 24.2N, 91.5W at 12Z. HURDAT does not list an organized storm on this date. Microfilm does not show an organized system on this date. Ship highlights: No gales or low pressures.

MWR: “On September 5 there was evidence of a weak easterly wave moving from the Caribbean into the Gulf of Mexico where a stagnant upper trough prevailed.” ASTR: “The position of an easterly wave (located near 46ºW) was forwarded to this office by Fleet Weather Central, Port Lyautey, on August 25.”

September 6:

HWM analyzes a spot low pressure at 24.2N, 90.5W at 12Z. HURDAT does not list an organized storm on this date. Microfilm shows a trough or tropical wave over the eastern central Gulf of Mexico at 12Z. Ship highlights: No gales or low pressures.

September 7:

HWM analyzes a tropical storm of at most 1010 mb at 25.0N, 90.0W at 12Z. HURDAT lists a 35 kt tropical storm at 25.0N, 89.5W at 12Z. Microfilm does not show an organized system on this date. Ship highlights: 35 kt SW and 1015 mb at 25.7N, 86.0W at 00Z (COADS).

MWR: “This wave was apparently the trigger which set off a weak circulation in the central Gulf on September 7.” ATSR: “This wave, although of weak intensity, crossed the Antilles on 2 September and continued across the Yucatan Peninsula at 0000Z, 7 September, and stagnated near 93ºW. By 1200Z, 7 September, a weak cold front moved southward into the Gulf of Mexico causing a large area of unstable conditions and heavy showers over the eastern Gulf of Mexico.”

September 8:

HWM analyzes a tropical storm of at most 1005 mb at 29.9N, 87.0W with a warm front to the northwest at 12Z. HURDAT lists a 35 kt tropical storm at 30.0N, 86.8W at 12Z. Microfilm shows a closed low pressure of at most 1005 mb at 29.5N, 87.0W with a frontal boundary extending north-south through the center at 12Z. Ship highlights: 10 kt NNE and 1005 mb at 29.6N, 88.6W at 09Z (micro). 20 kt SE and 1005 mb at 29.8N, 86.6W at 12Z (COADS). Land highlights: 20 kt SE and 1005 mb at Pensacola, FL at 09Z (micro). 10 kt E and 1004 mb at Milton, FL at 12Z (SWO). 9 kt E and 1005 mb at Dothan, AL at 19Z (SWO). 35 kt at St. Marks, FL (no time given, may be an estimate) (MWR).

MWR: “This depression moved northeastward and only barely reached storm force before going inland near Fort Walton, Fla., about 40 miles east of Pensacola, on the morning of the 8th. Highest winds reported were around 40 mph at St. Marks. Tampa had gusts to 52 mph in a squall. The highest tide reported was some 150 miles east of the center on Apalachee Bay where it ranged from 2.5 to 4 feet. Some flooding occurred due to the tides and rains, which were locally heavy, with 9.10 inches at Crawfordsville, Fla. There were no fatalities as a direct result of the storm although it was indirectly responsible for four deaths. The failure of Debbie to intensify further may be attributable to two factors. The upper-air pattern never conformed to that found to favor intensification. In addition, there was evidence that cooler air entered the circulation as it moved near the coast.” ATSR: “By 000Z, 8 September, a low which had “spun off” the easterly wave had drifted northeast and was now located on the weak frontal system with increased shower activity and winds of 30 to 40 knots, causing squalls throughout the north-eastern Gulf. Warning number ONE on Tropical Depression Debbie was issued at 0400Z, 8 September. Although Debbie was labeled as a tropical system she never attained true tropical characteristics. Throughout the span of Debbie’s life there was never a definite center on surface charts and at all times, she was under the influence of a cold trough extending aloft to all observed levels. Debbie moved ashore near Pensacola during the afternoon of 8 September. Only 3 warnings were issued on Debbie by this activity. The only results observed at coastal installations were gusty winds to 45 knots and heavy rains over West Florida, South Georgia and Alabama which caused minor flooding. Had upper level conditions been more favorable Debbie probably would have developed into a more definite tropical system. No reconnaissance flights were flown into Tropical Storm Debbie.”

September 9:

HWM and microfilm analyze a stationary front over the southeast of the United States, likely indicating that Debbie dissipated at 12Z. HURDAT lists a 30 kt tropical depression at 32.5N, 84.4W at 06Z (last position). Ship highlights: No gales or low pressures.

A tropical wave developed into Tropical Storm Debbie in the central Gulf of Mexico during the first week of September. The data is sparse over the Gulf of Mexico south of 25ºN and therefore, it is possible that Debbie might have developed a day earlier than it is shown in HURDAT. The first position, not genesis, is retained at 06Z on September 7th as a 35 kt tropical storm. 35 kt is also the peak intensity for the lifetime of this tropical cyclone. Minor track changes are introduced for the duration of this system. Debbie moved slowly to the northeast on the 7th. The only gale (35 kt) reported by a ship during the lifetime of this cyclone occurred at 00Z on the 7th and based on the winds reported by

nearby ships, it appears to be 5-10 kt too high. Nonetheless, a couple of ships reported 30 kt on the 8th and the 35 kt intensity in HURDAT is retained for September 7th and 8th. No aircraft reconnaissance missions investigated this tropical cyclone. On September 8th, the forward speed of the tropical cyclone increased as a frontal boundary approached from the northwest. Ship and land observations at 12Z on the 8th show that Debbie had become extratropical as dry air entered the center of the cyclone, indicated by the dew point gradient across the storm. A major change to HURDAT is to indicate that Debbie was an extratropical cyclone during the last 24 hours of its lifetime. At 12Z on the 8th, a ship inside the RMW of Debbie reported 20 kt SE and 1005 mb, indicating a central pressure of about 1003 mb, which has been added to HURDAT. The extratropical cyclone made landfall in the Florida panhandle near 30.3N, 86.1W, about 30 miles west of Panama City, FL, around 17Z on the 8th with winds of 35 kt. The only gales reported on land were 35 kt at St. Marks, FL, according to the Monthly Weather Review, but it is possible that this was an estimate. No station report from that location was found during the reanalysis. It is also possible that Debbie never reached tropical storm intensity while a tropical cyclone. The ship data over the northeast Gulf of Mexico is substantial and there was no reliable report of gales. After making landfall in Florida, the extratropical cyclone moved over southeast Alabama before dissipating over western Georgia after 06Z on September 9th. Its remnants became part of the frontal boundary over the Southeast of the United States. The development and characteristics of this tropical cyclone bear similarities to Tropical Storm Lee in 2011.

Tropical Storm Esther [September 16-19, 1957]

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40330 09/16/1957 M= 4  6 SNBR= 877 ESTHER      XING=1 SSS=0
40330 09/16/1957 M= 4  7 SNBR= 877 ESTHER      XING=1 SSS=0
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40335 09/16*  0   0   0    0*  0   0   0    0*  0   0   0    0*230 928  30    0*
40335 09/16*208 930  30    0*214 930  35    0*220 930  40    0*227 930  40    0*
            *** ***  **      *** ***  **      *** ***  **      *** ***  **

40340 09/17*237 928  35 1000*245 927  45    0*253 926  45 1004*263 923  45    0*
40340 09/17*234 930  40 1000*241 930  40    0*245 930  40    0*251 928  40 1004*
            *** ***  **      *** ***  **      *** ***  **    * *** ***  ** ****

40345 09/18*273 918  45    0*282 913  45    0*292 909  45 1005*304 905  45    0*
40345 09/18*264 923  45    0*279 916  50 1000*292 909  55    0*304 909  50    0*
            *** ***         *** ***  ** ****          **    *     ***  **

40350 09/19*315 905  35    0*325 905  25    0*335 910  25    0*  0   0   0    0*
40350 09/19*315 910  35 1002*325 910  25    0*335 910  25    0*  0   0   0    0*
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40355 TS
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U.S. Tropical Storm Landfall

09/18 12Z 29.2N 90.9W 55 kt LA

Minor track and intensity changes shown in McAdie et al. (2009). Evidence for these alterations comes from the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Monthly Weather Review, the Local Climatological Data, Surface Weather Observations, Navy reconnaissance book and Mexican synoptic maps.

September 14:

HWM analyzes a closed low pressure of at most 1010 mb at 22.7N, 95.0W at 12Z. HURDAT and microfilm do not list an organized storm on this date. Ship highlights: No gales or low pressures.

September 15:

HWM analyzes a closed low pressure of at most 1005 mb at 23.5N, 96.2W at 12Z. HURDAT and microfilm do not list an organized storm on this date. Ship highlights: No gales or low pressures.

MWR: “Squalliness and abnormally low pressure in the southwestern Gulf of Mexico on September 15 indicated that a tropical depression might be forming. For about 2 days prior to this date a weak cyclonic circulation aloft had been drifting northwestward across Central America toward the Gulf of Mexico.”

September 16:

HWM analyzes a closed low pressure of at most 1005 mb at 23.0N, 95.0W at 12Z. HURDAT lists a 30 kt tropical depression at 23.0N, 92.8W at 18Z (first advisory). Microfilm shows a closed low pressure of at most 1005 mb at 21.0N, 94.0W at 12Z. Ship highlights: 20 kt E and 1005 mb at 21.0N, 92.9W at 00Z (micro). 40 kt ESE and 1006 mb at 22.3N, 90.5W at 09Z (micro). 10 kt SE and 1005 mb at 21.8N, 92.8W at 12Z (COADS). 15 kt N and 1005 mb at 22.8N, 94.0W at 18Z (micro). Aircraft highlights: Penetration center fix measured a central pressure of 1000 mb and estimated maximum surface winds of 35 kt at 23.0N, 92.3W at 23Z (ATSR).

MWR: “On the evening of the 15th the New Orleans Weather Bureau Office issued a bulletin announcing the development of a depression and forecasting intensification.” ATSR: “On 12 September a low center on the UTC appeared at the surface and up to 700 mb over Nicaragua. This low persisted and drifted northwest on the ITC until early on 16 September when it broke away from the ITC and moved northward into the Gulf of Campeche near 92ºW. A Navy low-level reconnaissance flight was ordered to investigate

the Campeche Area during the afternoon of 16 September; the post-flight summary from this flight reported a minimum pressure of 1000 mb and a maximum wind of 35 knots with circular bands of weather echoes on radar."

September 17:

HWM analyzes a tropical storm of at most 1000 mb at 25.2N, 93.2W with a weakening frontal boundary to the west at 12Z. HURDAT lists a 45 kt tropical storm at 25.3N, 92.6W at 12Z. Microfilm shows a closed low pressure of at most 1002 mb at 25.5N, 93.0W at 12Z. Ship highlights: 25 kt NE and 1003 mb at 23.9N, 93.1W at 00Z (micro). 20 kt ENE and 1005 mb at 25.2N, 92.7W at 06Z (COADS). 35 kt SE and 1011 mb at 28.6N, 90.6W at 12Z (COADS). 40 kt ESE and 1010 mb at 28.6N, 90.5W at 18Z (micro). Aircraft highlights: Penetration center fix measured a central pressure of 1004 mb, estimated maximum surface winds of 45 kt and an eye diameter of 15 nm at 25.5N, 92.8W at 2000Z (ATSR).

MWR: "Esther grew to storm intensity by late on the 16th and began moving northward at about 10 mph. It never developed into a typical tropical storm with a small, well-defined eye but remained with a large area of relatively light winds roughly 100 miles across." ATSR: "Based on the recon flight and subsequent ship reports, Warning Number ONE, Tropical Storm Esther, was promulgated at 0400Z, 17 September. Although ESTHER never developed into a typically organized tropical storm, conditions at the upper levels were fairly favorable for further development. A second low-level recon flight was flown early on 17 September into ESTHER; this flight indicated that the storm was filling slightly (1004 mb) and that maximum winds were 45 kt. The strong winds were almost entirely on the east side of ESTHER and the center was poorly defined."

September 18:

HWM analyzes a tropical storm of at most 1000 mb at 29.0N, 90.9W at 12Z. HURDAT lists a 45 kt tropical storm at 29.2N, 90.9W at 12Z. Microfilm shows a closed low pressure of at most 1002 mb at 29.8N, 90.9W at 12Z. Ship highlights: 35 kt SSW and 1006 mb at 25.0N, 91.1W at 00Z (micro). 40 kt SE and 1008 mb at 27.7N, 89.6W at 02Z (micro). 40 kt S and 1008 mb at 27.0N, 89.9W at 06Z (COADS). 50 kt SSE and 1009 mb at 29.5N, 88.8W at 12Z (micro). Land highlights: 7 kt S and 1003 mb at New Orleans, LA at 0955Z (SWO). 40 kt SSW and 1005 mb at Burrwood, LA at 1010Z (SWO). 42 kt SE and 1011 mb at Mobile, AL at 1626Z (SWO). 45 kt S, gusts to 65 kt and 1012 mb at Pensacola, FL at 1837Z (SWO). 43 kt SSE and 1010 mb at Mobile, AL at 1848Z (SWO). 40 kt SSE and 1009 mb at Mobile, AL at 2319Z (SWO). 6 kt SE and 1003 mb at McComb, MS at 2158Z (SWO). Aircraft highlights: Penetration center fix measured a central pressure of 1008 mb and estimated maximum surface winds of 40 kt at 28.0N,

90.5W at 04Z (ATSR). Penetration center fix measured a central pressure of 1000 mb at 28.4N, 91.2W at 0815Z (ATSR). Penetration center fix measured a central pressure of 1005 mb and estimated maximum surface winds of 68 kt at 28.8N, 89.7W at 1246Z (ATSR).

MWR: "This area passed inland on the southeastern Louisiana coast about day-break on September 18, subsequently moving up the Mississippi Valley and weakening. As in the case of the first storm of the season (unnamed) and Debbie, much of the squalliness and high wind was a considerable distance to the east of the center. The highest reported wind speed was 52 mph at Pensacola airport, with gusts to 75 mph. The lowest pressure observed on land was 1003 mb at New Orleans and McComb, La., with 1000 mb reported by reconnaissance aircraft before the storm reached land. Squalls and heavy rains occurred in advance and to the east of the central area and continued along the Mississippi and Alabama coasts and near the mouth of the Mississippi River well after it passed. Five inches of rain fell at Buras, La., in 2.5 hours with a total of over 13 inches there. Amounts ranging upwards from 6 inches through southeastern Louisiana and near the Mississippi and Alabama coasts resulted in some flooding in those areas. The property damage chargeable to Esther was estimated at $1,500,00." ATSR: "ESTHER continued on a NNE course at about 11 knots and moved inland on the southeast coast of Louisiana about daybreak 18 September. A third low-level flight was dispatched to the area south of New Orleans at daybreak, 18 September, to assure that ESTHER had not developed a second center during the night. Although this third flight could not locate a center, it did report winds in squall areas up to 68 knots. The maximum wind reported by land stations was 45 knots with gusts to 65 knots at Pensacola. Minimum pressure recorded at land stations was 1003 mb."

September 19:

HWM analyzes a warm front over the southeast of the United States and a cold front over the plains at 12Z. HURDAT lists a 25 kt tropical depression at 33.5N, 91.0W at 12Z (last position). Microfilm shows a closed low pressure of at most 1008 mb at 34.0N, 92.0W at 12Z. Ship highlights: 35 kt SE and 1008 mb at 29.9N, 88.2W at 00Z (COADS). Land highlights: 10 kt S and 1004 mb at Liberty, MS at 00Z (micro).

Tropical Storm Esther developed over the southern Gulf of Mexico during the third week of September. Land stations observations and ship data in the eastern Bay of Campeche indicate a decrease in pressures of about 4-6 mb between September 14th and 16th. At 00Z on September 16th, ship data indicate that a well-defiled low level circulation had developed and a 30 kt tropical depression is analyzed to have formed, 18 hours earlier than originally in HURDAT. Minor track changes are introduced for the duration of this system. The tropical cyclone moved slowly to the north on the 16th and a ship at 09Z

reported 40 kt E and 1006 mb. The tropical cyclone is analyzed to have become a tropical storm at 06Z on the 16th, 18 hours earlier than originally shown in HURDAT. The first reconnaissance aircraft to investigate Esther reached the tropical storm at 23Z on the 16th measuring a central pressure of 1000 mb and estimating surface winds of 35 kt. A central pressure of 1000 mb suggests maximum sustained winds of 47 kt south of 25N from the Brown et al. pressure-wind relationship. Due to the low environmental pressures and slow forward speed, an intensity of 40 kt is selected for 00Z on the 17th, up from 35 kt originally in HURDAT, a minor intensity change. A central pressure of 1000 mb was present in HURDAT at 00Z on the 17th and has been retained. A couple of gales up to 40 kt were reported on the 17th, all of them over the eastern quadrant where the pressure gradient was the strongest. Another reconnaissance aircraft mission reached Esther at 18Z on the 17th measuring a central pressure of 1004 mb and estimating surface winds of 45 kt. A central pressure of 1004 mb suggests maximum surface winds of 36 kt north of 25N and 39 kt south of 25N, according to the pressure-wind relationship. Based on the ship data, an intensity of 40 kt is selected for 18Z on the 17th, down from 45 kt originally in HURDAT, a minor intensity change. A central pressure of 1004 mb is present in HURDAT at 12Z on the 17th and has been moved to 18Z based on the aircraft reconnaissance data.

On September 18th, Esther turned to the north-northeast and gained in forward speed and strength. A reconnaissance mission at 0815Z on the 18th measured a central pressure of 1000 mb. A central pressure of 1000 mb suggests maximum sustained winds of 44 kt north of 25N according to the pressure-wind relationship. Based on the faster forward speed of the storm and now near-normal environmental pressures, the intensity is analyzed at 50 kt, up from 45 kt in HURDAT, a minor intensity change. A central pressure of 1000 mb is added to 06Z on September 18th. There were other center fixes during the morning of the 18th but based on ship and land stations data, they likely missed the center, staying 60 to 120 nm east of the center. An aircraft reconnaissance mission at 1246Z reported a central pressure of 1005 mb, estimated surface winds of 68 kt, and indicated that the area of 50 kt winds extended 150 miles from the center. Ship and land stations observations indicate that the center fix was about 80 nm to the east of the actual center and therefore, the 1005 mb was likely not a central pressure, which has been removed from HURDAT at 12Z. Esther made landfall in southeast Louisiana around 12Z near 29.2N, 90.9W, about 60 nm southwest of New Orleans, with winds of 55 kt. This intensity is up from 45 kt originally in HURDAT, a minor intensity change. 55 kt is also the peak intensity for the lifetime of this tropical cyclone. The peak intensity is analyzed from a ship report of 50 kt at 12Z, also the large area of 50 kt winds reported by the reconnaissance aircraft and a couple of land observations of winds between 40 and 45 kt, all on the eastern quadrant of the storm. After making landfall in Louisiana, Esther turned to the north and quickly weakened, becoming a tropical depression at 06Z on September

19th. At 00Z on the 19th, Liberty, MS reported 10 kt S and 1004 mb, indicating a central pressure of about 1002 mb, which has been added to HURDAT. Dissipation occurred after 12Z on the 19th.

Hurricane Frieda [September 20-27, 1957]

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40360 09/20/1957 M= 8  7 SNBR= 878 FRIEDA      XING=0 SSS=0
40360 09/20/1957 M= 8  8 SNBR= 878 FRIEDA      XING=0 SSS=0
                         *

40365 09/20*  0   0   0    0*  0   0   0    0*317 658  25    0*308 656  25    0*
40365 09/20*  0   0   0    0*  0   0   0    0*317 658  25    0*310 658  25    0*
                                                              *** ***

40370 09/21*300 656  25    0*292 658  30    0*286 660  30 1001*282 662  30    0*
40370 09/21*297 659  25    0*282 659  30    0*272 658  30 1005*275 655  30 1004*
           *** ***            *** ***          *** ***     **** *** ***     ****

40375 09/22*278 665  35    0*275 676  50    0*272 691  50 1007*271 703  50    0*
40375 09/22*278 655  35    0*275 667  40 1001*267 682  40    0*267 698  45 1002*
                ***             ***  ** **** *** ***  **    * *** ***  ** ****

40380 09/23*271 712  50    0*272 717  45    0*278 720  45 1001*288 722  45    0*
40380 09/23*268 705  45    0*269 713  45    0*273 718  45 1005*280 722  45 1004*
           *** ***  **       *** ***          *** ***     **** ***          ****

40385 09/24*298 723  45    0*308 720  45    0*318 713  45 1001*328 703  45    0*
40385 09/24*290 722  45    0*304 720  45    0*315 710  45 1002*322 700  45    0*
           *** ***            ***              *** ***     **** *** ***

40390 09/25*338 688  50    0*350 670  60    0*364 652  70  992*377 634  70    0*
40390 09/25*332 685  60  995*344 666  70    0*358 645  75    0*374 626  75  975*
           *** ***  **  *** *** ***  **       *** ***  **    * *** ***  **  ***

40395 09/26*390 616  70    0*402 597  65    0E414 578  55    0E425 562  50    0*
40395 09/26E388 608  75  976E402 590  70    0E414 572  65    0E426 558  60    0*
          **** ***  **  ****    ***  **          ***  **      *** ***  **

40400 09/27E440 545  45    0E463 528  35    0E485 512  35    0*  0   0   0    0*
40400 09/27E440 545  55    0E458 535  50    0E480 525  50    0*  0   0   0    0*
                     **       *** ***  **      *** ***  **
40405 HR
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Minor changes the track and intensity shown in McAdie et al. (2009). Evidence for these alterations comes from the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Reconnaissance aircraft and Monthly Weather Review.

September 18:

HWM analyzes a cold front off the United States east coast at 12Z. HURDAT does not list an organized storm on this date. Microfilm shows a closed low pressure of at

most 1017 mb with a frontal boundary going through the center at 37.0N, 73.5W at 12Z. Ship highlights: No gales or low pressures.

September 19:

HWM analyzes a cold front off the United States east coast at 12Z. HURDAT does not list an organized storm on this date. Microfilm shows a frontal boundary off the United States east coast at 12Z. Ship highlights: No gales or low pressures.

ATSR: “When hurricane CARRIE moved eastward from Bermuda a weak cold front moved into the Atlantic between the southeast coast of the United States and Bermuda. On the 191200Z surface map a small closed low appeared on the cold front about 300 miles east-northeast of Cape Hatteras. During the next 48 hours this low drifted eastward then southeastward and became separated from the frontal system; meanwhile, it gradually assumed semitropical characteristics.”

September 20:

HWM analyzes a closed low pressure of at most 1010 mb at 30.1N, 65.3W with a weakening cold front to the north at 12Z. HURDAT lists a 25 knot tropical depression at 31.7N, 65.8W at 12Z (first position). Microfilm shows a closed low pressure of at most 1011 mb at 32.5N, 63.0W. Ship highlights: No gales or low pressures.

MWR: “Hurricane Frieda spent its life at sea and was of hurricane force for only a few hours. The circulation which developed into this storm began on September 20. A cold front pushing southward to the rear of Hurricane Carrie passed Bermuda and a low center of 1010 mb., appearing at first to be nothing more than an incipient frontal wave, rapidly developed. Elsewhere, significant features were a 1020-mb. surface anticyclone some 700 miles to the north, and northerly winds of near 55 mph at 500 mb and higher over the surface cyclone.”

September 21:

HWM analyzes a tropical storm of at most 1005 mb at 27.2N, 66.9W with a stationary front to the northeast at 12Z. HURDAT lists a 30 kt tropical depression at 28.6N, 66.0W at 12Z. Microfilm shows a closed low pressure of at most 1005 mb at 27.0N, 67.0W with a frontal boundary to the north at 12Z. Ship highlights: 5 kt SE and 1005 mb at 27.5N, 66.3W at 12Z (COADS). 10 kt NE and 1005 mb at 28.1N, 65.4W at 18Z (COADS).

MWR: “By early morning of the 21st, strong easterly winds of 63 mph were observed at the gradient level at Bermuda. The LST Nurvik reported the central pressure in the developing storm, about 400 miles south-southwest of Bermuda, as 1005 mb. Several

factors favored intensification at this time. The strong low-level easterly winds north of the area resulted in a strong cyclonic shear, the sea surface temperatures were very warm, raobs from the Narwik and from Bermuda indicated that the cold front had dissipated, and there were favorable high-level winds for evacuation."

September 22:

HWM analyzes a tropical storm of at most 1000 mb at 26.7N, 68.8W with a warm front to the northeast at 12Z. HURDAT lists a 50 kt tropical storm at 27.2N, 69.1W at 12Z. Microfilm shows a closed low pressure of at most 1005 mb at 26.5N, 68.5W at 12Z. Ship highlights: 35 kt NE and 1012 mb at 28.9N, 71.3W at 00Z (COADS). 35 kt NE and 1005 mb at 30.2N, 71.7W at 06Z (COADS). 35 kt NNE and 1011 mb at 24.7N, 71.8W at 12Z (micro). 35 kt NE and 1010 mb at 29.1N, 70.0W at 18Z (micro). 20 kt W and 1004 mb at 26.6N, 70.0W at 18Z (micro). Aircraft highlight: Penetration fix measured a central pressure of 1001 mb at 27.4N, 66.3W at 03Z (micro). Penetration fix measured a minimum pressure of 1007 mb and estimated surface maximum winds of 40 kt at 27.3N, 70.3W at 1750Z (micro). Radar fix at 27.1N, 70.1W at 2020Z (micro).

MWR: "By evening of the 21st, aircraft reconnaissance showed that central pressure had fallen to 1001 mb and winds were up to 60 mph in squalls east of the center. Frieda was a reality. The movement was rather slow to the southwest. Reconnaissance on the morning of September 22 found maximum winds of 50 to 60 mph in gusts with sustained winds generally 30 to 40 mph. Shower activity was considerably less than normal and there was no extensive cloud shield. Meanwhile, upper winds at Bermuda were rapidly veering from northerly to southeasterly with decreasing speeds. This occurred as a high-level anticyclone northwest of the storm weakened and split in response to the approach of a short wave in the westerlies. This left the upper ridge with two cells, one over Florida and the other northeast of Bermuda." ATSR: "At 220400Z the low was named Tropical Storm Frieda and Warning Number ONE was issued."

September 23:

HWM analyzes a tropical storm of at most 1000 mb at 27.8N, 71.9W at 12Z. HURDAT lists a 45 kt tropical storm at 27.8N, 72.0W at 12Z. Microfilm shows a closed low pressure of at most 1005 mb at 27.5N, 72.0W at 12Z. Ship highlights: 40 kt SE at 27.6N, 69.8W at 02Z (micro). 40 kt SSE and 1006 mb at 27.6N, 69.0W at 09Z (micro). 40 kt SSE and 1007 mb at 27.7N, 69.4W at 12Z (COADS). 20 kt E and 1005 mb at 27.9N, 72.0W at 15Z (COADS). 40 kt S and 1009 mb at 27.3N, 69.3W at 18Z (COADS). Aircraft highlights: Penetration center fix measured a central pressure of 1005 mb, estimated maximum surface winds of 50 kt and an eye diameter of 35 nm at 27.2N,

71.8W at 12Z (ATSR). Penetration center fix measured a central pressure of 1004 mb and estimated maximum surface winds of 45 kt at 27.5N, 71.5W at 1945Z (micro).

MWR: “With a less favorable Circulation for intensification, Frieda showed little change through the 23rd. At the same time, recurvature was favored by the new circulation pattern around the storm and it began to move toward the northwest and north at about 10 mph during the night of the 23rd.”

September 24:

HWM analyzes a tropical storm with a central pressure of 998 mb at 31.8N, 71.9W with a weakening front to the northwest at 12Z. HURDAT lists a 45 kt tropical storm at 31.8N, 71.3W at 12Z. Microfilm shows a closed low pressure of at most 1002 mb at 30.5N, 71.2W with a frontal boundary to the northwest at 12Z. Ship highlights: 40 kt S and 1008 mb at 26.7N, 70.7W at 00Z (microfilm shows 45 kt)(COADS). 40 kt S and 1008 mb at 29.5N, 69.8W at 02Z (COADS). 45 kt SE and 1008 mb at 29.6N, 69.1W at 06Z (COADS). 40 kt S and 1010 mb at 29.1N, 68.8W at 12Z (micro). 40 kt SSE and 1005 mb at 31.5N, 67.7W at 18Z (COADS). Aircraft highlights: Penetration center fix measured a central pressure of 1002 mb, estimated maximum surface winds of 50 kt and an eye diameter of 40 nm at 32.2N, 71.5W at 1130Z (ATSR).

MWR: “Simultaneously, as the short wave in the westerlies progressed eastward, the upper trough weakened and, perhaps in response to a more favorable high-level evacuation mechanism, the cloud systems began to show more organization and radar coverage became feasible for the first time. Forward velocity increased to 20 mph. toward the north-northeast on the 24th and little change was observed in surface pressures.” ATSR: “On 24 September reconnaissance aircraft could find only a large flat circulation center with no indications of a tropical storm cloud or precipitation center. FRIEDA never attained winds of hurricane force until after it became an extratropical low.”

September 25:

HWM analyzes a hurricane of at most 990 mb at 36.0N, 65.4W with a weakening stationary front to the west and a weakening cold front to the south at 12Z. HURDAT lists a 70 kt hurricane at 36.4N, 65.2W at 12Z. Microfilm shows a closed low pressure of at most 1002 mb at 37.5N, 64.7W with a frontal boundary to the north and west at 12Z. Ship highlights: 25 kt W and 998 mb at 32.4N, 68.9W at 00Z (micro). 40 kt S and 986 mb at 34.0N, 66.3W at 06Z (micro). 70 kt S and 992 mb at 35.8N, 64.7W at 12Z (COADS/MWR). 60 kt SSW and 1000 mb at 36.1N, 62.0W at 16Z (micro). 35 kt SW and 978 mb at 37.2N, 67.3W at 18Z (COADS/MWR). 50 kt SE and 994 mb at 38.3N, 60.3W at 18Z (micro).

MWR: “However, by morning of the 25th, the Canadian merchant ship Irvingbrook reported a barometer reading of 992 mb. and 80-mph winds. Frieda now was a hurricane but only for a few hours for the cold front associated with the short wave mentioned previously was dropping into her circulation. Some further decrease in central pressure occurred as shown by a report from the ship African Lightning, giving a pressure of 978 mb. However, this was interpreted as the result of extratropical deepening since the storm was spreading out and there was no observed wind speed such as the 115 m. p. h. that Fletcher’s formula would indicate under true tropical conditions with such a pressure.” ATSR: “FRIEDA never assumed truly tropical characteristics, but was reported throughout her life span as a large calm area near the center with the maximum winds being found several hundred miles away from the center in the east and north quadrants. FRIEDA drifted south, then west, and finally to a north to northeast direction and by 25 September was again under the influence of a polar trough.”

September 26:

HWM analyzes a hurricane of at most 985 mb at 41.2N, 58.0W with a warm front to the north and a cold front to the south at 12Z. HURDAT lists a 55 kt extratropical cyclone at 41.4N, 57.8W at 12Z. Microfilm shows an extratropical low pressure of at most 993 mb at 41.0N, 57.5W with a frontal boundary to the northeast and south at 12Z. Ship highlights: 65 kt NNE and 991 mb at 40.0N, 63.0W at 00Z (micro). 30 kt SW and 979 mb at 38.7N, 60.7W at 00Z (micro). 60 kt NE and 989 mb at 40.5N, 59.9W at 06Z (COADS). 55 kt N and 993 mb at 40.6N, 58.5W at 12Z (COADS). 45 kt NW and 1002 mb at 40.6N, 58.6W at 15Z (COADS). 60 kt SE and 985 mb at 42.3N, 54.3W at 18Z (COADS).

September 27:

HWM analyzes a tropical storm of at most 985 mb at 49.0N, 51.0W with a warm front to the north and a cold front to the east and south at 12Z. HURDAT lists a 35 kt extratropical cyclone at 48.5N, 51.2W at 12Z (last position). Microfilm shows an extratropical low pressure of at most 993 mb at 49.0N, 52.0W at 12Z. Ship highlights: 50 kt SE and 991 mb at 44.2N, 53.2W at 00Z (COADS). 50 kt NNW and 982 mb at 44.2N, 55.2W at 00Z (COADS). 10 kt NE and 988 mb at 46.2N, 53.5W at 06Z (micro). 15 kt NW and 986 mb at 46.4N, 52.3W at 09Z (micro). 50 kt SE and 990 mb at 48.2N, 49.1W at 12Z (COADS). 45 kt SW and 997 mb at 47.7N, 50.2W at 18Z (COADS). Land highlights: 15 kt W and 993 mb at St. John’s, Newfoundland, Canada at 12Z (micro).

MWR: “After becoming extratropical, Frieda continued rapidly northeastward, with gradually decreasing intensity, and passed across Newfoundland on the night of the 26th. No deaths or property losses have been charged to this storm.”

September 28:

HWM analyzes an extratropical cyclone of at most 985 mb at 55.0N, 58.0W with a stationary front to the south at 12Z. HURDAT does not a list an organized system on this date. Microfilm shows an extratropical low pressure of at most 984 mb at 55.0N, 58.0W at 12Z.

September 29:

HWM analyzes an extratropical cyclone of at most 995 mb at 59.0N, 54.0W at 12Z. HURDAT does not a list an organized system on this date. Microfilm shows an extratropical of at most 993 mb cyclone at 59.0N, 52.0W at 12Z.

September 30:

HWM analyzes an extratropical cyclone of at most 995 mb at 70.0N, 69.0W at 12Z. HURDAT does not a list an organized system on this date. Microfilm shows an extratropical of at most 990 mb cyclone at 65.0N, 70.0W at 12Z.

The final hurricane of the season developed from a frontal boundary that moved off the east coast of the United States into the western Atlantic on September 18th. An area of low pressure formed near Bermuda and at 12Z on September 20th, a 25 kt tropical depression is analyzed to have developed, as originally indicated in HURDAT. It is possible that the tropical cyclone may have formed earlier in the day but the ship and land observations were sparse during that time. Also, the cyclone was elongated E-W and for most of its lifetime, it had a large circulation with the strongest winds away from the center, an indication that it may have started as a subtropical cyclone. Minor track changes are introduced for the duration of this system. The depression moved southward on the September 20th, making a small counter-clockwise loop on the 21st before turning to the west. A ship passed close to the center at 12Z on the 21st measuring 5 kt SE and 1005 mb, which suggests a central pressure near 1005 mb. A central pressure of 1005 mb suggests maximum sustained winds of 34 kt north of 25N from the Brown et al. pressure-wind relationship. Due to the slow movement of the depression and broad nature of the circulation, winds are analyzed at 30 kt for 12Z on the 21st, same as originally in HURDAT. A central pressure of 1001 mb was present in HURDAT at 12Z on the 21st but appears to be incorrect since there was no aircraft reconnaissance on the 21st or any ship report with a lower pressure measurement than 1005 mb. Thus, the 1001 mb central pressure has been replaced with 1005 mb at 12Z on the 21st. The same ship measured 10 kt NE and 1005 mb at 18Z on the 21st, suggesting a central pressure of 1004 mb, which has been added to HURDAT. The first reconnaissance aircraft into the tropical cyclone arrived early on September 22nd, measuring a central pressure of 1001 mb at 03Z. A central pressure of 1001 mb suggests maximum sustained winds of 42 kt north of 25N

according to the pressure-wind relationship. An intensity of 40 kt is selected for 06Z on the 22nd, down from 50 kt originally in HURDAT, a minor intensity change. Intensification to a tropical storm is analyzed at 00Z on the 22nd, as originally shown in HURDAT. A central pressure of 1001 mb is added to 06Z on the 22nd. A central pressure of 1007 mb appears in HURDAT at 12Z on the 22nd, but this measurement made at 1750Z on this day was a peripheral pressure from reconnaissance, not a central pressure. Therefore, it has been removed from HURDAT. A ship at 18Z on the 22nd reported 20 kt W and 1004 mb, suggesting a central pressure of 1002 mb, which has been added to HURDAT. Another ship at 18Z on the 22nd, located about 120 nm from the center, reported 55 kt but observations from nearby ships indicate that it has a high bias. The intensity for Frieda at 12Z and 18Z on the 22nd is analyzed at 45 kt, down from 50 kt originally in HURDAT a minor intensity change.

On September 23rd, the track of Frieda turned to the north-northwest ahead of a frontal boundary approaching from the west. A ship reported 50 kt about 180 nm north-northeast of the center and also appears to have a high bias compared to nearby ships. The intensity is kept at 45 kt at 00Z on the 23rd, down from 50 kt originally in HURDAT, a minor intensity change. A couple of ships reported 40 kt winds at 02Z on the 23rd on the eastern quadrant, which had the strongest pressure gradient. A reconnaissance aircraft reached Frieda on September 23rd at 12Z measuring a central pressure of 1005 mb and estimated surface winds of 50 kt. HURDAT originally had 1001 mb at 12Z on the 24th, which seems to be an error and has been replaced with 1005 mb. A central pressure of 1005 mb suggests maximum sustained winds of 34 kt north of 25N according to the pressure-wind relationship. The intensity is kept at 45 kt, same as originally in HURDAT, based on the numerous ship reports of 40 kt and the 50 kt surface wind estimate from the aircraft. Another center fix at 1945Z on the 23rd measured a central pressure of 1004 mb, which has been added to HURDAT at 18Z on this day. On September 24th, Frieda turned to the north and later to the northeast ahead of the frontal boundary to the west. A reconnaissance mission arrived at 1130Z on the 24th measuring a central pressure of 1002 mb and estimated surface winds of 50 kt. A central pressure of 1002 mb suggests maximum sustained winds of 40 kt north of 25N according to the pressure-wind relationship. An intensity of 45 kt (unchanged) is analyzed at 12Z based on the ship observations and the surface wind estimate from the aircraft. A central pressure of 1001 mb appears in HURDAT at 12Z on the 24th and has been replaced with 1002 mb. It is interesting to note that the aircraft center fix at 1130Z on the 24th was likely about 60 nm too far to the north based on ship observations at 12Z and 18Z. On September 25th, Frieda gained in forward speed to the northeast and began to intensify, possibly due to the increase in baroclinicity. A ship reported 25 kt W and 998 mb at 00Z on the 25th, suggesting a central pressure of 995 mb, which has been added to HURDAT. A central pressure of 995 mb suggests maximum sustained winds of 52 kt north of 25N according

to the pressure-wind relationship. Due to the increase in forward speed, an intensity of 60 kt is analyzed for 00Z on the 25th, up from 50 kt in HURDAT, a minor intensity change. A ship close to the center of Frieda at 12Z on the 25th reported 70 kt S and 992 mb, and an intensity of 75 kt is analyzed at this time, up from 70 kt in HURDAT, a minor intensity change. HURDAT originally had a central pressure of 992 mb at 12Z on the 25th but this is clearly from the ship report and not a central pressure, so it has been removed. Intensification to a hurricane is analyzed at 06Z on the 25th, six hours earlier than originally in HURDAT. 75 kt is also the peak intensity for this tropical cyclone, up from 70 kt originally in HURDAT, a minor intensity change. At 18Z on the 25th, a ship very close to the center reported 35 kt SW and 978 mb, suggesting a central pressure of 975 mb which has been added to HURDAT. A central pressure of 975 mb suggests maximum sustained winds of 78 kt north of 35N according to the pressure-wind relationship. An intensity of 75 kt is analyzed at 18Z on the 25th since Frieda was undergoing extratropical transition. Transition to an extratropical cyclone is analyzed at 00Z on September 26th based coastal and ship observations clearly showing a temperature gradient across the storm and the development of frontal boundaries near the center. The extratropical transition is twelve hours earlier than originally shown in HURDAT. A ship near the center at 00Z on the 26th, reported 30 kt SW and 979 mb, suggesting a central pressure of 976 mb, which has been added to HURDAT. Frieda continued moving to the northeast as a powerful extratropical cyclone on the 26th. Early on September 27th, Frieda began to interact with another extratropical cyclone to the northwest and appears to have merged after 12Z on this day. The final position of Frieda at 12Z on the 27th is unchanged from the original HURDAT. The resulting extratropical cyclone intensified over the Labrador Sea and moved northwestward over the next couple of days.

Unnamed Tropical Storm #8 [October 23-27, 1957]

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40410 10/23/1957 M= 5  8 SNBR= 879 NOT NAMED   XING=0 SSS=0                    L
40410 10/23/1957 M= 5  9 SNBR= 879 NOT NAMED   XING=0 SSS=0
                       *                                                       *

40415 10/23*219 580  25    0*233 593  25    0*247 607  35  999*250 622  35    0*
40415 10/23*233 580  30    0*243 593  35    0*250 606  40  999*252 619  40    0*
            ***      **      ***      **      *** ***  **      *** ***  **

40420 10/24*247 638  35  999*249 650  40  993*254 658  45    0*266 660  50    0*
40420 10/24*249 632  45  998*249 642  50  993*254 650  50    0*262 656  50    0*
            *** ***  **  *** *** ***  **          ***  **      *** ***  **

40425 10/25*278 658  40  993*288 654  35    0*298 648  35  993*307 641  35    0*
40425 10/25*272 658  50  993*282 654  50  991*292 648  50  993*305 638  50  995*
            ***      **      ***      **  *** ***      **      *** ***  **  ***

40430 10/26*317 629  35    0*331 612  35    0*346 593  35    0*360 576  35    0*
40430 10/26*323 628  45    0*347 615  45    0*362 595  45    0*370 570  45    0*
            *** ***  **      *** ***  **      *** ***  **      *** ***  **
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40435 10/27E370 553  30    0E376 519  25    0E383 485  25    0E388 446  25    0*
40435 10/27*373 540  40    0*  0   0   0    0*  0   0   0    0*  0   0   0    0*
          **** ***  **     *  *       *     *  *   *   *     *  *   *   *
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40440 TS
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Major track changes and minor changes to the intensity shown in McAdie et al. (2009). Another major change is to indicate no extratropical transition for this cyclone. Evidence for these alterations comes from the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Air Force aircraft reconnaissance, and Monthly Weather Review.

October 22:

HWM analyzes a closed low pressure of at most 1015 mb at 23.0N, 59.0W with a stationary front to the north at 12Z. HURDAT does not list an organized storm on this date. Microfilm shows a frontal boundary north of the Leeward Islands at 12Z. Ship highlights: No gales or low pressures.

October 23:

HWM analyzes a tropical storm of at most 1005 mb at 24.5N, 60.5W with a warm front about 100 nm to the north at 12Z. HURDAT lists a 35 knot tropical storm at 24.7N, 60.7W at 12Z. Microfilm shows a closed low pressure of at most 1011 mb at 24.0N, 60.0W with a frontal boundary to the north at 12Z. Ship highlights: 15 kt SW and 1009 mb at 21.9N, 57.7W at 00Z (micro). 35 kt NE and 1017 mb at 29.2N, 65.5W at 18Z (COADS). 30 kt NE and 1002 mb at 26.2N, 61.7W at 18Z (COADS).

MWR: “On October 22 and 23, shower activity increased and pressures began falling near and to the north of the Lesser Antilles. A strong upper trough extended from the vicinity of Bermuda to Puerto Rico and on October 23 a small cut-off Low developed in this trough. The surface circulation increased markedly on this date.”

October 24:

HWM analyzes a tropical storm of at most 1000 mb at 25.5N, 65.3W with a warm front 300 nm to the north at 12Z. HURDAT lists a 45 kt tropical storm at 25.4N, 65.8W at 12Z. Microfilm shows a closed low pressure of at most 1002 mb at 25.5N, 64.5W at 12Z. Ship highlights: 35 kt NE and 1018 mb at 30.2N, 65.6W at 00Z (COADS). 10 kt SE and 999 mb at 25.0N, 63.0W at 00Z (COADS). 35 kt N and 1003 mb at 24.5N, 67.5W at 06Z (COADS). 35 kt NNW and 1002 mb at 24.5N, 68.0W at 12Z (COADS). 25 kt NNW and 1000 mb at 25.1N, 66.9W at 18Z (COADS). Aircraft highlights: Penetration center fix estimated maximum surface winds of 30 kt at 26.9N, 65.7W at 1130Z (micro).

Penetration center fix measured a minimum pressure of 1002 mb and a center diameter of 100 nm at 25.8N, 63.7W at 1430Z (micro).

MWR: "…in the evening a ship near the center of the circulation at about latitude 25N, longitude 63W, reported a barometer of 999 mb and winds up to 35 mph. On the 24th reports showed that there had been further intensification with winds in squalls up to 50 to 60 mph just north of the center and winds of 30 to 35 mph prevailing 200 to 400 miles from the center. The storm gradually curved from a northwesterly to a northerly direction at 12 to 15 mph."

October 25:

HWM analyzes a tropical storm of at most 995 mb at 29.8N, 64.8W at 12Z. HURDAT lists a 35 kt tropical storm at 29.8N, 64.8W at 12Z. Microfilm shows a closed low pressure of at most 1005 mb at 30.0N, 65.0W at 12Z. Ship highlights: 35 kt E and 997 mb at 28.2N, 63.9W at 00Z (COADS). 20 kt S and 993 mb at 27.8N, 65.3W at 06Z (micro). 40 kt NE and 1001 mb at 30.3N, 66.0W at 06Z (micro). 50 kt S and 1002 mb at 30.9N, 61.4W at 12Z (COADS). 35 kt E and 1003 mb at 33.9N, 62.7W at 18Z (COADS). Land highlights: 10 kt SE and 1004 mb at Bermuda at 06Z (micro). 15 kt SE and 1003 mb at Bermuda at 12Z (micro). 10 kt NNE and 1001 mb at Bermuda at 18Z (micro).

MWR: "The lowest surface pressure reported was 993 mb. by a ship near 28N, 65W at 0600 GMT on the 25th."

October 26:

HWM analyzes a tropical storm of at most 1000 mb at 35.3N, 59.5W with a weakening cold front to the east at 12Z. HURDAT lists a 35 kt tropical storm at 34.6N, 59.3W at 12Z. Microfilm shows a closed low pressure of at most 1008 mb at 35.5N, 60.0W at 12Z. Ship highlights: 35 kt SSE and 1006 mb at 34.0N, 61.5W at 00Z (COADS). 20 kt WSW and 1000 mb at 30.0N, 62.4W at 00Z (COADS). 35 kt S and 1006 mb at 34.0N, 60.4W at 06Z (COADS). 1000 mb at 35.4N, 62.1W at 06Z (micro). 40 kt SSE and 1003 mb at 34.0N, 58.7W at 12Z (COADS). 45 kt SW and 1006 mb at 35.0N, 57.0W at 18Z (micro). Land highlights: 10 kt N and 1004 mb at Bermuda at 00Z (micro).

MWR: "When the storm passed just east of Bermuda on the evening of October 25, there were strong winds east of the center but only moderate winds to the west in the area of Bermuda, the pressure gradient there having been weakened by the approach of an extratropical system which gradually absorbed the remnants by the 27th."

October 27:

HWM analyzes a small closed low pressure of at most 1010 mb at 39.0N, 49.0W with a cold front to the north at 12Z. HURDAT lists a 25 kt extratropical cyclone at 38.3N, 48.5W at 12Z. Microfilm shows a closed low pressure of at most 1011 mb at 38.5N, 48.0W with a frontal boundary to the north at 12Z. Ship highlights: 35 kt W and 1010 mb at 36.1N, 54.4W at 00Z (COADS).

A frontal system moved into the western Atlantic during the third week of October. While north of the Leeward Islands, the weakening frontal boundary likely generated a surface low pressure that slowly became better organized. A tropical depression is analyzed to have formed at 00Z on October 23rd, same as in the original HURDAT. Minor track changes are introduced for the duration of this system. The tropical depression moved to the northwest on the 23rd becoming a tropical storm at 06Z, six hours earlier than originally shown in HURDAT. A central pressure of 999 mb appears in HURDAT at 12Z on the 23rd and although there was no reconnaissance aircraft investigating the tropical cyclone on this date or ship observations near the center, the estimate seems reasonable and is retained. A central pressure of 999 mb suggests maximum sustained winds of 45 kt north of 25 N and 49 kt south of 25N from the Brown et al. pressure-wind relationship. An intensity of 40 kt is selected at 12Z on the 23rd due to the broad circulation of this tropical cyclone. HURDAT originally had 35 kt at 12Z on the 23rd, a minor change. On October 24th, the tropical storm turned to the west-southwest, before turning northwestward later on the day. Ship reports on the 24th indicate that this system was possibly a subtropical storm with weak winds near the center and the strongest winds found about 200 nm away from the center and a radius of closed isobar (ROCI) of about 350 nm. A ship reported 10 kt ESE and 999 mb, passing very close to the center. This suggests a central pressure of about 998 mb. HURDAT originally had 999 mb at 00Z on the 24th and this value has been replaced with 998 mb. A central pressure of 998 mb suggests maximum sustained winds of 45 kt north of 25 N and 51 kt south of 25N according to the pressure-wind relationship. An intensity of 45 kt has been selected for 00Z on the 24th, up from 35 kt originally in HURDAT, a minor change. Numerous ships reported gale force winds on the 24th, generally on the northern semi-circle where the pressure gradient was the strongest. A central pressure of 993 mb appears in HURDAT at 06Z on the 24th and although there were no reconnaissance aircraft investigating the cyclone at this time or ship observations near the center, it seems reasonable and it is retained. A central pressure of 993 mb suggests maximum sustained winds of 55 kt north of 25 N and 59 kt south of 25N according to the pressure-wind relationship. An intensity of 50 kt has been selected for 06Z on the 24th, up from 40

kt originally in HURDAT, a minor change. 50 kt is also the peak intensity for this tropical cyclone, no change to HURDAT although the time at which it occurs is different. HURDAT originally indicated an intensity of 50 kt at 18Z on the 24th, while the reanalysis suggests an intensity of 50 kt between 06Z on the 24th to 18Z on the 25th. A reconnaissance mission reached the tropical cyclone on the 24th, making a center fix at 26.9N, 65.7W at 1130Z and another center fix at 25.8N, 63.7W at 1422Z. In the second center fix, the aircraft reported a minimum pressure of 1002 mb and an eye diameter of about 100 nm. This reported pressure is not believed to be a central pressure and thus, not added to HURDAT. Furthermore, the center fixes contradict with the forward motion of the storm and it is believed that they are erroneous, likely in part due to the size of the cyclone. On October 25th, the tropical storm turned to the northeast and numerous ships close to the center continue to show a structure that is characterized by weak winds near the center and the strongest winds located about 200 nm away, especially to the north and east. A central pressure of 993 mb appears in HURDAT at 00Z on the 25th and although it seems to be an estimate, it looks reasonable and it is retained. A ship reported 20 kt S and 993 mb at 06Z on the 25th, which suggests a central pressure of about 991 mb and has been added to HURDAT. A central pressure of 991 mb suggests maximum sustained winds of 58 kt north of 25 N according to the pressure-wind relationship. Due to the broad nature of the tropical cyclone, an intensity of 50 kt has been selected for 06Z on the 25th, up from 35 kt originally in HURDAT, a minor change. A central pressure of 993 mb is present in HURDAT at 12Z on the 25th and appears to be an estimate but looks reasonable and it is retained. As a frontal boundary approached the tropical cyclone from the west, the cyclone began to increase in forward speed. At 18Z on the 25th, a ship close to the center reported 20 kt WSW and 997 mb, suggesting a central pressure of 995 mb, which has been added to HURDAT. A central pressure of 995 mb suggests maximum sustained winds of 52 kt north of 25 N according to the pressure-wind relationship. An intensity of 50 kt has been selected for 18Z on the 25th, up from 35 kt originally in HURDAT, a minor change. Late on the 25th, the tropical cyclone made its closest approach to Bermuda, passing about 90 nm southeast of the island. At this time, the strongest winds continued to be located on the northern and eastern quadrants of the storm, leaving Bermuda on the weak side with no tropical storm force winds reported. On October 26th, the tropical cyclone continued to increase in forward speed to the northeast. Late on the 26th, the circulation of the tropical cyclone began to become less organized as the frontal boundary started to absorb it. This process was completed by 06Z on October 27th based on ship reports and it is analyzed that the tropical cyclone had dissipated. This is 18 hours earlier than originally shown in HURDAT. Furthermore, it is analyzed that the tropical cyclone did not become extratropical at 00Z on the 27th before being absorbed as originally shown in HURDAT, a major change.

New Tropical Storm [November 3-7, 1957]

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37265 11/03/1957 M= 5 10 SNBR= 820 UNNAMED       XING=0 SSS=0                  L

37265 11/03*  0   0   0    0*  0   0   0    0*180 640  25    0*185 640  25 1004*
37265 11/04*190 638  30    0*197 630  30 1004*207 620  30    0*217 610  30    0*
37265 11/05*227 600  35    0*233 590  40 1001*239 580  45    0*250 570  45    0*
37265 11/06*264 558  40    0*274 542  40    0*286 523  35    0*301 504  35    0*
37265 11/07*310 485  30    0*315 460  30    0*320 435  25    0*  0   0   0    0*
37285 TS
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A new tropical storm has been added to HURDAT, not previously shown in McAdie et al. (2009). Evidence for its existence comes from the Historical Weather Map series, Microfilm, COADS ship database, and David Roth's suspect list.

November 1:

HWM analyzes a closed low pressure of at most 1010 near 20.0N, 64.0W with a stationary front to the north at 12Z. Microfilm shows a spot low pressure at 20.3N, 64.1W at 12Z. Ship highlights: No gale force winds or equivalent low pressures.

November 2:

HWM analyzes a closed low pressure of at most 1010 near but south of 20.0N, 64.0W with a weakening stationary front to the north at 12Z. Microfilm shows a closed and broad low pressure of at most 1011 at 15.0N, 65.0W at 12Z. Ship highlights: No gale force winds or equivalent low pressures.

MICRO: Miami Weather Bureau 1423Z "Attn Dunn. CNDS over northern Leewards at 1200Z and 1500Z indicate definite circulation pattern. Radar indicates two bands oriented WNW/SSE with nearest band 20 miles from station 60 miles long and about 5 miles wide and farthest band 60 miles from station 100 miles long. Center of circulation seems to be located 18.0N 63.7W at 1500Z. Request low level NAVY RECON soon as possible to scan area KNRR to 19N 63W thence to 16N 62W thence to KNRR."

November 3:

HWM analyzes a closed low pressure of at most 1010 near but south of 20.0N, 64.0W with a weakening stationary front to the north at 12Z. Microfilm shows a closed low pressure of at most 1008 at 18.0N, 64.0W at 12Z. Ship highlights: No gale force winds or equivalent low pressures. Land highlights: 5 kt SSW and 1005 mb at Saint Martin at 18Z (micro).

MICRO: San Juan Weather Bureau Bulletin at 01Z "Little change has been noted in connection with the weak circulation located near the Leeward Islands earlier this

afternoon. At 9 pm AST … 0100Z … it appears to be still centered near the island of Sint Maarten Netherlands Antilles or about 180 miles east-southeast of San Juan P.R. Its future movement remains uncertain but indications are for a slow northward drift during the next 12 hours. Highest winds are 25 mph in rain showers about 180 miles to west and northwest of center. Some slight increase in intensity is expected during the next 12 hours but no dangerous conditions are expected tonight."

MICRO: San Juan Weather Bureau Bulletin at 10Z "The weak low pressure noted Saturday near the island of Sint Maarten Netherlands Antilles appears to have drifted slowly eastward during the night and at 6 AM AST … 1000Z is located about 230 miles east-southeast of San Juan Puerto Rico. No dangerous winds have been reported. Pressures are low throughout the eastern Caribbean and adjacent Atlantic areas. Little or no intensification has taken place during the night and the highest winds are about 20 to 25 miles per hour in heavy rain showers over the Virgin Islands and eastern Puerto Rico. Future movement is uncertain but indications are for a slow northward movement with little intensification during the next 12 hours. People in the Northern Leeward and Virgin Islands should be on the lookout for later bulletins."

MICRO: San Juan Weather Bureau Bulletin at 16Z "An area of low pressure continues over the Northern Leeward islands. At 12 noon … 1600Z the center of this low pressure is poorly defined but appears to be located about 200 miles east-southeast of San Juan. It has remained almost stationary in the past 6 hours and there has been no intensification. NAVY reconnaissance aircraft in the area report highest winds of 20 to 30 miles per hour in showers to the northeast of the center. The aircraft are continuing to search the area for any signs of development. Movement during the next 12 hours is uncertain, however, indications are for a slow northward motion with little intensification."

MICRO: San Juan Weather Bureau Bulletin at 22Z "Pressures continue abnormally low over the northeastern Caribbean. The weak circulation noted yesterday is drifting slowly northward. At 600 AST 2200Z it is estimated to be centered a short distance north-northwest of the island of Sint Maarten Netherlands Antilles or about 200 miles east of San Juan P.R. NAVY reconnaissance this morning into the area gave evidence that only slight intensification has taken place during the past 12 hours but no dangerous winds are reported. Highest winds are estimated to be 20 to 25 mph in heavier rainshowers to the north and east of the center. Indications are for a continued northerly movement during the next 12 hours with little intensification during the period. People in the northern Leeward and Virgin Islands should however be in the lookout for later bulletins tonight."

November 4:

HWM analyzes a closed low pressure of at most 1010 near 20.0N, 63.0W at 12Z. Microfilm shows a closed low pressure of at most 1005 at 23.0N, 62.0W at 12Z. Ship highlights: 30 kt NE and 1007 mb at 20.7N, 65.5W at 00Z (COADS/micro). Land highlights: 5 kt W and 1005 mb at Saint Martin at 06Z (micro).

MICRO: San Juan Weather Bureau Bulletin at 01Z "Although pressures still continue abnormally low in the eastern Caribbean there now appears to be a definite trend toward rising pressure. The weak circulation is now accelerating north-northwestward. At 10 pm AST … 0100Z … It is estimated to be about 180 miles northeast of San Juan Puerto Rico moving north-northwestward. Indications are for a continued north-northwestward movement and some acceleration during the next 12 hours but with little intensification during the period. Highest winds are only 25 to 30 miles epr hour in the heavier showers to the north of the center. This is the last final bulletin to be issued by the San Juan Weather Bureau as the circulation no longer poses a threat to this area. Davis Weather Bureau."

November 5:

HWM analyzes a closed low pressure of at most 1010 near 22.2N, 62.5W with a cold front to the north at 12Z. Microfilm shows a closed low pressure of at most 1008 at 23.0N, 62.5W at 12Z. Ship highlights: 20 kt SW and 1003 mb at 23.3N, 59.0W at 06Z (COADS). 45 kt SW and 1012 mb at 21.8N, 56.2W at 12Z (micro). 20 kt NE and 1005 mb at 25.3N, 56.7W at 18Z (COADS)

November 6:

HWM analyzes a closed low pressure of at most 1010 near 27.0N, 50.5W with a weakening cold front to the west at 12Z. Microfilm does not show an organized storm at 12Z. Ship highlights: No gale force winds or equivalent low pressures.

November 7:

HWM analyzes a closed low pressure of at most 1010 near 32.5N, 44.0W with a cold front approaching from the west at 12Z. Microfilm does not show an organized storm at 12Z. Ship highlights: 10 kt NE and 1005 mb at 32.3N, 46.0W at 06Z (COADS).

November 8:

HWM shows a cold front over the north Atlantic associated with a strong extratropical cyclone, appears likely that the tropical cyclone or its remnants have been absorbed before 12Z. Microfilm is not available on this date.

A tropical wave moved into the eastern Caribbean Sea during the last days of October causing the development of a broad area of low pressure. The broad disturbance moved very little during the first days of November. A well-defined low pressure developed at 12Z on November 3rd near 18.0N 64.0W and a 25-kt tropical depression is analyzed to have developed at this time. The tropical cyclone moved slowly to the north on the 3rd and turned to the northeast on the 4th while gaining in forward speed. Saint Martin reported 5 kt SSW and 1005 mb at 18Z on the 3rd, suggesting a central pressure of 1004 mb, which has been added. A ship reported 30 kt northeast of the center and the intensity is increased to 30 kt at 00Z on November 4th. Saint Martin reported 5 kt W and 1005 mb at 06Z on the 4th, suggesting a central pressure of 1004 mb, which has been added. Intensification to a 35 kt tropical storm is analyzed at 00Z on November 5th, based primarily upon evidence later in the day. At 06Z on the 5th, a ship close to the center reported 20 kt SW and 1003 mb, suggesting a central pressure of 1001 mb, which has been added. A central pressure of 1001 mb suggests maximum sustained winds of 45 kt south of 25N from the Brown et al. pressure-wind relationship. Due to the low environmental pressures, an intensity of 40 kt is selected for 06Z on the 5th. A ship located on the southeast quadrant reported 45 kt SW at 12Z on the 5th and the intensity is increased to 45 kt. 45 kt is also the peak intensity for this tropical cyclone. Weakening started on November 6th as a frontal boundary approached from the west. It is analyzed that weakening to a tropical depression occurred at 00Z on November 7th. Later on the 7th, ship observations indicate that the tropical depression became less organized and either dissipated over the north Atlantic or was absorbed by the approaching frontal boundary. The last position is analyzed at 12Z on the 7th as a 25 kt tropical depression. An analog to this tropical cyclone is Hurricane Klaus in 1984.

1957 - Additional Notes

1) October 3-7: Historical Weather Maps and Microfilm indicate that an extratropical cyclone developed on October 4th along a frontal boundary over the western Atlantic, just off the southeast of the United States. The system rapidly intensified while moving to the north and later northwest into the Mid-Atlantic. Ships reported winds up to 60 kt. Nonetheless, the structure of the storm remained clearly non-tropical with a temperature gradient across the cyclone and low dew point values close to the center. Therefore, because the system was likely not tropical or subtropical, it is not added to HURDAT. This disturbance was in Jack Beven's List of Suspects.

Day	LAT	LONG	STATUS
October 3	Off US	SE Coast	Cold front
October 4	33N	72W	Extratropical

October 5	33N	73W	Extratropical
October 6	37N	75W	Extratropical
October 7	40N	80W	Extratropical

2) December 10-12: Historical Weather Maps indicate that a low pressure formed over the central Atlantic ahead of a frontal boundary. The disturbance moved rapidly to the north and only 1 gale was reported near the system during its lifetime (16Z on December 10th). Ship data on December 10th at 18Z show that the low-level circulation may have been closed. Nonetheless, ship data on December 11th indicate that the frontal boundary was absorbing the disturbance and the system was clearly gone by the 12th. It is interesting to note that Microfilm does not show a disturbance in this general area on these days. Therefore, because there is only one piece of evidence and the low-level circulation data is inconclusive, it is not added to HURDAT. This disturbance was in David Roth's List of Suspects.

Day	LAT	LONG	STATUS
December 10	25N	55W	Tropical Depression?
December 11	32N	57W	Tropical Depression?
December 12			Absorbed

1958 hurricane season

New Tropical Storm [May 24-29, 1958]

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37265 05/24/1958 M= 6  1 SNBR= 820 UNNAMED       XING=0 SSS=0
37265 05/24*215 845  25 1004*222 840  25    0*230 832  25    0*240 820  25   0*
37265 05/25*250 805  25 1002*260 793  25 1003*270 790  30 1004*279 789  35 1002*
37265 05/26*285 788  35    0*292 782  35    0*302 774  35 1001*315 760  35    0*
37265 05/27*330 740  40    0*345 720  45    0*358 705  50    0E370 700  50    0*
37265 05/28E380 695  50    0E388 685  55    0E396 670  50    0E410 650  45    0*
37265 05/29E430 645  40    0E450 650  35    0*  0   0   0    0*  0   0   0    0*
37285 TS
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A new tropical storm has been added to HURDAT, not previously shown in McAdie et al. (2009). Evidence for its existence comes from the Historical Weather Map series, Microfilm, Monthly Weather Review, COADS ship database, Surface Weather Observations, Mariners Weather Log and Jack Beven's and David Roth's suspect list.

May 21:

HWM is not available on this date (system south of 20ºN). Microfilm shows a closed low pressure of at most 1008 near 16.0N, 82.0W at 12Z. Ship highlights: No gale force winds or equivalent low pressures.

May 22:

HWM is not available on this date (system south of 20ºN). Microfilm shows a closed low pressure of at most 1008 near 16.0N, 84.0W at 12Z. Ship highlights: No gale force winds or equivalent low pressures.

May 23:

HWM analyzes a closed low pressure of at most 1010 near but south of 20.0N, 84.0W at 12Z. Microfilm shows a closed low pressure of at most 1008 near 19.0N, 84.0W at 12Z. Ship highlights: No gale force winds or equivalent low pressures.

May 24:

HWM analyzes a closed low pressure of at most 1010 near 22.0N, 84.0W at 12Z. Microfilm shows a closed low pressure of at most 1008 at 23.0N, 84.0W at 12Z. Ship highlights: No gale force winds or equivalent low pressures. Land highlights: 10 kt NE and 1005 mb at Cabo San Antonio, Cuba at 00Z (micro).

May 25:

HWM analyzes a closed low pressure of at most 1010 near 27.5N, 79.0W with a dissipating warm front to the north at 12Z. Microfilm shows a closed low pressure of at

most 1005 at 27.5N, 79.0W at 12Z. Ship highlights: 5 kt NE and 1005 mb at 24.8N, 83.2W at 00Z (COADS). 35 kt SE and 1010 mb at 29.6N, 77.1W at 18Z (micro). Land highlights: 10 kt NW and 1003 mb at Alligator Reef Light, FL at 00Z (micro). 15 kt SE and 1005 mb at High Rock, Bahamas at 06Z (micro). 15 kt ENE and 1005 mb at Vero Beach, FL at 1830Z (SWO).

May 26:

HWM analyzes a closed low pressure of at most 1010 near 27.0N, 50.5W with a weakening cold front to the west at 12Z. Microfilm shows a closed low pressure of at most 1005 at 31.0N, 77.0W at 12Z. Ship highlights: 35 kt ESE and 1006 mb at 29.5N, 77.4W at 00Z (COADS). 35 kt SE and 1001 mb at 30.2N, 77.4W at 06Z (COADS). 45 kt E and 1004 mb at 31.5N, 76.5W at 06Z (COADS). 15 kt SE and 1003 mb at 30.5N, 77.3W at 12Z (COADS). 10 kt SW and 1004 mb at 30.7N, 75.8W at 18Z (COADS).

May 27:

HWM analyzes a tropical storm of at most 1000 near 35.5N, 70.7W with a weakening cold front to the west and a warm front to the north at 12Z. Microfilm shows a closed low pressure of at most 1002 at 36.0N, 70.0W at 12Z. Ship highlights: 10 kt W and 1003 mb at 32.3N, 74.1W at 00Z (COADS). 40 kt NW and 999 mb at 34.2N, 71.8W at 03Z (COADS). 15 kt S and 1003 mb at 33.4N, 70.6W at 06Z (COADS). 40 kt SSE and 1004 mb at 35.5N, 67.9W at 12Z (COADS). 50 kt SSE and 1004 mb at 36.1N, 68.7W at 15Z (COADS). 35 kt NNE and 999 mb at 37.4N, 70.1W at 18Z (COADS). 50 kt NE and 1000 mb at 38.3N, 70.2W at 21Z (COADS).

May 28:

HWM analyzes a tropical storm of at most 1000 near 39.5N, 67.2W with a warm front to the north at 12Z. Microfilm shows a closed low pressure of at most 996 at 39.0N, 67.5W at 12Z. Ship highlights: 40 kt NW and 996 mb at 37.8N, 70.4W at 00Z (COADS). 55 kt N and 999 mb at 38.0N, 70.5W at 03Z (COADS). 45 kt NNW and 1005 mb at 38.5N, 71.0W at 06Z (COADS). 35 kt NE and 1001 mb at 40.2N, 68.3W at 12Z (COADS). 20 kt N and 996 mb at 41.0N, 66.5W at 18Z (COADS). Land highlights: 42 kt NE and 1008 mb at Nantucket Shoals, MA at 0855Z (SWO). 36 kt ENE (gusts to 40 kt) and 1008 mb at Georges Shoal, MA at 12Z (SWO). 23 kt NNE (gusts to 31 kt) and 1001 mb at Georges Shoal, MA at 20Z (SWO).

May 29:

HWM analyzes a tropical storm of at most 1000 near 48.0N, 63.7W with a warm front to the northeast and a stationary front to the west at 12Z. Microfilm shows a closed

low pressure of at most 999 near 49.0N, 68.0W with a frontal boundary to the south at 12Z. Ship highlights: 35 kt S and 1014 mb at 40.3N, 58.8W at 00Z (COADS). 15 kt W and 1000 mb at 42.9N, 65.4W at 06Z (COADS). Land highlights: 25 kt S and 998 mb at Halifax, Canada at 06Z (micro).

May 30:

HWM analyzes an extratropical cyclone of at most 990 near 57.0N, 63.0W with a stationary front to the southeast at 12Z. Microfilm indicates that the low pressure is off the map at 12Z. Ship highlights: No gale force winds or equivalent low pressures.

A broad area of low pressure developed over the southwestern Caribbean Sea around May 21st and slowly moved northwestward. The large disturbance intensified and became a 25 kt tropical depression at 00Z on May 24th, south of the Guanahacabibes peninsula of western Cuba. Cabo San Antonio, Cuba reported 10 kt NE and 1005 mb at 00Z on the 24th, suggesting a central pressure of 1004 mb, which has been added. Moving to the northeast, it crossed the province of Pinar del Río, Cuba as a tropical depression shortly after forming and passed close to the Florida Keys late on the 24th and early on the May 25th. It should be noted that the evidence for a closed low level circulation on May 24th and early on the 25th is modest as the tropical cyclone was on its formative stage. Alligator Reef, FL reported 10 kt NW and 1003 mb at 00Z on the 25th, suggesting a central pressure of 1002 mb, which has been added to HURDAT. Early on the 25th, the tropical depression reached the Bahamas where its forward speed decreased. High Rock, Bahamas reported 15 kt SE and 1005 mb at 06Z on the 25th, suggesting a central pressure of 1003 mb, which has been added. It is noted that despite the relatively low central pressures on the 24th and early on the 25th, these did not support tropical storm intensity because of the system's large size and low environmental pressure. Freeport, Bahamas reported 5 kt SW and 1005 mb at 12Z on the 25th, suggesting a central pressure of 1004 mb, which has been added. Intensification to a tropical storm is analyzed at 18Z on the 25th on the basis of a ship report of 35 kt northeast of the center. A ship near the center of the tropical storm reported 25 kt E and 1005 mb at 18Z on the 25th, suggesting a central pressure of 1002 mb, which has been added.

On May 26th, the tropical cyclone increased in forward speed to the northeast. Although the system was broad in nature, it was embedded within a moist environment with dew points in the low to mid 70s around its periphery. A ship reported 45 kt on the 26th but the report was over 200 nm from the center and near another ship that reported 20 kt. It is likely that the 45 kt ship has a high wind bias. However, two other ships closer to the center reported 35 kt winds on the 26th, confirming minimal tropical storm intensity on that date. A ship reported 15 kt SE and 1003 mb at 12Z on the 26th, suggesting a central pressure of 1001 mb, which has been added. A frontal system approached the tropical

storm from the west on May 27th causing further acceleration to the northeast. A couple of ships reported 40 kt early on the 27th and even 50 kt at 15Z on this date. The peak intensity is analyzed at 50 kt at 12Z on the 27th, likely partially influenced by baroclinic processes as the tropical cyclone began to acquire extratropical characteristics. Ship observations at 18Z on the 27th show a distinct temperature gradient E-W across the cyclone and the development of frontal features, especially a warm front to the northeast. It is analyzed that the tropical storm became an extratropical cyclone at 18Z on the 27th. The extratropical cyclone produced gale force winds on Nantucket Shoals, MA and Georges Shoal, MA on May 28th. Early on May 29th, the extratropical cyclone moved over the Atlantic provinces of Canada where it merged with another extratropical cyclone. Dissipation is analyzed after 06Z on the 29th.

Tropical Storm Alma [June 14-16, 1958]

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40445 06/14/1958 M= 3  1 SNBR= 880 ALMA        XING=0 SSS=0
40445 06/14/1958 M= 3  2 SNBR= 880 ALMA        XING=0 SSS=0
                       *

40450 06/14*  0   0   0    0*211 945  30    0*217 950  40    0*225 956  45    0*
40450 06/14*  0   0   0    0*209 945  30    0*215 950  40    0*223 956  50    0*
                             ***               ***               ***       **

40455 06/15*235 964  40  997*245 973  35 1006*256 981  35    0*267 990  30    0*
40455 06/15*232 964  60    0*241 973  60    0*247 983  45    0*251 993  30    0*
           ***       **    * ***       **    * *** ***  **      *** ***

40460 06/16*2791001  25    0*2911010  20    0*3031017  15    0*3141025  15    0*
40460 06/16*2531003  25    0*2551013  20    0*  0   0   0    0*  0   0   0    0*
           *******           *******           *   *   *        *   *   *

40465 TS
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Tropical Storm Landfall

06/15 09Z 24.4N 97.7W 60 kt Mexico

Major changes to the track and intensity shown in McAdie et al. (2009). Evidence for these alterations comes from the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Monthly Weather Review, Surface Weather Observations, Local Climatological Data, Mexican surface maps, Navy reconnaissance book and the NHC Storm Wallets.

June 12:

HWM analyzes a spot low pressure at 20.5N, 94.0W at 12Z. HURDAT does not list an organized storm on this date. Microfilm shows a trough or tropical wave over

the Yucatan peninsula at 12Z. Ship highlights: No gales or low pressures. Land highlights: 5 kt ENE and 1005 mb at Campeche, Mexico at 18Z (micro).

MWR: "Tropical storm Alma developed in an easterly wave that was first detected in the central Caribbean on June 9 and 10. Abnormally heavy shower activity was occurring on these dates over the western and central Caribbean Sea and northward across Cuba into the Bahamas. There was some evidence of a closed circulation at 1800 GMT on the 10th near latitude 15N, longitude 78W."

June 13:

HWM analyzes a closed low pressure of at most 1005 mb at 20.5N, 94.5W at 12Z. HURDAT does not list an organized storm on this date. Microfilm shows a trough or tropical wave over the Bay of Campeche at 12Z. Ship highlights: No gales or low pressures. Land highlights: 15 kt E and 1003 mb at Campeche, Mexico at 00Z (micro). 5 kt SE and 1003 mb at Ciudad del Carmen, Mexico at 12Z (micro).

MWR: "On succeeding maps, a weak circulation was observed and heavy rains continued over the northwestern Caribbean and eventually spread into Centra1 America. The weak circulation moved westward into the Yucatan Peninsula-Guatemala area on the 12th and into the Gulf of Campeche on the 13th." ATSR: "A low cell on the ITC was located over northern Guatemala causing intensive rainfall on June 13th."

June 14:

HWM analyzes a tropical storm of at most 1005 mb at 21.6N, 94.9W at 12Z. HURDAT lists a 40 kt tropical storm at 21.7N, 95.0W at 12Z. Microfilm shows a closed low pressure of at most 1005 mb at 23.0N, 96.8W at 12Z. Ship highlights: 40 kt SSE and 997 mb at 22.8N, 95.6W at 21Z (MWR). Land highlights: 1005 mb at Campeche, Mexico at 00Z (micro). 15 kt WNW and 1004 mb at Tampico, Mexico at 18Z (micro).

MWR: "The disturbance continued northwestward along and off the Mexican coast and developed into tropical storm Alma about midday, on the 14th some 150 miles east of Tampico. At 2100 GMT on the 14th, the Motor Vessel Mada, at latitude 22.8N, longitude 95.6W, reported a south-southeast wind of 45 mph, pressure of 997 mb, and mountainous seas. A Navy reconnaissance aircraft was dispatched to the storm on the 14th. However, the center had apparently moved inland and broken up before the aircraft reached the area. The plane reported maximum winds of 22 knots and minimum pressure of 1008 mb, and observed no radar echoes. … Highest winds reported were 45 to 50 mph from the MV Mada on the 14th." ATSR: "This low apparently was separated from the ITC by June 14 and gradually developed into a small tropical storm over the Gulf of Campeche. The first report (DTG 142100Z) of the storm was by a ship at 22.8N 95.7W. This message was not received until 150715Z. The ship reported winds of 45 miles per hour, pressure 997 mb, and mountainous seas."

June 15:

HWM analyzes a tropical storm of at most 1005 mb at 25.5N, 99.1W at 12Z. HURDAT lists a 35 kt tropical storm at 25.6N, 98.1W at 12Z. Microfilm shows a spot low pressure at 26.0N, 102.0W at 12Z. Ship highlights: 35 kt SW and 1006 mb at 20.2N, 93.0W at 05Z (MWR/micro). Land highlights: 15 kt W and 1004 mb at Tampico, Mexico at 00Z (micro). 1005 mb at Monterrey, Mexico at 12Z (micro). 35 kt, gusts to 40 kt at South Padre Island, TX at 16Z (WALLETS). 20 kt NNE and 1005 mb at Monterrey, Mexico at 18Z (micro). Aircraft highlights: Coast Guard aircraft measured 50 kt near 25.3N, 97.2W at 14Z (MWR).

MWR: "At 0500 GMT on the 15th, this ship, located about 100 miles northwest of Carmen, Mexico, was encountering south-southwest winds of 35 to 40 mph, pressure of 1006 mb and very rough seas." ATSR: "Warning Number One, Tropical Storm Alma, was issued at 150830Z. ALMA entered the coast of Mexico about sixty miles south of Brownsville, Texas, at approximately 151000Z. Except for heavy rains and flooding in the Rio Grande Valley, ALMA caused no damages. Highest wind from a coastal station was 45 miles per hour at Port Isabel, Texas. One reconnaissance flight was flown but ALMA had entered land prior to the aircraft arrival. … Highest reported winds were 50 knots from a Coast Guard aircraft 50 miles south of Port Isabel, Tex., at 0800 CST and 40 to 45 mph at south Padre Island, Tex., at 1000 CST on the 15th. Heavy rains fell over the hill country to the west of San Antonio, generally averaging 7 to 10 inches with some amounts reported as high as 20 inches a little to the west of Medina, Tex. Very little damage was caused by wind and tides associated with this storm and major damage to crops and property was associated with floods caused by the attendant rains. One death by drowning occurred in the Galveston area during passage of the storm."

June 16:

HWM analyzes a tropical storm of at most 1005 mb at 31.2N, 101.5W at 12Z. HURDAT lists a 15 kt tropical depression at 30.3N, 101.7W at 12Z. Microfilm shows a frontal boundary over the central United States and a closed low pressure of at most 1002 mb over northern Mexico at 12Z. Ship highlights: No gales or low pressures. Land highlights: 25 kt E and 1002 mb at Monterrey, Mexico at 00Z (micro).

June 17:

HWM analyzes a cold front across Texas at 12Z. HURDAT does not list an organized storm on this date. Microfilm at 12Z. Ship highlights: No gales or low pressures.

WALLETS: "Tropical Storm Alma developed in a low pressure area over the west Gulf of Mexico some 150 miles east of Tampico, Mexico about noon June 14, 1958. This low pressure area had been over the Bay of Campeche on June 13 probably having been

associated with low pressures of several days earlier over extreme eastern Pacific near Guatemala and an easterly wave from the Caribbean. The storm moved towards the northwest and reached the coast about 75 miles south of Brownsville, Texas early on the 15th and became disorganized as it moved up the Rio Grande Valley that day and lost its identity at all levels near Del Rio the following day, June 16, 1958."

Tropical Storm Alma developed from a tropical wave over the Bay of Campeche. Genesis is analyzed at 06Z on June 14th as a 30 kt tropical depression, no change from the original HURDAT. Coastal stations along the Bay of Campeche reported very low pressures on June 13th, possibly an indication that the tropical cyclone may have formed around 20N and 92W on that day. However, the data are not sufficient to start the system earlier. Intensification to a tropical storm is analyzed at 12Z on June 14th, same as the original HURDAT. Minor track changes are analyzed on the 14th. At 21Z on the 14th, a ship over the western Gulf of Mexico reported a pressure of 997 mb, winds of 40 kt SSE and mountainous seas. A peripheral pressure of 997 mb suggests maximum sustained winds greater than 53 kt south of 25N from the Brown et al. pressure-wind relationship. Intensities of 50 kt and 60 kt are selected at 18Z on June 14th and 00Z on June 15th, up from 45 kt and 40 kt originally in HURDAT, a major intensity change. A central pressure of 997 mb was present in HURDAT at 00Z on the 15th and since the pressure reported by the ship was not a central pressure, it has been removed. 60 kt is also the peak intensity for this tropical cyclone, up from 45 kt originally in HURDAT, a minor intensity change for 00Z. The intensity is kept at 60 kt for 06Z on the 16th, up from 35 kt originally in HURDAT, a major intensity change. A central pressure of 1006 mb is present in HURDAT at 06Z on the 15th but it was not a central pressure since it was reported by a ship over the Bay of Campeche, hundreds of miles from the center of Alma. Thus, it has been removed. It is possible that Alma continued to intensify until landfall, potentially achieving hurricane status. The tropical cyclone continued moving toward the northwest early on the 15th making landfall over a sparsely populated area in the northeast coast of Mexico around 09Z. Alma crossed the coast near 24.4N, 97.7W, about 35 nm southeast of San Fernando, Tamaulipas, Mexico or about 90 nm south-southwest of Brownsville, TX. The northern squalls of Alma impacted southern Texas producing 35 kt winds in South Padre Island, TX. Thus, this cyclone is considered a tropical storm impact for the United States. A reconnaissance aircraft investigated the western Gulf of Mexico on the 15th around 15Z and found that Alma had already moved inland. Minor track changes are analyzed on the 15th. Late on the 15th, the track of the tropical cyclone began to turn to the west-northwest. Weakening to a tropical depression is analyzed at 18Z on the 15th, no change from the original HURDAT. Observations from Monterrey, Mexico on June 16th indicate that Alma did not continue on a northwestward course into the Rio Grande Valley as shown by HURDAT but instead turned to the west passing south of the city. Major changes to the track are analyzed at 00Z and 06Z on the 16th. Dissipation is

analyzed at 06Z on the 16th over the mountainous terrain over northeast Mexico, twelve hours earlier than the original HURDAT.

Tropical Storm Becky [August 8-17, 1958]

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40470 08/08/1958 M=10  2 SNBR= 881 BECKY       XING=0 SSS=0
40470 08/08/1958 M=10  3 SNBR= 881 BECKY       XING=0 SSS=0
                       *

40475 08/08*  0   0   0    0*  0   0   0    0*153 210  25    0*156 235  25    0*
40475 08/08*161 185  25    0*163 195  25    0*165 205  25    0*167 218  25    0*
           *** ***  **      *** ***  **      *** ***          *** ***

40480 08/09*159 255  25    0*161 271  25    0*162 287  25    0*166 305  25    0*
40480 08/09*169 233  30    0*172 250  35    0*174 268  40    0*175 286  45    0*
           *** ***  **      *** ***  **      *** ***  **      *** ***  **

40485 08/10*169 322  25    0*170 339  25    0*170 355  25    0*171 368  25    0*
40485 08/10*175 304  45    0*175 322  45    0*175 340  45    0*175 358  45    0*
           *** ***  **      *** ***  **      *** ***  **      *** ***  **

40490 08/11*172 382  25    0*174 400  30    0*177 418  35    0*179 434  35    0*
40490 08/11*175 379  45    0*176 400  45    0*177 420  45    0*179 440  45    0*
           *** ***  **      ***      **          ***  **          ***  **

40495 08/12*181 451  40    0*185 475  45    0*189 500  50    0*189 524  50    0*
40495 08/12*181 461  45    0*182 483  45    0*183 505  50    0*185 529  50 1004*
                ***  **      *** ***          *** ***          *** ***     ****

40500 08/13*188 546  50    0*191 563  50    0*195 579  50    0*201 598  50    0*
40500 08/13*188 550  50    0*192 567  45    0*198 584  45    0*203 605  40 1009*
                ***          *** ***  **      *** ***  **      *** ***  ** ****

40505 08/14*209 619  50    0*219 646  50    0*230 672  50    0*239 691  50    0*
40505 08/14*214 621  40    0*222 647  40    0*230 674  40    0*240 698  40    0*
           *** ***  **      *** ***  **          ***  **      *** ***  **

40510 08/15*249 710  40    0*269 726  35    0*290 739  35    0*301 738  35    0*
40510 08/15*253 717  40    0*270 732  40    0*285 739  40    0*295 739  40    0*
           *** ***  **      *** ***  **      ***      **      *** ***  **

40515 08/16E312 734  30    0E322 734  25    0E333 734  25    0E348 723  25    0*
40515 08/16*310 738  40    0*322 737  40    0*335 730  40 1004*348 721  40    0*
          **** ***  **     *    ***  **     **** ***  ** *****    ***  **

40520 08/17E369 696  25    0E392 669  25    0E415 628  25    0E432 578  25    0*
40520 08/17*363 690  40    0E392 655  40    0E425 623  45    0*  0   0   0    0*
          **** ***  **          ***  **      *** ***  **        *   *   *

40525 TS
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Major changes to the track and intensity shown in McAdie et al. (2009). Another major change is to indicate extratropical transition over a day later than originally shown. Evidence for these alterations comes from the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Monthly Weather Review, Navy reconnaissance book, Mariners Weather Log and NHC Storm Wallets.

August 7:

HWM is not available on this date (system south of 20ºN). HURDAT does not list an organized storm on this date. Microfilm does not show an organized system at 12Z. Ship highlights: No gales or low pressures.

ATSR: “On 4 August this facility received a message from the Fleet Weather Central, Port Lyautey, which indicated that an easterly wave, labeled 3AW, was near 14 degrees west longitude. This wave was confirmed on 7 August near 25W. From 7 August to 11 August this wave continued westerly at about 5 degrees per day through an area of sparse or no reports.”

August 8:

HWM is not available on this date (system south of 20ºN). HURDAT lists a 25 knot tropical depression at 15.3N, 21.0W at 12Z (first position). Microfilm does not show an organized system at 12Z. Ship highlights: No gales or low pressures.

MWR: “Reports on August 7 and 8 from the Cape Verde Islands had indicated a westward-moving tropical depression.”

August 9:

HWM is not available on this date (system south of 20ºN). HURDAT lists a 25 knot tropical depression at 16.2N, 28.7W at 12Z. Microfilm shows a closed low pressure of at most 1011 mb at 15.0N, 31.0W at 12Z. Ship highlights: 45 kt ENE and 1004 mb at 18.1N, 28.1W at 18Z (MWL). 40 kt E and 1008 mb at 17.7N, 27.8W at 21Z (COADS/micro).

MWR: “A continued westward movement with some intensification was confirmed on August 9 by reports from the ship Tatra.”

August 10:

HWM is not available on this date (system south of 20ºN). HURDAT lists a 25 knot tropical depression at 17.0N, 35.5W at 12Z. Microfilm does not show an organized system at 12Z. Ship highlights: No gales or low pressures.

August 11:

HWM is not available on this date (system south of 20ºN). HURDAT lists a 35 knot tropical storm at 17.7N, 41.8W at 12Z. Microfilm shows a closed low pressure of at most 1011 mb at 17.0N, 43.0W at 12Z. Ship highlights: 30 kt NE and 1009 mb at 18.8N, 44.7W at 15Z (micro).

MWR: “Becky, the second tropical storm of the season, was first positively identified on August 11. A series of reports from the ship Industrious indicated the storm's existence near latitude 18N, longitude 45W, halfway between Puerto Rico and the Cape Verde Islands.” ATSR: “From 111200Z to 112100Z the SS INDUSTRIOUS reported each three hours indicating increasing seas and winds with a falling barometer near 18N 46W. This was the approximate position of the easterly wave…”

August 12:

HWM is not available on this date (system south of 20ºN). HURDAT lists a 50 knot tropical storm at 18.9N, 50.0W at 12Z. Microfilm shows a closed low pressure of at most 1014 mb at 18.0N, 51.0W at 12Z. Ship highlights: 45 kt ESE and 1013 mb at 19.6N, 45.8W at 00Z (micro). 40 kt E and 1014 mb at 19.9N, 49.3W at 12Z (micro). 45 kt E and 1011 mb at 20.4N, 50.0W at 15Z (micro). 40 kt ENE at 21.3N, 51.3W at 18Z (micro). Aircraft highlights: Penetration center fix measured a central pressure of 1004 mb and flight level winds (700 mb) of 60 kt at 18.4N, 52.6W at 16Z (WALLET/ATSR).

MWR: “The Weather Bureau Office at San Juan issued the first advisory at 0400 GMT, August 12. On August 12, reconnaissance aircraft flying at 700 mb reported a complete cyclonic circulation, a maximum wind speed at flight level of 60 kt, and minimum sea level pressure by dropsonde of 1006 mb. There after Becky continued on a westward to west-northwestward course passing about 290 miles northeast of Puerto Rico at the nearest point.” ATSR: “…at 120400Z, the first coordinated warning was issued on Tropical Storm Becky. On 12 August the USAF 59th Weather Reconnaissance Squadron located BECKY at 18.4N 52.6W with maximum winds of 40 knots and minimum pressure of 1006 mb.”

August 13:

HWM is not available on this date (system south of 20ºN). HURDAT lists a 50 knot tropical storm at 19.5N, 57.9W at 12Z. Microfilm shows a trough at 15N-23N, 59W at 12Z. Ship highlights: 40 kt NE and 1013 mb at 20.5N, 55.8W at 00Z (micro). 35 kt E and 1014 mb at 21.4N, 58.2W at 12Z (COADS). 40 kt SE and 1011 mb at 22.3N, 60.2W at 18Z (COADS). Aircraft highlights: Penetration center fix measured a central pressure of 1013 mb, estimated maximum surface winds of 45 kt and an eye diameter of 70 nm at 22.0N, 60.1W at 20Z (ATSR) (possible latitude error, maybe 21.0N). Radar center fix at 21.6N, 61.2W at 2148Z (ATSR). Penetration center fix at 21.4N, 61.5W at 2317Z (ATSR).

August 14:

HWM analyzes a closed low pressure of at most 1010 mb at 23.0N, 66.8W at 12Z. HURDAT lists a 50 knot tropical storm at 23.0N, 67.2W at 12Z. Microfilm shows a

trough at 18N-25N, 63W at 12Z. Ship highlights: 40 kt SE and 1016 mb at 22.5N, 59.4W at 00Z (COADS). 40 kt ESE and 1017 mb at 25.6N, 67.7W at 18Z (micro). Aircraft highlights: Radar center fix at 21.6N, 68.8W at 1151Z (ATSR).

August 15:

HWM analyzes a closed low pressure of at most 1010 mb at 29.2N, 72.9W at 12Z. HURDAT lists a 35 knot tropical storm at 29.0N, 72.9W at 12Z. Microfilm shows a closed low pressure of at most 1014 mb at 28.5N, 70.5W at 12Z. Ship highlights: 35 kt SE and 1013 mb at 25.2N, 67.2W at 00Z (micro). 40 kt SE at 28.1N, 72.1W at 17Z (micro). 45 kt SSE and 1011 mb at 31.4N, 71.8W at 18Z (COADS).

ATSR: “The subtropical high over the Atlantic north of BECKY was very strong throughout most of her life span; therefore, she moved very rapidly (over 20 knots average) until she recurved into a trough in the westerlies on 15 August. By 15 August she had reached a cold trough which had moved off the east coast of the United States and quickly became more diffuse in a large area of squalls.”

August 16:

HWM analyzes a closed low pressure of at most 1005 mb at 34.5N, 73.3W with a cold front to the north at 12Z. HURDAT lists a 25 knot extratropical depression at 33.3N, 73.4W at 12Z. Microfilm shows a closed low pressure of at most 1008 mb at 33.5N, 74.0W and a cold front to the north at 12Z. Ship highlights: 40 kt SW and 1012 mb at 30.8N, 71.7W at 00Z (COADS). 35 kt SSW and 1013 mb at 31.0N, 72.1W at 12Z (COADS). 35 kt S and 1009 mb at 33.6N, 71.0W at 18Z (COADS).

MWR: “Then the storm began to recurve broadly to the northwest and north and on the 16th toward the northeast around the western periphery of the subtropical high pressure area.”

August 17:

HWM analyzes a closed low pressure of at most 1010 mb at 43.4N, 61.8W with a warm front to the north and a cold front to the west at 12Z. HURDAT lists a 25 knot extratropical depression at 41.5N, 62.8W at 12Z. Microfilm shows an extratropical cyclone of at most 999 mb at 43.5N, 64.5W at 12Z. Ship highlights: 50 kt S and 1000 mb at 38.5N, 68.3W at 00Z (micro). 40 kt SW and 1012 mb at 30.8N, 71.7W at 00Z (COADS). 40 kt WNW and 995 mb at 40.4N, 64.4W at 09Z (micro). 45 kt W and 982 mb at 43.0N, 62.5W at 12Z (micro). 50 kt W and 992 mb at 45.6N, 58.2W at 18Z (COADS).

August 18:

HWM analyzes an extratropical cyclone of at most 995 mb at 52.5N, 48.5W, likely the system that absorbed Becky, at 12Z. HURDAT does not list an organized storm on this date. Microfilm shows a closed low pressure of at most 1011 mb at 52.0N, 50.0W with a frontal boundary to the north at 12Z.

MWR: "The minimum pressure of 1006 mb reported by the first reconnaissance into Becky was as low as any succeeding central pressure report while the storm was under close surveillance by aircraft. The area of gale winds gradually increased in size but remained mostly north and east of the center. Maximum reported winds increased very slowly from about 35 knots up to an estimated 55 or 60 knots during the first two and one-half days. Up to 75-knot winds were reported in squalls about 210 miles east-northeast of the center on August 14. Reconnaissance aircraft made frequent reference to lightning, heavy thunderstorms, and turbulence on the east and north sides of the storm. From the time of Becky's first confirmed existence until it began a northward course, the subtropical high pressure cell to the north of it remained well established with highest pressures generally above 1023 mb, which is about normal for the month of August. The average speed of the storm during the time it was under close surveillance by aircraft was about 20 knots. The reason for lack of intensification is not known, but an old empirical forecasting rule states that movement of 20 mph or more is unfavorable for intensification. Reconnaissance aircraft and ship reports in the region early on August 15 indicated that Becky had degenerated into an area of squalls with little if any cyclonic pattern. However, late on the 16th, after Becky moved into an old frontal zone and became extratropical, rapid intensification took place, with one ship for a short time reporting hurricane-force winds."

The first Cape Verde cyclone of the season formed between the Cape Verde Islands and the African coast on August 8th. Observations from ships and coastal stations indicate that a 25 kt tropical depression developed at 00Z on the 8th, making genesis twelve earlier than originally shown in HURDAT. Minor track alterations are analyzed during the lifetime of this tropical cyclone, except for major track changes on August 9th at 00Z and 06Z, east-northeast of that originally shown. The tropical depression moved westward passing just north of the Cape Verde Islands early on the 9th. Intensification to a tropical storm is analyzed at 06Z on the 9th, based on a ship measurement of 45 kt at 18Z on this day. This is 54 hours earlier than originally shown in HURDAT. Major intensity changes are analyzed between 18Z on the 9th to 00Z on the 11th as HURDAT originally showed 25 kt and the selected intensity is 45 kt. Becky continued to move westward on August 10th and 11th with a forward speed of about 21 knots. The intensity during these days is kept at 45 kt but ship observations were sparse. On August 12th, Becky crossed 50ºW and the ship observations became more numerous with a few reports of winds up to 45 kt. The first reconnaissance aircraft reached Becky at 16Z on the 12th measuring a central pressure of 1004 mb and flight level winds (700 mb) of 60 kt. Both MWR and the Navy reconnaissance book show that the central pressure measured during this mission was 1006 mb but the report of Becky in the Storm Wallets indicates that it was 1004 mb and this is the accepted value for the reanalysis. A central pressure of 1004 mb is added to

18Z on the 12th. A central pressure of 1004 mb suggests maximum sustained winds of 39 kt south of 25N from the Brown et al. pressure-wind relationship. Since Becky was moving at about 22 knots and a couple of ships reported 40-45 kt, an intensity of 50 kt is selected for 18Z on the 12th, same as the original HURDAT. 50 kt is also the peak intensity for this tropical cyclone, same as the original HURDAT.

Observations from ships, coastal stations in the Lesser and Greater Antilles, and reconnaissance aircrafts during August 13th, 14th and early on the 15th indicate that Becky was a very disorganized tropical cyclone and it may have weakened to a tropical wave during these days. The forward speed of about 20-25 kt during these days likely contributed to the disorganization. Nonetheless, the data available is not sufficient to justify downgrading Becky to a tropical wave. A reconnaissance aircraft reached Becky at 20Z on the 13th measuring a central pressure of 1013 mb, estimating surface winds of 45 kt and an eye diameter of 70 nm. Although the center fix is shown to have been made at 22.0N, data from the microfilm map at 18Z on the 13th, Storm Wallets and Navy reconnaissance book suggests that it was likely at 21.0N and that the central pressure was 1009 mb. A central pressure of 1009 mb is added to 18Z on the 13th. The intensity of Becky is gradually decreased to 40 kt on the 13th as a reflection of the system losing organization but a few ships still reported gale-force winds on that date, mainly in the northeast quadrant. On August 15th, the track of Becky turned to the north ahead of a frontal boundary. Ship observations late on the day indicated that it had a closed low-level circulation. Gale-force winds were reported on the 15th in the eastern quadrant of the tropical cyclone. HURDAT indicates that Becky becomes an extratropical cyclone at 00Z on August 16th but ship and coastal observations indicate that there were no frontal boundaries associated with the system and the actual cold front was still over the eastern United States. Transition to an extratropical cyclone is delayed until 06Z on the 17th, 30 hours later than originally shown in HURDAT. A ship passed close to the center of Becky at 12Z on the 16th reporting 20 kt NW and 1006 mb, suggesting a central pressure of 1004 mb. A central pressure of 1004 mb has been added to 12Z on the 16th. A central pressure of 1004 mb suggests 39 kt maximum winds south of 25N and 36 kt north of 25N, according to the pressure-wind relationships. Due to the now slower forward motion of Becky of about 14 knots, an intensity of 40 kt is selected at 12Z on the 16th, up from 25 kt originally in HURDAT, a minor intensity change. Late on the 16th, while located about 170 nm east of the Outer Banks, Becky began to interact with a frontal system to the northwest. At this time, the tropical cyclone began to increase in forward speed as it recurved to the northeast. Cold, dry continental air entered the circulation of Becky early on August 17th and it is analyzed that it became extratropical at 06Z. Ship observations suggest that although extratropical and along a frontal boundary, the circulation of Becky remained strong and distinct until after 12Z on the 17th. Slight intensification is noticed at 12Z on the 17th as a ship close to the center reported 45 kt and the intensity is increased to 45 kt at this time, up from 25 kt originally in HURDAT, a major intensity change. At 18Z on the 17th, the data does indicate that Becky has been absorbed by a larger extratropical cyclone to the northwest. Therefore, 12Z on the 17th is the last position analyzed before it was absorbed, six hours earlier than the original HURDAT.

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40530 08/11/1958 M=12  3 SNBR= 882 CLEO        XING=0 SSS=0
40530 08/11/1958 M=12  4 SNBR= 882 CLEO        XING=0 SSS=0
                       *

40535 08/11*  0   0   0    0*108 216  35    0*110 238  35    0*110 260  35    0*
40535 08/11*  0   0   0    0*120 205  25    0*120 230  25    0*120 255  30    0*
                           ***  ***  **      ***  ***  **      ***  ***  **

40540 08/12*111 280  40    0*112 299  45    0*114 318  45    0*117 338  50    0*
40540 08/12*120 278  30    0*120 298  35    0*120 318  40    0*120 338  50    0*
            ***  ***  **      ***  ***  **      ***        **      ***

40545 08/13*120 358  65    0*123 378  80    0*125 396  85    0*128 412  85    0*
40545 08/13*120 358  65    0*122 378  80    0*124 396  85    0*127 412  85    0*
                           ***              ***              ***

40550 08/14*130 427  90    0*133 442 100    0*138 457 115    0*144 471 120  962*
40550 08/14*131 427  90    0*135 442  95    0*140 457 100    0*146 471 100  960*
            ***              ***       **      ***      ***      ***      ***  ***

40555 08/15*151 483 125  962*158 490 125  962*167 493 130  960*181 495 135  952*
40555 08/15*152 483 105    0*159 490 105    0*167 494 110  959*181 496 120  947*
            ***      ***    * ***      ***    *      *** ***  ***      *** ***  ***

40560 08/16*196 498 140  948*210 503 115  955*224 508 110  955*239 514 110  957*
40560 08/16*198 499 120    0*213 504 115    0*227 510 105  954*241 516  95  959*
            *** *** ***    * *** ***        * *** *** ***  *** *** ***  **  ***

40565 08/17*254 522 110  963*269 532 110  967*282 543 110  971*293 552 105  970*
40565 08/17*254 524  95    0*267 534  90  959*281 544  85  965*294 553  85  968*
                ***  **    * *** ***  **  *** *** ***  **  *** *** ***  **  ***

40570 08/18*304 559 100  968*316 564  95  971*328 565  90  973*341 562  85  972*
40570 08/18*306 559  85    0*318 564  80    0*331 565  80  973*344 562  80  972*
            ***      **    * ***      **    * ***      **      ***      **

40575 08/19*357 555  85  971*376 543  80  972*398 525  80  974*423 501  80  979*
40575 08/19*358 557  80    0*376 549  85    0*399 524  85  973*424 499  80  980*
            *** ***  **    *     ***  **    * *** ***  **  *** *** ***      ***

40580 08/20*448 471  75    0E466 438  65    0E470 400  60    0E463 357  60    0*
40580 08/20E448 471  75    0E466 438  65    0E470 400  60    0E470 365  55    0*
          *                                                   *** ***  **

40585 08/21E453 314  55    0E442 273  40    0E430 232  35    0E420 205  35    0*
40585 08/21E463 330  50    0E452 295  40    0E440 260  35    0E428 230  35    0*
            *** ***  **      *** ***          *** ***          *** ***

40590 08/22E410 180  30    0*  0   0   0    0*  0   0   0    0*  0   0   0    0*
40590 08/22E418 210  30    0E409 192  25    0E400 180  25    0E392 170  25    0*
            *** ***          *** ***  **      *** ***  **      *** ***  **

40595 HR
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Major changes to the track and intensity shown in McAdie et al. (2009). Evidence for these alterations comes from the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Monthly Weather Review, Navy reconnaissance book, Mariners Weather Log, the National Hurricane Research Project (NHRP)(Shea and Gray, 1973) and NHC Storm Wallets.

August 10:

HWM is not available on this date (system south of 20ºN). HURDAT does not list an organized system on this date. Microfilm does not show an organized system at 12Z. Ship highlights: No gales or low pressures.

ATSR: “Earlier, about 8 August, there were indications that a disturbance passed to the south of the Cape Verde Islands and it is now believed that the TATRO covered as CLEO. Apparently CLEO formed from a vortex off the International Convergence Zone. … On 9 August the SS TATRO reported near 17N 28W with winds of 45 knots, pressure 1003.9 mb and heavy seas.”

August 11:

HWM is not available on this date (system south of 20ºN). HURDAT lists a 35 knot tropical storm at 11.0N, 23.8W at 12Z. Microfilm does not show an organized system at 12Z. Ship highlights: No gales or low pressures.

MWR: “The existence of hurricane Cleo was first suspected on August 11 based on reports from the Cape Verde Islands. Weather conditions and 24-hour surface pressure changes indicated that a fairly well developed easterly wave was passing through the area. Judging from surface and low-level wind reports, any possible circulation associated with the wave must have passed well to the south of the Cape Verdes.” ATSR: “Later, on 11 August, a storm formed near 18N 46W which was named BECKY. Some forecasters believe this storm was the same disturbance that was reported by the TATRO, however, this would mean that the disturbance had moved westward at about 25 knots. This speed is considered to be unlikely, based on climatological indications since normal speeds of a fully developed storm are nearer to 12 knots in that area.”

August 12:

HWM is not available on this date (system south of 20ºN). HURDAT lists a 45 knot tropical storm at 11.4N, 31.8W at 12Z. Microfilm shows a closed low pressure of at most 1011 mb at 14.5N, 31.5W at 12Z. Ship highlights: No gales or low pressures.

MWR: “On August 12 and 13, reports from several ships on the outer periphery of the suspected storm indicated that a large cyclonic circulation was developing; however, none was close enough to even estimate the location or intensity of Cleo.”

August 13:

HWM is not available on this date (system south of 20ºN). HURDAT lists an 85 knot hurricane at 12.5N, 39.6W at 12Z. Microfilm shows a closed low pressure of at most 1005 mb at 12.0N, 39.0W at 12Z. Ship highlights: No gales or low pressures.

August 14:

HWM is not available on this date (system south of 20ºN). HURDAT lists an 115 knot hurricane at 13.8N, 45.7W at 12Z. Microfilm shows a closed low pressure of at most 1011 mb at 13.0N, 47.0W at 12Z. Ship highlights: 35 kt SE and 1010 mb at 16.2N, 45.9W at 09Z (micro). 15 kt NW and 1001 mb at 12.6N, 47.6W at 12Z (micro). Aircraft highlights: Penetration center fix estimated maximum surface winds of 80 kt, measured a central pressure of 960 mb and an eye diameter of 15 nm at 14.7N, 47.2W at 1811Z (micro).

MWR: "On August 14, an Air Force reconnaissance aircraft located hurricane Cleo at 1820 GMT near latitude 14.7N, longitude 47.1W. By this time, Cleo had developed into a very intense storm with lowest pressure of 962 mb and winds estimated at 146 mph on the basis of fringe data, it is believed the storm was moving at about 21 mph from August 11 to 13; however, on August 14, the time of first aircraft penetration, the storm undoubtedly was decelerating as it began turning northward under the influence of a weak upper trough near longitude 50W." ATSR: "The first positive report on CLEO was on 14 August when the 59th Weather Reconnaissance Squadron positioned the eye at 14.7N 47.2W with flight level winds of 127 knots, surface winds estimated at 80 knots, center pressure 960 mb and well defined wall clouds."

August 15:

HWM is not available on this date (system south of 20ºN). HURDAT lists a 130 knot hurricane at 16.7N, 49.3W at 12Z. Microfilm shows a closed low pressure of at most 1005 mb at 17.0N, 49.5W at 12Z. Ship highlights: 25 kt SW and 1005 mb at 12.8N, 49.1W at 06Z (COADS). 40 kt SE and 1002 mb at 19.1N, 48.9W at 12Z (micro). 50 kt SE and 999 mb at 18.4N, 48.3W at 18Z (micro). 110 kt E and 994 mb at 19.4N, 48.6W (position likely erroneous) at 18Z (micro). 10 kt and 954 mb near 19.3N, 49.3W at 2320Z (WALLET). Aircraft highlights: Penetration center fix estimated maximum surface winds of 90 kt, measured a central pressure of 959 mb and an eye diameter of 10 nm at 17.0N, 49.6W at 14Z (micro). Penetration center fix estimated flight level winds (700 mb) of 110 kt and measured a central pressure of 947 mb at 19.0N, 49.7W at 2030Z (micro/MWR).

MWR: "Although the highest winds were reported by reconnaissance aircraft on first penetration, the hurricane did not reach maximum intensity (based on pressure and radar pattern) until the 15th when a dropsonde in the eye at 2030 GMT indicated a sea level pressure of 947 mb. It is probable that the aircraft did not find the area of maximum winds on this day so it still may be assumed that this was the date of maximum intensity." ATSR: "After the first fix at 141822Z no further fixes were received until 151400Z. This latter fix indicated that CLEO was moving northwest (305). A further fix at 152030Z indicated that CLEO was now moving on a course of 355 at 18 knots. These two latter fixes further indicated that the center pressure was about the same (960 mb) but that the storm was concentrated in a very small area. The following is quoted from the post-flight

summary from GULL ONE CLEO on 15 August: “CLEO IS A SMALL BUT INTENSE STORM. DIAMTER OF EYE IS TEN MILES … MAX SURFACE WIND ESTIMATED AT 90 KNOTS. THIS STORM IS SO SMALL THAT IT WOULD HAVE BEEN VERY DIFFICULT IF NOT IMPOSSIBLE TO LOCATE WITHOUT APN 82 … MARSH” This was indicative of CLEO’s character throughout most of her life span, a small-cored vicious hurricane with strong winds extending out a very short distance from her center.”

August 16:

HWM analyzes a hurricane with a central pressure of 953 mb at 22.5N, 51.0W at 12Z. HURDAT lists an 110 knot hurricane at 22.4N, 50.8W at 12Z. Microfilm shows a closed low pressure of at most 1011 mb at 20.0N, 51.0W at 12Z. Ship highlights: 55 kt E and 1000 mb at 18.5N, 48.1W at 00Z (micro). 110 kt ENE and 996 mb at 20.3N, 47.8W (position likely erroneous) at 03Z (micro). 65 kt SE and 1002 mb at 22.3N, 51.6W at 06Z (micro). 95 kt SSE and 998 mb at 20.7N, 47.2W (position likely erroneous) at 09Z (micro). 45 kt WNW and 999 mb at 22.0N, 51.1W at 12Z (micro). 70 kt SE and 1005 mb at 20.5N, 46.9W (position likely erroneous) at 12Z (micro). 60 kt ESE and 1006 mb at 26.5N, 49.2W at 21Z (MWL). Aircraft highlights: Radar center fix estimated maximum surface winds of 75 kt and an eye diameter of 28 nm at 21.5N, 50.4W at 08Z (ATSR). Penetration center fix estimated flight level winds (700 mb) of 102 kt, measured a central pressure of 954 mb and an eye diameter of 15 nm at 23.0N, 51.2W at 14Z (micro). Penetration center fix estimated flight level winds (500 mb) of 90 kt, measured a central pressure of 959 mb and an eye diameter of 30 nm at 25.0N, 51.9W at 2052Z (micro).

MWR: “On the 16th, the storm turned toward the north-northwest and gradually increased its forward speed. Recurvature south of latitude 20ºN during August is very unusual and in this case was never completed. An active short wave which passed through the Northeastern States on the 16th and 17th began to affect Cleo by the 18th as the storm slowed to about 14 mph and gradually turned to a northward course.”

August 17:

HWM analyzes a hurricane with a central pressure of 972 mb at 28.3N, 54.3W at 12Z. HURDAT lists a 110 knot hurricane at 28.2N, 54.3W at 12Z. Microfilm shows an open low pressure at 28.7N, 54.5W at 12Z. Ship highlights: 55 kt SE and 1010 mb at 26.2N, 48.9W at 00Z (micro). 40 kt SE and 1011 mb at 28.7N, 50.0W at 06Z (micro). 45 kt SW and 1000 mb at 26.8N, 53.2W at 12Z (micro). 40 kt S and 1007 mb at 27.9N, 52.7W at 18Z (micro). Aircraft highlights: Penetration center fix measured a central pressure of 959 mb at 27.9N, 53.8W at 0930Z (ATSR/micro). Penetration center fix measured a central pressure of 965 mb at 28.8N, 54.9W at 1330Z (ATSR/micro). Penetration center fix estimated surface winds of 88 kt, measured a central pressure of 968 mb and an eye diameter of 20 nm at 29.8N, 55.4W at 1930Z (micro).

August 18:

HWM analyzes a hurricane with a central pressure of 973 mb at 32.9N, 56.5W at 12Z. HURDAT lists a 110 knot hurricane at 32.8N, 56.5W at 12Z. Microfilm shows a closed low pressure of at most 1002 mb at 33.0N, 57.0W with a frontal boundary to the north at 12Z. Ship highlights: 35 kt E and 1005 mb at 32.9N, 56.0W at 00Z (micro). 40 kt SE and 1004 mb at 33.0N, 54.5W at 06Z (micro). 35 kt SSE and 1013 mb at 32.0N, 52.1W at 12Z (micro). 35 kt S and 1019 mb at 35.5N, 49.7W at 18Z (micro). Aircraft highlights: Penetration center fix estimated surface winds of 80 kt and measured a central pressure of 973 mb at 33.5N, 56.3W at 14Z (ATSR/micro). Penetration center fix estimated surface winds of 84 kt, measured a central pressure of 972 mb, and a RMW of 22 nm at 33.0N, 56.0W around 1630Z (NHRP). Penetration center fix measured a central pressure of 971 mb at 34.8N, 56.1W at 1935Z (ATSR/micro).

ATSR: "After CLEO's turn toward the north, following the first positive location on 14 August, she continued on a course between north-northwest and north for four days and finally recurved through north at about 1000Z on 18 August."

August 19:

HWM analyzes a hurricane with a central pressure of 976 mb at 40.0N, 52.9W with a warm front to the north and a dissipating front to the west at 12Z. HURDAT lists a 110 knot hurricane at 39.8N, 52.5W at 12Z. Microfilm shows a closed low pressure of at most 999 mb at 40.0N, 53.0W with a frontal boundary to the west at 12Z. Ship highlights: 40 kt SSW and 1019 mb at 34.6N, 50.5W at 00Z (COADS). 40 kt S and 1019 mb at 36.5N, 49.7W at 06Z (micro). 45 kt S and 1020 mb at 36.3N, 50.3W at 12Z (COADS). 55 kt SSW and 998 mb at 42.0N, 47.3W at 18Z (micro). 65 kt SW and 982 mb at 42.2N, 48.7W at 20Z (micro). Aircraft highlights: Penetration center fix estimated surface winds of 79 kt, measured a central pressure of 973 mb and an eye diameter of 30 nm at 39.4N, 52.9W at 1055Z (ATSR/micro). Penetration center fix estimated surface winds of 70-75 kt and measured a central pressure of 973 mb at 39.8N, 52.8W at 1112Z (micro). Penetration center fix measured a central pressure of 976 mb at 40.4N, 51.8W at 1336Z (ATSR/micro). Penetration center fix estimated surface winds of 88 kt, measured a central pressure of 980 mb and an eye diameter of 40 nm at 43.3N, 48.5W at 1930Z (micro).

MWR: "On the 19th Cleo accelerated to around 29 mph on a northeastward and later a more eastward course until becoming extratropical on the 20th."

August 20:

HWM analyzes a tropical storm of at most 995 mb at 47.1N, 40.1W with a warm front just to the north at 12Z. HURDAT lists a 60 knot extratropical storm at 47.0N, 40.0W at 12Z. Microfilm shows an extratropical cyclone of at most 1011 mb at 46.0N, 38.0W at 12Z. Ship highlights: 45 kt S and 1012 mb at 43.9N, 44.2W at 00Z (COADS). 60 kt S and 1003 mb at 45.4N, 41.0W at 06Z (COADS). 50 kt SSW and 1007 mb at 44.0N, 41.0W at 09Z (COADS). 50 kt SW and 1004 mb at 44.8N, 39.5W at 12Z (COADS). 45 kt NNE and 1004 mb at 46.5N, 39.8W at 18Z (micro).

August 21:

HWM analyzes an extratropical cyclone of at most 1005 mb at 44.0N, 28.0W at 12Z. HURDAT lists a 35 knot extratropical storm at 43.0N, 23.2W at 12Z. Microfilm shows that the extratropical cyclone has moved off the northeast edge of the synoptic map at 12Z. Ship highlights: 45 kt S at 45.4N, 28.6W at 00Z (COADS). 35 kt WNW and 1009 mb at 42.4N, 33.2W at 06Z (COADS). 35 kt NW and 1014 mb at 42.2N, 33.1W at 12Z (COADS).

August 22:

HWM analyzes an extratropical cyclone of at most 1010 mb at 40.5N, 18.0W at 12Z. HURDAT lists a 30 knot extratropical depression at 41.0N, 18.0W at 00Z (last position). Microfilm is not available on this date. Ship highlights: No gales or low pressures.

August 23:

HWM analyzes an extratropical cyclone of at most 1015 mb at 38.0N, 17.5W at 12Z. HURDAT does not list an organized storm on this date. Microfilm is not available on this date. Ship highlights: No gales or low pressures.

August 24:

HWM analyzes an extratropical cyclone of at most 1015 mb at 40.0N, 3.5W at 12Z. HURDAT does not list an organized storm on this date. Microfilm is not available on this date. Ship highlights: No gales or low pressures.

August 25:

HWM analyzes a cold front over western Europe at 12Z. HURDAT does not list an organized storm on this date. Microfilm is not available on this date. Ship highlights: No gales or low pressures.

MWR: “Fortunately hurricane Cleo remained at sea throughout its history and no reports were received of any severe damage to shipping or loss of life despite the storm's traversal of the principal transatlantic shipping lanes. An interesting account of a vessel passing through the eye of Cleo can be found in the November Mariners Weather Log.”

The first hurricane of the season developed from a tropical wave that left the African coast around August 9th. Genesis is analyzed at 06Z on August 11th, same as the original HURDAT. Ship and coastal observations indicate that the system was a tropical depression at formation, and an intensity of 25 kt is selected for 06Z on the 11th, down from the original 35 kt in HURDAT, a minor intensity change. Intensification to a tropical storm is delayed 24 hours until 06Z on August 12th, indicating a gradual strengthening of the tropical cyclone. Minor track alterations are introduced during the lifetime of Cleo, except for August 21st at 06Z through August 22nd at 00Z when it was an extratropical cyclone. The Navy reconnaissance book indicates that originally there was confusion on the reports of ship observations from the eastern Atlantic concerning Becky and Cleo. Becky had formed a few days earlier in the same general area. The ship SS TATRO located near 17N 28W on August 9th reported 45 kt and 1004 mb and originally it was not clear to which storm it corresponded. It is now clear that the SS TATRO was reporting on Becky and not Cleo. The observations became sparse as the tropical storm moved generally westward toward the central Atlantic. Intensification to a hurricane is analyzed at 00Z on August 13th, same as the original HURDAT. The first gale-force winds were observed on August 14th and at 1811Z on this day, a reconnaissance aircraft reached the hurricane measuring a central pressure of 960 mb, estimating surface winds of 80 kt and an eye diameter of 15 nm. A central pressure of 960 mb suggests maximum sustained winds of 102 kt south of 25N intensifying from the Brown et al. pressure-wind relationship. An eye diameter of 15 nm suggests an RMW of about 12 nm and climatology suggests about the same. An intensity of 100 kt is selected for 18Z on the 14th, down from 120 kt originally shown in HURDAT, a major intensity change. A central pressure of 962 mb was present in HURDAT at 18Z on the 14th and has been replaced with 960 mb. Intensification to a major hurricane is now analyzed at 12Z on the 14th, six hours later than originally shown in HURDAT. Cleo gradually intensified on August 15th as the track turned to the north-northwest while located over 650 nm east of the Leeward Islands. A central pressure of 962 mb was present in HURDAT at 00Z and 06Z on the 15th and they have been removed since there was no reconnaissance aircraft investigating the hurricane at these times and no central pressure measurements was received from ships in the area. (The original HURDAT for this hurricane had central pressure values for each 6 hour period from 18Z on the 14th to 18Z on the 19th. These were obviously analyses that were added in, not based upon actual observations. These have now been removed from HURDAT.) A reconnaissance mission reached Cleo at 14Z on the 15th measuring a central pressure of 959 mb and estimating surface winds of 90 kt and an eye diameter of 10 nm. A central pressure of 959 mb suggests maximum sustained winds of 104 kt south of 25N intensifying from the pressure-wind relationship. An eye diameter of 10 nm suggests an RMW of about 7 nm and climatology suggests about 12 nm. Since the hurricane has a smaller RMW, an intensity of 110 kt is selected at 12Z on

the 15th, down from 130 kt originally in HURDAT, a major intensity change. Another reconnaissance aircraft reached Cleo at 2030Z on the 15th measuring a central pressure of 947 mb. A central pressure of 947 mb suggests maximum sustained winds of 116 kt south of 25N intensifying from the pressure-wind relationship. An intensity of 120 kt is selected for 18Z on the 15th, down from 135 kt originally in HURDAT, a minor intensity change. Major intensity changes are also analyzed at 00Z and 06Z on the 15th. The original HURDAT shows 125 kt for the mentioned times and the selected intensity is 105 kt for both times. A central pressure of 960 mb is present in HURDAT at 12Z on the 15th and based on the reconnaissance report at 14Z, it has been replaced with 959 mb. Similarly, HURDAT originally had a central pressure of 952 mb at 18Z on the 15th and has been replaced with 947 mb reported by the reconnaissance aircraft at 2030Z. A few ships reported gale-force winds on August 15th, and although the position seems to be erroneous, a few even reported hurricane-force winds. The ship TAHITIEN entered the eye of Cleo late on the 15th measuring a minimum pressure of 954 mb and estimating surface winds around 105 kt, consistent with aircraft reconnaissance. A major intensity change is analyzed at 00Z on the 16th as HURDAT originally had 140 kt and the selected intensity for this time is 120 kt. 120 kt is also the peak intensity of Cleo, down from 140 kt originally in HURDAT, a major intensity change. There is no evidence to support Cleo attaining category 5 throughout its lifetime.

On August 16th, Cleo turned to the northwest. A reconnaissance aircraft reached the hurricane at 14Z on the 16th measuring a central pressure of 954 mb and estimating flight level winds of 102 kt and an eye diameter of 15 nm. A central pressure of 954 mb suggests maximum sustained winds of 107 kt south of 25N and 104 kt south of 25N weakening from the pressure-wind relationships. An eye diameter of 15 nm suggests an RMW of about 12 nm and climatology suggests about 18 nm. An intensity of 105 kt is selected for 12Z on the 16th, down from 110 kt originally in HURDAT, a minor intensity change. A central pressure of 955 mb is present in HURDAT at 12Z on the 16th and has been replaced with the 954 mb reported by the reconnaissance aircraft at 14Z on this day. Central pressures of 948 mb and 955 mb are present in HURDAT at 00Z and 06Z, respectively, on the 16th, but there is no evidence that these were measured central pressures as there were no reports of central pressures by aircraft or ships around these times, and thus, they have been removed. Cleo may have undergone an eyewall replacement cycle late on the day as the central pressure increased and the eye expanded. Another reconnaissance aircraft reached Cleo at 20Z on the 16th measuring a central pressure of 959 mb and estimating flight level winds of 90 kt and an eye diameter of 30 nm. A central pressure of 959 mb suggests maximum sustained winds of 99 kt south of 25N weakening and 92 kt north of 25N weakening, from the pressure-wind relationships. An eye diameter of 30 nm suggests an RMW of about 23 nm and climatology suggests about 12 nm. An intensity of 95 kt is selected for 18Z on the 16th, down from 110 kt originally shown in HURDAT, a minor intensity change. Weakening below major hurricane status is now analyzed 36 hours earlier than originally shown in HURDAT. A central pressure of 957 mb is present in HURDAT at 18Z on the 16th and has been replaced with 959 mb reported by the reconnaissance aircraft at 20Z on this day. On August 17th, Cleo continued to the northwest and three center penetrations occurred on this day. The first aircraft reached Cleo at 0930Z measuring a central pressure of 959 mb.

The second aircraft measured a central pressure of 965 mb at 1330Z. A central pressure of 965 mb suggests maximum sustained winds of 90 kt north of 25N and 86 kt north of 25N weakening from the pressure-wind relationships. An intensity of 85 kt is selected for 12Z on the 17th, down from 110 kt originally in HURDAT, a major intensity change. A central pressure of 959 mb is added to HURDAT at 06Z and 965 mb is added to 12Z on the 17th, replacing the existing 967 mb and 971 mb, respectively. These central pressures in HURDAT do not correspond with the central pressures reported by the reconnaissance aircraft. A central pressure of 963 mb is present in HURDAT at 00Z on the 17th and has been removed since there was no reconnaissance aircraft in the area around this time and no central pressure was reported by ships. The last center penetration of August 17th occurred at 1930Z measuring a central pressure of 968 mb, an eye diameter of 20 nm and estimated surface winds of 88 kt. A central pressure of 968 mb suggests maximum sustained winds of 87 kt north of 25N and 83 kt north of 25N weakening from the pressure-wind relationships. An eye diameter of 20 nm suggests an RMW of about 15 nm and climatology suggests about 23 nm. Although the eye had contracted from the previous day, the central pressure continued to rise and an intensity of 85 kt is selected for 18Z on the 17th, down from 105 kt originally in HURDAT, a major intensity change. A central pressure of 968 mb has been added to 18Z on the 17th, replacing the existing 970 mb.

Early on August 18th, Cleo passed about 430 nm northeast of Bermuda while making a turn to the north. A reconnaissance aircraft reached the hurricane at 14Z on the 18th measuring a central pressure of 973 mb and estimating surface winds of 80 kt. A central pressure of 973 mb suggests maximum sustained winds of 81 kt north of 25N and 77 kt north of 25N weakening from the pressure-wind relationships. An intensity of 80 kt is selected for 12Z on the 18th, down from 90 kt originally in HURDAT, a minor intensity change. The central pressure of Cleo remained almost constant during the next 24 hours. The National Hurricane Research Project reported a central pressure of 972 mb around 1630Z on the 18th and 971 mb was reported at 1930Z by a reconnaissance aircraft on this day. A central pressure of 972 mb is present in HURDAT at 18Z on the 18th and has been retained. Central pressures of 968 mb and 971 mb are present in the original HURDAT at 00Z and 06Z, respectively, on the 18th and although they appear reasonable, they have been removed because there were no reconnaissance missions around 00Z and 06Z, and no ships reported central pressures. On August 19th, Cleo turned to the northeast and started to increase in forward speed ahead of a frontal boundary. A reconnaissance aircraft measured a central pressure of 973 mb and estimated surface winds of 79 kt and an eye diameter of 30 nm at 1055Z. A central pressure of 973 mb suggests maximum sustained winds of 80 kt north of 35N from the Landsea et al. pressure-wind relationship. An eye diameter of 30 nm suggests an RMW of about 23 nm and climatology suggests about 28 nm. Due to the relatively small size of the hurricane and forward speed of about 27 kt, an intensity of 85 kt is selected at 12Z on the 19th, up from 80 kt originally in HURDAT. A central pressure of 973 mb is added to HURDAT at 12Z on the 19th replacing the existing 974 mb. Later on the 19th, a final reconnaissance mission reported a central pressure of 980 mb, estimated surface winds of 88 kt and an eye diameter of 40 nm at 1930Z. A central pressure of 980 mb suggests maximum sustained winds of 73 kt north of 35N from the pressure-wind relationship. An eye diameter of 40 nm suggests an

RMW of about 30 nm and climatology suggests about 40 nm. Same as earlier on the day, due to the relatively small size of Cleo and rapid forward speed of about 30 kt, an intensity of 80 kt is selected for 18Z on the 19th, same as the original HURDAT. A central pressure of 980 mb is added to HURDAT at 18Z on the 19th replacing the existing 979 mb.

Ship observations late on August 19th indicate that Cleo had begun to take on extratropical characteristics with a warm front developing in the northeast quadrant. It is analyzed that Cleo became an extratropical cyclone at 00Z on August 20th, six hours earlier than originally shown in HURDAT. At this time, ship reports show a clear temperature gradient E-W across the circulation, indicating cold, dry air entraining into the center of the hurricane. Furthermore, the observations also show that the warm front over the northeast quadrant was closer to the center of Cleo at 00Z on the 20th than late on the 19th. On the 20th, the track of Cleo turned to the east and later to the east-southeast. Weakening below hurricane force occurred at 12Z on the 20th, same as the original HURDAT. On August 21st, Cleo continued to move east-southeast passing about 330 nm northeast of the Azores. The intensity of the extratropical cyclone decreased steadily on the 21st and dissipation is analyzed to have occurred after 18Z on the 22nd, 18 hours later than originally shown in HURDAT.

Hurricane Daisy [August 24-31, 1958]

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40600 08/24/1958 M= 8  4 SNBR= 883 DAISY       XING=0 SSS=0
40600 08/24/1958 M= 8  5 SNBR= 883 DAISY       XING=0 SSS=0
                         *

40605 08/24*  0   0   0    0*  0   0   0    0*252 736  35    0*259 746  40    0*
40605 08/24*  0   0   0    0*  0   0   0    0*258 740  35    0*261 745  40    0*
                                            *** ***          *** ***

40610 08/25*264 753  50 1002*267 757  55 1000*270 760  65  997*272 763  65  994*
40610 08/25*263 749  50 1002*265 753  50 1000*268 756  55  996*271 759  60  990*
           *** ***          *** ***  **      *** ***  **  *** *** ***  **  ***

40615 08/26*274 765  65  989*278 768  65  985*281 770  70  979*285 771  75  974*
40615 08/26*274 764  65  989*278 768  75  985*281 770  85  979*285 771  95  974*
                ***                  **                  **                **

40620 08/27*288 769  80  968*291 766  85  963*294 762  90  956*298 757  95  944*
40620 08/27*288 769 100  968*290 765 105  963*292 760 110  952*296 756 120  942*
                   ***      *** *** ***      *** *** ***  *** *** *** ***  ***

40625 08/28*304 751 105  935*315 746 110  938*330 742 110  946*346 741 110  955*
40625 08/28*303 750 120    0*315 746 115    0*331 742 115  947*347 741 110  949*
           *** *** ***    *         ***    * ***     ***  *** ***          ***

40630 08/29*362 740 110  963*380 729 110  970*398 708 105  977*412 683  90  982*
40630 08/29*363 739 100  963*380 726  90  970E400 704  80  977E415 679  70  982*
           *** *** ***          ***  **     **** ***  **     **** ***  **

40635 08/30E420 650  85  987E430 605  55    0E422 561  50    0E415 529  50    0*
40635 08/30E420 650  65  987E425 610  60    0E422 570  50    0E422 530  50    0*
                   **     *** ***  **          ***          *** ***

40640 08/31E410 496  45    0E410 459  40    0E410 422  35    0E417 389  30    0*
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40640 08/31E422 490  50    0*  0   0   0    0*  0   0   0    0*  0   0   0    0*
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40645 HR
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Minor changes to the track and major changes to the intensity shown in McAdie et al. (2009). Evidence for these alterations comes from the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Monthly Weather Review, Jack D. Tracy (MWR, 1966), the Local Climatological Data, Surface Weather Observations, Mariners Weather Log, Navy reconnaissance book and NHC Storm Wallets.

August 22:

HWM analyzes a trough or tropical wave along 20N-27W, 71W at 12Z. HURDAT does not list an organized storm on this date. Microfilm shows a frontal boundary north of the Leeward Islands at 12Z. Ship highlights: No gales or low pressures.

MWR: “Hurricane Daisy formed in a strong easterly wave which passed through the Lesser Antilles during August 20-21.”

August 23:

HWM analyzes a spot low pressure at 22.5N, 72.9W at 12Z. HURDAT does not list an organized storm on this date. Microfilm shows a closed low pressure of at most 1014 mb at 21.0N, 72.5W at 12Z. Ship highlights: No gales or low pressures.

MWR: “There was little indication of intensification, however, until the 23d, when the wave passed through the Windward Passage and a definite increase in its amplitude was evident.” ATSR: “An easterly wave was noted at approximately 50 degrees west longitude on 19 August. This wave moved generally westward at 17 knots until 23 August. On the 231200Z synoptic chart, a weak circulation (maximum winds of 10 knots) had developed in the vicinity of Great Inagua, Bahama Islands. Although there was no indicated deepening of this system at that time, the easterly wave became almost stationary at this longitude.”

August 24:

HWM analyzes a tropical storm of at most 1010 mb at 25.4N, 73.7W at 12Z. HURDAT lists a 35 knot tropical storm at 25.2N, 73.6W at 12Z (first position). Microfilm shows a closed low pressure of at most 1011 mb at 26.5N, 74.0W at 12Z. Ship highlights: 35 kt SW and 1005 mb at 26.0N, 74.3W at 16Z (micro). 40 kt SE and 1009 mb at 27.1N, 74.6W at 21Z (micro). Aircraft highlights: Penetration center fix measured a central pressure of 1002 mb and estimated surface winds of 45 kt at 2311Z (ATSR/MWR).

MWR: “A vortex developed on the 24th and reconnaissance aircraft located an eye just north of the central Bahamas with maximum winds of about 55 mph and a central pressure of 1002 mb.” ATSR: “The circulation made a “break off” from the wave and moved slowly northward. At 240600Z, a definite circulation was in evidence at 26N 73W. Maximum winds of 20 knots were reported by ships in the area. A Navy reconnaissance WV3 from Jacksonville was ordered into the area on the 24th. The eye was located by this flight at 242311Z and the first warning was issued at 250100Z.”

August 25:

HWM analyzes a tropical storm of at most 1005 mb at 27.3N, 76.0W at 12Z. HURDAT lists a 65 knot hurricane at 27.0N, 76.0W at 12Z. Microfilm shows a closed low pressure of at most 1008 mb at 26.5N, 75.5W at 12Z. Ship highlights: 50 kt SE and 1009 mb at 27.2N, 74.2W at 00Z (micro). 35 kt SW and 1005 mb at 26.0N, 74.3W at 00Z (micro). 45 kt SSE and 1010 mb at 27.1N, 74.6W at 06Z (COADS). 40 kt ESE and 1009 mb at 26.9N, 75.2W at 12Z (COADS). 55 kt SE and 1016 mb at 26.4N, 74.4W at 18Z (COADS). Aircraft highlights: Penetration center fix measured a central pressure of 996 mb and estimated winds of 70 kt at 5000 ft at 26.7N, 75.5W 1310Z (micro). Radar center fix at 27.0N, 75.6W at 1603Z (micro). Penetration center fix measured a central pressure of 990 mb and estimated winds of 50 kt at 5000 ft at 2030Z (micro).

MWR: “The first advisory was issued at 0100 GMT August 25. Hurricane Daisy moved very slowly north-northwestward during the 25th and the morning of the 26th.” ATSR: “During the morning of 25 August, a ridge at the 200 mb level pushed across the southeast coast of the United States and brought high-level divergence to the area. DAISY commenced rapid intensification and hurricane force winds were first observed the same day.”

August 26:

HWM analyzes a hurricane with a central pressure of 975 mb at 28.2N, 77.0W and a frontal boundary over the Southeast of the United States at 12Z. HURDAT lists a 70 knot hurricane at 28.1N, 77.0W at 12Z. Microfilm shows a closed low pressure of at most 999 mb at 28.5N, 77.0W with a frontal boundary over the Southeast of the United States at 12Z. Ship highlights: 35 kt N and 1006 mb at 27.0N, 77.1W at 00Z (micro). 75 kt NNE and 996 mb at 28.2N, 76.7W at 13Z (micro). 55 kt S and 1007 mb at 28.9N, 75.7W at 18Z (micro). Aircraft highlights: Radar center fix estimated surface winds of 50 kt and an eye diameter of 20 nm at 27.8N, 76.3W at 0115Z (micro). Radar center fix at 27.9N, 76.9W at 06Z (ATSR). Radar center fix estimated an eye diameter of 12 nm at 28.1N, 77.0W at 0944Z (ATSR).

MWR: “The hurricane recurved initially near latitude 28N on the 26th, and its forward speed accelerated.”

August 27:

HWM analyzes a hurricane of at most 990 mb at 29.5N, 76.0W with cold front to the northwest at 12Z. HURDAT lists a 90 knot hurricane at 29.4N, 76.2W at 12Z. Microfilm shows a closed low pressure of at most 1002 mb at 30.0N, 76.0W with a frontal boundary to the northwest at 12Z. Ship highlights: 50 kt S at 28.0N, 75.5W at 06Z (micro). 25 kt ESE and 1001 mb at 31.0N, 74.8W at 12Z (COADS). 40 kt SSE and 1004 mb at 29.6N, 74.0W at 18Z (micro). 50 kt SW and 1005 mb at 28.5N, 75.1W at 21Z (MWL). Aircraft highlights: Radar center fix estimated an eye diameter of 14 nm at 29.2N, 76.8W at 01Z (ATSR). Radar center fix estimated an eye diameter of 10 nm at 29.0N, 76.2W at 0630Z (ATSR). Penetration center fix estimated surface winds of 90 kt, an eye diameter of 10 nm and measured a central pressure of 952 mb at 14Z (ATSR). Penetration center fix estimated surface winds of 109 kt, an RMW of 10 nm and measured a central pressure of 944 mb around 1630Z (NHRP). Penetration center fix estimated surface winds of 104 kt, an RMW of 12 nm and measured a central pressure of 940 mb around 19Z (NHRP). Penetration center fix estimated surface winds of 100 kt, an eye diameter of 12 nm and measured a central pressure of 935 mb (erroneous, 948 mb according to MWR) at 1945Z (ATSR).

August 28:

HWM analyzes a hurricane of at most 990 mb at 33.1N, 74.5W with cold front to the west at 12Z. HURDAT lists an 110 knot hurricane at 33.0N, 74.2W at 12Z. Microfilm shows a closed low pressure of at most 1002 mb at 33.5N, 74.0W with a frontal boundary to the northwest at 12Z. Ship highlights: 40 kt WSW and 1006 mb at 28.5N, 75.2W at 00Z (COADS). 35 kt NE and 1008 mb at 32.3N, 77.9W at 06Z (micro). 40 kt S and 1010 mb at 31.0N, 71.9W at 09Z (micro). 40 kt SE and 1011 mb at 35.6N, 73.8W at 12Z (micro). 50 kt SE and 1001 mb at 36.8N, 72.7W at 18Z (COADS). 100 kt WNW and 999 mb at 35.0N, 74.8W at 21Z (micro). Land highlights: 25 NNW and 1000 mb at Cape Hatteras, NC at 21Z (micro). Aircraft highlights: Radar center fix at 30.5N, 75.1W at 0001Z (ATSR). Radar center fix at 31.6N, 74.5W at 06Z (ATSR). Radar center fix estimated flight level winds of 105 kt and an eye diameter of 15 nm at 0930Z (ATSR). Penetration center fix estimated surface winds of 100 kt, an eye diameter of 15 nm and measured a central pressure of 947 mb at 14Z (ATSR/micro). Penetration center fix estimated surface winds of 101 kt, an RMW of 20 nm and measured a central pressure of 950 mb around 17Z (NHRP). Penetration center fix estimated surface winds of 110 kt and measured a central pressure of 949 mb at 1933Z (ATSR).

MWR: “The center passed about 75 miles east of Hatteras on the 28th moving about 20 mph. It then passed about 70 miles southeast of Nantucket, moving east-northeastward about 25 mph on a second recurve. Neither the North Carolina nor the New England

coasts, however, felt much effect of this severe hurricane. The strongest wind at Hatteras was NNW 27 mph, with gusts to 36." ATSR: "DAISY developed further and winds increased to values in excess of 100 knots."

August 29:

HWM analyzes a hurricane of at most 995 mb at 39.5N, 70.5W with a frontal just north and west at 12Z. HURDAT lists a 105 knot hurricane at 39.8N, 70.8W at 12Z. Microfilm shows a closed low pressure of at most 999 mb at 40.0N, 71.0W with a frontal boundary going through the center at 12Z. Ship highlights: 55 kt SSW and 994 mb at 36.0N, 74.0W at 00Z (micro/MWL). 45 kt WSW and 1001 mb at 36.5N, 71.9W at 06Z (micro). 55 kt SSW and 1005 mb at 38.5N, 70.0W at 12Z (micro). 40 kt S and 1008 mb at 39.1N, 64.8W at 18Z (micro). Land highlights: 35 kt (gusts to 40 kt) at Block Island, RI (no time given) (MWR). 60 kt (gusts to 76 kt) at Texas Tower (Georges Shoal), 120 miles east of Cape Cod, MA (no time given) (MWR). (37 kt ENE and 1005 mb at Nantucket Shoals, MA at 12Z (SWO). 45 kt NE (gusts to 52 kt) and 997 mb at Nantucket Shoals, MA at 15Z (SWO). 55 kt N (gusts to 66 kt) at Nantucket Shoals, MA at 17Z (SWO). 54 kt NE (gusts to 68 kt) at Georges Shoal, MA at 18Z (SWO). Aircraft highlights: Penetration center fix at 36.8N, 73.8W at 02Z (ATSR). Penetration center fix measured a central pressure of 967 mb at 37.7N, 72.9W at 0428Z (ATSR/micro). Penetration center fix estimated an eye diameter of 20 nm and measured a central pressure of 973 mb at 0812Z (micro). Radar center fix estimated surface winds of 75 kt at 39.2N, 71.4W at 1446Z (ATSR/micro). Penetration center fix at 41.8N, 67.2W at 1930Z (ATSR).

MWR: "Block Island reported 40 mph, with gusts to 45. A Texas Tower, 120 miles east of Cape Cod, experienced a sustained wind of 69 mph with gusts to 87. There was no loss of life or appreciable property damage in the United States from Daisy."

August 30:

HWM analyzes a tropical storm of at most 1000 mb at 42.2N, 56.0W with a weakening cold front just north at 12Z. HURDAT lists a 50 knot extratropical storm at 42.2N, 56.1W at 12Z. Microfilm shows a closed low pressure of at most 999 mb at 43.5N, 55.0W with a frontal boundary to the west at 12Z. Ship highlights: 60 kt SW and 1005 mb at 39.7N, 64.2W at 00Z (COADS). 50 kt S and 1001 mb at 41.2N, 59.8W at 06Z (COADS). 55 kt WSW and 999 mb at 41.4N, 56.5W at 12Z (MWL). 55 kt W and 999 mb at 40.9N, 56.4W at 15Z (COADS). 50 kt N and 1008 mb at 40.9N, 57.1W at 18Z (COADS).

August 31:

HWM analyzes a tropical storm of at most 1000 mb at 41.0N, 42.0W with a cold front to the south and northeast at 12Z. HURDAT lists a 35 knot extratropical storm at 41.0N, 42.2W at 12Z. Microfilm shows that the extratropical cyclone has moved off the northeast edge of the synoptic map at 12Z. Ship highlights: 50 kt NNE and 1006 mb at 41.8N, 51.6W at 00Z (COADS). 50 kt NNE and 1009 mb at 42.3N, 49.1W at 06Z (COADS). 40 kt N and 1011 mb at 43.0N, 47.0W at 12Z (COADS). 40 kt NE and 1012 mb at 43.8N, 44.8W at 18Z (COADS).

September 1:

HWM analyzes an extratropical cyclone of at most 985 mb at 50.5N, 23.0W, likely indicating that Daisy has been absorbed, at 12Z. HURDAT does not list an organized storm on this date. Microfilm is not available on this date. Ship highlights: 40 kt SW and 1005 mb at 39.3N, 35.8W at 00Z (COADS). 35 kt WSW and 1013 kt at 36.4N, 34.5W at 06Z (COADS).

Hurricane Daisy developed from a tropical wave just north of the central Bahamas. A strong tropical wave was noticeable in the ship and coastal observations over the northern Caribbean during the 22nd and 23rd of August. A well-defined surface center formed on August 24th at 12Z and a 35 kt tropical storm is analyzed to have developed at this time, same as the original HURDAT. It is possible that Daisy may have formed about twelve to eighteen hours earlier but the data is not sufficient to make a conclusive assessment. The track alterations were minor during the lifetime of this tropical cyclone. The forward speed of Daisy was slow during its first days and it gradually intensified. The first reconnaissance aircraft to reach Daisy occurred at 2311Z on the 24th measuring a central pressure of 1002 mb and estimating surface winds of 45 kt. A central pressure of 1002 mb suggests maximum sustained winds of 42 kt south of 25N intensifying from the Brown et al. pressure-wind relationship. Due in part to a ship report of 50 kt northeast of the center, an intensity of 50 kt analyzed at 00Z on September 25th, same as originally shown in HURDAT. A central pressure of 1002 mb was in HURDAT at 00Z on the 25th and has been retained. (The original HURDAT for this tropical cyclone had central pressure values for each 6 hour period from 00Z on the 25th to 00Z on the 31th. These were obviously analyses that were added in, not based upon actual observations. Most of the analyzed central pressures appear reasonable and have been retained.) The next aircraft reached Daisy at 1310Z on the 25th measuring a central pressure of 996 mb and estimating flight level winds of 70 kt. A central pressure of 996 mb suggests maximum sustained winds of 52 kt north of 25N intensifying from the pressure-wind relationship. Daisy was moving at about 4 kt but it was also synoptically a small tropical cyclone, thus an intensity of 55 kt has been selected for 12Z on the 25th, 10 kt less than the original

HURDAT. A central pressure of 996 mb has been added to HURDAT at 12Z on the 25th, replacing the existing 997 mb. Another reconnaissance aircraft visited Daisy late on the 25th measuring a central pressure of 990 mb and estimated 50 kt at 5000 feet of altitude at 2030Z. A central pressure of 990 mb suggests maximum sustained winds of 62 kt north of 25N intensifying from the pressure-wind relationship. Due to the slow forward speed of about 5 kt but small size of the tropical cyclone, an intensity of 60 kt has been selected for 18Z on the 25th, down from 65 kt originally in HURDAT, a minor intensity change. A central pressure of 990 mb has been added to 18Z on the 25th, replacing the existing 994 mb in the original HURDAT. No central pressures were reported on August 26th but it is likely that Daisy experienced a period of rapid intensification based from the estimates of the eye diameter reported by the reconnaissance aircraft radar, ship observations and subsequent central pressure measurements on the 27th. The eye diameter of Daisy decreased from 20 nm to 12 nm between 1930Z on the 25th and 0944Z on the 26th according to reports from the reconnaissance aircrafts. A few ships reported tropical storm force winds and there was even a ship at 12Z near the center of the hurricane that registered 75 kt. Intensification to a hurricane is analyzed at 00Z on the 26th, six hours later than the original HURDAT. A major intensity change is analyzed at 18Z on the 26th. An intensity of 95 kt is selected for this time and 75 kt is originally shown in HURDAT. Late on the 26th, the track of Daisy turned to the north and then northeast.

A reconnaissance aircraft reached the hurricane at 14Z on September 27th measuring a central pressure of 952 mb and estimating surface winds of 90 kt and an eye diameter of 10 nm. A central pressure of 952 mb suggests maximum sustained winds of 108 kt north of 25N intensifying from the pressure-wind relationship. An eye diameter of 10 nm suggests an RMW of about 8 nm and climatology suggest about 19 nm. Due to the slow forward speed of about 6 kt but relatively small size, an intensity of 110 kt is selected for 12Z on the 27th, up from 90 kt originally in HURDAT, a major intensity change. Based on this information, intensification to a major hurricane is analyzed at 00Z on the 27th, 24 hours earlier than originally in HURDAT. Major intensity changes are also analyzed at 00Z and 06Z on the 27th. HURDAT originally had 80 kt and 85 kt, respectively, and the analyzed intensities for these times are 100 kt and 105 kt, respectively. A central pressure of 952 mb has been added to HURDAT at 12Z on the 27th, replacing the existing 956 mb. Daisy continued to gain strength on the 27th according to reports from the aircraft reconnaissance. The central pressure decreased to 944 mb around 1630Z, 942 mb around 18Z and 940 mb around 19Z, according to the National Hurricane Research Project. A central pressure of 942 mb suggests maximum sustained winds of 118 kt north of 25N intensifying from the pressure-wind relationship. The NHRP reconnaissance aircraft also reported an RMW of 12 nm and climatology suggest about 14 nm. Due to a forward speed of about 8 kt and an RMW close to climatology, an intensity of 120 kt is selected for 18Z on the 27th, up from 95 kt originally in HURDAT, a major intensity change. 120

kt is also the peak intensity of Daisy, up from 110 kt originally in HURDAT between 06Z on September 28th to 06Z on the 29th. A central pressure of 944 mb is present in HURDAT at 18Z on the 27th and has been replaced with 942 mb measured by the NHRP reconnaissance aircraft. A central pressure of 935 mb is present in HURDAT at 00Z on the 28th, but an article on the Monthly Weather Review (Tracy, 1966) indicates that there was an error made during the measurement of this central pressure and that the actual value was 948 mb. Thus, the central pressure of 935 mb has been removed from HURDAT. A central pressure of 938 mb is in HURDAT at 06Z on the 28th and has also been removed since there is no evidence that the central pressure decreased below 940 mb.

The next aircraft to reach the hurricane occurred at 14Z on the 28th measuring a central pressure of 947 mb, and estimating surface winds of 100 kt and an eye diameter of 15 nm. A central pressure of 947 mb suggests maximum sustained winds of 108 kt north of 25N from the pressure-wind relationship. An eye diameter of 15 nm suggests an RMW of about 12 nm and climatology suggests 23 nm. Since Daisy was moving at about 16 kt and the RMW was smaller than the climatological value, an intensity of 115 kt is selected at 12Z on the 28th, up from 110 kt originally in HURDAT, a minor intensity change. A central pressure of 947 mb is added to 12Z on the 28th, replacing the exiting 946 mb. Another reconnaissance aircraft measured a central pressure of 949 mb at 1933Z, suggesting maximum sustained winds of 106 kt north of 25N from the Brown et al. pressure-wind relationship and 98 kt north of 35N from the Landsea et al. pressure-wind relationship. Around 17Z, the NHRP reconnaissance aircraft reported an RMW of 20 nm and climatology suggest about 25 nm. Daisy was moving at about 16 kt and remained a small hurricane, thus an intensity of 110 kt is selected for 18Z on the 28th, same as the original HURDAT. A central pressure of 955 mb was present in HURDAT at 18Z on the 28th and has been replaced with 949 mb. Late on the 28th, Daisy passed about 90 nm east of Cape Hatteras. No tropical storm force winds were reported, indicative of the small size of the hurricane. Early on the 29th, Daisy made a sharp turn to the northeast increasing in forward speed ahead of a frontal boundary. Central pressures of 967 mb and 973 mb were reported at 0428Z and 0812Z, respectively, by the reconnaissance aircraft. A central pressure of 970 mb was in HURDAT at 06Z on the 29th and has been retained based on a blend of these two measurements. A central pressure of 970 mb suggests maximum sustained winds of 82 kt north of 35N from the pressure-wind relationship. Due to the fast forward speed of about 25 kt and small size of the hurricane, an intensity of 90 kt is selected at 06Z on the 29th, down from 110 kt originally in HURDAT, a major intensity change. A major intensity change is also analyzed at 12Z and 18Z on the 29th. HURDAT originally had 105 kt and 90 kt, respectively, and the selected intensities are 80 kt and 70 kt, respectively. Ship and coastal observations indicate that Daisy began to acquire extratropical characteristics early on the 29th. The surface analysis early on the

29th suggests that the circulation was becoming more elongated N-S with frontal features developing as the hurricane became embedded within the frontal boundary. It is analyzed that Daisy became an extratropical cyclone at 12Z on the 29th, twelve hours earlier than originally shown in HURDAT. Late on the 29th, the extratropical cyclone passed about 50 nm southeast of Cape Cod. Gale force winds were reported at Block Island and Nantucket. Georges Shoals located about 120 nm east of Cape Cod, experienced hurricane-force gusts. The extratropical cyclone continued to weaken on the 30th while its track turned to the east. Daisy passed about 90 nm south of Nova Scotia early on the 30th. Weakening below hurricane force is analyzed at 06Z on the 30th, same as the original HURDAT. Ship observations on August 31st indicate that a larger extratropical cyclone over the north Atlantic gradually absorbed the much smaller Daisy. Dissipation is analyzed after 00Z on the 31st, eighteen hours earlier than originally shown in HURDAT.

Date	Original HURDAT Central Pressure	Evidence	Changes
Aug 25 00Z	1002 mb	Penetration center fix: 1002 mb at 2311Z on Aug 24th	Retained
Aug 25 06Z	1000 mb	Ship: 20 kt SW and 1001 mb at 09Z on Aug 25th	Retained
Aug 25 12Z	997 mb	Penetration center fix: 996 mb at 1310Z on Aug 25th	996 mb
Aug 25 18Z	994 mb	Penetration center fix: 990 mb at 2030Z on Aug 25th	990 mb
Aug 26 00Z	989 mb	No central pressure reports but appear reasonable based on the central pressure reports from late Aug 25th and 14Z on Aug 27th	Retained
Aug 26 06Z	985 mb		
Aug 26 12Z	979 mb		
Aug 26 18Z	974 mb		
Aug 27 00Z	968 mb		
Aug 27 06Z	963 mb		
Aug 27 12Z	956 mb	Penetration center fix: 952 mb at 14Z on Aug 27th	952 mb
Aug 27 18Z	944 mb	Penetration center fix: 942 mb at 18Z on Aug 25th	942 mb

Aug 28 00Z	935 mb	Tracy, 1966 indicates that 935 mb measured at 1945Z on Aug 27th was 948 mb	Removed
Aug 28 06Z	938 mb	No evidence the central pressure dropped below 940 mb measured by the NHRP around 19Z on Aug 27th	Removed
Aug 28 12Z	946 mb	Penetration center fix: 947 mb at 14Z on Aug 28th	947 mb
Aug 28 18Z	955 mb	Penetration center fix: 949 mb at 1933Z on Aug 28th	949 mb
Aug 29 00Z	963 mb	No central pressure reports but appear reasonable	Retained
Aug 29 06Z	970 mb		
Aug 29 12Z	977 mb		
Aug 29 18Z	982 mb		
Aug 30 00Z	987 mb		

Hurricane Ella [August 30 – September 7, 1958]

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40650 08/30/1958 M= 8  5 SNBR= 884 ELLA        XING=1 SSS=0
40650 08/30/1958 M= 9  6 SNBR= 884 ELLA        XING=1 SSS=0
                    *  *

40655 08/30*  0   0   0    0*137 566  30    0*140 596  35    0*154 620  35    0*
40655 08/30*  0   0   0    0*125 580  30    0*138 600  35    0*148 619  35    0*
                           *** ***          *** ***          *** ***

40660 08/31*161 640  35 1009*162 656  50    0*163 672  65    0*165 693  85    0*
40660 08/31*155 638  40    0*159 655  50    0*160 672  60    0*163 690  65    0*
           *** ***  **    * *** ***          ***       **      *** ***  **

40665 09/01*169 711  95    0*176 724  95    0*184 737  95    0*192 750  95    0*
40665 09/01*168 707  75  983*175 721  85    0*182 734  95    0*191 748  75  989*
           *** ***  **  *** *** ***  **      *** ***          *** ***  **  ***

40670 09/02*200 763 100    0*206 772  70    0*210 780  60    0*214 791  45    0*
40670 09/02*200 762  75    0*207 774  55    0*211 782  50    0*213 792  45    0*
              ***  **      *** ***  **      *** ***  **      *** ***

40675 09/03*218 802  45    0*219 811  45    0*220 820  55    0*223 832  60    0*
40675 09/03*215 804  50    0*217 817  50    0*219 830  55 1003*221 842  60    0*
           *** ***  **      *** ***  **      *** ***     **** *** ***

40680 09/04*227 845  60    0*229 856  60    0*232 867  60    0*239 881  60    0*
40680 09/04*224 854  60 1001*228 866  60    0*232 877  60 1003*238 888  60    0*
           *** ***     **** *** ***             ***     **** *** ***

40685 09/05*246 895  60    0*254 908  60    0*261 921  60    0*266 932  60    0*
40685 09/05*247 901  55    0*256 915  55    0*263 928  50 1002*268 940  50    0*
           *** ***  **      *** ***  **      *** ***  ** **** *** ***  **
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40690 09/06*270 945  55    0*275 963  40    0*281 982  30    0*2831005  30    0*
40690 09/06*271 953  50 1001*274 968  50 1001*275 980  30    0*275 988  25 1002*
           *** ***  ** **** *** ***  ** **** *** ***         *** ***  ** ****

(September 7th is new to HURDAT)
40693 09/07*275 995  25 1005*  0   0   0    0*  0   0   0    0*  0   0   0    0*

40695 HR
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Hurricane Landfall

09/01 12Z 18.2N 73.4W 95 kt Haiti
09/02 00Z 20.0N 76.2W 75 kt Cuba

Tropical Storm Landfall

09/03 11Z 21.8N 82.7W 55 kt Cuba
09/03 17Z 22.1N 84.0W 60 kt Cuba

U.S. Tropical Storm Impact

09/03 12Z 21.9N 83.0W 50 kt FL
09/05 18Z 26.8N 94.0W 40 kt LA

U.S. Tropical Storm Landfall

09/06 08Z 27.5N 97.2W 50 kt TX

Major changes to the intensity and minor changes to the track shown in McAdie et al. (2009). Evidence for these alterations comes from the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Monthly Weather Review, the Local Climatological Data, Surface Weather Observations, Navy reconnaissance book, Mariners Weather Log, Perez et al. (2000), and NHC Storm Wallets.

August 29:

HWM is not available on this date (system south of 20ºN). HURDAT does not list an organized storm on this date. Microfilm shows a tropical wave extending along 10N-16N, 50-52W at 12Z. Ship highlights: No gales or low pressures.

MWR: “First indication of Ella was a fairly active easterly wave in the vicinity of longitude 50W on August 29. Reconnaissance aircraft on a routine flight east of the Windward and Leeward Islands reported a wind shift and above average shower activity, but no indication of a cyclonic circulation.”

August 30:

HWM is not available on this date (system south of 20ºN). HURDAT lists a 35 knot tropical storm at 14.0N, 59.6W at 12Z. Microfilm shows a tropical wave along longitude 60W, from 10N-16N at 12Z. Ship highlights: No gales or low pressures.

MWR: "The wave moved through the islands during the 30th causing heavy rains and winds of 35 to 40 mph and lowest pressure around 1010 mb." ATSR: "ELLA formed in the Leeward Islands, under circumstances, that were definitely unfavorable for hurricane development. ELLA was first detected with a closed vortex late on the 30th of August very near Guadaloupe Island."

August 31:

HWM is not available on this date (system south of 20ºN). HURDAT lists a 65 knot hurricane at 16.3N, 67.2W at 12Z. Microfilm shows closed low pressure of at most 1002 mb at 15.5N, 67.0W at 12Z. Ship highlights: 35 kt E and 1009 mb at 16.5N, 66.7W at 06Z (micro). 56 kt E and 1000 mb at 16.2N, 67.0W at 12Z (COADS/MWL). 50 kt SE and 1007 mb at 15.6N, 66.4W at 12Z (micro). 40 kt S and 1006 mb at 16.3N, 69.5W at 21Z (micro). Aircraft highlights: Radar center fix estimated surface winds of 50 kt and measured a minimum pressure (not a central pressure) of 1009 mb at 16.5N, 64.7W at 0330Z (micro). Radar center fix estimated surface winds of 35 kt at 16.1N, 66.7W at 10Z (ATSR). Radar center fix estimated an eye diameter of 40 nm at 16.1N, 67.2W at 12Z (ATSR). Radar center fix estimated surface winds of 75 kt and an eye diameter of 28 nm at 16.1N, 67.7W at 14Z (ATSR). Radar center fix estimated surface winds of 80 kt and an eye diameter of 14 nm at 16.6N, 69.4W at 20Z (ATSR). Penetration center fix estimated surface winds of 80 kt, measured a central pressure of 983 mb and an eye diameter of 30 nm at 16.8N, 70.5W at 23Z (ATSR).

MWR: "Reconnaissance aircraft located a center by radar at latitude 16.3N., longitude 64.7W., during the evening of the 30th (local time) and the first advisory was issued on tropical storm Ella. Highest winds were estimated at 55 to 60 mph near the center and the minimum pressure had dropped to about 1009 mb. Advice to small craft and residents of the islands from Puerto Rico eastward and southward had previously by bulletins had been given previously from the San Juan Bureau Weather Bureau Office. The storm intensified rapidly as it moved westward at about 18 mph in the eastern Caribbean and by 1600 GMT of the 31st winds were estimated by aircraft at 85 mph …" ATSR: "A Navy reconnaissance aircraft investigated the area just to the west of the Leeward Islands early on the morning of the 31st, and the eye was centered by radar at 310330Z, 80 miles south of Saint Croix Island. ELLA rapidly developed into a full hurricane and, by mid-afternoon on the 31st, hurricane force winds were reported by reconnaissance aircraft. … Later on the 31st (312130Z) the reconnaissance aircraft tracking ELLA reported that the eye was becoming diffuse and as the center passed over south-western Haiti, it became

very diffuse."

September 1:

HWM is not available on this date (system south of 20ºN). HURDAT lists a 95 knot hurricane at 18.4N, 73.7W at 12Z. Microfilm shows a tropical wave or trough along longitude 75W, from 14N-21N at 12Z. Ship highlights: No gales or low pressures. Land highlights: 40 kt ENE and 1006 mb at Guantanamo Bay, Cuba at 21Z (micro). Aircraft highlights: Radar center fix estimated an eye diameter of 30 nm at 17.0N, 70.9W at 0035Z (ATSR). Radar center fix measured a minimum pressure (not a central pressure) of 996 mb and estimated an eye diameter of 20 nm at 16.8N, 71.4W at 02Z (ATSR). Radar center fix at 18.1N, 73.2W at 11Z (ATSR). Penetration center fix measured a minimum pressure (not a central pressure) north of the center of 999 mb at 18.3N, 73.5W at 1242Z (ATSR). Penetration center fix measured a central pressure of 989 mb, estimated surface winds of 110 kt and an eye diameter of 16 nm at 19.7N, 75.5W at 2042Z (ATSR/MWR/WALLET).

MWR: "… increasing to 110 mph by 0400 GMT of September 1. The course had changed to the west-northwest during the day, as the center skirted along and just south of the Dominican Republic and Haitian coasts, causing torrential rains and considerable damage on the southern slopes of the mountains. It was thought that the hurricane passed over the southwestern peninsula of Haiti, however, since the original intensity was maintained until it encountered the Sierra Maestra in eastern Cuba, the center of the hurricane may have skirted along the immediate south coast of Haiti. In fact, reports from the Haitian Meteorological Service indicate the hurricane followed a path parallel to the peninsula. Reconnaissance aircraft on September 1 reported winds of 115 mph and lowest pressure of 989 mb while the center was over the Caribbean Sea between Jamaica, Haiti, and eastern Cuba. The center passed inland over the Sierra Maestra in Oriente Province in eastern Cuba a short distance west of Santiago and the storm weakened below hurricane strength. It never regained hurricane force in its long path along the southern coast of Cuba, across the Gulf of Mexico, to the lower Texas coast." ATSR: "ELLA continued intensification and late on the first of September wind velocity of 110 knots was reported by the Navy aircraft. On passing over water between Haiti and Cuba, ELLA reorganized and winds of 110 knots were estimated near the center until the 2nd."

September 2:

HWM analyzes a hurricane of at most 1005 mb at 21.0N, 78.2W at 12Z. HURDAT lists a 60 knot tropical storm at 21.0N, 78.0W at 12Z. Microfilm shows closed low pressure of at most 1008 mb at 20.0N, 80.0W at 12Z. Ship highlights: 40 kt ESE and 1011 mb at 21.5N, 76.6W at 00Z (micro). 35 kt SE and 1010 mb at 17.8N, 74.9W at 06Z

(COADS). 35 kt ESE and 1009 mb at 18.2N, 75.0W at 12Z (COADS). 40 kt SE and 1011 mb at 18.9N, 75.3W at 18Z (COADS). Land highlights: 50 kt SSE, gusts to 60 kt and 1008 mb at Santiago de Cuba, Cuba at 03Z (micro). 35 kt and 1018 mb at Carysfort Reef Light, FL at 1230Z (SWO). 41 kt and 1010 mb at Alligator Reef Light, FL at 1530Z (SWO). 35 kt E, gusts to 45 kt, and 1012 mb at Key West, FL at 2335Z (SWO). Aircraft highlights: Radar center fix estimated an eye diameter of 25 nm at 20.0N, 76.2W at 0030Z (ATSR). Radar center fix estimated flight level winds (500 mb) of 74 kt and an eye diameter of 12 nm at 21.6N, 78.1W at 0853Z (ATSR). Radar center fix estimated surface winds of 50 kt and measured a minimum pressure (not a central pressure) of 1010 mb at 21.7N, 78.3W at 1645Z (MICRO/ATSR).

MWR: “As the storm moved west-northwestward along the southern coast of Cuba, a building high pressure system was moving into the Atlantic States, and consequently gale warnings were hoisted on the lower east coast of Florida and in the Florida Keys, because of the anticipated increase of pressure gradient caused by interaction between the two systems. Highest winds had dropped to 40 to 50 mph in squalls but the area of squalls and rather heavy rain extended across Cuba into the southern Bahamas and the Florida Straits and Keys.” ATSR: “ELLA moved inland into Cuba and lost much of her “punch” during her journey over land for almost the entire length of Cuba.”

September 3:

HWM analyzes a tropical storm of at most 1005 mb at 22.2N, 82.3W at 12Z. HURDAT lists a 55 knot tropical storm at 22.0N, 82.0W at 12Z. Microfilm shows closed low pressure of at most 1005 mb at 21.5N, 83.5W at 12Z. Ship highlights: 35 kt ENE and 1010 mb at 23.8N, 81.4W at 03Z (micro). 45 kt SE and 1009 mb at 20.5N, 80.5W at 12Z (COADS). 50 kt ESE and 1012 mb at 24.8N, 83.8W at 15Z (COADS). 50 kt SE and 1012 mb at 24.3N, 83.0W at 18Z (COADS). 50 kt E and 1013 mb at 24.4N, 85.4W at 21Z (micro). Land highlights: 50 kt SSE and 1006 mb at Cabo Cruz, Cuba at 00Z (micro). 40 kt ESE, gusts to 45 kt and 1012 mb at Key West, FL at 06Z (micro). 15 kt SW and 1005 mb at Isla de la Juventud, Cuba at 12Z (micro). 37 kt and 1014 mb at Dry Tortugas Light, FL at 1230Z (SWO). 36 kt ESE, gusts to 44 kt and 1015 mb at Key West, FL at 1550Z (SWO). 50 kt ENE and 1013 mb at Dry Tortugas Light, FL at 21Z (micro). Aircraft highlights: Radar center fix estimated surface winds of 40 kt and measured a minimum pressure (not a central pressure) 1006 mb at 22.8N, 82.9W at 0330Z (ATSR). Radar center fix measured a minimum pressure (not a central pressure) 1006 mb at 22.6N, 84.9W at 2110Z (ATSR).

MWR: “The center crossed extreme western Cuba on the 3rd, moving toward the west-northwest at 12 mph. A west-northwestward course was continued at 12 to 15 mph across the Gulf of Mexico, with highest winds generally about 50 mph.”

September 4:

HWM analyzes a tropical storm with a central pressure of 1004 mb at 23.4N, 86.7W at 12Z. HURDAT lists a 60 knot tropical storm at 23.2N, 86.7W at 12Z. Microfilm shows a tropical wave or trough along longitude 90W, from 22N-28N at 12Z. Ship highlights: 55 kt E and 1011 mb at 24.4N, 85.4W at 00Z (COADS/MWR). 55 kt E and 1012 mb at 24.4N, 85.4W at 06Z (COADS). 50 kt E and 1009 mb at 21.5N, 84.8W at 12Z (COADS). 40 kt ESE and 1015 mb at 28.5N, 88.7W at 18Z (COADS). 50 kt E and 1012 mb at 26.2N, 89.3W at 21Z (micro). Land highlights: 43 kt E and 1016 mb at Dry Tortugas Light, FL at 0030Z (SWO). 57 kt E at Dry Tortugas, FL at 04Z (MWR). Aircraft highlights: Penetration center fix estimated surface winds of 60 kt and measured a central pressure of 1003 mb at 23.5N, 87.6W at 1440Z (ATSR).

ATSR: "It was believed that ELLA would regain much of her lost strength when she passed over water into the Gulf of Mexico, but she never regained hurricane force winds. The maximum recorded winds after 040000Z (Dry Tortugas wind 040000Z was 090/57 knots) gradually decreased. the SS *Jean Lykes* reported a wind of 55 knots near latitude 24.5N, longitude 85.5W late on the 3rd."

September 5:

HWM analyzes a tropical storm of at most 1005 mb at 26.2N, 92.0W at 12Z. HURDAT lists a 60 knot tropical storm at 26.1N, 92.1W at 12Z. Microfilm shows closed low pressure of at most 1002 mb at 27.0N, 94.0W at 12Z. Ship highlights: 40 kt ESE and 1007 mb at 26.2N, 90.0W at 00Z (COADS). 40 kt ENE and 1010 mb at 28.8N, 92.2W at 06Z (COADS). 25 kt SSE and 1005 mb at 26.6N, 92.0W at 09Z (micro). 35 kt ESE and 1010 mb at 28.2N, 91.1W at 12Z (COADS). 40 kt ESE and 1011 mb at 28.8N, 90.8W at 18Z (micro). Land highlights 40 kt ESE and 1015 mb at Grande Isle, LA at 18Z (micro). Aircraft highlights: Radar center fix estimated an eye diameter of 30 nm at 24.1N, 88.2W at 0230Z (ATSR). Radar center fix at 24.6N, 88.9W at 0630Z (ATSR). Radar center fix estimated surface winds of 50 kt and measured a minimum pressure (not a central pressure) 1006 mb at 27.6N, 93.8W at 19Z (ATSR).

MWR: "Grand Isle, La., reported gusts to 75 mph during a squall on the morning of the 5th … Highest winds on the Texas and Louisiana coasts were generally around 40 mph with tides 2 to 4 feet above normal." ATSR: "… and when ELLA went ashore near Corpus Christi, the maximum winds recorded were at Sabine Pass Coast Guard Station – "Highest gusts ENE 50 mph several times 051900C to 052100C."

September 6:

HWM analyzes a closed low pressure of at most 1005 mb at 27.0N, 98.0W at 12Z. HURDAT lists a 30 knot tropical depression at 28.1N, 98.2W at 12Z. Microfilm shows closed low pressure of at most 1005 mb at 27.5N, 98.0W at 12Z. Ship highlights: 15 kt ENE and 1003 mb at 26.9N, 96.5W at 00Z (COADS). Land highlights 47 kt, gusts to 55 kt at Port Lavaca, TX (no time given but likely early on the 6th) (WALLET). 4 kt NNW and 1002 mb at Kingsville, Texas at 0756Z (SWO). 5 kt SSE and 1005 mb at Corpus Christi, TX at 12Z (micro). 14 kt SSW and 1005 mb at Harlinger, TX at 2056Z (SWO). Aircraft highlights: Radar center fix at 27.8N, 96.8W at 0624Z (ATSR).

September 7:

HWM does not analyze an organized storm at 12Z. HURDAT does not list an organized storm on this date. Microfilm shows closed low pressure of at most 1008 mb at 28.2N, 101.2W at 12Z. Ship highlights: No gales or low pressures. Land highlights: 5 kt E and 1006 mb at Laredo, TX at 00Z (micro).

Hurricane Ella developed from a tropical wave just east of the Lesser Antilles during late August. Genesis is analyzed at 06Z on August 30th as a 30 kt tropical depression, same as the original HURDAT. Minor track alterations are introduced during the lifetime of Ella. Intensification to a tropical storm is analyzed at 12Z on the 30th, same as the original HURDAT. Late on August 30th, Ella entered the eastern Caribbean Sea passing between Martinique and St. Lucia. The tropical cyclone turned westward on the 31st and steadily intensified as the eye diameter contracted based on the reports from the reconnaissance aircrafts. The first reconnaissance aircraft reached the tropical cyclone early on August 31st making a couple of radar center fixes and estimating surface winds of 50 kt. A central pressure of 1009 mb was present in HURDAT at 00Z on the 31st but it has been removed since the reconnaissance aircraft did not make a penetration fix and the 1009 mb was a peripheral pressure. A ship passed close to the center of Ella at 12Z on the 31st reporting 56 kt E and 1000 mb. A reconnaissance aircraft made a penetration center fix at 23Z on the 31st measuring a central pressure of 983 mb, estimating surface winds of 80 kt and an eye diameter of 30 nm. A central pressure of 983 mb suggests maximum sustained winds of 74 kt south of 25N intensifying from the Brown et al. pressure-wind relationship. An eye diameter of 30 nm suggests an RMW of about 22 nm and climatology suggests about 14 nm. The forward speed of Ella was around 14 kt and an intensity of 75 kt is analyzed at 00Z on September 1st, down from 95 kt originally in HURDAT, a major intensity change. A central pressure of 983 mb is added to HURDAT at 00Z on the 1st. Based upon this information early on the 1st, intensification to a

hurricane is analyzed at 18Z on the 31st, six hours later than originally shown in HURDAT. A major intensity change is analyzed at 18Z on the 31st, as HURDAT originally had 85 kt and the analyzed intensity is 65 kt. On September 1st, the track of Ella turned to the northwest passing south of the Dominican Republic early on the day. It is analyzed that Ella continued to intensify until making landfall in the mountainous Tiburon peninsula in southwest Haiti. Landfall occurred around 12Z on the 1st near 18.2N, 73.4W or about 65 nm southwest of Port-Au-Prince, Haiti with winds of 95 kt. Data from the reconnaissance aircraft at 20Z on the 1st indicates that the central pressure had increased to 989 mb (the Navy reconnaissance book indicates that the central pressure was 995 mb at this time but MWR and advisories suggest it was 989 mb), estimated surface winds of 110 kt and an eye diameter of 16 nm. HURDAT originally indicated that Ella did not weaken while crossing the mountainous terrain, which appears unlikely. A central pressure of 989 mb suggests maximum sustained winds of 65 kt south of 25N according to the pressure-wind relationship. An eye diameter of 16 nm suggests an RMW of about 12 nm and climatology suggests about 16 nm. Based on the RMW being slightly smaller than average, a forward speed of about 15 kt and putting some weight on the estimated surface winds, an intensity of 75 kt is selected for 18Z on the 1st, down from 95 kt originally in HURDAT, a major intensity change. A central pressure of 989 mb has been added to 18Z on the 1st. Ella continued to move northwestward making landfall in southeastern Cuba around 00Z on September 2nd. Landfall occurred near 20.0N, 76.2W or about 20 nm west of Santiago de Cuba with winds of 75 kt. HURDAT originally had 100 kt at 00Z on the 2nd, a major intensity change. Perez et al. indicates that Ella is recognized in Cuba as a category 1 hurricane impact, same as this reanalysis. Thus, Ella is analyzed to have never reached major hurricane status and the peak intensity is 95 kt, down from 100 kt originally in HURDAT. It is possible that Ella may have reached major hurricane status before impacting Haiti, but it is unlikely that it was a major hurricane when it struck Cuba as the very high terrain of the Tiburon peninsula should have disrupted the small circulation of the cyclone.

Weakening occurred over the mountainous terrain of eastern Cuba. Ella is analyzed to have weakened to a tropical storm at 06Z on the 2nd, six hours earlier than originally in HURDAT. Late on the 2nd, the track of the tropical cyclone turned to the west and Ella moved back into the Caribbean Sea. Reconnaissance aircraft investigated Ella during the 2nd making a few radar center fixes but it appears that the disorganized state of the tropical storm caused the center fixes to be erroneous showing the system farther northward compared to the ship and coastal observations. These center fixes were generally disregarded for the reanalysis and more weight was put on the ship and coastal observations. Also around September 2nd, a significant pressure gradient was developing between Ella and a strong high pressure to the north. From this point on to the demise of the tropical cyclone, the strongest winds were found on the northern quadrant and

generally about 100-200 nm away from the center. While over the Caribbean Sea and likely in part due to the pressure gradient to the north, Ella started to slowly intensify. On a general west-northwest track, the tropical storm made landfall in La Isla de la Juventud, Cuba near 21.8N, 82.7W or about 5 nm east of Nueva Gerona, around 11Z with winds of 55 kt. A reporting station (or a stationary ship) in the southern portion of Isla de la Juventud reported 15 kt SW and 1005 mb, suggesting a central pressure of 1003 mb, which has been added to HURDAT at 12Z on the 3rd. A central pressure of 1003 mb suggests maximum sustained winds of 41 kt south of 25N according to the pressure-wind relationship. Due ships north of the center reporting winds up to 50 kt, an intensity of 55 kt is selected at 12Z on the 3rd, same as the original HURDAT. The system continued west-northwest making another landfall around 17Z near 22.1N, 84.0W or about 15 nm east of Sandino, Cuba as a 60 kt tropical storm. Late on the 3rd, Ella entered the Gulf of Mexico turning northwestward early on September 4th. A ship reported 15 kt NE and 1003 mb at 00Z on the 4th, suggesting a central pressure of 1001 mb, which has been added to HURDAT. No change in intensity is analyzed on the 4th. The highest winds reported in Florida were 57 kt at 04Z on the 4th at Dry Tortugas, but since the measurement was at an elevation of about 158 ft above ground, the reduction formula suggests winds of around 50 kt at the surface. On the 4th, ships north of Ella reported winds up to 55 kt. A reconnaissance aircraft measured a central pressure of 1003 mb and estimated surface winds of 60 kt at 1440Z on the 4th. A central pressure of 1003 mb has been added to HURDAT at 12Z on the 4th. The radar and penetration fixes from the reconnaissance aircrafts on the 4th do not agree with the surface observations from ships and coastal stations on the position of the center of Ella, likely due to the somewhat disorganized center of the cyclone. Thus, for the reanalysis of the track, more weight has been put on the observations from ships and coastal stations. Ella began to slowly weaken on September 5th as it moved farther away from the strong high pressure to the northeast. A ship reported 25 kt SE and 1005 mb at 09Z on the 5th, suggesting a central pressure of about 1002 mb, which has been added to HURDAT at 12Z on the 5th. Late on the 5th, the tropical storm made its closest approach to Louisiana producing winds of 40 kt at Grand Isle. On September 6th, the track of Ella changed to the west. A ship reported 15 kt ENE and 1003 mb at 00Z on the 6th suggesting a central pressure of 1001 mb, which has been added to HURDAT. Landfall occurred around 09Z on the 6th near 27.4N, 97.3W or about 20 nm south of Corpus Christi, TX, with winds of 50 kt. Kingsville, TX, reported 4 kt NNW and 1002 mb around 08Z on the 6th, suggesting a central pressure of about 1001 mb, which has been added to HURDAT at 06Z on the 7th. Highest winds reported in Texas were 47 kt at Port Lavaca at an unknown time but likely early on the 6th. Weakening to a tropical depression is analyzed at 12Z on the 6th, same as the original HURDAT. Surface observations from southern Texas and northeastern Mexico indicate that the forward speed of Ella slowed significantly after moving inland and a moderate

track change had to be made for 18Z on the 6th. Furthermore, HURDAT shows dissipation to have occurred after 18Z on the 6th but observations in the mentioned area indicate that a closed circulation was still present at 00Z on September 7th. Dissipation is now shown to have occurred after 00Z on the 7th, six hours later than the original HURDAT. Laredo, TX, reported 5 kt E and 1006 mb at 00Z on the 7th, suggesting a central pressure of 1005 mb, which has been added to HURDAT.

Tropical Storm Fifi [September 4-11, 1958]

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40700 09/04/1958 M= 9  6 SNBR= 885 FIFI        XING=0 SSS=0
40700 09/04/1958 M= 8  7 SNBR= 885 FIFI        XING=0 SSS=0
                     *  *

40705 09/04*  0   0   0    0*  0   0   0    0*101 448  25    0*106 462  25    0*
40705 09/04*  0   0   0    0*  0   0   0    0*101 448  25    0*106 467  25    0*
                                                              ***

40710 09/05*111 475  25    0*116 486  30    0*122 498  45    0*133 519  45    0*
40710 09/05*114 485  30    0*124 503  35    0*135 521  40    0*144 537  45 1000*
           *** ***  **      *** ***  **      *** ***  **      *** ***     ****

40715 09/06*145 541  50 1000*156 557  65    0*166 571  75    0*175 583  80    0*
40715 09/06*152 549  50    0*159 561  55    0*166 571  60    0*175 583  55    0*
           *** ***         * *** ***  **                **                **

40720 09/07*184 596  75    0*195 610  65    0*206 623  65    0*213 634  65    0*
40720 09/07*185 596  50 1004*195 609  50    0*205 621  50 1003*211 631  50 1000*
           ***      ** ****     ***  **      *** ***  ** **** *** ***  ** ****

40725 09/08*219 642  60    0*226 648  60    0*230 653  60    0*231 656  55    0*
40725 09/08*216 638  45 1003*221 644  45    0*226 649  45    0*229 654  45 1000*
           *** ***  ** **** *** ***  **      *** ***  **      *** ***  ** ****

40730 09/09*233 658  50    0*235 659  50    0*236 660  50    0*238 662  50    0*
40730 09/09*232 658  45    0*234 661  45    0*236 663  40 1003*238 664  35 1007*
           ***      **      *** ***  **          ***  ** ****     ***  ** ****

40735 09/10*241 665  50    0*247 668  45    0*255 671  45    0*264 671  40    0*
40735 09/10*241 666  35    0*246 668  35    0*253 670  30    0*261 671  30 1009*
               ***  **      ***      **      *** ***  **      ***      ** ****

40740 09/11*272 669  40    0*276 667  40    0*280 662  40    0*289 653  50    0*
40740 09/11*269 669  30    0*276 667  30    0*284 658  25 1010*296 645  25 1009*
           ***      **                **      *** ***  ** **** *** ***  ** ****

(September 12th is removed from HURDAT)
40745 09/12*297 643  55    0*302 632  45    0*307 621  35    0*313 613  25    0*
40745 09/12*  0   0   0    0*  0   0   0    0*  0   0   0    0*  0   0   0    0*
               *   *   *        *   *   *        *   *   *        *   *   *

40750 HR
40750 TS
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Major changes to the track and intensity shown in McAdie et al. (2009). Evidence for these alterations comes from the NHC microfilm maps, the Historical Weather Maps

series, the COADS ship database, Monthly Weather Review, Navy reconnaissance book and the NHC Storm Wallets.

September 3:

HWM is not available on this date (system south of 20ºN). HURDAT does not list an organized storm on this date. Microfilm does not show an organized system at 12Z. Ship highlights: No gales or low pressures.

MWR: "Possibly the increase in winds at 700 mb shown by the regular Gull Papa reconnaissance flight on September 3 was the first bit of evidence of the existence of the easterly wave which later developed into Fifi."

September 4:

HWM is not available on this date (system south of 20ºN). HURDAT lists a 25 knot tropical depression at 10.1N, 44.8W at 12Z (first position). Microfilm does not show an organized system at 12Z. Ship highlights: No gales or low pressures.

MWR: "On the 4th, the suspicious area was coordinated by the *SS Robin Hood*, located near latitude 12N, longitude 48W, which reported squalls and pressure of 1008.8 mb, falling. Later that day the Robin *Hood's* wind veered from east to south but the development was so weak and slow that no cyclonic circulation could be found by the aircraft. The flight did observe cumulonimbus tops being blown toward the northeast and this was in agreement with a high-level vortex over the extreme eastern part of the Caribbean Sea."

September 5:

HWM is not available on this date (system south of 20ºN). HURDAT lists a 45 knot tropical storm at 12.2N, 49.8W at 12Z. Microfilm shows a closed low pressure of at most 1005 mb at 16.0N, 52.0W at 12Z. Ship highlights: No gales or low pressures. Aircraft highlights: No gales or low pressures. Penetration center fix estimated surface winds of 55 kt and measured a central pressure of 1000 mb at 14.9N, 54.3W at 2045Z (ATSR/WALLET).

MWR: "Early on the 5th, reconnaissance indicated possibly two centers of action, but by afternoon a single center was firmly established. The first advisory, at 2200 GMT September 5, located tropical storm Fifi at latitude 15.1N, longitude 55.0W with highest winds of 50 to 55 mph. A solid wall cloud was observed and the sea level pressure was 1000 mb. This was the lowest central pressure observed during the history of the storm although it was equaled at a later date." ATSR: "The easterly wave, from which FIFI developed, was first reported to be approximately 300 miles off to the coast of northwest

Africa, or at 22 degrees west longitude. This wave was designated 7AW in a regular easterly wave message from Fleet Weather Central, Port Lyautey, six days before FIFI was discovered. This wave was tracked along at 12 knots. Until 5 September, there was never any reason to suspect that 7AW was anything more than a weak wave. On 5 September, there were two routine flights into the area – an Air Force GULL PAPA and Navy Delta. The winds and weather of these two flights indicated that 7AW had intensified and was now a strong easterly, with the possibility of a circulation. It was decided to divert GULL PAPA to the area of a possible center and at 052045Z the eye was centered by visual means at 14.9N 54.3W. At this early stage, FIFI could only be located by surface pressure and winds – the eye was not discernible at 700 mb. The minimum pressure was 1000 mb, and the maximum winds were to be 55 knots in the northwest quadrant a short distance from the center."

September 6:

HWM is not available on this date (system south of 20ºN). HURDAT lists a 75 knot hurricane at 16.6N, 57.1W at 12Z. Microfilm shows a closed low pressure of at most 1005 mb at 16.8N, 57.0W at 12Z. Ship highlights: No gales or low pressures. Aircraft highlights: 25 kt ESE and 1005 mb at 15.9N, 55.3W at 00Z (micro). Penetration center fix estimated surface winds of 75-80 kt and measured a central pressure of 1010 mb at 17.0N, 57.5W at 1330Z (ATSR/WALLET/MWR). Penetration center fix at 18.0N, 59.5W at 20Z (ATSR).

MWR: "Fifi had been moving rapidly northwestward about 23 mph, but by early afternoon of the 6th the forward speed had decreased to 16 mph and the storm had increased to hurricane intensity. It was located near latitude 17.0N, longitude 57.5W at 1330 GMT on the 6th, attended by surface winds up to 92 mph north of the center. This was the maximum intensity of hurricane Fifi." ATSR: "Although the winds increased in intensity on the 6th of September, to hurricane force (75 knots), the surface pressure rose to 1010 mb. From all reports the pressure fluctuated between 1000 and 1010 mb throughout FIFI's life."

September 7:

HWM analyzes a hurricane of at most 1005 mb at 20.8N, 62.5W at 12Z. HURDAT lists a 65 knot hurricane at 20.6N, 62.3W at 12Z. Microfilm shows a closed low pressure of at most 1005 mb at 20.5N, 62.5W at 12Z. Ship highlights: No gales or low pressures. Aircraft highlights: No gales or low pressures. Penetration center fix estimated flight level winds (700 mb) of 70 kt and measured a central pressure of 1004 mb at 19.0N, 60.4W at 02Z (ATSR). Penetration center fix at 20.0N, 61.1W at 0750Z (ATSR). Penetration center fix measured a central pressure of 1003 mb at 20.7N, 62.5W

at 14Z (ATSR/WALLET). Penetration center fix measured a central pressure of 1000 mb at 21.1N, 63.6W at 20Z (ATSR/WALLET).

MWR: "The storm slowed to around 12 mph and highest winds decreased to 75 mph on the 7th."

September 8:

HWM analyzes a tropical storm of at most 1005 mb at 23.0N, 65.5W at 12Z. HURDAT lists a 60 knot tropical storm at 23.0N, 65.3W at 12Z. Microfilm shows a closed low pressure of at most 1008 mb at 23.0N, 65.0W at 12Z. Ship highlights: No gales or low pressures. Aircraft highlights: Penetration center fix measured a central pressure of 1003 mb and estimated an eye diameter of 15 nm at 21.5N, 63.8W at 02Z (ATSR). Penetration center fix estimated surface winds of 50 kt, measured a central pressure of 1009 mb and an eye diameter of 20 nm at 22.8N, 65.1W at 1537Z (micro). Penetration center fix measured a central pressure of 1000 mb at 22.8N, 65.7W at 1930Z (ATSR/WALLET). Penetration center fix at 23.1N, 65.8W at 2309Z (ATSR/WALLET).

MWR: "During the 8th, Fifi continued on a northwestward course at 7 mph and maximum winds dropped to 60 mph. Prior to this time, a jet maximum at high levels had worked around peninsular Florida."

September 9:

HWM analyzes a tropical storm of at most 1005 mb at 23.5N, 66.1W at 12Z. HURDAT lists a 50 knot tropical storm at 23.6N, 66.0W at 12Z. Microfilm shows a closed low pressure of at most 1005 mb at 23.6N, 66.1W at 12Z. Ship highlights: No gales or low pressures. Aircraft highlights: No gales or low pressures. Penetration center fix measured a central pressure of 1003 mb at 23.5N, 67.1W at 1135Z (ATSR/WALLET). Penetration center fix estimated flight level winds (700 mb) of 50 kt, measured a central pressure of 1005 mb and an eye diameter of 40 nm at 24.0N, 67.1W at 1430Z (micro). Penetration center fix measured a central pressure of 1007 mb at 24.0N, 66.4W at 1949Z (ATSR/WALLET).

MWR: "… by evening of the 8th it was located from the central Bahamas to Bermuda. It was this wind field which influenced the storm to make a turn to the north during the 9th and 10th."

September 10:

HWM analyzes a tropical storm of at most 1010 mb at 25.6N, 66.8W at 12Z. HURDAT lists a 45 knot tropical storm at 25.5N, 67.1W at 12Z. Microfilm shows a closed low pressure of at most 1014 mb at 24.0N, 67.0W at 12Z. Ship highlights: 20 kt

NNW and 1005 mb at 25.9N, 69.2W at 18Z (micro). Aircraft highlights: Penetration center fix estimated surface winds of 35 kt at 25.9N, 67.0W at 1430Z (ATSR/WALLET). Penetration center fix estimated surface winds of 20 kt and measured a central pressure of 1009 mb at 26.2N, 66.8W at 1930Z (ATSR/WALLET).

September 11:

HWM analyzes a tropical storm of at most 1010 mb at 28.5N, 66.2W and a cold front to the northwest at 12Z. HURDAT lists a 45 knot tropical storm at 28.0N, 66.2W at 12Z. Microfilm shows a trough along longitude 65N, from 25N-35N at 12Z. Ship highlights: Aircraft highlights: No gales or low pressures. Penetration center fix estimated surface winds of 45 kt and measured a central pressure of 1010 mb at 28.6N, 65.4W at 1330Z (ATSR/WALLET). Penetration center fix estimated surface winds of 55 kt and measured a central pressure of 1009 mb at 29.9N, 64.1W at 1930Z (ATSR/WALLET).

MWR: "Fifi turned northeastward and accelerated during the 11th. The storm passed within 150 miles of the Leeward Islands and approximately the same distance southeast of Bermuda. No loss of life or property damage was reported."

Storm Wallet Preliminary Report: "On the 11th its movement accelerated to the northeast and winds began to increase again as it moved into the westerlies near Bermuda."

September 12:

HWM analyzes a tropical storm of at most 1015 mb at 30.7N, 62.2W and a cold front just to the north at 12Z. HURDAT lists a 35 knot tropical storm at 30.7N, 62.1W at 12Z. Microfilm shows a frontal boundary over the western Atlantic, likely indicating that Fifi has been absorbed, at 12Z. Ship highlights: No gales or low pressures.

September 13:

HWM analyzes a frontal boundary over the North Atlantic, likely indicating that Fifi has been absorbed, at 12Z. HURDAT does not list an organized storm on this date. Microfilm shows a frontal boundary over the western Atlantic at 12Z. Ship highlights: No gales or low pressures.

Tropical Storm Fifi developed east of the Lesser Antilles during the first days of September. Data over the central Atlantic is sparse and it is possible that Fifi may have developed earlier than indicated. The first position is at 12Z on September 4th as a 25 kt tropical depression, same as the original HURDAT. Track alterations are generally minor for the lifetime of Fifi, except for September 5th at 12Z were a major track change was implemented. The tropical cyclone moved generally west-northwest at a fast forward speed on the 4th. The first reconnaissance aircraft to reach the system occurred at 2045Z

on September 5th measuring a central pressure of 1000 mb and estimating surface winds of 55 kt. A central pressure of 1000 mb suggests maximum sustained winds of 47 kt south of 25N from the Brown et al. pressure-wind relationship. An intensity of 45 kt is selected for 18Z on the 5th, same as the original HURDAT. A central pressure of 1000 mb was present in HURDAT at 00Z on September 6th and has been moved to 18Z on the 5th. Based upon this information, intensification to a tropical storm is analyzed at 06Z on the 5th, six hours earlier than originally shown in HURDAT. Fifi continued to intensify on the 6th. A reconnaissance aircraft reached the tropical storm at 1330Z on the 6th estimating surface winds of 75-80 kt and measuring a central pressure of 1010 mb. It is likely that the measured minimum pressure of 1010 mb was not a central pressure and therefore, it is not added to HURDAT. The true central pressure around 12Z on the 6th likely did not drop appreciably, as reliable values of 1000 mb and 1004 mb were observed at 2045Z on the 5th and 02Z on the 7th, respectively. Due to the discrepancy between the observed pressure and estimated surface winds, as well as the preceding and subsequent aircraft reconnaissance, the intensity at 12Z is analyzed at 60 kt, down from the original 75 kt in HURDAT, a minor intensity change. 60 kt is also the peak intensity for Fifi, down from 80 kt originally in HURDAT, a major intensity change. Thus, it is analyzed that Fifi never attained hurricane intensity during its lifetime. Another major intensity change is analyzed at 18Z on the 6th. HURDAT originally had 80 kt and 55 kt is now analyzed.

Early on September 7th, Fifi made its closest approach on the Leeward Islands, passing about 100 nm northeast of Barbuda while on a northwest track. A reconnaissance aircraft measured a central pressure of 1004 mb and estimated flight level winds of 70 kt at 02Z on the 7th. A central pressure of 1004 mb suggests maximum sustained winds of 41 kt south of 25N weakening from the pressure-wind relationship. Due to the forward speed of about 16 kt and small synoptic scale of the tropical cyclone, an intensity of 50 kt is analyzed at 00Z on the 7th, down from 75 kt originally in HURDAT, a major intensity change. A central pressure of 1004 mb is added to HURDAT at 00Z on the 7th. Another reconnaissance mission measured a central pressure of 1003 mb at 14Z on the 7th, suggesting maximum sustained winds of 41 kt south of 25N from the pressure-wind relationship. Once again, due to the forward speed of about 15 kt and small size of the tropical cyclone, an intensity of 50 kt is selected for 12Z on the 7th, down from 65 kt originally in HURDAT, a minor intensity change. A central pressure of 1003 mb is added to HURDAT at 12Z on the 7th. The last measured central pressure on the 7th by a reconnaissance aircraft was 1000 mb at 20Z. A central pressure of 1000 mb suggests maximum sustained winds of 47 kt south of 25N from the pressure-wind relationship. At this time, the forward speed of Fifi had decreased to about 10 kt but still remained small synoptically, thus an intensity of 50 kt is analyzed at 00Z on the 7th, down from 65 kt originally in HURDAT, a minor intensity change. A central pressure of 1000 mb is added

to HURDAT at 18Z on the 7th. The forward speed of the tropical cyclone decreased significantly on September 8th and 9th. A reconnaissance aircraft measured a central pressure of 1003 mb and an eye diameter of 15 nm at 02Z on the 8th. A central pressure of 1003 mb suggests maximum sustained winds of 41 kt south of 25N from the pressure-wind relationship. An eye diameter of 15 nm suggests an RMW of about 11 nm and climatology suggests about 17 nm. The forward speed had decreased to 8 kt but Fifi remained a small tropical storm, thus an intensity of 45 kt is selected for 00Z on the 8th. A central pressure of 1003 mb is added to HURDAT at 00Z on the 8th. Another penetration center fix at 1537Z estimated surface winds of 50 kt, an eye diameter of 20 nm and measured a central pressure of 1009 mb. It is likely that the aircraft did not measure the central pressure based on a central pressure measurement of 1000 mb at 20Z by another reconnaissance mission. Therefore, the 1009 mb is likely not a central pressure and not added to HURDAT. A central pressure of 1000 mb suggests maximum sustained winds of 47 kt south of 25N from the pressure-wind relationship. Since Fifi was moving at about 5 kt but remained a small cyclone, an intensity of 45 kt is selected at 18Z on the 8th, down from the original 55 kt in HURDAT, a minor intensity change. A central pressure of 1000 mb is added to HURDAT at 18Z on the 8th.

Observations from the reconnaissance aircraft on September 9th indicated that Fifi became less organized, especially late in the day. A central pressure of 1003 mb was measured at 1135Z, suggesting maximum sustained winds of 41 kt south of 25N from the pressure-wind relationship. An intensity of 40 kt is selected at 12Z on the 9th, down from 50 kt originally in HURDAT, a minor intensity of change. A central pressure of 1003 mb is added to HURDAT at 12Z on the 9th. A penetration center fix measured a central pressure of 1007 mb at 1949Z. A central pressure of 1007 mb suggests maximum sustained winds of 35 kt south of 25N weakening and 29 kt north of 25N weakening, from the pressure-wind relationships. An intensity of 35 kt is selected for 18Z on the 9th, down from 50 kt originally in HURDAT, a minor intensity change. On September 10th, Fifi started to increase in forward speed as it moved northward and later northeastward ahead of a frontal boundary. Weakening to a tropical depression is analyzed at 12Z on the 10th, 30 hours earlier than originally shown in HURDAT. Central pressures of 1009, 1010 and 1009 mb were measured on the by the reconnaissance aircrafts at 1949Z on the 9th, and 1430Z and 1930Z on the 10th, respectively, and have been added to HURDAT at 18Z on the 9th, and 12Z and 18Z on the 10th, respectively. Ship and aircraft observations suggest that Fifi became increasingly less organized on September 11th and dissipation is analyzed to have occurred after 18Z on the 10th about 150 nm south of Bermuda, 24 hours earlier than originally shown in HURDAT. HURDAT suggests that the system re-intensified late on the 10th and early on the 11th, but the observations clearly indicate that these winds were associated with the frontal boundary and not likely to be associated

with tiny Fifi. Observations suggest that Fifi weakened into a surface trough on September 11th and was absorbed shortly thereafter.

Tropical Storm Gerda [September 14-22, 1958]

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40755 09/13/1958 M= 3  7 SNBR= 886 GERDA       XING=0 SSS=0
40755 09/14/1958 M= 9  8 SNBR= 886 GERDA       XING=0 SSS=0
         **         *  *

40760 09/13*  0   0   0    0*  0   0   0    0*151 620  25    0*159 642  35    0*
40760 09/13*  0   0   0    0*  0   0   0    0*  0   0   0    0*  0   0   0    0*
                                              *   *   *        *   *   *

40765 09/14*166 661  35    0*172 679  45    0*176 694  50    0*179 706  60 1004*
40765 09/14*  0   0   0    0*  0   0   0    0*175 694  40    0*178 706  50 1004*
              *   *   *        *   *   *      ***       **      ***       **

40770 09/15*182 719  45    0*186 733  40    0*190 748  35    0*195 768  25    0*
40770 09/15*181 719  40    0*183 734  40    0W185 759  35    0W187 786  35    0*
           ***       **      ***  ***         ****  ***         ****  ***

(September 16th through 22nd is new to HURDAT)
40771 09/16W188 815  30    0W185 845  30    0W181 870  25    0W176 892  25    0*
40772 09/17W176 905  25    0W180 914  25    0W186 920  25    0W193 925  25    0*
40773 09/18W199 930  25    0W204 935  25    0W208 940  25    0W212 944  25    0*
40774 09/19W216 948  25    0W218 952  25    0*221 958  30    0*225 965  35 1004*
40775 09/20*233 972  40 1001*241 976  40    0*255 978  35 1003*270 978  30 1003*
40776 09/21*284 975  30    0*296 970  25    0*305 960  25    0*311 946  25    0*
40777 09/22*313 930  25    0*  0   0   0    0*  0   0   0    0*  0   0   0    0*

40780 TS
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Tropical Storm Landfall

09/14 21Z 18.0N 71.2W 50 kt Dominican Republic
09/20 08Z 24.5N 97.7W 40 kt Mexico

Minor changes to the track and intensity shown in McAdie et al. (2009). One day is removed from this system at the beginning of the track. Six additional days are added to the end of this cyclone. Evidence for these alterations comes from the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Monthly Weather Review, Local Climatological Data, Surface Weather Observations, Mexican Observations, Navy reconnaissance book and the NHC Storm Wallets.

September 12:

HWM is not available on this date (system south of 20ºN). HURDAT does not list an organized storm on this date. Microfilm shows a tropical wave east of the Lesser Antilles near Longitude 56W at 12Z. Ship highlights: No gales or low pressures.

MWR: “The seventh tropical cyclone of the season, Gerda, developed in an easterly wave which was first identified about 400 statute miles east of the Lesser Antilles on September 11. Reconnaissance aircraft found no evidence of cyclonic flow or unusual weather in the wave on September 12.” ATSR: “The 12 September surface analysis, as derived from Navy reconnaissance aircraft and land station reports, indicated a weak, low pressure about 200 miles east of Barbados.”

September 13:

HWM is not available on this date (system south of 20ºN). HURDAT lists a 25 knot tropical depression at 15.1N, 62.0W at 12Z (first position). Microfilm shows a tropical wave over the eastern Caribbean Sea near Longitude 61W at 12Z. Ship highlights: No gales or low pressures.

MWR: “ … but on the following day, September 13, surface reports from the Windward Islands indicated that the wave had intensified. The same reports indicated some evidence of cyclonic circulation in the Caribbean Sea, a short distance west of Martinique.” ATSR: “This low moved over the Antilles early on 13 September with very light winds but with heavy rainfall at most of the reporting stations. A Navy reconnaissance flight investigated the eastern Caribbean late on 13 September. This flight reported heavy rain but the pressure pattern indicated the low had degenerated into an easterly wave without a circulation center.”

September 14:

HWM is not available on this date (system south of 20ºN). HURDAT lists a 50 kt tropical storm at 17.6N, 69.4W at 12Z. Microfilm shows a tropical wave over the central Caribbean Sea near Longitude 70W at 12Z. Ship highlights: 40 kt SE and 1011 mb at 17.6N, 64.1W at 00Z (COADS). 45 kt SE and 1012 mb at 16.4N, 65.1W at 06Z (COADS). 35 kt ESE and 1013 mb at 17.0N, 68.0W at 12Z (COADS). 35 kt ESE and 1013 mb at 19.8N, 70.0W at 18Z (COADS). Land highlights: 40 kt at Roosevelt Roads NAS, PR at 03Z (WALLET). 35 kt at Ponce, PR at 09Z (WALLET). 37 kt at Cabo Rojo, PR at 15Z (WALLET). Aircraft highlights: Penetration center fix measured a central pressure of 1004 mb at 17.8N, 70.8W at 1910Z (ATSR). Penetration center fix estimated maximum surface winds of 60 kt and an eye diameter of 20 nm at 17.9N, 71.1W at 2118Z (ATSR). Radar center fix at 18.0N, 71.4W at 2230Z (ATSR).

MWR: “…but apparently it was not well defined because aircraft reconnaissance did not confirm its existence until about noon (EST) of September 14. At that time the cyclonic circulation was centered 75 miles southwest of Ciudad Trujillo [Santo Domingo], Dominican Republic, with highest winds 60 kt. in the southeastern quadrant and a minimum central pressure of 1004 mb. The center of Gerda, moving west-northwestward

about 18 mph, passed over the southern peninsula of the Dominican Republic and evidently the mountainous terrain of that island disrupted the cyclonic flow around its center." ATSR: "At 0700Z, 14 September, the ship PANDORA reported a "storm center" with winds of 65 knots at 17.6N, 67.6W, or about 65 miles southwest of Ramey AFB, Puerto Rico. Another Navy reconnaissance flight was dispatched to the area and, after thorough investigation found a very weak circulation at 17.8N 70.8W, surface pressure of 1004 mb. The circulation at that time was entering land along the mountainous southern coast of Hispaniola. During the next ten hours GERDA remained over the mountainous terrain and lost all characteristics of a circulation." Tropical Cyclone Report: "By 0600Z on the 14th a ship observation (presumably Navy) about 30 miles SSW of Cabo Rojo reported "gusts to 65 kts, storm center located by radar at 17.6N, 67.6W."

September 15:

HWM is not available on this date (system south of 20ºN). HURDAT lists a 35 kt tropical storm at 19.0N, 74.8W at 12Z. Microfilm shows a tropical wave over the central Caribbean Sea near Longitude 76W at 12Z. Ship highlights: 35 kt NE and 1011 mb at 16.3N, 70.5W at 00Z (COADS). 35 kt ESE and 1015 mb at 20.7N, 73.1W at 12Z (COADS). 35 kt E and 1011 mb at 18.8N, 78.6W at 18Z (COADS). Land highlights: 40 kt at Port-au-Prince, Haiti at 06Z (WALLET).

MWR: "On September 15, reconnaissance planes could not locate evidence of a circulation and reports thereafter indicated that tropical storm Gerda had again degenerated into an easterly wave. Gale warnings were issued for the southern coasts of Puerto Rico and Dominican Republic in connection with Gerda. Three deaths in Puerto Rico, two of which were drownings, were attributed to the storm." ATSR: "By 1000Z, 15 September, the only remains of GERDA was a strong rapidly moving easterly wave oriented southwest from the southern coast of Cuba and the final warning was issued at that time."

September 16:

HWM is not available on this date (system south of 20ºN). HURDAT does not list an organized storm on this date. Microfilm shows a closed low pressure of at most 1011 mb at 17.5N, 86.0W at 12Z. Ship highlights: 35 kt E and 1017 mb at 23.1N, 74.4W at 00Z (COADS).

ATSR: "Reconnaissance flights were continued for the next two days along the easterly wave but no further indications of tropical storm formation were observed."

September 17:

HWM is not available on this date (system south of 20ºN). HURDAT does not list an organized storm on this date. Microfilm shows a tropical wave along 18-23N, 92W at 12Z. Ship highlights: No gales or low pressures.

September 18:

HWM is not available on this date (system south of 20ºN). HURDAT does not list an organized storm on this date. Microfilm shows a closed low pressure of at most 1008 mb at 19.5N, 92.8W at 12Z. Ship highlights: No gales or low pressures.

September 19:

HWM shows a warm front over the northern coast of the Gulf of Mexico at 12Z. HURDAT does not list an organized storm on this date. Microfilm shows a tropical wave along 20-25N, 92W at 12Z. Ship highlights: 1004 mb near 21.0N, 94.5W (report says "early on the 19th") (WALLET).

New Orleans Weather Bureau Bulletin 1930Z: "A few squalls developed in the southwest Gulf of Mexico last night and aircraft reconnaissance this morning indicated that a weak low pressure area has developed. At 130 PM CST the low was centered about 90 statue miles northeast off of the upper Mexican coast. The low is expected to continue north-northwest at about the same rate moving inland a little south of Brownsville Texas tonight. A few squalls with winds up to 35 mph may occur along the lower Texas coast tonight and small craft Port Aransas southward should remain in port. An increase in the heavy rain in south and central Texas is likely during the next 24 hours causing additional flooding in that area and all interests should watch for flood bulletins from local weather bureau offices."

September 20:

HWM shows a closed low pressure of at most 1005 mb at 25.5N, 97.5W with a stationary front to the north at 12Z. HURDAT does not list an organized storm on this date. Microfilm shows a closed low pressure of at most 1005 mb at 25.5N, 97.7W at 12Z. Ship highlights: 15 kt SE and 1005 mb at 22.4N, 96.4W at 00Z (COADS). 35 kt SSE and 1009 mb at 27.7N, 94.9W at 18Z (COADS). Land highlights: 5 kt NE and 1002 mb at Soto La Marina, Mexico at 00Z (micro). 5 kt SE and 1004 mb at Brownsville, Texas at 12Z (micro). 6 kt SE and 1004 mb at Port Isabel, Texas at 18Z (SWO).

New Orleans Weather Bureau Bulletin 13Z: "The small low moved inland from the western Gulf of Mexico and at 7 AM CST it was centered near Brownsville Texas moving northward about 15 mph. A few squalls with winds up to 35 mph are occurring

off the Texas coast. The low is expected to move northward at about the same rate today and turn northeastward moving through east Texas tonight. A few squalls and rough seas are expected along the Texas and western Louisiana coasts through tonight and small craft in that area

September 21:

HWM shows a stationary front over Texas and a second warm-front over northern Texas and Oklahoma at 12Z. HURDAT does not list an organized storm on this date. Microfilm shows a closed low pressure of at most 1011 mb at 31.5N, 91.0W with a frontal boundary to the northeast and southwest, and a second warm-front over northern Texas and Oklahoma at 12Z. Ship highlights: No gales or low pressures.

September 22:

HWM shows a warm front over the northwest coast of the Gulf of Mexico at 12Z. HURDAT does not list an organized storm on this date. Microfilm shows a frontal boundary north of the Gulf of Mexico at 12Z. Ship highlights: No gales or low pressures.

Local Climatological Data Corpus Christi, Texas: "A small tropical low developed in the southwest Gulf of Mexico from a weak easterly wave on the 18th of Sep. This small low pressure area did not develop as it moved northward and only caused some locally heavy rains in the area. It moved over Brownsville and then north to our area, passing from the south to the north over Corpus Christi during the afternoon of the 20th. Winds remained light most of the time during the day. The very unstable air caused the formation of two funnel clouds near Freer the evening of the 20th. Our lowest pressure during the passage of the low center was 29.67."

A strong tropical wave entered the eastern Caribbean Sea on September 13th moving rapidly to the west-northwest. HURDAT indicates that genesis occurred on September 13th at 12Z as a 25 kt tropical depression, but observations from ships and reconnaissance aircrafts indicate that the tropical wave did not have a closed circulation on the 13th and early on the 14th. Genesis is delayed 24 hours until September 14th at 12Z as a 40 kt tropical storm based on reports from the reconnaissance aircraft later on the day and a couple of ships reporting tropical storm force winds. It is interesting to note that advisories on Gerda were originally started at 21Z on the 14th and the MWR Tracks of Centers of Cyclones at Sea Level for the month of September has Gerda starting at 06Z on the 14th. The northern portion of the tropical wave was quite active on September 14th causing tropical storm force winds in Puerto Rico and nearby islands. A couple of ships also reported gale force winds on the 14th, similar to this reanalysis. A reconnaissance mission reached the tropical cyclone at 1904Z measuring a central pressure of 1004 mb and at 2118Z estimated surface winds of 60 kt and an eye diameter of 20 nm. A central

pressure of 1004 mb suggests maximum sustained winds of 39 kt from the south of 25N Brown et al. pressure-wind relationship. An eye diameter of 20 nm suggests an RMW of about 15 nm and climatology suggests about the same. An intensity of 50 kt is analyzed at 18Z on the 14th, down from 60 kt originally in HURDAT, a minor intensity change. The analyzed intensity is a combination between the obtained value from the pressure-wind relationship and the estimated surface winds reported by the reconnaissance aircraft. 50 kt is also the peak intensity during the lifetime of this tropical cyclone, down from 60 kt originally in HURDAT. A central pressure of 1004 mb was already in HURDAT at 18Z on the 14th and has been retained. Landfall occurred at 21Z on the 14th on the Barahona Peninsula in the southern Dominican Republic near 18.0N, 71.2W as a 50 kt tropical storm. The mountainous terrain of Hispaniola took its toll on Gerda and weakening to a tropical wave is analyzed at 12Z on September 15th. HURDAT maintained Gerda as a tropical cyclone until 18Z on the 15th but reports from ships, coastal stations and a reconnaissance aircraft indicate that it did not have a closed circulation after 06Z on the 15th. Ships still reported gale-force winds late on September 15th and on that basis, the intensity of the tropical wave is retained at gale-force at 12Z and 18Z on this day. HURDAT originally indicated that Gerda had weakened to a tropical depression at 18Z on the 15th and dissipated afterwards.

The tropical wave moved rapidly across the western Caribbean Sea on September 16th. Weakening below gale-force is analyzed at 00Z on the 16th. Around 12Z on September 17th, the tropical wave entered the Bay of Campeche and the forward speed of the disturbance decreased. Over the next couple of days, the disturbance moved northwestward gaining in organization. A 30 kt tropical depression is analyzed to have developed at 12Z on September 19th based on observations later in the day. It is possible that development may have occurred a day earlier due to the scarcity of ships in the Bay of Campeche. At 18Z on the 19th, a ship reported 20 kt N and 1006 mb near the center of the cyclone, suggesting a central pressure of about 1004 mb, which has been added to HURDAT. A central pressure of 1004 mb suggests maximum sustained winds of 39 kt south of 25N according to the pressure-wind relationship. Based on generally low environmental pressures and slow forward speed of about 8 kt, an intensity of 35 kt is selected at 18Z on the 19th. A reconnaissance aircraft visited the tropical cyclone on the 19th estimating surface winds of 35 kt and a minimum pressure of 1005 mb, but did not make a center fix. At 00Z on September 20th, the north-northwestward motion of Gerda brought the center closer to the coast of northeast Mexico. At this time, Soto la Marina, Mexico reported 5 kt NE and 1002 mb, suggesting a central pressure of 1001 mb, which has been added to HURDAT. A central pressure of 1001 mb suggests maximum sustained winds of 45 kt according to the south of 25N pressure-wind relationship. An intensity of 40 kt is selected at 00Z on the 20th due to the slow forward speed of Gerda and low environmental pressures. Landfall is analyzed at 08Z on the 20th over

northeastern Tamaulipas, Mexico at 24.5N, 97.7W as a 40 kt tropical storm. At 12Z on the 20th, Brownsville, Texas reported 5 kt SE and 1004 mb, suggesting a central pressure of 1003 mb, which has been added to HURDAT. Late on the 20th, Gerda turned to the north and increased in forward speed. Weakening to a tropical depression occurred at 18Z on the 20th. Gerda was a tropical depression when it reached Texas and was not a tropical storm impact for the state. At 18Z on the 20th, Port Isabel, Texas reported 6 kt NE and 1004 mb, suggesting a central pressure of 1003 mb, which has been added to HURDAT. A ship reported 35 kt at 18Z on the 20th but appears to have a slight high bias. On September 21st, Gerda turned to the northeast ahead of a frontal boundary. Microfilm analyzes a frontal system across the tropical cyclone and another frontal system to the north at 12Z on the 21st. Observations around the tropical depression show dew points in the low 70s northwest of the center, indicating that the analyzed frontal boundary in microfilm is likely non-existent. The depression is not analyzed to have become extratropical at any point during its lifetime. Dissipation is analyzed after 00Z on September 22nd over western Louisiana. The re-development of Gerda in the Gulf of Mexico is mentioned as a suspect in Jack Beven's List of Suspects. An analog to this tropical cyclone is Tropical Storm Helene in 2012.

Hurricane Helene [September 21 – October 4, 1958]

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40780 09/21/1958 M=14  8 SNBR= 887 HELENE      XING=0 SSS=3
40780 09/21/1958 M=14  9 SNBR= 887 HELENE      XING=0 SSS=3
                       *

40785 09/21*  0   0   0    0*185 515  25    0*190 542  25    0*195 563  25    0*
40785 09/21*  0   0   0    0*170 520  25    0*176 542  25    0*183 563  25    0*
                           *** ***            ***              *** ***

40790 09/22*201 583  25    0*207 602  25    0*213 619  25 1015*219 635  30 1014*
40790 09/22*191 584  25    0*201 604  25    0*211 624  25    0*219 641  30 1013*
           *** ***            *** ***            *** ***          **** ****     ****

40795 09/23*225 648  35 1013*230 658  40 1011*234 669  45 1009*240 682  45 1007*
40795 09/23*224 652  35    0*230 662  40    0*235 672  40 1003*240 684  45 1000*
           *** ***          * *** ***          * *** ***  **       *** ***     ****

40800 09/24*247 696  45 1005*257 709  50 1004*267 720  65 1002*272 729  65  998*
40800 09/24*246 696  50    0*256 707  55    0*265 717  60  997*272 724  65    0*
           ***       **     * *** ***  **     * *** ***  **  *** *** ***         *

40805 09/25*277 734  65  993*283 736  70  987*288 739  75  984*292 743  80  983*
40805 09/25*277 730  65  993*283 735  70  987*288 739  70  984*292 742  70  982*
           *** ***             ***                      **       *** ***  **  ***

40810 09/26*296 748  85  980*299 754  85  977*303 761  90  967*310 771 105  955*
40810 09/26*295 747  65  986*297 754  80  974*302 762  95  963*309 773 110  948*
           *** ***  **  *** ***      **  *** *** ***  **  *** *** *** ***  ***

40815 09/27*317 781 110  943*324 785 110  934*331 782 115  938*339 775 115  943*
40815 09/27*316 783 115  943*323 786 125  933*331 785 120  938*339 776 120    0*
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           *** *** ***      *** *** ***  ***     *** ***          *** ***    *

40820 09/28*348 758 110  946*358 732 110  950*369 705 105  954*380 683  90  957*
40820 09/28*347 759 115  938*355 738 110  950*366 713 105  954*380 683 100  943*
           *** *** ***  *** *** ***          *** ***                  ***  ***

40825 09/29*390 659  85  959*417 619  70  963*457 590  65  966E490 566  65  968*
40825 09/29E400 650  90  951E430 625  80  963E465 602  75  966E495 560  70  968*
          **** ***  **  ******* ***  **     **** ***  **      *** ***  **

40830 09/30E520 524  60  972E539 488  60    0E550 450  60    0E562 411  55    0*
40830 09/30E515 515  65  972E535 488  60    0E550 460  60    0E562 415  60    0*
           *** ***  **      ***                 ***              ***  **

40835 10/01E570 373  55    0E573 345  55    0E575 320  50    0E577 289  50    0*
40835 10/01E570 373  60    0E570 345  60    0E565 320  65    0E558 300  70    0*
                 **                ***      ***      **      *** ***  **

40840 10/02E575 255  50    0E561 212  45    0E543 173  45    0E531 154  45    0*
40840 10/02E550 270  70    0E540 230  65    0E523 205  55    0E507 190  50    0*
           *** ***  **      *** ***  **      *** ***  **      *** ***  **

40845 10/03E522 142  40    0E518 134  35    0E514 125  35    0E510 104  35    0*
40845 10/03E510 160  50    0E512 138  45    0E512 128  40    0E512 115  40    0*
           *** ***  **      *** ***  **      *** ***  **      *** ***  **

40850 10/04E505  73  35    0E516  49  35    0*  0   0   0    0*  0   0   0    0*
40850 10/04E512  85  35    0E512  55  35    0*  0   0   0    0*  0   0   0    0*
           ***  **          ***  **

40855 HR NC3
40855 HR SC1NC3
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U.S. Hurricane Impact

09/27 15Z 33.4N 78.2W 80 kt South Carolina
09/27 18Z 33.9N 77.6W 110 kt North Carolina

U.S. Tropical Storm Impact

09/28 03Z 35.1N 74.9W 40 kt Virginia

Major changes to the track and intensity shown in McAdie et al. (2009). Evidence for these alterations comes from the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Monthly Weather Review, Surface Weather Observations, Navy reconnaissance book, Mariners Weather Log and NHC Storm Wallets.

September 20:

HWM is not available on this date (system south of 20ºN). HURDAT does not list an organized system on this date. Microfilm shows a tropical wave along longitude 47W, extending from 12N-20N at 12Z. Ship highlights: No gales or low pressures.

MWR: “Hurricane Helene, one of the most intense storms of the 1958 season as well as the most destructive, developed from an easterly wave which can be traced back to the Cape Verde Islands on September 16. Slow intensification of the wave began near longitude 50W on September 20 with pressure falls and above normal shower activity reported by shipping in the area.” ATSR: “Hurricane Helene, the eight storm of the 1958 season, started from an easterly wave which was tracked across the Atlantic commencing 17 September. The wave message, designated 7SM, as received from Fleet Weather Central, Port Lyautey, on 16 September indicated that it was of moderate strength; however, from 16 to 20 September, it appeared to be very weak. On 20 September, ship reports of heavy showers and rain activity in the vicinity of the wave warranted a Navy reconnaissance flight on 21 September. The flight reported only a weak circulation with less than 20 knots surface wind.”

September 21:

HWM is not available on this date (system south of 20ºN). HURDAT lists a 25 knot tropical depression at 19.0N, 54.2W at 12Z. Microfilm shows a tropical wave along longitude 54W, extending from 12N-20N at 12Z. Ship highlights: 40 kt SE and 1012 mb at 18.5N, 52.0W at 18Z (micro).

MWR: “On the 21st, aircraft located evidence of a weak circulation near 19N, 54W with maximum winds of 35 to 40 mph in scattered squalls.”

September 22:

HWM analyzes a tropical storm of at most 1010 mb at 21.3N, 62.5W at 12Z. HURDAT lists a 25 knot tropical depression at 21.3N, 61.9W at 12Z. Microfilm shows a tropical wave along longitude 61W, extending from 18N-25N at 12Z. Ship highlights: No gales or low pressures. Aircraft highlights: Penetration center fix measured a central pressure of 1013 mb and estimated surface winds of 20 kt at 22.1N, 64.9W at 1930Z (ATSR/MWR).

MWR: “The incipient storm moved on a west-northwestward course at approximately 20 mph on the 22nd with little change in intensity. However, an extensive anticyclone in the upper troposphere was developing off the South Atlantic coast during this period so that the disturbance was moving into a much more favorable environment for the deepening process to begin.” ATSR: “The USAF GULL PAPA was diverted to the area on 22 September and reported a well-defined circulation, strong radar definition but with less than 20 knots surface wind and sea-level pressure of 1013 mb.”

September 23:

HWM analyzes a tropical storm of at most 1010 mb at 23.5N, 68.0W at 12Z. HURDAT lists a 45 knot tropical storm at 23.4N, 66.9W at 12Z. Microfilm shows a closed low pressure of at most 1011 mb at 23.5N, 68.0W at 12Z. Ship highlights: 15 kt W and 1002 mb at 23.5N, 68.5W at 15Z (COADS). 40 kt NW and 1009 mb at 24.0N, 69.0W at 18Z (micro). 40 kt SW and 1001 mb at 24.5N, 69.3W at 21Z (micro). Aircraft highlights: Penetration center fix at 23.6N, 67.7W at 10Z (ATSR). Penetration center fix measured a central pressure of 1003 mb and estimated surface winds of 45 kt at 23.7N, 68.3W at 1330Z (ATSR). Penetration center fix at 24.1N, 69.1W at 1930Z (ATSR).

MWR: “On the morning (EST) of the 23rd, reconnaissance aircraft located a center near 23N, 68W, indicating a slowing of forward speed to 12 mph and an increase of winds to 50 mph in squalls.” ATSR: “Again on 23 September, the routine GULL PAPA was cancelled in favor of further reconnaissance of this circulation. This flight reported the storm center at 23.7N 68.3W with maximum surface winds of 45 knots, sea-level pressure of 1003 mb but with a poor radar presentation. Shortly after this report, the first warning on Tropical Storm HELENE was issued.”

September 24:

HWM analyzes a hurricane with a central pressure of 997 mb at 26.5N, 72.0W and a warm front to the north at 12Z. HURDAT lists a 65 knot hurricane at 26.7N, 72.0W at 12Z. Microfilm shows a closed low pressure of at most 1005 mb at 26.5N, 72.0W at 12Z. Ship highlights: 40 kt SSW and 1001 mb at 24.8N, 69.4W at 00Z (micro). 30 kt SSE and 1001 mb at 25.0N, 69.6W at 03Z (micro). 40 kt SE and 1012 mb at 26.1N, 69.4W at 06Z (micro). 65 kt S and 1013 mb at 26.0N, 69.1W at 09Z (micro). 65 kt SSE 27.6N, 70.9W at 18Z (micro). 50 kt S at 27.5N, 70.9W at 21Z (micro). Aircraft highlights: Radar center fix estimated an eye diameter of 15 nm at 24.7N, 69.8W at 02Z (ATSR). Penetration center fix measured a central pressure of 997 mb, and estimated surface winds of 55 kt and an eye diameter of 9 nm at 26.7N, 71.6W at 1330Z (ATSR). Radar center fix estimated an eye diameter of 10 nm at 27.2N, 72.9W at 19Z (ATSR).

MWR: “Helene continued on a west-northwestward course at 12 to 15 mph through the 24th with slow intensification.”

September 25:

HWM analyzes a hurricane with a central pressure of 980 mb at 28.9N, 74.0W and a dissipating front to the north at 12Z. HURDAT lists a 75 knot hurricane at 28.8N, 73.9W at 12Z. Microfilm shows a closed low pressure of at most 1005 mb at 29.0N, 74.0W at 12Z. Ship highlights: 40 kt E and 1013 mb at 29.2N, 72.4W at 00Z (COADS).

40 kt S and 1010 mb at 27.0N, 70.0W at 03Z (micro). 40 kt SE and 1010 mb at 26.5N, 70.8W at 06Z (COADS). 65 kt ESE and 1009 mb at 30.0N, 72.7W at 12Z (micro). 35 kt SE and 1006 mb at 30.0N, 71.5W at 15Z (micro). 40 kt SSE and 1011 mb at 27.7N, 71.1W at 18Z (COADS). 35 kt N and 1010 mb at 28.6N, 77.1W at 21Z (micro). Aircraft highlights: Radar center fix estimated surface winds of 60 kt and an eye diameter of 20 nm at 29.2N, 73.7W at 1737Z (ATSR). Penetration center fix measured a central pressure of 982 mb, and estimated surface winds of 75 kt and an eye diameter of 30 nm at 29.2N, 74.2W at 1826Z (ATSR). Penetration center fix measured a central pressure of 982 mb, estimated surface winds of 76 kt and a 28 nm RMW at 29.0N, 74.0W around 1820Z (NHRP).

September 26:

HWM analyzes a hurricane of at most 1000 mb at 30.0N, 76.0W at 12Z. HURDAT lists a 90 knot hurricane at 30.3N, 76.1W at 12Z. Microfilm shows a closed low pressure of at most 996 mb at 30.5N, 76.0W at 12Z. Ship highlights: 40 kt W and 1006 mb at 29.8N, 78.0W at 00Z (COADS). 45 kt SW and 1002 mb at 28.7N, 75.2W at 0230Z (micro). 40 kt ESE and 1015 mb at 33.7N, 75.9W at 06Z (micro). 35 kt S and 1007 mb at 28.6N, 74.2W at 09Z (micro). 35 kt S and 1007 mb at 28.9N, 74.8W at 12Z (micro). 50 kt NE and 1002 mb at 31.3N, 77.4W at 15Z (COADS). 65 kt NW and 981 mb at 29.0N, 74.7W at 18Z (micro). 65 kt W and 998 mb at 30.0N, 78.3W at 21Z (MWL). Aircraft highlights: Radar center fix estimated an eye diameter of 20 nm at 29.5N, 74.9W at 0055Z (ATSR). Penetration center fix measured a central pressure of 986 mb at 29.5N, 74.8W at 0230Z (ATSR). Penetration center fix at 29.5N, 75.5W at 06Z (ATSR). Penetration center fix measured a central pressure of 974 mb, estimated surface winds of 50 kt and an eye diameter of 20 nm at 29.8N, 75.7W at 08Z (ATSR). Penetration center fix measured a central pressure of 963 mb, estimated surface winds of 55 kt and an eye diameter of 32 nm at 30.5N, 76.8W at 14Z (ATSR). Penetration center fix measured a central pressure of 948 mb, estimated surface winds of 99 kt and a 25 nm RMW at 30.0N, 76.0W around 1830Z (NHRP). Penetration center fix measured a central pressure of 948 mb, estimated surface winds of 110 kt and an eye diameter of 32 nm at 31.1N, 77.8W at 20Z (ATSR). Penetration center fix measured a central pressure of 948 mb, estimated surface winds of 119 kt and a 15 nm RMW at 30.0N, 76.0W around 2030Z (NHRP). Radar center fix at 31.1N, 77.9W at 2307Z (ATSR).

MWR: “On the 26th, reconnaissance aircraft found that the hurricane's central pressure had dropped to 948 mb with winds near the center in excess of 100 mph compared to 988 mb and 75 to 90 mph winds the day before. On September 26, at 1100 EST, hurricane emergency warnings were issued for the coastal areas from Savannah, Ga., to Cape Fear, N.C. At this time the center of Helene was located about 260 miles east of Brunswick,

Ga., moving northwestward toward the coast at 14 mph, and the hurricane center was forecast to reach the coast in the vicinity of Charleston. During the evening it became apparent that Helene was gradually acquiring a more northward component of motion and hurricane warnings were extended northward along the North Carolina coast to Cape Hatteras. The western edge of the hurricane eye came within approximately 10 miles of the coast at Cape Fear and a portion of the intense convective wall cloud passed over land in this area." ATSR: "HELENE was probably the best covered storm in history by reconnaissance aircraft and land-based radar. From 261100Z to 280430Z, the storm was under constant surveillance by both. During the period when HELENE threatened the Carolina coast, AEWRON FOUR WV-3 "Super Connies" made dropsondes and storm penetrations "at will," further proving the ability of the aircraft to penetrate a severe hurricane."

September 27:

HWM analyzes a hurricane of at most 990 mb at 33.4N, 78.0W and a frontal boundary to the northwest at 12Z. HURDAT lists an 115 knot hurricane at 33.1N, 78.2W at 12Z. Microfilm shows a closed low pressure of at most 993 mb at 33.5N, 78.5W with a frontal boundary to the northwest at 12Z. Ship highlights: 50 kt W and 1006 mb at 29.3N, 78.6W at 00Z (COADS). 40 kt SE and 1011 mb at 33.7N, 74.7W at 03Z (micro). 35 kt SW and 1006 mb at 30.8N, 77.3W at 06Z (COADS). 40 kt SE and 1006 mb at 32.0N, 75.5W at 12Z (micro). 55 kt S at 32.1N, 75.6W at 15Z (micro). 55 kt SSW and 996 mb at 36.6N, 76.5W at 18Z (COADS). 65 kt S and 994 mb at 34.1N, 74.9W at 20Z (MWL). 70 kt SSW and 1000 mb at 32.4N, 75.7W at 21Z (MWL). Land highlights: 40 kt E and 1004 mb at Frying Pan, NC at 06Z (micro). 994 mb at Sullivan's Islands, SC at 0920Z (WALLET). 60 kt E and 992 mb at Frying Pan, NC at 12Z (micro). 90 kt S (gusts to 105 kt) and 973 mb at Frying Pan, NC at 1430Z (micro). 50 kt NNE (gusts to 90 kt) and 987 mb at Wilmington, NC at 15Z (micro). 74 kt N (gusts to 117 kt) and 977 mb at Wilmington, NC at 18Z (micro). 60 kt NW (gusts to 108 kt) and 983 mb at Wilmington, NC at 20Z (SWO). Gusts estimated to 125 kt, 948 mb at Cape Lookout, NC at 2230Z (WALLET). 971 mb at Oriental, NC at 2330Z (WALLET). 56 kt NNW (gusts to 84 kt) and 983 mb at Cherry Point, NC at 2359Z (SWO). Aircraft highlights: Penetration center fix estimated surface winds of 100 kt and an eye diameter of 25 nm at 31.5N, 78.3W at 0130Z (ATSR). Penetration center fix measured a central pressure of 943 mb at 31.7N, 78.5W at 0230Z (ATSR). Penetration center fix measured a central pressure of 933 mb and an eye diameter of 25 nm at 32.4N, 78.6W at 0630Z (ATSR). Penetration center fix measured a central pressure of 932 mb, estimated surface winds of 100 kt and an eye diameter of 25 nm at 32.7N, 78.7W at 08Z (ATSR). Penetration center fix measured a central pressure of 938 mb, estimated surface winds of 75 kt and an eye diameter of 25 nm at 33.1N, 78.5W at 11Z (ATSR). Radar center fix measured a peripheral pressure of

940 mb at 1730Z (ATSR). Penetration center fix measured a central pressure of 938 mb and estimated surface winds of 75 kt at 34.4N, 76.3W at 2230Z (ATSR).

MWR: “Helene moved on a northwestward course at 8 to 10 mph during the 26th as it continued to deepen, finally attaining a minimum pressure of 933 mb around midnight (local time) at a position some 80 miles east of Charleston, S.C. Hurricane-force winds, accompanied by high tides and torrential rains, pounded the coastal areas from Cape Fear to Cape Lookout. The Weather Bureau at Wilmington, N.C. recorded a maximum wind (one mile) of 88 mph and a peak gust of 135 mph. Both of these speeds greatly exceeded all previous records there. Total rainfall at Wilmington during the hurricane was 8.29 inches. At Cape Fear, winds were estimated at 125 mph with gusts to 150 to 160 mph. According to Sumner, the wind speeds and wind damage associated with Helene indicate a more intense hurricane than Hazel of 1954, but the fact that the center of Helene passed about 20 miles off the coast prevented the extremely high tides and wave damage associated with the 1954 hurricane. Reconnaissance and other types of observational data from hurricane Helene provided a wealth of material for research and some interesting experimental work was accomplished. Two balloon-borne radio tracking beacons were dropped into the eye of Helene by aircraft of the National Hurricane Research Project and remained in the eye for a significant period. A Navy plane also dropped a metallicized inflated plastic ball on the ocean surface in the eye for radar tracking. It was observed on radar for 12 hours or more.”

September 28:

HWM analyzes a hurricane of at most 985 mb at 36.9N, 70.2W and a dissipating front just to the northwest at 12Z. HURDAT lists a 105 knot hurricane at 36.9N, 70.5W at 12Z. Microfilm shows a closed low pressure of at most 990 mb at 36.5N, 70.5W with a frontal boundary to the north and west at 12Z. Ship highlights: 65 kt SSE and 990 mb at 34.8N, 74.1W at 00Z (COADS). 55 kt SSW and 997 mb at 33.3N, 74.5W at 03Z (micro). 60 kt W and 1000 mb at 33.5N, 74.8W at 06Z (COADS). 70 kt S and 988 mb at 35.9N, 70.8W at 12Z (COADS). 100 kt N and 996 mb at 37.9N, 70.5W at 12Z (micro). 75 kt SE and 988 mb at 38.1N, 66.4W at 18Z (micro). 110 kt NW and 958 mb at 37.5N, 67.4W at 20Z (micro). Land highlights: 50 kt E (gusts to 75 kt) and 978 mb at Cape Hatteras, NC at 0055Z (SWO). 40 kt NNE and 1003 mb at Langley, VA at 0156Z (SWO). 60 kt NNE (gusts to 90 kt) and 975 mb at Cape Hatteras, NC at 0255Z (SWO). 50 kt NNE and 1002 mb at Chesapeake Light, VA at 06Z (micro). Aircraft highlights: Radar center fix at 34.6N, 75.9W at 00Z (ATSR). Penetration center fix measured a central pressure of 945 mb at 34.9N, 75.1W at 03Z (ATSR). Penetration center fix measured a central pressure of 955 mb and estimated an eye diameter of 24 nm at 35.6N, 73.0W at 08Z (ATSR). Penetration center fix measured a central pressure of

966 mb, estimated surface winds of 90 kt and estimated an eye diameter of 24 nm at 36.9N, 70.0W at 14Z (ATSR). Penetration center fix measured a central pressure of 943 mb and estimated surface winds of 105 kt at 38.7N, 66.9W at 2130Z (ATSR). Penetration center fix measured a central pressure of 951 mb at 39.0N, 65.0W at 2230Z (ATSR).

September 29:

HWM analyzes a hurricane of at most 970 mb at 46.9N, 59.0W and a warm front to the northeast and a cold front to the south at 12Z. HURDAT lists a 65 knot hurricane at 45.7N, 59.0W at 12Z. Microfilm shows an extratropical cyclone of at most 978 mb at 42.0N, 62.0W at 12Z. Ship highlights: 975 mb at 40.5N, 65.7W at 00Z (COADS). 65 kt N and 1003 mb at 39.9N, 69.4W at 00Z (COADS). 65 kt NNW and 990 mb at 42.5N, 64.0W at 06Z (COADS). 80 kt SSW and 975 mb at 40.9N, 62.2W at 06Z (micro). 55 kt NW and 983 mb at 43.3N, 61.2W at 09Z (micro). 55 kt NW and 993 mb at 43.4N, 60.4W at 12Z (micro). 70 kt SW and 979 mb at 45.7N, 56.2W at 15Z (COADS). 60 kt W and 989 mb at 45.7N, 56.4W at 18Z (COADS). Land highlights: 50 kt N and 990 mb at Halifax, Canada at 06Z (micro). 30 kt ESE and 978 mb at St. Paul Island, Canada at 12Z (micro). 30 kt SE and 973 mb at Benton, Canada at 18Z (micro). 45 kt WSW and 982 mb at St. Paul Island, Canada at 18Z (micro).

MWR: “After recurvature, Helene moved northeastward at an accelerated rate and crossed Newfoundland on the 29th. The storm continued across the Atlantic as a large and vicious extratropical Low that dominated the weather over a large area for several more days.”

September 30:

HWM analyzes an extratropical cyclone of at most 970 mb at 55.5N, 45.0W at 12Z. HURDAT lists a 60 knot extratropical storm at 55.0N, 45.0W at 12Z. Microfilm shows an extratropical cyclone of at most 993 mb at 55.5N, 42.5W at 12Z. Ship highlights: 60 kt SW and 988 mb at 48.2N, 50.1W at 00Z (COADS). 50 kt N and 976 mb at 53.6N, 50.7W at 06Z (COADS). 50 kt SW and 981 mb at 52.2N, 44.0W at 12Z (COADS). 60 kt NW and 986 mb at 54.0N, 47.0W at 18Z (COADS).

October 1:

HWM analyzes an extratropical cyclone of at most 970 mb at 57.0N, 33.0W at 12Z. HURDAT lists a 50 knot extratropical storm at 57.5N, 32.0W at 12Z. Microfilm shows that the extratropical cyclone has moved off the northeast edge of the synoptic map at 12Z. Ship highlights: 60 kt WSW and 987 mb at 53.6N, 35.3W at 00Z (COADS). 55 kt WSW and 989 mb at 52.9N, 33.0W at 06Z (COADS). 60 kt W and 996 mb at

52.8N, 35.5W at 09Z (COADS). 55 kt WNW and 999 mb at 52.8N, 35.5W at 12Z (COADS). 70 kt W and 996 mb at 53.4N, 35.5W at 18Z (COADS).

October 2:

HWM analyzes an extratropical cyclone of at most 985 mb at 55.7N, 14.9W at 12Z. HURDAT lists a 45 knot extratropical storm at 54.3N, 17.3W at 12Z. Microfilm is not available on this date. Ship highlights: 40 kt W and 985 mb at 53.2N, 20.8W at 00Z (COADS). 45 kt W and 1004 mb at 46.5N, 28.8W at 06Z (COADS). 45 kt NW and 988 mb at 49.1N, 26.9W at 12Z (COADS). 50 kt NW and 1000 mb at 47.3N, 29.2W at 14Z (COADS). 45 kt W and 1002 mb at 43.2N, 23.6W at 18Z (COADS). 50 kt NW and 998 mb at 47.4N, 26.9W at 20Z (COADS).

October 3:

HWM analyzes an extratropical cyclone of at most 980 mb at 56.5N, 14.0W at 12Z. HURDAT lists a 35 knot extratropical storm at 51.4N, 12.5W at 12Z. Microfilm is not available on this date. Ship highlights: 45 kt W and 999 mb at 43.5N, 23.7W at 00Z (COADS). 45 kt NNW and 999 mb at 44.2N, 23.0W at 06Z (COADS). 35 kt NW and 1000 mb at 45.4N, 20.7W at 12Z (COADS). 40 kt S and 991 mb at 48.8N, 6.3W at 18Z (COADS). Land highlights: 10 kt S and 988 mb at Kerry, Ireland at 12Z (HWM).

October 4:

HWM analyzes a frontal boundary over western Europe at 12Z. HURDAT lists a 35 knot extratropical storm at 51.6N, 4.9W at 06Z (last position). Microfilm is not available on this date. Ship highlights: 25 kt SW and 987 mb at 50.1N, 7.5W at 00Z (COADS). 30 kt SSW and 992 mb at 50.3N, 2.7W at 06Z (COADS).

October 5:

HWM analyzes a frontal boundary over western Europe at 12Z. HURDAT does not list an organized storm on this date. Microfilm is not available on this date. Ship highlights: No gales or low pressures.

Hurricane Helene developed from a tropical wave that left the African coast around mid-September. Microfilm indicates that the wave showed little signs of development as it tracked westward across the eastern and central Atlantic, although the ship data over this area of the basin is sparse. Minor track changes are analyzed during the lifetime of Helene as a tropical cyclone; major track changes were analyzed at 12Z and 18Z on October 2nd when the system was an extratropical cyclone. The first position is at 06Z on September 21st as a 25 kt tropical depression, same as the original HURDAT. The actual genesis of this tropical cyclone is highly uncertain due to the low ship traffic east of the

Lesser Antilles, but the data available suggests that the center was about 90 nm south than originally shown in HURDAT. It is also possible that the tropical cyclone did not develop a well-defined low-level circulation until September 22nd based on aircraft reconnaissance reports and ship observations. A ship reported 40 kt SE on September 21st at 18Z but this was about 300 nm east of the center and appears to have a high wind bias. The first reconnaissance aircraft penetration center fix measured a central pressure of 1013 mb and estimated surface winds of 20 kt at 1930Z on September 22nd. (Central pressures values for each 6 hour period were present in the original HURDAT between September 22nd at 12Z and September 30th at 00Z. Some of these were obviously analyses that were added in, not based upon actual observations. Thus, based on actual observations, some were retained and others removed. Detailed information on these changes can be found in the table at the end.) Intensification to a tropical storm is analyzed at 00Z on September 23rd, same as the original HURDAT. The next reconnaissance aircraft reached Helene at 1330Z and measured a central pressure of 1003 mb and estimated surface winds of 45 kt. A central pressure of 1003 mb suggests maximum sustained winds of 41 kt intensifying south of 25N from the Brown et al. pressure-wind relationship. An intensity of 40 kt is selected for 12Z on the 23rd, 5 kt less than originally shown in HURDAT, a minor intensity change. A few ships late on September 23rd reported low-end tropical storm force winds near the tropical cyclone.

On September 24th, Helene continued to intensify while moving to the northwest. A reconnaissance aircraft reached the tropical cyclone at 1330Z and measured a central pressure of 997 mb, estimated surface winds of 55 kt and an eye diameter of 9 nm. A central pressure of 997 mb suggests maximum surface winds of 51 kt north of 25N from the pressure-wind relationship. An eye diameter of 9 nm suggests an RMW of about 7 nm and the climatological value is 20 nm. Based on an RMW smaller than the climatology value and a forward speed of about 14 kt, an intensity of 60 kt is selected at 12Z on the 24th, down from 65 kt originally in HURDAT, a minor intensity change. Intensification to a hurricane is analyzed at 18Z on the 24th, six hours later than originally shown in HURDAT. A ship reported 65 kt S at 09Z on the 24th, but it was located about 150 nm southeast of the center and it is likely to have a high wind bias, compared to other ships nearby. Late on September 25th, the Navy and NHRP were investigating Helene and measured a central pressure of 982 mb around 18Z. The Navy aircraft also estimated surface winds of 75 kt and an eye diameter of 30 nm, while the NHRP aircraft estimated surface winds of 76 kt and an RMW of 28 nm. A central pressure of 982 mb suggests maximum sustained winds of 73 kt north of 25N intensifying. Since the forward speed of the hurricane had decreased to about 5 kt and the RMW is somewhat larger than climatology (28 nm vs 22 nm), an intensity of 70 kt is selected for 18Z on the 25th, down from 80 kt originally in HURDAT, a minor intensity change. Another penetration center fix at 0230Z on September 26th measured a central pressure of 986 mb, indicating that

Helene may have temporarily weakened. A central pressure of 986 mb suggests maximum sustained winds of 65 kt north of 25N from the pressure-wind relationship. An intensity of 65 kt is selected for 00Z on the 26th, down from 85 kt originally in HURDAT, a major intensity change. It is possible that Helene may have weakened to a high-end tropical storm early on the 26th. Soon thereafter, Helene started to rapidly intensify. A reconnaissance aircraft measured a central pressure of 974 mb, estimated surface winds of 50 kt and an eye diameter of 20 nm at 08Z on the 26th. A central pressure of 974 mb suggests maximum surface winds of 83 kt north of 25N intensifying from the pressure wind-relationship. An eye diameter of 20 nm suggests an RMW of about 15 nm and the climatological value is 23 nm. Based on the RMW being smaller than the climatological value and a forward speed of about 8 kt, an intensity of 80 kt is selected for 06Z on the 26th, down from 85 kt originally in HURDAT, a minor intensity change. Another reconnaissance aircraft measured a central pressure of 963 mb, estimated surface winds of 55 kt and an eye diameter of 32 nm at 14Z on the 26th. A central pressure of 963 mb suggests maximum surface winds of 96 kt north of 25N intensifying from the pressure wind-relationship. An eye diameter of 32 nm suggests an RMW of about 24 nm and the climatological value is 22 nm. Because the RMW is similar to climatology and the forward speed was about 10 kt, an intensity of 95 kt is selected for 12Z on the 26th, up from 90 kt originally in HURDAT, a minor intensity change. Finally, a NHRP reconnaissance aircraft measured a central pressure of 948 mb, estimated surface winds of 99 kt and an RMW of 25 nm around 1830Z on the 26th. Later at 20Z, a Navy aircraft measured a central pressure of 948 mb, estimated surface winds of 110 kt and an eye diameter of 32 nm. A central pressure of 948 mb suggests maximum surface winds of 112 kt north of 25N intensifying from the pressure wind-relationship. Based on an RMW slightly larger than climatology (25 nm versus 20 nm) and a forward speed of about 13 kt, an intensity of 110 kt is selected for 18Z on the 26th, up from 105 kt originally in HURDAT, a minor intensity change. Intensification to a major hurricane is analyzed at 18Z on the 26th, same as shown in the original HURDAT.

On September 27th, Helene continued to intensify as it approached the United States and started to turn to the north and later to the northeast. A reconnaissance aircraft measured a central pressure of 943 mb at 0230Z on the 27th. A central pressure of 943 mb suggests maximum surface winds of 117 kt north of 25N intensifying from the pressure wind-relationship. An eye diameter of 25 nm measured at 0630Z at the 27th suggests an RMW of about 19 nm and the climatological value is 21 nm. Since the RMW is close to the climatological value and the forward speed was about 10 kt, an intensity of 115 kt is selected for 00Z on the 27th, up from 110 kt originally in HURDAT, a minor intensity change. Another reconnaissance aircraft measured a central pressure of 933 mb at 06Z on the 27th. The aircraft also estimated surface winds of 100 kt and an eye diameter of 25 nm at 08Z. A central pressure of 933 mb suggests maximum surface winds of 127 kt north of

25N intensifying from the pressure wind-relationship. An eye diameter of 25 nm suggests an RMW of about 19 nm and the climatological value is 21 nm. An intensity of 125 kt is selected for 06Z on the 27th, up from 110 kt originally in HURDAT, a minor intensity change. The next reconnaissance aircraft measured a central pressure of 938 mb, estimated surface winds of 75 kt and an eye diameter of 25 nm at 11Z on the 27th. A central pressure of 938 mb suggests maximum surface winds of 116 kt north of 25N and 111 kt north of 25N weakening from the pressure wind-relationship. An eye diameter of 25 nm suggests an RMW of about 19 nm and the climatological value is 23 nm. An intensity of 120 kt is selected for 12Z on the 27th, up from 115 kt originally in HURDAT, a minor intensity change. Late on the 27th, the eye of Helene passed very close to North Carolina, about 10 nm south of Cape Fear and Cape Lookout. The strongest winds likely affected southeast North Carolina. The strongest winds reported in North Carolina were 74 kt at Wilmington and 110 kt estimated at Cape Fear. The Schwerdt et al. parametric hurricane wind model suggests that the highest sustained winds that impacted North Carolina reached 110 kt. The same wind model suggests that South Carolina was impacted by 92 kt winds, but since the winds that affected the state were coming from the north and northeast moving over land, a 15% wind reduction was implemented, suggesting maximum winds of 80 kt. Therefore, Helene is analyzed as a category 3 hurricane impact for North Carolina and category 1 hurricane impact for South Carolina. The strongest winds likely affected eastern South Carolina. The strongest winds reported in South Carolina were 35 kt at Myrtle Beach on the 27th at 15Z. Moreover, tropical storm force winds impacted southern Virginia and both, the hurricane wind model and surface observations at Norfolk and Langley, indicate that the highest winds were around 40 kt. Early on September 28th, Helene started to move away from the United States ahead of a frontal boundary. A reconnaissance aircraft measured a central pressure of 938 mb and estimated surface winds of 75 kt at 2230Z on the 27th. A central pressure of 938 mb suggests maximum surface winds of 116 kt north of 25N from the Brown et al. pressure wind-relationship and 104 kt north of 35N from the Landsea et al. pressure-wind relationship. Based on a forward speed of about 10 kt, an intensity of 115 kt is selected for 00Z on the 28th, up from 110 kt originally in HURDAT, a minor intensity change. Two more penetration center fixes reported a central pressure of 945 mb at 03Z and 955 mb at 08Z on the 28th. A blend of these two measurements suggests a central pressure of about 950 mb around 06Z on the 27th, same as the original HURDAT. The aircraft also reported an eye diameter of 24 nm at 08Z on the 28th. A central pressure of 950 mb suggests sustained maximum winds of 101 kt north of 25N weakening and 97 kt north of 35kt, according to the corresponding pressure-wind relationships. An eye diameter of 24 nm suggests an RMW of about 18 nm and the climatological value is 25 nm. At this time, Helene was increasing in forward speed as it moved northeastward. Based on a forward

speed of about 25 kt and an RMW smaller than climatology, an intensity of 110 kt is selected at 06Z on the 28th, same as originally shown in HURDAT.

On the 28th, Helene started to interact with a frontal boundary off the Mid-Atlantic of the United States and began to acquire extratropical characteristics. A reconnaissance aircraft at 14Z estimated surface winds of 90 kt and measured a pressure of 966 mb. Based on central pressure reports earlier and later on the day, it is likely that this pressure report was not a central pressure and has not been added to HURDAT. The last reconnaissance aircraft to reach Helene measured a central pressure of 943 mb and estimated surface winds of 105 kt at 2130Z and 951 mb at 2230Z on the 28th. A central pressure of 943 mb suggests maximum surface winds of 101 kt north of 35N from the pressure-wind relationship. Since the hurricane was becoming extratropical and also moving very rapidly (~39 kt) towards the east-northeast, an intensity of 100 kt is selected at 18Z on the 28th, up from 90 kt originally in HURDAT, a minor intensity change. Early on September 29th, coastal and ship observations indicate that Helene had become an extratropical cyclone. A temperature gradient had developed E-W across the circulation, along with frontal features. Extratropical transition is analyzed eighteen hours earlier than originally shown in HURDAT. Later on the 29th, Helene moved over the Atlantic provinces of Canada before moving northeast into the North Atlantic. It is analyzed that Helene reached Canada as a powerful extratropical cyclone and not as a hurricane as originally shown in HURDAT. Weakening below hurricane force occurred at 06Z on September 30th, six hours later than originally shown in HURDAT. Late on October 1st, ship observations indicate that the extratropical cyclone regained winds of hurricane force, but the strengthening was short-lived as the system started to weaken again on October 2nd. Major intensity changes are analyzed at 18Z on the 1st, and 00Z and 06Z on the 2nd. The analyzed intensity for these times is 70 kt, 70 kt and 65 kt, and HURDAT originally showed 50 kt, 50 kt and 45 kt, respectively. Late on the 2nd, the extratropical cyclone weakened again below hurricane force and kept a general eastward track. Early on October 4th, the weakened extratropical cyclone merged with another extratropical cyclone to the north. The last position is analyzed at 00Z on the 4th, same as originally shown in HURDAT.

Date	Original HURDAT Central Pressure	Evidence	Changes
Sep 22 12Z	1015 mb	Ship: 20 kt E and 1012 mb at 12Z on Sep 22nd	Removed
Sep 22 18Z	1014 mb	Penetration center fix: 1013 mb at 1930Z on Sep 22nd	1013 mb

Sep 23 00Z	1013 mb	Based on penetration center fix at 18Z on Sep 23rd	Removed
Sep 23 06Z	1011 mb		
Sep 23 12Z	1009 mb	Penetration center fix: 1003 mb at 1330Z on Sep 23rd	1003 mb
Sep 23 18Z	1007 mb	Ship: 15 kt W and 1002 mb at 15Z on Sep 23rd	1000 mb
Sep 24 00Z	1005 mb	Lower central pressures at 18Z on Sep 23rd and 122Z on Sep 24th	Removed
Sep 24 06Z	1004 mb		
Sep 24 12Z	1002 mb	Penetration center fix: 997 mb at 1330Z on Sep 24th	997 mb
Sep 24 18Z	998 mb	Lower central pressure at 12Z on Sep 24th	Removed
Sep 25 00Z	993 mb	No central pressure reports but appear reasonable	Retained
Sep 25 06Z	987 mb		
Sep 25 12Z	984 mb		
Sep 25 18Z	983 mb	Penetration center fix: 982 mb at 1826Z on Sep 25th	982 mb
Sep 26 00Z	980 mb	Penetration center fix: 986 mb at 0230Z on Sep 26th	986 mb
Sep 26 06Z	977 mb	Penetration center fix: 974 mb at 08Z on Sep 26th	974 mb
Sep 26 12Z	967 mb	Penetration center fix: 963 mb at 14Z on Sep 26th	963 mb
Sep 26 18Z	955 mb	Penetration center fix: 948 mb around 1830Z on Sep 26th	948 mb
Sep 27 00Z	943 mb	Penetration center fix: 943 mb at 0230Z on Sep 27th	Retained
Sep 27 06Z	934 mb	Penetration center fix: 933 mb at 06Z on Sep 27th	933 mb
Sep 27 12Z	938 mb	Penetration center fix: 938 mb at 11Z on Sep 27th	Retained
Sep 27 18Z	943 mb	Lower central pressures measured at 12Z on Sep 27th and 00Z on Sep 28th	Removed
Sep 28 00Z	946 mb	Penetration center fix: 938 mb at 2230Z on Sep 27th	938 mb
Sep 28 06Z	950 mb	Penetration center fixes: 945 mb at 03Z on	Retained

		Sep 28th and 955 mb at 08Z on Sep 28th	
Sep 28 12Z	954 mb	No central pressure reports but appears reasonable	
Sep 28 18Z	957 mb	Penetration center fix: 943 mb at 2130Z on Sep 28th	943 mb
Sep 29 00Z	959 mb	Penetration center fix: 951 mb at 2230Z on Sep 28th	951 mb
Sep 29 06Z	963 mb	No central pressure reports but appear reasonable	Retained
Sep 29 12Z	966 mb		
Sep 29 18Z	968 mb		
Sep 30 00Z	972 mb		

Hurricane Ilsa [September 24-30, 1958]

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40860 09/24/1958 M= 7  9 SNBR= 888 ILSA        XING=0 SSS=0
40860 09/24/1958 M= 7 10 SNBR= 888 ILSA        XING=0 SSS=0
                         **

40865 09/24*  0   0   0    0*173 508  30    0*177 521  35    0*181 543  40  998*
40865 09/24*  0   0   0    0*175 515  50    0*177 529  50    0*179 543  50  998*
                            *** ***  **          ***  **      ***       **

40870 09/25*183 557  45    0*184 564  50    0*185 571  65    0*187 579  65    0*
40870 09/25*180 556  55    0*181 568  60    0*183 581  65  985*186 593  70  980*
           *** ***  **      *** ***  **      *** ***      *** *** ***  **  ***

40875 09/26*190 588  70    0*194 598  75    0*200 607  95    0*207 611 105    0*
40875 09/26*190 600  80    0*194 605  90  962*197 608  95  956*200 611 110  940*
              ***  **          ***  **  *** *** ***  **  *** ***     ***  ***

40880 09/27*214 612 115    0*219 613 110    0*223 613 105    0*232 612 100    0*
40880 09/27*204 613 120  932*209 613 105  949*219 611 100    0*232 610  90    0*
           *** *** ***  *** ***     ***  *** *** *** ***          ***  **

40885 09/28*245 611 100    0*262 615  95    0*280 619  90    0*295 616  90    0*
40885 09/28*245 611  75    0*259 615  65  989*276 619  75    0*293 618  80  980*
                 **       ***       **  *** ***      **      ***       **  ***

40890 09/29*310 608  90    0*328 595  85    0*348 576  85    0*371 549  80    0*
40890 09/29*310 610  80  980*329 594  80  980E350 580  80    0E374 549  80    0*
              ***  **  *** *** ***  **  ******* ***  **     ****       **

40895 09/30*399 513  60    0E431 478  55    0*  0   0   0    0*  0   0   0    0*
40895 09/30E399 518  70    0E438 460  60    0*  0   0   0    0*  0   0   0    0*
              ***  **      *** ***  **

40900 HR
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Minor changes to the track and major changes to the intensity shown in McAdie et al. (2009). Evidence for these alterations comes from the NHC microfilm maps, the

Historical Weather Maps series, the COADS ship database, Monthly Weather Review, and Navy reconnaissance book and NHC Storm Wallets.

September 23:

HWM is not available on this date (system south of 20ºN). HURDAT does not list an organized system on this date. Microfilm does not show an organized system at 12Z. Ship highlights: No gales or low pressures.

MWR: “Ship reports on September 23 indicated that special aircraft reconnaissance into the area east of the Antilles was necessary.”

September 24:

HWM is not available on this date (system south of 20ºN). HURDAT lists a 35 knot tropical storm at 17.7N, 52.1W at 12Z. Microfilm shows a closed low pressure of at most 999 mb at 17.5N, 54.0W at 12Z. Ship highlights: 40 kt ENE and 1002 mb at 18.5N, 54.7W at 18Z (micro). 50 kt E and 1007 mb at 18.5N, 54.7W at 2030Z (micro). Aircraft highlights: Penetration center fix estimated surface winds at 35 kt and measured a central pressure of 998 mb at 17.7N, 54.0W at 1606Z (MWR).

MWR: “Tropical storm Ilsa was located at 1606 GMT on the 24th at latitude 17.7N, longitude 54.0W, about 800 statute miles east of San Juan, P.R., and 1,300 miles east-southeast of the position of tropical storm Helene. At this time, highest winds were 40 mph and central pressure 997.6 mb.” ATSR: “On 24 September a vortex was definitely confirmed by an Air Force reconnaissance aircraft at 241728Z in position 17.7N 54.0W.”

September 25:

HWM is not available on this date (system south of 20ºN). HURDAT lists a 65 knot hurricane at 18.5N, 57.1W at 12Z. Microfilm shows a closed low pressure of at most 1005 mb at 18.0N, 57.0W at 12Z. Ship highlights: 35 kt N and 1009 mb at 18.1N, 57.6W at 12Z (micro). 60 kt E and 1005 mb at 19.5N, 59.9W at 18Z (micro). Aircraft highlights: Radar center fix at 18.7N, 57.5W at 1120Z (ATSR). Penetration center fix estimated surface winds at 65 kt, measured a central pressure of 985 mb and an eye diameter of 30 nm at 17.7N, 54.0W at 14Z (ATSR). Penetration center fix estimated surface winds at 70 kt, measured a central pressure of 980 mb and an eye diameter of 30 nm at 18.8N, 59.8W at 20Z (ATSR).

MWR: “By the 25th, Ilsa and Helene, both of hurricane intensity, were located some 1,100 miles apart.”

September 26:

HWM analyzes a hurricane with a central pressure of 957 mb at 20.0N, 60.8W at 12Z. HURDAT lists a 95 knot hurricane at 20.0N, 60.7W at 12Z. Microfilm shows a closed low pressure of at most 993 mb at 20.0N, 60.5W at 12Z. Ship highlights: 35 kt SE and 1013 mb at 17.6N, 55.7W at 00Z (micro). 40 kt ENE and 1015 mb at 22.0N, 61.5W at 03Z (micro). 70 kt SSE at 18.9N, 59.4W at 06Z (COADS). 70 kt SSE at 19.3N, 59.1W at 09Z (COADS). 85 kt SE at 19.5N, 58.9W at 12Z (COADS). 70 kt SE at 19.5N, 58.8W at 15Z (COADS). 70 kt SE at 19.3N, 58.3W at 18Z (COADS). 60 kt SE at 19.1N, 58.1W at 21Z (COADS). Aircraft highlights: Radar fix estimated an eye diameter of 35 nm at 19.3N, 59.8W at 0110Z (ATSR). Penetration center fix measured a central pressure of 962 mb at 19.5N, 60.4W at 0730Z (ATSR/micro). Penetration center fix measured a central pressure of 956 mb at 19.8N, 60.6W at 1330Z (ATSR/micro). Penetration center fix estimated surface winds at 80 kt, measured a central pressure of 940 mb and an eye diameter of 30 nm at 20.1N, 61.3W at 20Z (ATSR/micro).

MWR: “Ilsa deepened rapidly on the 26th, reaching 932 mb (dropsonde), a fall of 48 mb in about 24 hr. The eye was well defined, and spiral bands were described as a typical textbook picture. Winds were estimated to exceed 125 mph.”

September 27:

HWM analyzes a hurricane with a central pressure of 984 mb at 22.5N, 61.2W at 12Z. HURDAT lists a 105 knot hurricane at 22.3N, 61.3W at 12Z. Microfilm shows a closed low pressure of at most 1008 mb at 21.5N, 62.0W at 12Z. Ship highlights: 40 kt SE and 1008 mb at 20.4N, 58.9W at 12Z (micro). 65 kt SE and 1008 mb at 22.9N, 59.8W at 15Z (micro). 60 kt SE and 1005 mb at 22.4N, 59.7W at 18Z (micro). 50 kt SE and 1009 mb at 23.7N, 58.7W at 21Z (micro). Aircraft highlight: Penetration center fix measured a central pressure of 932 mb at 20.7N, 61.2W at 02Z (ATSR/micro). Penetration center fix measured a central pressure of 949 mb and an eye diameter of 40 nm at 20.9N, 61.1W at 08Z (ATSR). Penetration center fix at 22.4N, 61.0W at 14Z (ATSR). Penetration center fix at 23.5N, 60.8W at 1930Z (ATSR).

MWR: “The storm began to fill on the 27th and regular advisories were discontinued on the 30th. No loss of life or property damage was reported.”

September 28:

HWM analyzes a hurricane with a central pressure of 967 mb at 28.1N, 61.9W at 12Z. HURDAT lists a 90 knot hurricane at 28.1N, 61.9W at 12Z. Microfilm shows a closed low pressure of at most 993 mb at 29.0N, 62.5W at 12Z. Ship highlights: 35 kt S at 22.4N, 57.0W at 00Z (COADS). 50 kt SE and 1005 mb at 26.5N, 59.9W at 03Z

(micro). 45 kt NE and 1006 mb at 28.3N, 62.1W at 06Z (micro). 90 kt S and 1001 mb at 28.5N, 61.0W at 12Z (micro). 45 kt NW and 1003 mb at 28.3N, 64.4W at 15Z (COADS). 95 kt SSW and 998 mb at 28.1N, 61.4W at 18Z (micro). Aircraft hilights: Radar center fix at 26.3N, 60.8W and an eye diameter of 45 nm at 02Z (ATSR). Penetration center fix estimated surface winds at 60 kt, measured a central pressure of 989 mb and an eye diameter of 50 nm at 27.8N, 61.8W at 0728Z (ATSR). Penetration center fix at 27.7N, 62.2W at 1348Z (ATSR). Penetration center fix measured a central pressure of 980 mb at 29.1N, 61.9W at 17Z (ATSR/micro). Penetration center fix measured a central pressure of 975 mb at 30.6N, 61.3W at 2140Z (ATSR/micro).

September 29:

HWM analyzes a hurricane with a central pressure of 975 mb at 34.8N, 57.5W and a cold front just to the northwest at 12Z. HURDAT lists an 85 knot hurricane at 34.8N, 57.6W at 12Z. Microfilm shows a closed low pressure of at most 1002 mb with a frontal boundary going through the center at 35.0N, 59.0W at 12Z. Ship highlights: 45 kt SSE and 1001 mb at 33.1N, 58.0W at 06Z (COADS). 40 kt NW and 1003 mb at 38.8N, 58.5W at 12Z (COADS). 75 kt WNW at 35.2N, 54.5W at 18Z (micro). Aircraft highlights: Penetration center fix measured a central pressure of 980 mb at 30.8N, 60.7W at 0130Z (ATSR/micro). Penetration center fix measured a central pressure of 980 mb at 32.9N, 58.9W at 0744Z (ATSR/micro). Penetration center fix at 35.3N, 56.7W at 1415Z (ATSR). Radar center fix at 37.7N, 54.3W at 1936Z (ATSR).

September 30:

HWM analyzes an extratropical cyclone of at most 995 mb at 46.0N, 41.5W embedded within a frontal boundary at 12Z. HURDAT lists a 55 knot extratropical storm at 43.1N, 47.8W at 06Z (last position). Microfilm shows that Ilsa has been absorbed by a much larger extratropical cyclone (Helene) to the north at 12Z. Ship highlights: 50 kt S and 1007 mb at 38.9N, 49.5W at 00Z (micro). 35 kt S and 997 mb at 43.7N, 45.4W at 06Z (COADS). 40 kt SSW and 992 mb at 46.0N, 41.2W at 12Z (micro).

Hurricane Ilsa developed from a tropical wave over the central Atlantic late on September. The first position, not genesis, is analyzed at 06Z on September 24th as a 50 kt tropical storm based on observations later on the day, up from 30 kt originally in HURDAT, a major intensity change. Data over the central Atlantic is sparse and the genesis of Ilsa could have occurred substantially earlier than originally shown in HURDAT. Minor track changes are introduced for the duration of this system. At 1606Z on the 24th, a reconnaissance aircraft reached Ilsa measuring a central pressure of 998 mb and estimating surface winds of 35 kt. A central pressure of 998 mb suggests maximum winds of 51 kt south of 25N from the Brown et al. pressure-wind relationship. An

intensity of 50 kt is selected for 18Z on the 24th, up from 40 kt originally in HURDAT, a minor intensity change. A central pressure of 998 mb is present in HURDAT at 18Z on the 24th and has been retained. Gale-force winds up to 50 kt were reported by ships late on the 24th. Ilsa moved west-northwest on September 25th and continued to strengthen. A reconnaissance aircraft reached the tropical cyclone at 14Z on the 25th measuring a central pressure of 985 mb and estimated surface winds of 65 kt and an eye diameter of 30 nm. A central pressure of 985 mb suggests maximum winds of 71 kt south of 25N intensifying from the pressure-wind relationship. An eye diameter of 30 nm suggests an RMW of about 22 nm and climatology suggests about 15 nm. Due to the RMW being larger than climatology, an intensity of 65 kt is selected at 12Z on the 25th, same as the original HURDAT. Intensification to a hurricane is analyzed at 12Z on the 25th, same as the original HURDAT. A central pressure of 985 mb is added to HURDAT at 12Z on the 25th. Another reconnaissance aircraft reached Ilsa at 20Z on the 25th measuring a central pressure of 980 mb and estimated surface winds of 70 kt and an eye diameter of 30 nm. A central pressure of 980 mb suggests maximum winds of 78 kt south of 25N intensifying from the pressure-wind relationship. An eye diameter of 30 nm suggests an RMW of about 22 nm and climatology suggests about 16 nm. Since the RMW remained slightly larger than average, an intensity of 70 kt is selected at 18Z on the 25th, up from 65 kt in the original HURDAT, a minor intensity change. A central pressure of 980 mb is added to HURDAT at 18Z on the 25th.

Early on September 26th, Ilsa made its closest approach to the Leeward Islands passing about 130 nm northeast of Barbuda. On this day, the forward speed of the hurricane decreased to about 4 kt and the track turned to the northwest while rapidly gaining strength. A reconnaissance aircraft reached the hurricane at 0730Z on the 26th measuring a central pressure of 962 mb. A central pressure of 962 mb suggests maximum winds of 100 kt south of 25N intensifying according to the pressure-wind relationship. Due to the slow forward speed of about 4 kt and large RMW from the previous day and confirmed on a reconnaissance mission later on the 26th, an intensity of 90 kt is selected for 06Z, up from 75 kt originally in HURDAT, a minor intensity change. A central pressure of 962 mb is added to 06Z on the 26th. Another reconnaissance aircraft measured a central pressure of 956 mb at 1330Z on the 26th. A central pressure of 956 mb suggests maximum winds of 107 kt south of 25N intensifying according to the pressure-wind relationship. Due to the slow forward speed of about 4 kt and relatively large RMW, an intensity of 95 kt is selected for 06Z, same as the original HURDAT. A central pressure of 956 mb is added to 12Z on the 26th. The last center penetration on the 26th by the reconnaissance aircraft occurred at 20Z measuring a central pressure of 940 mb and estimating surface winds of 80 kt and an eye diameter of 30 nm. A central pressure of 940 mb suggests maximum winds of 123 kt south of 25N intensifying according to the pressure-wind relationships. An eye diameter of 30 nm suggests an RMW of about 22 nm

and climatology suggests about 12 nm. Due to the RMW being larger than climatology and slow forward speed of about 4 kt, an intensity of 110 kt is selected at 18Z on the 26th, up from 105 kt in the original HURDAT, a minor intensity change. A central pressure of 940 mb is added to 18Z on the 26th. Intensification to a major hurricane is analyzed at 18Z on the 26th, same as the original HURDAT. On September 27th, the track of Ilsa turned to the north slowly gaining in forward speed. The period of rapid intensification continued into the morning of the 27th when a reconnaissance aircraft measured a central pressure of 932 mb at 02Z. A central pressure of 932 mb suggests maximum winds of 130 kt south of 25N intensifying according to the pressure-wind relationship. Since the hurricane was still moving at around 5 kt and the RMW was larger than climatology, an intensity of 120 kt is selected at 00Z on the 27th, up from 115 kt originally in HURDAT, a minor intensity change. 120 kt is also the peak intensity for this hurricane, up from 115 kt originally in HURDAT, a minor intensity change. A central pressure of 932 mb is added to 00Z on the 27th. The next reconnaissance aircraft found that Ilsa had begun to weaken, measuring a central pressure of 949 mb and an eye diameter of 40 nm at 08Z. A central pressure of 949 mb suggests maximum winds of 108 kt south of 25N weakening according to the pressure-wind relationships. An eye diameter of 40 nm suggests an RMW of about 30 nm and climatology suggests about 14 nm. Because the hurricane was moving around 8 kt and the RMW was larger than average, an intensity of 105 kt is selected for 06Z on the 27th, down from 110 kt originally in HURDAT, a minor intensity change. A central pressure of 949 mb is added to 06Z on the 27th. Weakening below major hurricane status is analyzed at 12Z on the 27th, 18 hours earlier than originally shown in HURDAT. Most ships remained away from the circulation of Ilsa on the 27th but a few reported tropical storm force winds.

Ilsa continued to weaken on September 28th. A reconnaissance aircraft reached the hurricane at 0728Z measuring a central pressure of 989 mb and estimating surface winds of 60 kt and an eye diameter of 50 nm. A central pressure of 989 mb suggests maximum winds of 58 kt north of 25N weakening according to the pressure-wind relationships. An eye diameter of 50 nm suggests an RMW of about 38 nm and climatology suggests about 24 nm. Although the RMW is larger than average, the forward speed had increased to about 17 kt and a few ships reported hurricane-force winds, thus an intensity of 65 kt is selected for 06Z on the 28th, down from 95 kt originally in HURDAT, a major intensity change. A central pressure of 989 mb is added to 06Z on the 28th. Another major intensity change is at 00Z on the 28th as 75 kt is the selected and HURDAT originally had 100 kt. A ship reported 90 kt at 12Z and 95 kt at 18Z but it appears likely that the wind reports were elevated and/or biased high based on the reports from the reconnaissance aircrafts. Another aircraft reached Ilsa at 17Z on the 28th measuring a central pressure of 980 mb. A central pressure of 980 mb suggests maximum winds of 73 kt north of 25N and 77 kt north of 25N intensifying according to the pressure-wind relationships. Since the

hurricane was moving at about 18 kt ahead of a frontal boundary, an intensity of 80 kt is selected at 18Z on the 28th, down from 90 kt originally in HURDAT, a minor intensity change. A central pressure of 980 mb is added to HURDAT at 18Z on the 28th. Ilsa passed about 200 nm east of Bermuda early on September 29th while accelerating to the northeast. A reconnaissance aircraft penetrated the center of the hurricane at 0130Z and 0744Z measuring a central pressure of 980 mb in both occasions. A central pressure of 980 mb suggests maximum winds of 73 kt north of 25N according to the pressure-wind relationship. An intensity of 80 kt is selected for 00Z and 06Z on the 29th, down from 90 kt and 85 kt, respectively; both are minor intensity changes to the original HURDAT. Ship observations at 12Z on the 29th indicate that the center of Ilsa had become embedded within the frontal boundary associated with a larger extratropical cyclone (Helene) to the north. Thus, it is analyzed that Ilsa became an extratropical cyclone at 12Z on the 29th, 18 hours earlier than originally shown in HURDAT. Weakening below hurricane force is analyzed at 06Z on the 30th, six hours later than originally shown in HURDAT. Ship observations indicate that Ilsa was absorbed by the larger extratropical cyclone after 06Z on September 30th. The last position is analyzed at 06Z on the 30th, same as the original HURDAT.

Hurricane Janice [October 4-13, 1958]

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40905 10/05/1958 M= 9 10 SNBR= 889 JANICE      XING=0 SSS=0                    L
40905 10/04/1958 M=10 11 SNBR= 889 JANICE      XING=0 SSS=0                    L
         **        ** **

(October 4th is new to HURDAT)
40907 10/04*  0   0   0    0*  0   0   0    0*185 811  30    0*190 812  30    0*

40910 10/05*  0   0   0    0*192 813  30    0*200 816  30    0*209 815  35  999*
40910 10/05*194 813  30 1005*198 814  30    0*203 814  35    0*209 812  40 1002*
           *** ***  ** **** *** ***          *** ***  **          ***  ** ****

40915 10/06*218 810  40  999*225 801  45  999*233 791  50  998*246 778  55  997*
40915 10/06*216 806  45    0*224 799  45  999*233 788  50  998*245 776  55  991*
           *** ***  **    * *** ***              ***  **      *** ***  **  ***

40920 10/07*260 766  60  996*272 756  65  988*282 750  75  987*287 747  80  990*
40920 10/07*258 766  65  985*272 756  65    0*283 751  65    0*289 748  65  983*
           ***      ** ****                * *** ***  **    * *** ***  **  ***

40925 10/08*292 745  80  995*300 742  80  995*308 738  80  992*315 733  70  990*
40925 10/08*294 745  65    0*300 742  65  986*307 738  65    0*314 733  65    0*
           ***      **    *          **  *** ***      **    * ***      **    *

40930 10/09*320 726  70  987*321 719  65  985*322 710  65  983*327 697  65  977*
40930 10/09*318 728  65  984*320 721  65  985*322 709  70  983*327 696  75  977*
           *** ***  **  *** *** ***              ***  **          ***  **

40935 10/10*333 682  65  970*341 670  75  968*350 658  80  970*360 639  80  970*
40935 10/10*333 684  80  970*340 671  80  968*348 657  80  970*360 639  80  970*
              ***  **      *** ***  **      *** ***
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40940 10/11*370 615  80  968*381 590  80  972*393 560  75    0*412 513  70    0*
40940 10/11*372 615  80  968*384 590  80  972*399 559  75  974*415 515  75    0*
           ***               ***               *** ***       *** *** ***  **

40945 10/12*433 461  65    0E449 422  50    0E462 382  50    0E472 335  50    0*
40945 10/12E433 470  65    0E450 430  55    0E462 382  45    0E472 335  45    0*
           *    ***          *** ***  **                **                **

40950 10/13E480 282  45    0E487 235  45    0*  0   0   0    0*  0   0   0    0*
40950 10/13E480 282  45    0*  0   0   0    0*  0   0   0    0*  0   0   0    0*
                            *  *   *   *

40955 HR
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Tropical Storm Landfall

10/06 03Z 22.0N 80.3W 50 kt Cuba
10/06 16Z 24.2N 78.0W 55 kt Bahamas
10/06 21Z 25.1N 77.1W 60 kt Bahamas

Hurricane Landfall

10/06 23Z 25.5N 76.8W 65 kt Bahamas

Minor changes to the track and intensity shown in McAdie et al. (2009). Evidence for these alterations comes from the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Monthly Weather Review, Surface Weather Observations, Navy reconnaissance book, Mariners Weather Log, Perez et al. (2000) and NHC Storm Wallets.

October 1:

HWM is not available on this date (system south of 20ºN). HURDAT does not list an organized system on this date. Microfilm shows a tropical wave along 12N-20N, 66W-69W at 12Z. Ship highlights: No gales or low pressures.

MWR: “A fairly active easterly wave passed through the Lesser Antilles on September 30 and into the Virgin Islands on October 1.”

October 2:

HWM is not available on this date (system south of 20ºN). HURDAT does not list an organized system on this date. Microfilm shows a tropical wave along 13N-25N, 70W-72W at 12Z. Ship highlights: 35 kt ESE and 1009 mb at 16.6N, 69.3W at 18Z (micro).

October 3:

HWM is not available on this date (system south of 20ºN). HURDAT does not list an organized system on this date. Microfilm shows a tropical wave along 15N-23N, 74W-77W at 12Z. Ship highlights: 40 kt E and 1013 mb at 20.9N, 74.2W at 06Z (COADS/MWL). 35 kt ESE and 1012 mb at 17.5N, 75.7W at 12Z (micro). 35 kt E and 1011 mb at 16.1N, 73.7W at 1630Z (micro).

MWR: "By midday of the 2d, the wave had reached central Hispaniola, and 24 hours later extended from extreme eastern Cuba southward near Jamaica. A broad flat quasi-circulation was evident southwest of Jamaica on the 3rd, however, reconnaissance aircraft on this date found no closed circulation. Squalls in the northern semicircle were attended by maximum winds of 40 mph and the lowest sea level pressure observed was 1010 mb."

October 4:

HWM is not available on this date (system south of 20ºN). HURDAT does not list an organized system on this date. Microfilm shows a closed low pressure of at most 1008 mb at 17.7N, 81.7W at 12Z. Ship highlights: 35 kt SE and 1014 mb at 17.1N, 75.6W at 00Z (COADS). Land highlights: 40 kt E and 1011 mb at Kingston, Jamaica at 06Z (micro).

MWR: "By the 4th the wave had moved to the central Cuba-Grand Cayman Island area. This wave had been attended by heavy shower and thunderstorm activity from the central Caribbean northward across Puerto Rico, Hispaniola, Cuba, and into the Bahamas as it progressed westward. By the 4th this circulation was located a short distance southwest of Grand Cayman Island. The aircraft found a large but very weak circulation with minimum pressure of 1008 mb and maximum winds of 25 mph."

October 5:

HWM analyzes a tropical storm of at most 1005 mb at 20.1N, 81.4W at 12Z. HURDAT lists a 30 knot tropical depression at 20.0N, 81.6W at 12Z. Microfilm shows a closed low pressure of at most 1005 mb at 20.5N, 82.0W at 12Z. Ship highlights: 30 kt NW and 1005 mb at 20.6N, 83.3W at 12Z (micro). 35 kt S and 1008 mb at 20.5N, 80.0W at 15Z (micro). 35 kt ENE and 1003 mb at 21.6N, 80.6W at 18Z (micro). 45 kt NE and 999 mb at 21.5N, 81.2W at 21Z (micro). Land highlights: 5 kt WNW and 1006 mb at Grand Cayman at 00Z (micro). Aircraft highlights: Penetration center fix estimated surface winds of 35 kt and measured a central pressure of 1002 mb at 1756Z (ATSR).

MWR: “The weak circulation drifted slowly north-northwestward during the night, gradually becoming better organized, and by afternoon of the 5th had developed into a tropical storm with the center just south of the central Cuban coast, Winds had increased to 40 to 45 mph in squalls within 60 miles north and east of the center.” ATSR: “Although the first warning on JANICE was issued 051600Z, an area of squalls and gusty winds, associated with a series of easterly waves, had been watched closely since the first of October when a Navy reconnaissance aircraft was dispatched from Roosevelt Roads to investigate the area to the south of Puerto Rico. No circulation was found and the winds were light except for a band of easterlies just south of Puerto Rico where the maximum wind was 30 knots. Again on 3 October, a Navy aircraft investigated the easterly in the central Caribbean and found no vortex, but the winds had increased to 35 knots and the band of higher winds had now spread over the north central Caribbean. On the fourth, a “Track Bravo” was flown out of Jacksonville. This flight reported a weak pressure and wind circulation approximately 50 miles southeast of Grand Cayman at approximately 1300Z; however, the maximum surface winds observed were 20 knots and the minimum pressure was 1008 mb. There was an apparent “break off” of the ITC on the fourth just to the south of the most active area on the easterly wave, lending further cause for intensification. The first warning was issued on JANICE at 051600Z. A diverted “Navy Track Alfa” located the tropical depression center at 051735Z in position 20.9N 81.9W. Maximum observed winds were 35 knots.”

October 6:

HWM analyzes a tropical storm of at most 1000 mb at 23.5N, 79.0W at 12Z. HURDAT lists a 50 knot tropical storm at 23.3N, 79.1W at 12Z. Microfilm shows a closed low pressure of at most 999 mb at 23.5N, 78.0W at 12Z. Ship highlights: 35 kt NNE and 1000 mb at 21.5N, 80.5W at 00Z (micro). 35 kt S and 1009 mb at 19.6N, 79.0W at 03Z (micro). 35 kt S and 1006 mb at 20.0N, 78.4W at 06Z (COADS). 30 kt S and 1002 mb at 22.3N, 77.6W at 12Z (COADS). 40 kt SSE and 1004 mb at 24.7N, 74.7W at 18Z (micro). 45 kt SSE and 1006 mb at 24.2N, 74.3W at 21Z (COADS). Land highlights: 35 kt NE and 1002 mb at Cienfuegos, Cuba at 00Z (micro). 35 kt SSE and 1008 mb at Cabo Cruz, Cuba at 03Z (micro). 1001 mb at Cienfuegos, Cuba at 06Z (micro). 55 kt SW and 1001 mb at Cayo Coco, Cuba at 12Z (micro). 30 kt SW and 997 mb at Mangrove Cay, Bahamas at 15Z (micro). 45 kt SSE and 1004 mb at 24.3N, 75.5W at 18Z (micro). 30 kt SSE and 988 mb at Eleuthera, Bahamas at 21Z (micro). 30 kt NE and 991 mb at Mangrove Cay, Bahamas (no time given) (WALLET). Aircraft highlights: Radar center fix at 23.2N, 78.6W at 12Z (ATSR). Radar center fix estimated an eye diameter of 80 nm at 23.6N, 78.3W at 14Z (ATSR). Penetration center fix at 24.8N, 77.3W at 1830Z (ATSR). Penetration center fix estimated surface winds of 65 kt and

measured a central pressure of 996 mb at 25.1N, 77.6W at 20Z (ATSR). Penetration center fix at 25.9N, 76.1W at 2330Z (ATSR).

MWR: “The storm turned northeastward and crossed Cuba during the night and by midday of the 6th was centered between New Providence and Andros Island in the central Bahamas. Minimum pressure in the Bahamas was 988 mb. at Harbour Island, Eleuthera. Highest wind was 63 mph at San Salvador, although Nassau reported 61 mph. The storm, gradually increased in force and size and accelerating in forward speed during this period, reached hurricane intensity during the evening of the 6th. Minimum sea level pressure at this time by dropsonde was around 996 mb.” ATSR: “Hurricane force winds were first observed at 061800Z after the center had crossed Andros Island and was again out over water.”

October 7:

HWM analyzes a hurricane with a central pressure of 983 mb at 28.6N, 75.0W with a dissipating front to the north at 12Z. HURDAT lists a 75 knot hurricane at 28.2N, 75.0W at 12Z. Microfilm shows a closed low pressure of at most 990 mb at 28.5N, 75.2W with a frontal boundary to the north at 12Z. Ship highlights: 65 kt E and 993 mb at 26.2N, 76.3W at 00Z (COADS). 50 kt ENE and 999 mb at 27.6N, 75.8W at 03Z (MWL). 55 kt SSW and 994 mb at 26.6N, 75.2W at 06Z (COADS). 65 kt SSW and 999 mb at 27.4N, 74.4W at 12Z (COADS). 55 kt S and 994 mb at 29.2N, 74.2W at 18Z (COADS). Land highlights: 15 kt W and 993 mb at Eleuthera, Bahamas at 00Z (micro). 40 kt SW and 1005 mb at Cat Island, Bahamas at 06Z (micro). 20 kt NNW and 1003 mb at Abaco Island, Bahamas at 12Z (micro). Aircraft highlights: Penetration center fix at 25.8N, 77.0W at 0045Z (ATSR). Radar center fix estimated an eye diameter of 30 nm at 26.2N, 76.4W at 02Z (ATSR). Radar center fix estimated flight level winds of 55 kt and measured a minimum pressure (not a central pressure) of 987 mb at 28.3N, 75.2W at 08Z (ATSR). Penetration center fix at 28.7N, 75.2W at 1330Z (micro). Penetration center fix estimated surface winds of 80 kt, measured a central pressure of 983 mb and an eye diameter of 30 nm at 29.3N, 75.1W at 1930Z (micro).

MWR: “The hurricane decelerated in forward speed from 15-20 mph to 7 mph by afternoon of the 7th.”

October 8:

HWM analyzes a hurricane with a central pressure of 985 mb at 30.8N, 73.8W at 12Z. HURDAT lists an 80 knot hurricane at 30.8N, 73.8W at 12Z. Microfilm shows a closed low pressure of at most 999 mb at 31.2N, 73.5W at 12Z. Ship highlights: 65 kt S and 992 mb at 30.0N, 74.2W at 00Z (COADS). 50 kt NW and 994 mb at 31.2N, 74.9W at 06Z (COADS). 40 kt N and 1004 mb at 33.4N, 76.0W at 12Z (micro). 40 kt S and

1011 mb at 31.2N, 70.4W at 18Z (COADS). 45 kt N and 1010 mb at 31.8N, 77.1W at 21Z (micro). Aircraft highlights: Penetration center fix estimated surface winds of 40 kt, measured a central pressure of 993 mb and an eye diameter of 50 nm at 29.5N, 74.4W at 02Z (ATSR). Penetration center fix measured a central pressure of 986 mb at 30.1N, 74.0W at 0745Z (ATSR). Penetration center fix at 30.9N, 73.7W at 1330Z (ATSR). Penetration center fix at 31.2N, 73.0W at 2007Z (ATSR).

October 9:

HWM analyzes a hurricane with a central pressure of 988 mb at 32.5N, 71.5W at 12Z. HURDAT lists a 65 knot hurricane at 32.2N, 71.0W at 12Z. Microfilm shows a closed low pressure of at most 990 mb at 32.2N, 70.8W at 12Z. Ship highlights: 40 kt NNE and 1010 mb at 33.7N, 76.8W at 00Z (COADS). 45 kt S and 998 mb at 31.0N, 71.7W at 03Z (micro). 50 kt SW and 1001 mb at 30.6N, 71.7W at 06Z (micro). 55 kt W and 998 mb at 31.4N, 71.0W at 12Z (COADS). 50 kt SW and 1006 mb at 30.7N, 70.7W at 18Z (COADS). Aircraft highlights: Penetration center fix estimated flight level (500 mb) winds of 55 kt, measured a central pressure of 984 mb and an eye diameter of 50 nm at 31.8N, 72.7W at 0144Z (micro). Penetration center fix at 32.0N, 72.5W at 0430Z (ATSR). Penetration center fix at 32.0N, 70.2W at 1345Z (ATSR). Radar center fix at 32.9N, 69.3W at 1908Z (ATSR). Penetration center fix at 33.1N, 68.5W at 2340Z (ATSR).

MWR: “The hurricane drifted slowly north-northeastward to northeastward then began accelerating northeastward to east-northeastward on the 9th.”

October 10:

HWM analyzes a hurricane with a central pressure of 972 mb at 35.0N, 65.7W at 12Z. HURDAT lists an 80 knot hurricane at 35.0N, 65.8W at 12Z. Microfilm shows a closed low pressure of at most 996 mb at 34.8N, 66.2W at 12Z. Ship highlights: 35 kt WNW and 1014 mb at 32.1N, 71.8W at 00Z (COADS). 10 kt E and 1005 mb at 40.7N, 68.0W at 18Z (COADS). Aircraft highlights: Penetration center fix at 33.6N, 68.0W at 02Z (ATSR). Penetration center fix measured a central pressure of 968 mb at 34.1N, 67.0W at 0735Z (ATSR/micro). Penetration center fix at 34.9N, 65.5W at 13Z (ATSR). Penetration center fix at 36.1N, 63.3W at 1930Z (ATSR).

MWR: “Minimum sea level pressure by dropsonde was 968 mb. on the 10th. Highest winds were estimated at 90 mph over a small area near the center of the hurricane on the 7th and again on the 10th, with slightly lower wind speeds on intervening days.”

October 11:

HWM analyzes a hurricane with a central pressure of 974 mb at 39.1N, 55.8W and a cold front to the northwest at 12Z. HURDAT lists a 75 knot hurricane at 39.3N, 56.0W at 12Z. Microfilm shows a closed low pressure of at most 981 mb at 40.3N, 56.3W with a frontal boundary to the west at 12Z. Ship highlights: 40 kt SW and 1013 mb at 33.8N, 65.0W at 00Z (COADS). 65 kt SSW and 1002 mb at 36.7N, 57.6W at 06Z (micro). 75 kt WSW and 976 mb at 40.0N, 54.7W at 12Z (MWL). 75 kt S and 992 mb at 40.6N, 50.1W at 18Z (micro). Aircraft highlights: Penetration center fix measured a central pressure of 974 mb at 39.4N, 56.7W at 1035Z (ATSR/micro). Penetration center fix measured a central pressure of 974 mb at 40.5N, 54.4W at 1351Z (ATSR/micro).

MWR: "… continued until the 11th when it began losing tropical characteristics and later merged with a deep low pressure system that moved from the Canadian Maritime Provinces into the North Atlantic."

October 12:

HWM analyzes a tropical storm of at most 1000 mb at 46.4N, 37.2W and a cold front to the west at 12Z. HURDAT lists a 50 knot extratropical storm at 46.2N, 38.2W at 12Z. Microfilm shows that Janice has been absorbed by a larger extratropical cyclone to the northwest at 12Z. Ship highlights: 25 kt S and 981 mb at 44.5N, 45.1W at 03Z (COADS). 55 kt SSW and 995 mb at 44.0N, 41.0W at 06Z (COADS). 40 kt WSW and 1004 mb at 45.5N, 38.6W at 12Z (COADS).

October 13:

HWM analyzes a spot low pressure at 50.5N, 20.0W at 12Z. HURDAT lists a 45 knot extratropical storm at 48.7N, 23.5W at 06Z (last position). Microfilm indicates that Janice has been absorbed at 12Z. Ship highlights: 35 kt SW and 1009 mb at 46.3N, 27.2W at 00Z (COADS). 40 kt WSW and 1015 mb at 45.5N, 29.0W at 06Z (COADS).

The last tropical cyclone of the 1958 Hurricane Season developed from a strong tropical wave that entered the Caribbean Sea on early October. The vigorous disturbance produced tropical storm force winds on October 2nd, 3rd and early on the 4th. Ship and coastal observations, however, along with reconnaissance aircraft investigative missions, indicate that a well-defined low-level circulation did not form until around 12Z on the 4th while the system was over the western Caribbean, just south of the Cayman Islands. By this time, the forward speed of the disturbance had decreased to about 5 kt. Genesis is analyzed at 12Z on the 4th as a 30 kt tropical depression, eighteen hours earlier than

originally shown in HURDAT. Minor track alterations are analyzed for the lifetime of this tropical cyclone. The tropical depression moved generally northward making landfall in Grand Cayman around 00Z on October 5th. Grand Cayman reported 5 kt WNW and 1006 mb at 00Z on the 5th, suggesting a central pressure of 1005 mb, which has been added to HURDAT. A central pressure of 1005 mb suggests maximum sustained winds 37 kt south of 25N according to the Brown et al. pressure-wind relationship. Due to the slow forward speed of about 5 kt and low environmental pressures (outer closed isobar of 1009 mb), an intensity of 30 kt has been selected for 00Z on the 5th. Intensification to a tropical storm is analyzed at 12Z on the 5th, six hours earlier than the original HURDAT, based upon information later on the day. A reconnaissance aircraft investigated Janice at 1756Z on the 5th measuring a central pressure of 1002 mb and estimating surface winds of 35 kt. A central pressure of 1002 mb suggests maximum sustained winds of 43 kt south of 25N from the pressure-wind relationship. Based on the slow forward speed, low environmental pressures and a ship report of 45 kt at 21Z, an intensity of 40 kt is selected for 18Z on the 5th, up from 35 kt originally in HURDAT. A central pressure of 999 mb was present in HURDAT at 18Z on the 5th, it has been removed and replaced with the 1002 mb measured by the reconnaissance aircraft because 999 mb and 45 kt were reported by a ship at 21Z, thus 999 mb is not a central pressure. For the same reason, the central pressure of 999 mb at 00Z on October 6th has been removed. Late on the 5th, the track of Janice turned to the northeast as it approached the southern coast of Cuba.

Landfall in Cuba is analyzed at 03Z on the 6th near 22.0N, 80.3W or about 10 nm southeast of Cienfuegos, as a 50 kt tropical storm. Perez et al. (2000) also indicates that Janice was a tropical storm at landfall in Cuba. Slight weakening occurred over Cuba and Janice emerged into the Atlantic as a 45 kt tropical storm. Over the warm waters of the Bahamas, the tropical storm began to strengthen as it increased in forward speed to the northeast on the 6th. At 12Z, Cayo Coco, Cuba reported 55 kt SW and 1001 mb. The wind report appears to have a high bias based on nearby wind reports and that it blowing from the land to the sea. The intensity at 12Z on the 6th is analyzed at 50 kt, same as the original HURDAT. Around 16Z on the 6th, Janice made landfall on Andros Island as a 55 kt tropical storm. Mangrove Cay, on the southern end of Andros Island, reported a minimum pressure of 991 mb and it is likely, based on the track of the tropical cyclone, that this was a central pressure, which has been added to HURDAT at 18Z on the 6th. Furthermore, at 18Z on the 6th, Mangrove Cay was reporting 30 kt NW and 994 mb, which also suggests a central pressure of around 991 mb. A central pressure of 991 mb suggests maximum sustained winds of 61 kt south of 25N intensifying and 60 kt north of 25N intensifying, according to the pressure-wind relationship. Due to the low environmental pressures and forward speed of about 15 kt, an intensity of 55 kt is selected for 18Z on the 6th, same as the original HURDAT. A central pressure of 991 mb was added to HURDAT at 18Z, replacing the existing 997 mb. Central pressures of 999

mb and 998 mb were present in HURDAT at 06Z and 12Z, respectively, on the 6th and have been retained as they appear reasonable. A second Bahamian landfall occurred around 21Z on Rose Island near New Providence as a 60 kt tropical storm and a third landfall occurred around 23Z on North Eleuthera as a 65 kt hurricane. A reconnaissance aircraft reported 996 mb at 20Z on the 6th but based on the observations in the Bahamas, it has been determined that it was not a central pressure. At 21Z on the 7th, North Eleuthera reported 30 kt SSE and 988 mb, suggesting a central pressure of 985 mb, which has been added to HURDAT at 00Z on October 7th. A central pressure of 985 mb suggests maximum sustained winds of 69 kt north of 25N intensifying from the pressure-wind relationship. Data from a reconnaissance aircraft at 00Z on the 7th indicated that the RMW was about 22 nm and climatology is 20 nm. Based on low environmental pressures (outer closed isobar about 1007 mb), an intensity of 65 kt is selected for 00Z on the 7th, up from 60 kt originally in HURDAT, a minor intensity change. Intensification to a hurricane is analyzed at 00Z on the 7th, six hours earlier than originally shown in HURDAT. The next reconnaissance aircraft reached Janice at 1930Z on the 7th and measured a central pressure of 983 mb, estimated surface winds of 80 kt and an eye diameter of 30 nm. A central pressure of 983 mb suggests maximum sustained winds of 69 kt north of 25N from the pressure-wind relationship. An eye diameter of 30 nm suggests an RMW of about 22 nm and climatology is 20 nm. Based on the slow forward speed of the hurricane of about 6 kt, an intensity of 65 kt is selected at 18Z on the 7th, 15 kt less than originally shown in HURDAT, a minor intensity change. A couple of ships reported gale-force winds on the 7th and even a report of 65 kt at 12Z. Between October 7th and the 9th, Janice entered an area of weak steering currents between the United States and Bermuda, resulting in a slow motion toward the northeast. The next penetration center fix measured a pressure of 993 mb at 02Z on October 8th but based on the central pressure reports from late on the 7th and later on the 8th, it is determined that it was not a central pressure. A central pressure of 986 mb was measured by a reconnaissance aircraft at 0745Z. A central pressure of 986 mb suggests maximum sustained winds of 65 kt north of 25N according to the pressure-wind relationship. An intensity of 65 kt is selected at 06Z on the 8th based on a ship report 65 kt S and 992 mb at 00Z on this day. HURDAT originally had 80 kt at 06Z on the 8th, a minor intensity change. A central pressure of 986 mb is added to HURDAT, replacing the existing 995 mb at 06Z on the 8th.

A reconnaissance aircraft reached Janice on October 9th at 0144Z and measured a central pressure of 984 mb and an eye diameter of 50 nm. A central pressure of 984 mb suggests maximum sustained winds of 68 kt north of 25N according to the pressure-wind relationship. An eye diameter of 50 nm suggests an RMW of about 38 nm and climatology is 25 nm. Based on the RMW being larger than climatology and the slow forward speed of the hurricane of about 5 kt, an intensity of 65 kt is selected for 00Z on the 9th, down from 70 kt originally in HURDAT, a minor intensity change. A central

pressure of 984 mb is added to HURDAT at 00Z on the 9th, replacing the existing 987 mb. The forward speed of Janice started to increase late on the 9th and the hurricane began to intensify. A couple of ships near the center of the hurricane reported gale-force winds on the 9th. On October 10th, a reconnaissance aircraft measured a central pressure of 968 mb at 0735Z, suggesting maximum surface winds of 91 kt north of 25N intensifying from the Brown et al. pressure-wind relationship and 84 kt north of 35N from the Landsea et al. pressure-wind relationship. Due to a large RMW, an intensity of 80 kt is selected for 06Z on the 10th, up from 75 kt originally in HURDAT, a minor intensity change. 80 kt is also the peak intensity for this hurricane, same as originally shown in HURDAT. A central pressure of 968 mb was present in HURDAT at 06Z on the 10th and has been retained. Janice began to interact with a frontal boundary on the 11th and the hurricane started to acquire extratropical characteristics. At 1035Z on the 11th, the last reconnaissance aircraft to investigate Janice measured a central pressure of 974 mb, suggesting maximum surface winds of 79 kt north of 35N from the pressure-wind relationship. Because Janice was starting to become extratropical, an intensity of 75 kt is selected at 12Z on the 11th, same as originally shown in HURDAT. A central pressure of 974 mb is added to HURDAT at 06Z on the 11th. A couple of ships observed hurricane-force winds on the 11th, especially a ship at 12Z that reported 75 kt WSW and 976 mb. Ship observations early on October 12th indicate that Janice had become an extratropical cyclone, with a significant the temperature gradient E-W across the cyclone. Transition to an extratropical cyclone is analyzed at 00Z on the 12th, six hours earlier than originally shown in HURDAT. Weakening below hurricane intensity occurred at 06Z on the 12th, same as the original HURDAT. Janice continued to move rapidly to the northeast on the 12th and early on October 13th, and was absorbed by a stronger extratropical cyclone to the north. The last position is analyzed at 00Z on the 13th, six hours earlier than originally shown in HURDAT.

Date	Original HURDAT Central Pressure	Evidence	Changes
Oct 5 00Z		Grand Cayman: 5 kt WNW and 1006 mb at 00Z on Oct 5th	1005 mb
Oct 5 18Z	999 mb	Penetration center fix: 1002 mb at 1756Z on Oct 5th	1002 mb
Oct 6 00Z	999 mb	Ship: 45 kt NE and 999 mb at 21Z on Oct 5th	Removed
Oct 6 06Z	999 mb	No central pressures but appear reasonable with an intensifying storm	Retained
Oct 6 12Z	998 mb		

Oct 6 18Z	997 mb	Mangrove Cay: 30 kt NW and 994 mb at 18Z on Oct 6th	991 mb
Oct 7 00Z	996 mb	North Eleuthera: 30 kt SSE and 988 mb at 21Z on Oct 6th	985 mb
Oct 7 06Z	988 mb	Lower central pressures at 00Z and 18Z on Oct 7th	Removed
Oct 7 12Z	987 mb		
Oct 7 18Z	990 mb	Penetration center fix: 983 mb at 1930Z on Oct 7th	983 mb
Oct 8 00Z	995 mb	Lower central pressures at 18Z on Oct 7th and 06Z on Oct 8th	Removed
Oct 8 06Z	995 mb	Penetration center fix: 986 mb at 0745Z on Oct 8th	986 mb
Oct 8 12Z	992 mb	Lower central pressures at 06Z on Oct 8th and 00Z on Oct 9th	Removed
Oct 8 18Z	990 mb		
Oct 9 00Z	987 mb	Penetration center fix: 984 mb at 0144Z on Oct 9th	984 mb
Oct 9 06Z	985 mb	No central pressure reports but appear reasonable	Retained
Oct 9 12Z	983 mb		
Oct 9 18Z	977 mb		
Oct 10 00Z	970 mb		
Oct 10 06Z	968 mb	Penetration center fix: 968 mb at 0735Z on Oct 10th	
Oct 10 12Z	970 mb	No central pressure reports but appear reasonable	
Oct 10 18Z	970 mb		
Oct 11 00Z	968 mb		
Oct 11 06Z	972 mb		
Oct 11 12Z		Penetration center fix: 974 mb at 1035Z on Oct 11th	974 mb

1958 - Additional Notes

1) January 14-17: Historical Weather Maps show an extratropical cyclone over the north Atlantic on January 14th. The system slowly moves southward on the 15th as it detaches from its parent frontal boundary and becomes an occluded low. The occluded low slowly weakens during the next couple of days before being absorbed by a frontal boundary on January 18th. Gale-force winds were only observed on the 14th. Therefore, because the system was likely not tropical or subtropical, it is not added to HURDAT. This disturbance was in Jack Beven's and David Roth's List of Suspects.

Day	Latitude	Longitude	Status
January 14	38N	44W	Extratropical
January 15	32N	48W	Occluded
January 16	33N	44W	Occluded
January 17	35N	45W	Occluded
January 18			Absorbed

2) May 20 - June 1: Historical Weather Maps indicate that a frontal boundary over the central Atlantic weakened into a trough of low pressure on May 22nd. The disturbance drifted slowly to the west over the next couple of days. Ship observations show that a closed low-level circulation developed on May 27th as the disturbance was located about 700 nm northeast of the Leeward Islands. A strong pressure gradient developed on May 28th and gale-force winds were being reported about 350 nm northeast of the center. On May 30th, as the disturbance started to move northward ahead of a frontal boundary, the gale-force winds were closer to the center but still located about 200 nm to the northeast. Ship observations on May 31st indicate that the system began to weaken and was absorbed by a frontal boundary on June 1st. Therefore, because the gale-force winds were far removed from the center and likely associated with the synoptic pressure gradient, it is not added to HURDAT. This disturbance was in Jack Beven's and David Roth's List of Suspects.

Day	Latitude	Longitude	Status
May 20	Central Atlantic		Dissipating cold front
May 21	Central Atlantic		Trough
May 22	Central Atlantic		Trough
May 23	Central Atlantic		Trough
May 24	Central Atlantic		Trough
May 25	Central Atlantic		Trough
May 26	Central Atlantic		Trough
May 27	26N	52W	Tropical Depression?
May 28	26N	50W	Tropical Storm?
May 29	26N	49W	Tropical Storm?
May 30	30N	48W	Tropical Storm?
May 31	34N	50W	Tropical Depression?

June 1	41N	46W	Absorbed

3) August 22-27: A strong tropical wave left the African coast around August 21st. Microfilm shows a tropical cyclone symbol on August 22nd southwest of the Cape Verde Islands. A closed low pressure was intermittently tracked for the next couple of days as the disturbance moved west-northwest. Ship and coastal observations indicate that a closed low-level circulation was present but no tropical storm force winds were found on the microfilm, COADS or Mariners Weather Log. Microfilm indicates that the disturbance likely weakened into a tropical wave on August 27th over the central Atlantic. Therefore, because no gale-force winds were found associated to this disturbance, it is not added to HURDAT.

Day	Latitude	Longitude	Status
August 22	10-16N	19W	Tropical Wave
August 23	14N	24W	Tropical Storm?
August 24	14N	29W	Tropical Storm?
August 25	15N	33W	Tropical Storm?
August 26	18N	37W	Tropical Depression?
August 27	13-21N	41W	Tropical Wave

4) September 8-10: Mariners Weather Log's Track of Centers of Cyclones at Sea Level indicate that a low pressure developed about 400 nm east of the Lesser Antilles on September 8th and remained generally stationary for about a day. On the 10th, the disturbance moved northwest before dissipating east of the Lesser Antilles. This disturbance was in Jack Beven's List of Suspects.

Day	Latitude	Longitude	Status
September 8	8N	52W	Tropical Depression?
September 9	8N	52W	Tropical Depression?
September 10	12N	55W	Tropical Depression?

5) October 4-7: Historical Weather Maps indicate that a low pressure formed about 800 nm northeast of the Leeward Islands on October 4th. The disturbance moved generally to the northwest before dissipating on October 7th ahead of a frontal boundary over the northwest Atlantic. COADS were obtained but produced no tropical storm force winds. Therefore, because no gale-force winds were found associated with this disturbance, it is not added to HURDAT. This disturbance was in Ryan Truchelut's List of Suspects.

Day	Latitude	Longitude	Status
October 4	23N	49W	Tropical Depression?

October 5	25N	58W	Tropical Depression?
October 6	28N	56W	Tropical Depression?
October 7	35N	45W	Absorbed

6) October 15-19: Historical Weather Maps and microfilm show a frontal boundary over the Bahamas and north of the Greater Antilles around mid-October. A low pressure system forms in the tail-end of the frontal boundary late on October 15th and starts moving northeastward increasing in forward speed. Gale-force winds developed to the north and northeast of the center on October 16th. On October 17th, ship observations indicate that the disturbance has become an extratropical cyclone with gales as it raced to the northeast. It continued quickly to the northeast for the next two days before dissipating. Therefore, because the disturbance maintains a baroclinic appearance on the HWM and microfilm maps based on the ship observations, it is not added to HURDAT. This disturbance was in Ryan Truchelut's List of Suspects.

Day	Latitude	Longitude	Status
October 14	North of the Greater Antilles		Cold front
October 15	21N	70W	Subtropical Depression?
October 16	25N	68W	Subtropical Depression?
October 17	30N	65W	Extratropical
October 18	37N	56W	Extratropical
October 19	55N	50W	Extratropical

7) October 17-24: Historical Weather Maps show a frontal boundary over the eastern Gulf of Mexico around mid-October. A low pressure forms on the tail-end of the frontal boundary on October 18th and starts moving to the northeast crossing Florida between the 18th and 19th. On October 19th, a high pressure system over the Northeast blocks the extratropical cyclone off the Southeast of the United States. On October 21st, the disturbance becomes an occluded low and begins to weaken. Another frontal boundary arrives from the west on October 23rd and on the next day, the disturbance is moving away from the United States as an extratropical cyclone. Therefore, because the system was likely not tropical or subtropical, it is not added to HURDAT. This disturbance was in Ryan Truchelut's List of Suspects.

Day	Latitude	Longitude	Status
October 17	Northern Gulf of Mexico		Warm front
October 18	25N	88W	Extratropical
October 19	31N	78W	Extratropical
October 20	35N	72W	Extratropical

October 21	33N	78W	Occluded
October 22	31N	78W	Occluded
October 23	36N	74W	Occluded
October 24	39N	68W	Extratropical

1959 hurricane season

Tropical Storm Arlene [May 28 – June 1, 1959]

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40960 05/28/1959 M= 6  1 SNBR= 890 ARLENE      XING=1 SSS=0
40960 05/28/1959 M= 5  1 SNBR= 890 ARLENE      XING=1 SSS=0
                    *

40965 05/28*  0   0   0    0*  0   0   0    0*238 866  30    0*245 872  30    0*
40965 05/28*  0   0   0    0*  0   0   0    0*240 870  30    0*247 875  30    0*
                                            *** ***          *** ***

40970 05/29*253 877  35    0*265 890  35    0*274 900  40    0*276 908  45    0*
40970 05/29*255 882  35    0*265 890  35    0*274 901  35    0*278 912  40 1002*
           *** ***                          ***          *** ***  ** ****

40975 05/30*278 915  45 1000*281 919  45 1000*284 920  50 1000*291 919  40    0*
40975 05/30*278 918  45 1000*279 919  45    0*285 919  50  996*292 919  55  993*
              ***          ***             * *** ***      *** ***       **  ***

40980 05/31*299 917  30    0*304 915  25    0*310 912  25    0*317 909  25    0*
40980 05/31*298 917  55    0*304 915  40    0*309 912  30    0*315 909  25    0*
           ***       **                **      *** ***  **      ***

40985 06/01*323 906  25    0*328 899  25    0*331 891  25    0*332 886  25    0*
40985 06/01*321 905  25    0*  0   0   0    0*  0   0   0    0*  0   0   0    0*
           *** ***

40990 06/02*334 874  25    0*336 853  25    0*338 833  25    0*342 807  25    0*
40990 06/02*  0   0   0    0*  0   0   0    0*  0   0   0    0*  0   0   0    0*

40995 TS
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U.S. Tropical Storm Landfall

05/30 21Z 29.5N 91.9W 55 kt LA
05/30 23Z 29.7N 91.8W 55 kt LA

Minor changes to the track and major changes to the intensity shown in McAdie et al. (2009). Another major change is to indicate that the tropical cyclone dissipated 42 hours earlier than originally shown in HURDAT. Evidence for these alterations comes from the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Monthly Weather Review, Navy reconnaissance book, Surface Weather Observations, State Climatological Data, Mariners Weather Log and NHC Storm Wallets.

May 25:

HWM analyzes a trough or tropical wave along 14-23N, 77-79W at 12Z. HURDAT does not list an organized system on this date. Microfilm shows a trough or tropical wave along 12-25N, 81W at 12Z. Ship highlights: No gales or low pressures.

MWR: “Tropical storm Arlene originated in an easterly wave which was fairly well defined with a northeast-southwest orientation over the Dominican Republic as early as

May 23. Shower activity indicating low stability was evident over a wide area including most of the Caribbean Sea and the Bahamas. At 0700 EST on the 25th, a weak cyclonic flow appeared at 500 mb over the northwestern Caribbean, but there was no evidence of any concentrated bad weather. About this time a slow but definite increase in pressure gradient began north of western Cuba, leaving an extensive area of relatively slight gradient over the western Caribbean Sea." ATSR: "Tropical Storm Arlene formed on an easterly wave which progressed through the western Caribbean producing copious precipitation. A closed low formed first at the 500 mb level (250000Z) and then developed towards the lower layers."

May 26:

HWM analyzes a trough or tropical wave along 17-25N, 79-81W at 12Z. HURDAT does not list an organized system on this date. Microfilm shows a trough or tropical wave along 15-25N, 83W at 12Z. Ship highlights: No gales or low pressures. Land highlights: 35 kt ESE and 1017 mb at Dry Tortugas, FL at 12Z (micro).

May 27:

HWM analyzes a trough or tropical wave along 17-27N, 79-84W at 12Z. HURDAT does not list an organized system on this date. Microfilm shows a trough or tropical wave along 19-25N, 78-82W at 12Z. Ship highlights: No gales or low pressures. Land highlights: 36 kt NNE and 1018 mb at Carysfort Reef, FL at 06Z (SWO). 35 kt E and 1018 mb at Alligator Lighthouse, FL at 18Z (micro).

MWR: "This trend in the pressure pattern continued until wind warnings were required for small craft on both coasts of Florida on May 27. The 500-mb Low had moved into the southeastern Gulf of Mexico on May 27."

May 28:

HWM analyzes a tropical storm of at most 1010 mb at 24.8N, 87.0W at 12Z. HURDAT lists a 30 knot tropical depression at 23.8N, 86.6W at 12Z (first position). Microfilm shows a closed low pressure of at most 1011 mb at 24.0N, 87.0W at 12Z. Ship highlights: 35 kt E and 1012 mb at 25.2N, 84.6W at 00Z (COADS).

MWR: "On the 0700 EST surface chart of May 28 a ship reported a light southwest wind at 22.5N, 88.5W, providing the first indication that the closed circulation had extended down to the surface." ATSR: "Ship reports indicated that this low became closed on the surface at 281800Z."

May 29:

HWM analyzes a tropical storm of at most 1005 mb at 27.0N, 90.2W at 12Z. HURDAT lists a 40 knot tropical storm at 27.4N, 90.0W at 12Z. Microfilm shows a closed low pressure of at most 1011 mb at 27.0N, 90.0W at 12Z. Ship highlights: 35 kt SE and 1008 mb at 27.1N, 88.0W at 00Z (COADS). 35 kt NE at 26.2N, 89.7W at 02Z (micro). 35 kt ESE and 1012 mb at 25.7N, 86.5W at 06Z (COADS). 35 kt SSE and 1006 mb at 26.9N, 88.9W at 12Z (COADS). 35 kt SSE and 1008 mb at 26.5N, 88.0W at 15Z (micro). 35 kt SSE and 1013 mb at 26.6N, 88.2W at 18Z (COADS). 35 kt SSE at 27.6N, 90.3W at 21Z (micro). Aircraft highlights: Penetration center fix measured a central pressure of 1008 mb, estimated maximum surface winds of 45 kt and an eye diameter of 40 nm at 12Z (ATSR). Penetration center fix measured a central pressure of 1002 mb and estimated maximum surface winds of 45 kt at 1854Z (ATSR).

MWR: “Ship reports during the evening of May 28 confirmed the development of tropical storm Arlene and the New Orleans Weather Bureau office at 2100 CST issued the first tropical storm advisory of the 1959 season. The storm center moved northwestward for about 12 hours from its initial position near 26N, 88W.” ATSR: “Increased to storm intensity by 290000Z. On the basis of these reports, the first warning was issued at 290300Z and aircraft reconnaissance ordered. The Navy reconnaissance aircraft reported 45-knot winds at 291200Z. ARLENE reached maximum intensity of 50 knots at 291800Z. At the time of most rapid intensification (291200Z), a strong outflow mechanism was evidenced at 200 mb.”

May 30:

HWM analyzes a tropical storm of at most 1005 mb at 27.5N, 92.0W at 12Z. HURDAT lists a 50 knot tropical storm at 28.4N, 92.0W at 12Z. Microfilm shows a closed low pressure of at most 999 mb at 28.5N, 92.3W at 12Z. Ship highlights: 45 kt N at 28.0N, 92.0W at 00Z (micro). 20 kt W and 998 mb at 28.6N, 92.4W at 12Z (micro). 40 kt SSE and 999 mb at 28.3N, 91.9W at 12Z (micro). 35 kt N and 1008 mb at 29.6N, 92.5W at 18Z (micro). Land highlights: 35 kt SE and 1003 mb at Point Au Fer Reef Light, LA at 18Z (micro). 20 kt NNE and 1001 mb at Weeks Island, LA at 22Z (WALLET). 48 kt (gusts to 65 kt) and 1000 mb at Patterson, LA at 2330Z (MWR/CLIMO). Aircraft highlights: Penetration center fix measured a central pressure of 1000 mb, estimated maximum surface winds of 50 kt and an eye diameter of 8 nm at 01Z. Penetration center fix measured a central pressure of 1004 mb and estimated maximum surface winds of 40 kt at 1540Z. Penetration center fix measured a central pressure of 993 mb and estimated maximum surface winds of 40 kt at 1917Z.

MWR: “Thereafter it moved westward for 12 hours, became stationary at 28N, 92W during the night of May 29-30. Then moved northward across the Louisiana coast between Weeks Island and Pt. Au Fer, La., during the late afternoon of May 30. Winds diminished gradually after the center crossed the coast. Highest winds reported in the storm were 48 kt with gusts to 65 kt on the Louisiana coast. Lowest central pressure reported was 999.7 mb. at Patterson, La. Several ships and Navy reconnaissance aircraft also reported a central pressure of around 1000 mb while the storm was over the Gulf of Mexico. Highest tides were 3 feet above normal at Weeks Island and Pt. Au Fer, La. One man was drowned in the surf at Galveston.”

May 31:

HWM analyzes a closed low pressure of at most 1010 mb at 31.0N, 91.5W with a cold front to the northwest and a warm front to the northeast at 12Z. HURDAT lists a 25 knot tropical depression at 31.0N, 91.2W at 12Z. Microfilm shows a closed low pressure of at most 1008 mb at 31.0N, 91.5W at 12Z. Ship highlights: No gales or low pressures. Land highlights: 10 kt N and 1005 mb at Lafayette, LA at 00Z (micro). 20 kt SSE and 1003 mb at Baton Rouge, LA at 0658Z (SWO).

June 1:

HWM analyzes a closed low pressure of at most 1010 mb at 33.5N, 89.0W with a cold front to the northwest at 12Z. HURDAT lists a 25 knot tropical depression at 33.1N, 89.1W at 12Z. Microfilm shows a closed low pressure of at most 1011 mb at 33.0N, 89.0W with a frontal boundary to the northwest at 12Z. Ship highlights: No gales or low pressures.

June 2:

HWM analyzes a closed low pressure of at most 1015 mb at 35.0N, 82.0W with a frontal boundary to the northwest at 12Z. HURDAT lists a 25 knot tropical depression at 33.8N, 83.3W at 12Z. Microfilm shows a closed low pressure of at most 1011 mb at 34.0N, 82.5W with a frontal boundary extended to the south and another to the northwest at 12Z. Ship highlights: No gales or low pressures.

June 3:

HWM analyzes an extratropical cyclone of at most 1005 mb at 42.0N, 68.0W at 12Z. HURDAT does not list an organized system on this day. Microfilm shows an extratropical cyclone of at most 1002 mb at 39.5N, 71.5W at 12Z. Ship highlights: 35 kt S and 1015 mb at 32.9N, 71.6W at 00Z (COADS). 35 kt WSW and 1004 mb at 38.4N, 70.9W at 12Z (COADS). 40 kt SSW and 1010 mb at 40.2N, 64.6W at 18Z (COADS).

June 4:

HWM analyzes an extratropical cyclone of at most 1005 mb at 42.0N, 68.0W at 12Z. HURDAT does not list an organized system on this day. Microfilm shows a large extratropical cyclone over the Labrador Sea at 12Z. Ship highlights: No gales or low pressures.

A strong tropical wave moved across the Caribbean Sea during the last week of May. The disturbance became better organized over the southeast Gulf of Mexico and a well-defined low level circulation developed at 12Z on May 28th. Genesis is analyzed at 12Z on May 28th as a 30 kt tropical depression, same as the original HURDAT. Minor alterations were made to the track of this tropical cyclone between May 28th at 12Z and June 1st at 00Z. The tropical depression moved northwestward and intensified into a tropical storm at 00Z on May 29th, same as the original HURDAT. The first reconnaissance aircraft to reach Arlene occurred at 12Z on the 29th estimating surface winds of 45 kt and a central pressure of 1008 mb. Around this time, a couple of ships near the center reported pressures of 1006 mb with 35 kt SE and 1007 mb with 20 kt W, indicating that the pressure measured by the aircraft was not a central pressure. Thus, it is not added to HURDAT. Another aircraft measured a central pressure of 1002 mb and estimated surface winds of 45 kt at 1854Z on the 29th. A central pressure of 1002 mb suggests maximum sustained winds of 40 kt north of 25N from the Brown et al. pressure-wind relationship. At this time, Arlene was starting to slow its forward speed and was moving around 7 kt to the west. An intensity of 40 kt is selected at 18Z on the 29th, 5 kt less than the original HURDAT, a minor intensity change. A central pressure of 1002 mb is added to HURDAT at 18Z on the 29th. The next reconnaissance aircraft reached Arlene at 01Z on May 30th measured a central pressure of 1000 mb, estimated surface winds of 50 kt and an eye diameter 8 nm. A central pressure of 1000 mb suggests maximum sustained winds of 44 kt north of 25N from the pressure-wind relationship. At 00Z on the 30th, a ship just west of the center reported 45 kt N. Based on the data from the aircraft center fix and ship observation, an intensity of 45 kt is selected at 00Z on the 30th, same as the original HURDAT. A central pressure of 1000 mb was present in HURDAT at 00Z on the 30th and has been retained.

Arlene became almost stationary early on the 30th before starting to move northward later on the day. A ship at 12Z on the 30th reported 20 kt W and 998 mb, suggesting a central pressure of 996 mb, which has been added to HURDAT replacing the existing 1000 mb. A central pressure of 1000 mb was present in HURDAT at 06Z on the 30th, but based on ship observations and reconnaissance data later on the day, it has been removed. A central pressure of 996 mb suggests maximum sustained winds of 50 kt north of 25N from the pressure-wind relationship. An intensity of 50 kt is analyzed at 12Z on the 30th

based on the reconnaissance data and land observations later on the day. This intensity agrees with the original shown in HURDAT. At 1917Z, a penetration center fix measured a central pressure of 993 mb and estimated surface winds of 40 kt. A central pressure of 993 mb suggests maximum sustained winds of 55 kt north of 25N from the pressure-wind relationship. An intensity of 55 kt is analyzed at 18Z on the 30th based on the reconnaissance data and land observations later on the day. This intensity is 15 kt more than originally shown in HURDAT, a minor intensity change. A central pressure of 993 mb is added to HURDAT at 18Z on the 30th. Landfall occurred around 21Z near 29.5N, 91.9W on Marsh Island located on south-central Louisiana as a 55 kt tropical storm. Shortly after, the center of Arlene moved into the West Cote Blanche Bay and made a second landfall around 23Z near 29.7N, 91.8W or about 15 miles south of New Iberia as a 55 kt tropical storm. A report on Tropical Storm Arlene in the Louisiana State Climatological Data indicates that Patterson, LA reported 48 kt sustained with gusts at 65 kt and a pressure of 1000 mb at 2330Z on the 30th. MWR indicates that a central pressure was measured at Patterson, LA, but the data suggests that landfall occurred west of Patterson, LA, thus it is not a central pressure. An intensity of 55 kt is analyzed at 00Z on May 31st, up from 30 kt originally in HURDAT, a major intensity change. 55 kt is also the peak intensity for this tropical cyclone, up from 50 kt originally in HURDAT at 12Z on the 30th, a minor intensity change. After landfall, the track turned to the northeast and the tropical storm started to weaken. Weakening to a tropical depression is analyzed at 12Z on the 31st, twelve hours later than originally shown in HURDAT. Surface observations indicate that Arlene continued to weaken late on the 31st and early on June 1st. Dissipation is analyzed after 00Z on the 1st, 42 hours earlier than originally shown in HURDAT. The remnants of Arlene continued moving northeastward ahead of a frontal boundary before becoming absorbed a few days later over the southeastern United States.

Tropical Storm Beulah [June 15-19, 1959]

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41000 06/15/1959 M= 4  2 SNBR= 891 BEULAH      XING=0 SSS=0
41000 06/15/1959 M= 5  2 SNBR= 891 BEULAH      XING=0 SSS=0
                       *

41005 06/15*  0   0   0    0*  0   0   0    0*  0   0   0    0*211 947  25    0*

41010 06/16*217 952  25    0*220 956  45    0*223 960  50    0*226 962  50    0*
41010 06/16*216 952  30    0*221 957  40    0*225 961  50    0*228 963  60  987*
           ***       **       *** ***  **      *** ***          *** ***  **  ***

41015 06/17*228 963  55    0*230 965  55    0*231 967  55    0*232 971  60  987*
41015 06/17*229 964  60    0*230 965  60  987*230 967  55  992*229 969  55  992*
           *** ***  **                 **  *** ***          *** *** ***  **  ***

41020 06/18*230 973  55    0*224 973  45    0*218 972  35    0*212 972  30    0*
41020 06/18*226 970  50  997*223 971  45    0*221 972  40 1001*210 973  40 1001*
           *** ***  **  *** *** ***          ***      ** **** *** ***  ** ****
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(June 19th is new to HURDAT)
41023 06/19*218 974 35   0*214 976 25   0* 0   0   0   0* 0   0   0   0*

41025 TS

Tropical Storm Landfall

06/19 02Z 21.7N 97.5W 35 kt Mexico

Minor changes to the track and intensity shown in McAdie et al. (2009). A major change is to indicate that Beulah made landfall as a tropical storm in Mexico. Evidence for these alterations comes from the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Monthly Weather Review, Navy reconnaissance book, Surface Weather Observations, Mariners Weather Log and NHC Storm Wallets.

June 13:

HWM analyzes a closed low pressure of at most 1010 mb at 21.0N, 95.5W at 12Z. HURDAT does not list an organized system on this date. Microfilm shows a trough or tropical wave along 18-26N, 93W at 12Z. Ship highlights: No gales or low pressures.

MWR: “The synoptic situation contributing to the formation and dissipation of Beulah was rather complex. Pressure first began to fall over the western Gulf on June 13 with the movement of a weak cold front into the northern Gulf. A rather strong anticyclone centered over the Great Lakes contributed to a marked increase in the easterly flow over the northern Gulf.” ATSR: “For several days prior to the formation of Tropical Storm BEULAH, widespread cloudiness and precipitation prevailed over the Gulf of Mexico as a series of easterly waves entered from the Caribbean, a weakening cold front entered from the north, and the Equatorial Front surged northward toward the Gulf of Campeche.”

June 14:

HWM analyzes a spot low at 21.0N, 96.0W at 12Z. HURDAT does not list an organized system on this date. Microfilm shows a closed low pressure of at most 1008 mb at 24.0N, 95.0W with a frontal boundary to the northeast at 12Z. Ship highlights: No gales or low pressures.

June 15:

HWM analyzes a closed low pressure of at most 1005 mb at 21.5N, 96.0W at 12Z. HURDAT lists a 25 knot tropical depression at 21.1N, 94.7W at 18Z (first position).

Microfilm shows a closed low pressure of at most 1005 mb at 21.5N, 93.0W at 12Z. Ship highlights: No gales or low pressures.

MWR: “This High broke down rapidly on the 15th and 16th with the approach of an active short wave from the Plains States, probably one of the factors that prevented Beulah from becoming a well developed storm.” ATSR: “By 150000Z, A well developed low at 500 mb formed over the western Gulf of Mexico and surface reports revealed increased precipitation and a possible low in the southwestern Gulf.”

June 16:

HWM analyzes a tropical storm of at most 1005 mb at 23.0N, 96.0W at 12Z. HURDAT lists a 50 knot tropical storm at 23.3N, 96.0W at 12Z. Microfilm shows a closed low pressure of at most 1005 mb at 22.7N, 95.8W at 12Z. Ship highlights: 50 kt NE and 997 mb near 23.0N, 96.0W at 09Z (MWR/micro). 10 kt SSE and 1004 mb at 22.9N, 94.3W at 12Z (COADS). 40 kt S and 996 mb at 22.7N, 95.8W at 18Z (COADS/MWL). Land highlights: 20 kt W and 1004 mb at Tampico, Mexico at 12Z (HWM). Aircraft highlights: Penetration center fix measured a central pressure of 988 mb, estimated maximum surface winds of 45 kt and an eye diameter of 25 nm at 22.7N, 96.3W at 1630Z (ATSR). Penetration center fix measured a central pressure of 987 mb, estimated maximum surface winds of 45 kt and an eye diameter of 25 nm at 22.9N, 96.3W at 1832Z (ATSR).

MWR: “Tropical Storm Beulah was first detected during the night of June 15-16 when the SS Hondo reported a 50-kt. northeasterly wind with heavy rain and high seas near 23N, 96W. The storm was short lived as it drifted northwestward on the 16th, westward during the 17th.” ATSR: “Navy aircraft reconnaissance was ordered on the afternoon of June 15th for takeoff early on the 16th. This aircraft reported a wind, cloud, and pressure eye located at 22.5N, 96.4W at 161541Z (at about the same time this report was received, a late report from the SS HONDO was received stating that an intense tropical depression had been encountered with winds of force 10 at 0900Z in the same approximate location). On the basis of this information, the first warning was issued at 1900Z.”

June 17:

HWM analyzes a tropical storm of at most 1000 mb at 23.5N, 96.2W at 12Z. HURDAT lists a 55 knot tropical storm at 23.1N, 96.7W at 12Z. Microfilm shows a closed low pressure of at most 993 mb at 23.0N, 96.8W at 12Z. Ship highlights: 40 kt S at 22.2N, 96.2W at 00Z (COADS). 35 kt W and 1000 mb at 22.1N, 96.4W at 06Z (COADS). Land highlights: 15 kt W and 1004 mb at Tuxpan, Mexico at 00Z (micro). 10 kt NW and 1005 mb at Tampico, Mexico at 06Z (micro). 15 kt W and 1003 mb at Tampico, Mexico at 12Z (micro). 25 kt W and 1005 mb at Tampico, Mexico at 18Z

(micro). Aircraft highlights: Radar center fix estimated an eye diameter of 15 nm at 22.9N, 96.3W at 0255Z (ATSR). Penetration center fix measured a central pressure of 987 mb, estimated maximum surface winds of 50 kt and an eye diameter of 18 nm at 22.9N, 96.4W at 06Z (ATSR). Penetration center fix measured a central pressure of 992 mb, estimated maximum surface winds of 60 kt and an eye diameter of 28 nm at 23.0N, 96.8W at 13Z (ATSR). Penetration center fix measured a central pressure of 992 mb, estimated maximum surface winds of 50 kt and an eye diameter of 25 nm at 22.8N, 97.0W at 19Z (ATSR).

MWR: "Highest winds were estimated by reconnaissance aircraft at 61 kt with lowest pressure 987 mb."

June 18:

HWM analyzes a tropical storm of at most 1005 mb at 22.2N, 97.5W at 12Z. HURDAT lists a 35 knot tropical storm at 21.8N, 97.2W at 12Z. Microfilm shows a closed low pressure of at most 1005 mb at 22.0N, 97.0W at 12Z. Ship highlights: No gales or low pressures. Land highlights: 15 kt NNW and 1005 mb at Tampico, Mexico at 00Z (micro). 15 kt NW and 1005 mb at Tampico, Mexico at 06Z (micro). 10 kt NNW and 1004 mb at Tampico, Mexico at 12Z (micro). Aircraft highlights: Penetration center fix measured a central pressure of 997 mb, estimated maximum surface winds of 40 kt and an eye diameter of 15 nm at 22.5N, 96.9W at 01Z (ATSR). Radar center fix at 22.3N, 97.1W at 06Z (ATSR). Penetration center fix measured a central pressure of 1001 mb, estimated maximum surface winds of 30 kt and an eye diameter of 12 nm at 22.1N, 97.3W at 1330Z (ATSR). Penetration center fix measured a central pressure of 1001 mb, estimated maximum surface winds of 30 kt and an eye diameter of 12 nm at 21.9N, 97.3W at 19Z (ATSR).

MWR: "Turned southward moving inland over Mexico south of Tampico on the 18th. The storm weakened rapidly on turning southward late on the 17th, and winds were generally less than 30 kt. as it moved inland. No reports of damage have been received from Mexico; it was probably minor."

June 19:

HWM analyzes a spot low at 21.0N, 99.5W at 12Z. HURDAT does not list an organized system on this date. Microfilm shows a tropical wave along 17-25N, 94W at 12Z. Ship highlights: No gales or low pressures.

The origin of Tropical Storm Beulah is uncertain. A frontal boundary entered the northwestern Gulf of Mexico on June 13th and likely interacted with a trough or tropical wave over the southwestern Gulf. A decrease of about 2-3 millibars was noticed on June

14th on the coastal stations of the western Gulf of Mexico compared to a day earlier. The first position is analyzed at 18Z on June 15th as a 25 kt tropical depression, same as the original HURDAT. The actual genesis timing is uncertain because of the lack of observations on the Bay of Campeche and it is possible that the tropical cyclone may have developed earlier. Minor track changes were analyzed during the lifetime of this system. Intensification to a tropical storm is analyzed at 06Z on the 16th, same as originally shown in HURDAT. The ship SS HONDO reported 50 kt NE and 997 mb at 09Z on June 16th. A reconnaissance aircraft measured a central pressure of 987 mb, estimated surface winds of 45 kt and an eye diameter of 25 nm at 1832Z on the 16th. A central pressure of 987 mb suggests maximum surface winds of 68 kt south of 25N from the Brown et al. pressure-wind relationship. An eye diameter of 25 nm suggests an RMW of about 19 nm and climatology is 18 nm. Due to a forward speed of about 3 kt and low environmental pressures (outer closed isobar of 1007 mb), an intensity of 60 kt is selected at 18Z on the 16th, up from 50 kt originally in HURDAT, a minor intensity change. A central pressure of 987 mb is added to HURDAT at 18Z on the 16th. It is possible that Beulah may have reached hurricane intensity late on the 16th or early on June 17th, but the data available is not sufficient to justify hurricane intensity. The next aircraft to reach Beulah occurred at 06Z on the 17th and measured a central pressure of 987 mb, estimated surface winds of 50 kt and an eye diameter of 18 nm. A central pressure of 987 mb suggests maximum surface winds of 68 kt south of 25N from pressure-wind relationship. An eye diameter of 18 nm suggests an RMW of about 14 nm and climatology suggests about 18 nm. Since Beulah was almost stationary and the environmental pressures remained low, an intensity of 60 kt is again analyzed at 06Z on the 17th, up from 55 kt originally shown in HURDAT. A central pressure of 987 mb is added to HURDAT at 06Z on the 17th. 60 kt is also the peak intensity for this tropical cyclone, same as the original HURDAT, but 12-24 hours later.

The next penetration center fix measured a central pressure of 992 mb, estimated surface winds of 60 kt and an eye diameter of 28 nm at 13Z. A central pressure of 992 mb suggests maximum sustained winds of 61 kt south of 25N from the pressure-wind relationship. An eye diameter of 28 nm suggests an RMW of about 21 nm and climatology is 18 nm. Due to the slow forward speed of about 2 kt, an intensity of 55 kt is selected at 12Z on the 17th, same as originally shown in HURDAT. A central pressure of 992 mb is added to HURDAT at 12Z on the 17th. At 19Z, another penetration center fix measured a central pressure of 992 mb, estimated surface winds of 50 kt and an eye diameter of about 25 nm. An intensity of 55 kt is selected for 18Z on the 17th, 5 kt less than originally shown in HURDAT. A central pressure of 987 mb was present in HURDAT at 18Z on the 17th and has been replaced with 992 mb. Beulah continued to weaken on June 18th as it moved generally southward. A reconnaissance aircraft measured a central pressure of 997 mb and estimated surface winds of 40 kt at 01Z on the

18th. A central pressure of 997 mb suggests maximum sustained winds of 54 kt south of 25N weakening from the pressure-wind relationship. Due to the slow forward speed of about 3 kt, an intensity of 50 kt is selected at 00Z on the 18th, 5 kt less than originally shown in HURDAT, a minor intensity change. A central pressure of 997 mb is added to HURDAT at 00Z on the 18th. Another two penetration center fixes measured 1001 mb, estimated surface winds of 30 kt at 1330Z and 19Z on the 18th. A central pressure of 1001 mb suggests maximum sustained winds of 45 kt south of 25N from the pressure-wind relationship. Due to the slow forward speed of about 2 kt and low environmental pressures, an intensity of 40 kt is selected at 12Z and 18Z on the 17th, up from 35 kt and 30 kt, respectively, in HURDAT, minor intensity changes. A central pressure of 1001 mb is added to HURDAT at 12Z and 18Z on the 18th. The last position in HURDAT is at 18Z on the 18th over the Gulf of Mexico but surface observations, especially Tampico and Tuxpan, indicate that Beulah remained a closed low pressure system for at least twelve more hours. The small tropical cyclone moved southwestward early on June 19th making landfall about 02Z around 21.7N, 97.5W near Cabo Rojo, Mexico or about halfway between Tuxpan and Tampico, as a 35 kt tropical storm. Having the system make landfall before dissipating is consistent with the assessment in the MWR. Weakening to a tropical depression is analyzed at 06Z on the 19th, twelve hours later than originally shown in HURDAT. Dissipation occurred shortly after 06Z on the 19th.

Unnamed Tropical Storm #3 [June 18-22, 1959]

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41030 06/18/1959 M= 4  3 SNBR= 892 NOT NAMED   XING=0 SSS=0
41030 06/17/1959 M= 6  3 SNBR= 892 NOT NAMED   XING=1 SSS=0
         **         *                              *

(June 17th is new to HURDAT)
41035 06/17*  0   0   0    0*  0   0   0    0*  0   0   0    0*250 880  30
1004*
                                                          *** ***  **
****

41035 06/18*256 867  30    0*272 835  30    0*288 803  30    0*304 777  35
0*
41035 06/18*259 863  35    0*272 835  40 1002*286 805  40  998*302 775  45
0*
            *** ***  **              ** **** *** ***  **  *** *** ***  **

41040 06/19*322 751  50  993*350 705  60    0*384 653  65  974E412 621  70
0*
41040 06/19E320 740  55    0E345 700  60    0E384 650  65  974E412 625  70
0*
           **** ***  **    ***** ***         *    ***              ***
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41045 06/20E437 606  70    0E453 610  60    0E460 628  50    0E456 622  50
0*
41045 06/20E437 610  70    0E455 620  60    0E460 630  50    0E456 630  50
0*
                ***          *** ***             ***              ***

41050 06/21E454 602  45    0E463 570  45    0E473 537  45    0E486 498  45
0*
41050 06/21E454 620  45    0E463 580  45    0E473 545  40    0E482 515  35
0*
                ***              ***             ***  **      *** ***  **

(June 22nd is new to HURDAT)
41051 06/22E488 490  35    0E490 470  30    0E490 450  30    0*  0   0   0
0*
            *** ***  **      *** ***  **      *** ***  **

41055 HR
41055 TS
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U.S. Tropical Storm Landfall

06/18 08Z 27.6N 82.7W 40 kt FL

Minor changes to the track and intensity shown in McAdie et al. (2009). Additionally, extratropical transition is shown 18 hours earlier than originally in HURDAT. Evidence for these alterations comes from the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Monthly Weather Review, Surface Weather Observations, and Mariners Weather Log.

June 15:

HWM analyzes a stationary cold front over the northern Gulf of Mexico at 12Z. HURDAT does not list an organized system on this date. Microfilm Ship highlights: No gales or low pressures.

MWR: “While Beulah was developing in the southwestern Gulf of Mexico, an unstable easterly wave was noted in the northwestern Caribbean on June 15.”

June 16:

HWM analyzes a spot low at 24.0N, 89.0W with a stationary front to the northwest and Beulah to the west at 12Z. HURDAT does not list an organized system on this date. Microfilm shows a trough over the central Gulf of Mexico at 12Z. Ship highlights: 35 kt SE and 1008 mb at 25.3N, 87.1W at 12Z (COADS). 35 kt S and 1012 mb at 26.3N, 86.8W at 18Z (COADS).

MWR: “This wave moved northwestward into the central Gulf on the 16th.”

June 17:

HWM analyzes a tropical storm of at most 1005 mb at 24.0N, 89.0W with a weakening front to the northeast and Beulah to the west at 12Z. HURDAT does not list an organized system on this date. Microfilm shows a closed low pressure of at most 1005 mb at 28.5N, 87.0W at 12Z. Ship highlights: 5 kt SE and 1004 mb at 25.0N, 89.3W at 12Z (HWM). 5 kt S and 1005 mb at 25.0N, 87.4W at 18Z (COADS).

MWR: “A weak closed circulation appeared in the east-central Gulf on the 17th. It began moving northeastward.”

June 18:

HWM analyzes a tropical storm of at most 1000 mb at 28.2N, 80.4W with a stationary front to the northeast at 12Z. HURDAT lists a 30 knot tropical depression at 28.8N, 80.3W at 12Z. Microfilm shows a closed low pressure of at most 1005 mb at 29.0N, 80.0W with a frontal boundary to the north at 12Z. Ship highlights: 35 kt S and 1006 mb at 25.7N, 85.3W at 00Z (COADS). 35 kt SSW and 1016 mb at 27.2N, 79.3W at 12Z (COADS). 45 kt NE and 1003 mb at 30.7N, 76.6W at 18Z (COADS). 40 kt SW and 997 mb at 30.7N, 75.9W at 20Z (MWL). 55 kt SE and 982 mb (possible low pressure bias) at 30.7N, 74.7W at 20Z (micro). Land highlights: 40 kt S and 1008 mb at Dry Tortugas Light, FL at 00Z (micro). 40 kt at West Palm Beach, FL (no time given) (CLIMO). 18 kt SW and 1004 mb at Tampa, FL at 08Z (SWO). 12 kt SW and 1003 mb at MacDill AFB, FL at 09Z (SWO). 35 kt W at Sarasota, FL at 12Z (SWO). 20 kt SSW and 1002 mb at Cape Canaveral, FL at 12Z (SWO). 35 kt WNW at Sarasota, FL at 13Z (SWO). 35 kt NW at Sarasota, FL at 14Z (SWO).

MWR: “When the tropical depression was still about 350 miles west of Miami, a tornado moved across the city of Miami at about 10 pm EST on the 17th, lasting 20-30 minutes and causing approximately $1,500,000 damage, many injuries, but no deaths. At the same time another tornado formed north of West Palm Beach and lasted about 20 minutes but fortunately traversed a sparsely inhabited area. The tropical cyclone moved across central Florida during the night of June 17-18 attended by heavy rains and gusty winds, fluctuating rapidly in the Sarasota-Bradenton area from 9-13 kt to 43 kt. Tides 2 to 3 feet above normal were reported along the beaches from St. Petersburg to Naples causing damage estimated at $156,000. The torrential rains following previous heavy rainfall caused considerable additional damage to crops, particularly in the Fort Myers area. Several bulletins on this storm were issued by the Miami Hurricane Center. The last, on the afternoon of June 18, indicated winds of 43 to 56 kt, and the likelihood of additional development, and contained cautionary advices to shipping.”

June 19:

HWM analyzes a hurricane of at most 990 mb at 37.2N, 66.5W with a cold front to the southwest and a weakening front to the west and north at 12Z. HURDAT lists a 65 knot hurricane at 38.4N, 65.3W at 12Z. Microfilm shows a closed low pressure of at most 999 mb at 38.5N, 65.0W at 12Z. Ship highlights: 50 kt W and 1008 mb at 26.6N, 74.4W at 00Z

(COADS). 60 kt WSW (gusts to 80 kt) and 993 mb at 0250Z (micro). 35 kt SSW and 1013 mb at 29.1N, 71.2W at 06Z (COADS). 65 kt NW and 999 mb at 38.7N, 65.3W at 12Z (micro). 35 kt SSW and 1013 mb at 29.1N, 71.2W at 06Z (COADS). 974 mb (no position or time given, but likely around 12Z) (MWR). 40 kt SSE and 985 mb at 40.5N, 61.5W at 18Z (COADS).

MWR: “After passing off the Florida east coast the storm deepened steadily and at 0250 GMT on the 19th, the Atlantic Union reported a barometer reading of 993 mb, falling, and west-southwesterly winds occasionally 80 kt. Although the hurricane was in a diffused frontal zone, it now appears to have remained warm-core and essentially tropical for some time. The lowest reported pressure was 974 mb. The hurricane struck the Canadian Maritime Provinces in the vicinity of Northumberland Straits. Associated wind and barometric data as the storm moved inland are lacking, but the press reported 33 deaths, mostly lobster fishermen, and considerable property damage. Notices of this severe storm had been carried in the NSS bulletins.”

June 20:

HWM analyzes a tropical storm of at most 985 mb at 46.0N, 64.0W with a weakening cold front to the west and a cold front to the east at 12Z. HURDAT lists a 50 knot extratropical cyclone at 46.0N, 62.8W at 12Z. Microfilm shows a closed low pressure of at most 984 mb at 45.5N, 63.7W with a frontal boundary to the west at 12Z. Ship highlights: 50 kt NW and 997 mb at 42.6N, 62.4W at 00Z (COADS). 35 kt ESE and 998 mb at 46.0N, 58.0W at 06Z (COADS). 45 kt SW and 989 mb at 44.4N, 63.4W at 12Z (COADS). 35 kt S and 989 mb at 44.8N, 61.8W at 18Z (COADS). Land highlights: 50 kt E and 993 mb at Iles de la Madelaine, Canada at 06Z (micro). 35 kt ESE and 995 mb at Iles de la Madelaine, Canada at 12Z (micro).

MWR: “The hurricane struck the Canadian Maritime Provinces in the vicinity of Northumberland Straits. Associated wind and barometric data as the storm moved inland are lacking, but the press reported 33 deaths, mostly lobster fishermen, and considerable property damage. Notices of this severe storm had been carried in the NSS bulletins.”

June 21:

HWM analyzes a closed low pressure of at most 1000 mb at 47.0N, 55.0W with a weakening front to the east at 12Z. HURDAT lists a 45 knot extratropical cyclone at 47.3N, 53.7W at 12Z. Microfilm shows a closed low pressure of at most 999 mb at 47.0N, 54.0W at 12Z. Ship highlights: 45 kt SW and 1001 mb at 41.2N, 60.7W at 00Z (COADS). 45 kt W at 37.7N, 59.7W at 06Z (COADS). 35 kt WSW and 1008 mb at 41.1N, 52.9W at 12Z (COADS). 35 kt SW and 1006 mb at 42.4N, 49.6W at 18Z (COADS).

June 22:

HWM analyzes a closed low pressure of at most 1000 mb at 49.0N, 43.0W with a cold front to the northwest at 12Z. HURDAT does not list

an organized storm on this date. Microfilm shows a closed low pressure of at most 1002 mb at 58.0N, 32.0W at 12Z. Ship highlights: 35 kt W and 1011 mb at 42.2N, 50.5W at 00Z (COADS).

June 23:

HWM analyzes an extratropical cyclone of at most 1000 mb at 52.0N, 27.0W at 12Z. HURDAT does not list an organized storm on this date. Microfilm shows a closed low pressure of at most 1005 mb at 55.0N, 30.0W with a frontal boundary to the north at 12Z. Ship highlights: No gales or low pressures.

A tropical wave reached the western Caribbean Sea around mid-June and soon after entered the southeastern Gulf of Mexico. At the same time, Tropical Storm Bertha was brewing over the southwest Gulf. The disturbance remained largely disorganized on June 16th and early on the 17th while moving very slowly westward, almost stationary. The system began to move northeastward late on the 17th and became better organized. Genesis is analyzed at 18Z on the 17th as a 30 kt tropical depression, six hours earlier than originally shown in HURDAT. A ship near the center reported 5 kt S and 1005 mb at 18Z on the 17th indicating a central pressure of 1004 mb, which has been added to HURDAT. Minor track alterations are indicated during the lifetime of this tropical cyclone. The tropical cyclone exhibited some subtropical characteristics from the beginning, including the large size of the circulation and the strongest winds being present about 200 nm away from the center in the eastern quadrant. Intensification to a tropical storm occurred at 00Z on June 18th, eighteen hours earlier than originally shown in HURDAT. The first report of gale-force winds occurred at 00Z on the 18th as a ship reported 35 kt in the southeast quadrant. The tropical storm moved rapidly to the northeast reaching the Florida Gulf coast early on the 18th. MacDill Air Force Base near Tampa, FL reported 12 kt SW and 1003 mb at 09Z on the 18th indicating a central pressure of 1002 mb, which has been added to HURDAT at 06Z. A central pressure of 1002 mb suggests maximum sustained winds of 40 kt north of 25N from the Brown et al. pressure-wind relationship. Since the tropical storm was moving at about 33 kt but had a large circulation, an intensity of 40 kt is selected at 06Z on the 18th, up from 30 kt originally in HURDAT, a minor intensity change. Landfall occurred around 08Z as a 40 kt tropical storm near 27.6N, 82.7W or about 10 nm southwest of St. Petersburg. This intensity is consistent with 35 kt sustained wind reports from Sarasota, FL. The landfall intensity is 10 kt higher than originally shown in HURDAT, a minor intensity change. The synoptic map at 06Z on the 18th indicates that the tropical storm was elongated NE-SW and a moderate temperature gradient was starting to develop between the northeastern and southeastern quadrants. Still, the tropical storm was embedded within a tropical airmass and the approaching cold front was located over central Georgia. Cape Canaveral reported 20 kt SSW (land exposure wind) and

1002 mb at 12Z on the 18th, suggesting a central pressure of about 998 mb, which has been added to HURDAT. The tropical storm rapidly crossed Florida, entering the Atlantic at about 11Z on the 18th. The tropical cyclone rapidly began to intensify over the Atlantic Ocean late on the 18th as it began to acquire extratropical characteristics. Transition to an extratropical cyclone is analyzed at 00Z on June 19th, eighteen hours earlier than originally shown in HURDAT. The synoptic map at 00Z on the 19th clearly shows that the cyclone had developed a warm and cold front, along with a significant temperature gradient. The peak intensity of this system as a tropical cyclone is analyzed at 45 kt at 12Z on the 19th, likely partially influenced by baroclinic processes. This is 20 kt lower than originally shown in HURDAT, which indicated that the peak intensity was 65 kt at 18Z on the 18th, a major intensity change.

A central pressure of 993 mb was present in HURDAT at 00Z on the 19th and has been removed since this was reported by a ship at 0230Z along with winds of 60 kt and gusts to 80 kt. Two ships reported 65 kt at 12Z on the 19th and it is analyzed that the extratropical cyclone reached hurricane-force intensity at this time, same as the original HURDAT. A central pressure of 974 mb was present in HURDAT at 12Z on the 19th and has been retained as it seems reasonable, although it is only mentioned in the Monthly Weather Review and does not appear in any of the other available sources. It is also interesting to mention that while extratropical, the synoptic map at 12Z on the 19th shows that the system retained a tight core of strong winds. The extratropical cyclone interacted with another extratropical cyclone over the Northeast of the United States on the 19th causing the motion of the system to change to the north and later northwest. Weakening below hurricane force occurred at 06Z on June 20th, same as originally shown in HURDAT. Early on the 20th, the strong extratropical cyclone made landfall over Nova Scotia and remained over the area for the next eighteen hours. The extratropical cyclone began to move eastward early on the 21st and continued to weaken. The center crossed eastern Newfounland around 12Z on the 21st and weakening below gale-force winds occurred at 06Z on June 22nd. The weak extratropical cyclone was absorbed by a large extratropical cyclone located southeast of Greenland after 12Z on the 22nd, eighteen hours later than originally shown in HURDAT.

Tropical Storm Cindy [July 4-12, 1959]

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41060 07/05/1959 M= 8  4 SNBR= 893 CINDY       XING=1 SSS=1
41060 07/04/1959 M= 9  4 SNBR= 893 CINDY       XING=1 SSS=0
         **          *                                *

(July 4th is new to HURDAT)
41063 07/04*  0   0   0    0*  0   0   0    0E315 790  25    0E310 790  25    0*
                                             **** ***  **     **** ***  **

41065 07/05*  0   0   0    0*  0   0   0    0*296 785  25    0*298 783  25    0*
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41065 07/05E305 789  25    0E300 787  25    0*298 785  25    0*298 783  25    0*
           **** ***  **     **** ***  **      ***
41070 07/06*300 782  25    0*303 780  25    0*306 779  25    0*309 776  25    0*
41070 07/06*300 782  25    0*303 780  25    0*305 779  30    0*308 777  35    0*
                                             ***      **      *** ***  **
41075 07/07*312 773  30    0*315 771  35    0*317 770  45    0*321 768  50    0*
41075 07/07*313 774  40    0*318 772  40    0*320 770  45    0*321 769  50    0*
           *** ***  **      *** ***  **      *** ***                ***
41080 07/08*324 769  55    0*324 775  60    0*323 782  65    0*323 788  65    0*
41080 07/08*322 770  55  997*323 775  60    0*324 781  60  995*324 787  60    0*
           *** ***      *** *** ***         *** ***  **  *** *** ***  **
41085 07/09*324 793  65    0*330 798  50    0*337 802  35    0*341 803  30    0*
41085 07/09*325 794  60  995*332 800  50    0*337 802  35    0*341 803  30    0*
           *** ***  **  *** *** ***
41090 07/10*345 799  30    0*351 792  30    0*359 779  30    0*370 762  35    0*
41090 07/10*345 799  30    0*351 792  35    0*359 779  35    0*369 764  40    0*
                                   **                **      *** ***  **
41095 07/11*382 743  40    0*395 724  45    0*412 703  50    0E435 677  50    0*
41095 07/11*380 746  45    0*395 723  50    0*412 703  50  998E443 673  45 1000*
           *** ***  **          ***  **                    *** *** ***  ** ****
41100 07/12E458 649  45    0E480 620  35    0E502 591  35    0E524 562  35    0*
41100 07/12E463 650  40    0E483 620  35    0E505 591  30    0E530 562  25    0*
           *** ***  **      ***             ***      **      ***        **

41105 HR SC1
41105 TS
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U.S. Tropical Storm Landfall

07/09 03Z 32.8N 79.7W 60 kt SC
07/11 12Z 41.2N 70.3W 50 kt MA
07/11 13Z 41.7N 70.0W 50 kt MA

Minor changes to the track and intensity shown in McAdie et al. (2009). Evidence for these alterations comes from the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Monthly Weather Review, Navy reconnaissance book, Surface Weather Observations, Mariners Weather Log, Jarrell et al. (1992) and NHC Storm Wallets.

July 3:

HWM and microfilm analyze a frontal system over the southeast United States and northwestern Atlantic at 12Z. HURDAT does not list an organized system on this date. Ship highlights: No gales or low pressures.

July 4:

HWM analyzes a spot low at 29.0N, 80.0W with a weakening cold front to the north at 12Z. HURDAT does not list an organized system on this date. Microfilm shows a closed low pressure of at most 1014 mb at 32.0N, 79.5W with a frontal boundary to the north at 12Z. Ship highlights: No gales or low pressures.

ATSR: “Hurricane Cindy developed from a stagnant low on a trailing cold front off the northern Florida coast. As this low drifted eastward and then northward during the period of 4 to 7 July, it slowly warmed and intensified.”

July 5:

HWM analyzes a closed low pressure of at most 1010 mb with a warm front to the northeast at 29.8N, 78.8W at 12Z. HURDAT lists a 25 knot tropical depression at 29.6N, 78.5W at 12Z (first position). Microfilm shows a closed low pressure of at most 1011 mb at 29.8N, 78.7W with a frontal boundary to the northeast at 12Z. Ship highlights: No gales or low pressures.

MWR: “The circulation which produced the storm had been noticed first some three days earlier (July 5th) off the Florida upper east coast. A deepening low pressure system had moved from the Great Lakes to the Canadian Maritime Provinces while the associated cold front moved southeastward and became stationary from near Bermuda to extreme northern Florida. With the fracture of the short-wave trough, a cut-off Low developed off the south Atlantic coast-most pronounced at the 500-mb level. Usually tropical storms forming in this type of situation develop slowly, remain small, and seldom intensify too much more than minimal hurricane strength. Cindy conformed to this pattern.”

July 6:

HWM analyzes a tropical storm of at most 1010 mb at 31.2N, 77.8W at 12Z. HURDAT lists a 25 knot tropical depression at 30.6N, 77.9W at 12Z. Microfilm shows a closed low pressure of at most 1011 mb at 31.0N, 78.1W at 12Z. Ship highlights: No gales or low pressures.

MWR: “On July 6, winds just east of the center increased to 26-35 kt as convective activity, evidenced by numerous showers extending outward some 200 miles to the north, contributed to the conversion from a cold to a warm-core system. An intensifying anticyclone increased the easterly gradient north of the center and Cindy developed and intensified”

July 7:

HWM analyzes a tropical storm of at most 1010 mb at 32.0N, 76.4W with a cold front to the north at 12Z. HURDAT lists a 45 knot tropical storm at 31.7N, 77.0W at 12Z. Microfilm shows a closed low pressure of at most 1014 mb at 32.0N, 77.5W at 12Z.

Ship highlights: 40 kt S at 31.4N, 76.0W at 00Z (COADS). 40 kt SW and 1015 mb at 30.2N, 77.0W at 06Z (COADS). 50 kt S and 1013 mb at 32.0N, 76.2W at 12Z (COADS). 50 kt SSE and 1008 mb at 32.4N, 76.5W at 18Z (COADS). 50 kt S and 1013 mb at 31.8N, 76.4W at 23Z (MWL). Aircraft highlights: Penetration center fix measured a central pressure of 997 mb, estimated maximum surface winds of 60 kt and an eye diameter of 15 nm at 32.2N, 76.9W at 2145Z (ATSR).

MWR: "A reconnaissance plane located the eye late on the afternoon of the 7th some 190 miles east of Charleston with maximum winds 52 to 56 kt and minimum pressure 997 mb." ATSR: "At 072145Z, a Navy reconnaissance aircraft reported a wind, cloud, and pressure eye which indicated that this circulation had attained tropical characteristics. First warning on CINDY was issued at 072330Z."

July 8:

HWM analyzes a hurricane of at most 1005 mb at 32.9N, 76.7W with a weakening cold front to the north at 12Z. HURDAT lists a 65 knot hurricane at 32.3N, 78.2W at 12Z. Microfilm shows a closed low pressure of at most 1011 mb at 32.2N, 78.1W with a frontal boundary to the north at 12Z. Ship highlights: 50 kt S and 1005 mb at 32.1N, 76.6W at 00Z (COADS). 50 kt S and 1012 mb at 31.7N, 77.0W at 06Z (COADS). 50 kt NNW and 1012 mb at 32.0N, 79.0W at 09Z (micro). 25 kt ENE and 998 mb at 32.2N, 78.7W at 11Z (micro). 35 kt SE and 1021 mb at 32.9N, 75.9W at 12Z (COADS). 55 kt ESE and 1014 mb at 32.8N, 77.3W at 15Z (MWL). 45 kt NW and 1011 mb at 32.3N, 79.2W at 18Z (COADS). Land highlights: 41 kt N (fastest mile) at Charleston, SC (no time given, but likely late on the 8th) (CLIMO). 1005 mb at Charleston, SC (no time given, but likely late on the 8th or early on the 9th) (CLIMO). Aircraft highlights: Radar center fix at 32.5N, 76.9W at 00Z (ATSR). Radar center fix estimated an eye diameter of 17 nm at 32.3N, 77.6W at 0542Z (ATSR). Penetration center fix measured a central pressure of 995 mb, estimated maximum surface winds of 35 kt and an eye diameter of 12 nm at 32.3N, 78.2W at 13Z (ATSR). Penetration center fix measured a central pressure of 1000 mb, estimated maximum surface winds of 60 kt and an eye diameter of 15 nm at 32.4N, 78.8W at 1727Z (ATSR). Penetration center fix measured a central pressure of 995 mb at 32.5N, 79.2W at 23Z (ATSR).

ATSR: "Under the influence of a 200 mb high cell, CINDY continued to intensify attaining a maximum wind speed of 65 knots just before passing inland near Charleston, South Carolina, on the afternoon of 8 July." Preliminary Report: "During the night of July 7-8 it began moving slowly westward toward the South Carolina coast, under close surveillance by Navy reconnaissance aircraft operating from Jacksonville and Air Defense Command land based radar located near Charleston, SC and Wilmington, NC. It barely reached hurricane force July 8, with highest winds in squalls near the center of 70 to 75 miles per hour."

July 9:

HWM analyzes a tropical storm of at most 1015 mb at 34.2N, 79.8W with a cold front to the northwest and a warm front to the northeast at 12Z. HURDAT lists a 35 knot tropical storm at 33.7N, 80.2W at 12Z. Microfilm shows a closed low pressure of at most 1011 mb at 33.9N, 80.7W with a frontal system to the northwest and northeast at 12Z. Ship highlights: 40 kt S and 1016 mb at 32.0N, 78.0W at 00Z (COADS). 35 kt W and 1014 mb at 31.7N, 79.2W at 06Z (micro). Land highlights: 56 kt at McClellanville, SC (no time given but likely early on the 9th) (MWR). 35 kt N (gusts to 50 kt) and 1012 mb at Congaree AB, SC at 0955Z (SWO). Aircraft highlights: Radar center fix estimated flight level winds of 56 kt and an eye diameter of 24 nm at 32.9N, 79.3W at 0130Z (ATSR). "Jul – SC1 – Cat 1 – 993 mb" (Jarrell et al. (1992).

MWR: "The small storm moved northwestward, reaching hurricane intensity a short distance offshore, and the center made landfall about 0245 GMT on the 9th between Charleston and Georgetown, S.C. Winds of 56 kt were recorded at McClellanville, a short distance inland, with squalls estimated at just about hurricane force in the sparsely settled coastal area. The storm tide was about 4 feet above normal near the center. The storm curved northward through South Carolina on the 9th." ATSR: "Recurvature took place on 9 July in advance of a cold front." Preliminary Report: "The center moved inland near McClellanville, SC (between Georgetown and Charleston) about 9:30 pm EST July 8 [0230Z on the 9th] attended by winds of whole gale force, tides up to about 4 feet above normal, and heavy rain."

July 10:

HWM analyzes a tropical storm of at most 1010 mb at 36.0N, 77.7W with a cold front to the northwest at 12Z. HURDAT lists a 30 knot tropical depression at 35.9N, 77.9W at 12Z. Microfilm shows a closed low pressure of at most 1008 mb at 36.0N, 77.9W with a frontal boundary to the northwest at 12Z. Ship highlights: 35 kt SSW and 1018 mb at 34.4N, 76.1W at 06Z (COADS). 40 kt S and 1013 mb at 36.4N, 75.1W at 18Z (COADS). 45 kt S and 1013 mb at 36.1N, 75.1W at 21Z (COADS). Land highlights: 42 kt NW (gusts to 52 kt) at Charlotte, NC at 2105Z (SWO).

July 11:

HWM analyzes a tropical storm of at most 1010 mb at 42.0N, 70.6W with a weakening front close to the west at 12Z. HURDAT lists a 50 knot tropical storm at 41.2N, 70.3W at 12Z. Microfilm shows a closed low pressure of at most 1002 mb at 41.5N, 70.0W with a frontal boundary to the north at 12Z. Ship highlights: 30 kt S and 1002 mb at 37.9N, 74.5W at 00Z (COADS). 65 kt S (45 kt MWL) and 1003 mb at 38.9N, 72.1W at 06Z (COADS). 35 kt S and 1012 mb at 40.9N, 68.4W at 15Z (COADS). Land highlights: 40 kt SSE (gusts to 47 kt) at Nantucket Shoals, MA at 1056Z (SWO). 25 kt

SSW and 1001 mb at Nantucket, MA at 1159Z (SWO). 47 kt SE (gusts to 51 kt) at Georges Shoal, MA at 13Z (SWO). 36 kt SSW at Georges Shoal, MA at 18Z (SWO). 10 kt NE and 1001 mb at Eastport, ME at 18Z (micro).

MWR: “Then turned northeastward at a little faster rate to the southern tip of Chesapeake Bay by late afternoon on July 10. The sustained winds had dropped rapidly after the center moved inland but gusts up to 39 kt were still occurring at this time. As the remains of the circulation moved back into the Atlantic, marked re-intensification took place. At 0600 GMT, with the center some 75-100 miles off the New Jersey coast, the ship Ocean Monarch reported winds of 65 kt just southeast of the center, and other ships reported 45 to 50 kt. Accelerating northeastward, Cindy had passed across Cape Cod by 1200 GMT July 11. Winds were generally 22 to 35 kt. along the coast but ranged up to 35 to 52 kt over the open waters just east of the center with a gust of 59 kt. at Block Island, R.I.”

July 12:

HWM analyzes a tropical storm of at most 1015 mb at 49.1N, 59.8W with a warm front to the northeast and a cold front to the south at 12Z. HURDAT lists a 35 knot extratropical cyclone at 50.2N, 59.1W at 12Z. Microfilm shows a closed low pressure of at most 1011 mb at 52.0N, 59.5W with a frontal boundary to the south at 12Z. Ship highlights: 40 kt SW and 1014 mb at 44.4N, 63.4W at 00Z (COADS).

July 13:

HWM analyzes an extratropical cyclone of at most 1010 mb at 56.0N, 44.0W at 12Z. HURDAT does not list an organized system on this date. Microfilm does not show an organized system at 12Z. Ship highlights: No gales or low pressures.

July 14:

HWM analyzes an extratropical cyclone of at most 1005 mb at 62.0N, 27.0W at 12Z. HURDAT does not list an organized system on this date. Microfilm is not available on this date. Ship highlights: No gales or low pressures.

July 15:

HWM analyzes an extratropical cyclone of at most 995 mb at 60.0N, 22.0W at 12Z. HURDAT does not list an organized system on this date. Microfilm is not available on this date. Ship highlights: No gales or low pressures.

July 16:

HWM analyzes an extratropical cyclone of at most 990 mb at 62.0N, 22.0W at 12Z. HURDAT does not list an organized system on this date. Microfilm is not available on this date. Ship highlights: No gales or low pressures.

July 17:

HWM analyzes an extratropical cyclone of at most 995 mb at 64.0N, 18.0W at 12Z. HURDAT does not list an organized system on this date. Microfilm is not available on this date. Ship highlights: No gales or low pressures.

July 18:

HWM analyzes an extratropical cyclone of at most 995 mb at 69.0N, 14.0W at 12Z. HURDAT does not list an organized system on this date. Microfilm is not available on this date. Ship highlights: No gales or low pressures.

July 19:

HWM analyzes an extratropical cyclone of at most 1005 mb at 70.0N, 22.0W at 12Z. HURDAT does not list an organized system on this date. Microfilm is not available on this date. Ship highlights: No gales or low pressures.

A slow-moving frontal boundary entered the western Atlantic Ocean on July 3rd allowing for the development of a frontal low just off the southeast coast of the United States. Genesis is analyzed at 12Z on July 4th as a 25 kt extratropical depression. The system initially moved slowly to the south, later turning to the east on July 5th. Transition to a tropical depression is analyzed at 12Z on the 5th, same as the original HURDAT, based on surface observations indicating the dissipation of the frontal features and a more uniform and tropical airmass around the system. Minor alterations were made to the track of this tropical cyclone for all days of its existence. The tropical depression turned to the northeast on July 6th and intensification to a tropical storm is indicated at 18Z on the 6th, six hours earlier than originally shown in HURDAT, based on a ship report of 40 kt SW and 1014 mb at 00Z on July 7th. Cindy continued to intensify on the 7th according to a couple of ships reports of gale-force winds, reaching up to 50 kt later on the day. The first reconnaissance aircraft reached Cindy at 2145Z on the 7th measuring a central pressure of 997 mb, estimating surface winds of 60 kt and an eye diameter of 15 nm. A central pressure of 997 mb suggests maximum sustained winds of 49 kt north of 25N from the Brown et al. pressure-wind relationship. An eye diameter of 15 nm suggests an RMW of about 12 nm and the climatological value is 26 nm. Due to an RMW smaller than average and environmental pressures higher than average, but Cindy being almost stationary, an intensity of 55 kt is selected for 00Z on July 8th, same as the original HURDAT. A central pressure of 997 mb is added to HURDAT at 00Z on the 8th. Cindy turned to the west on the 8th and gained in forward speed. A couple of ships reported gale-force winds, up to 55 kt. The next aircraft reached Cindy at 13Z on the 8th measuring a central pressure of 995 mb, estimating surface winds of 35 kt and an eye diameter of 12 nm. A central pressure of 995 mb suggests maximum sustained winds of 52 kt north of 25N from the pressure-

wind relationship. An eye diameter of 12 nm suggests an RMW of about 9 nm and the climatological value is 27 nm. Since the RMW is smaller than average and the environmental pressures higher than average, but the forward speed was about 7 kt, an intensity of 60 kt is selected for 12Z on the 8th, 5 kt lower than originally shown in HURDAT, a minor intensity change. A central pressure of 995 mb is added to HURDAT at 12Z on the 8th. The next penetration fixes occurred at 1645Z and 1727Z on the 8th, reporting central pressures of 1002 mb and 1000 mb, respectively, along with estimated surface winds of 60 kt and an eye diameter of 15 nm. Later at 23Z, a penetration fix reported a central pressure of 995 mb, which makes the reports of central pressures at 1645Z and 1727Z a bit suspicious, although the system could have slightly weakened at those times. The intensity at 00Z on July 9th is analyzed at 60 kt, down from 65 kt originally in HURDAT, a minor intensity change. A central pressure of 995 mb is added to HURDAT at 00Z on the 9th. 60 kt is also the peak intensity of Cindy, down from 65 kt originally in HURDAT, a minor intensity change. Thus, it is analyzed that Cindy did not reach hurricane intensity during its lifetime.

Landfall occurred around 03Z on the 9th as a 60 kt tropical storm near 32.8N, 79.7W or about 15 nm northeast of Charleston, SC. All surface observations available (reconnaissance aircraft, ships and coastal stations) indicate that Cindy was a high-end tropical storm when it made landfall in South Carolina. No hurricane-force winds or equivalent low pressures were reported by ships, coastal stations or estimated by reconnaissance aircraft either at the surface or flight level. This intensity is based primarily upon the aircraft reconnaissance fix that occurred about four hours before landfall. This is consistent with the 56 kt sustained winds observed in McClellanville, SC. An approaching frontal boundary caused Cindy to turn to the northeast late on the 9th and increase in forward speed. Weakening to a tropical depression occurred at 18Z on the 9th, same as the original HURDAT. A ship near the North Carolina coast reported 35 kt SE at 06Z on the 10th and it is analyzed that Cindy regained tropical storm status at this time, twelve hours earlier than originally in HURDAT. Cindy moved back over the Atlantic Ocean late on the 10th and continued to gain strength. A ship at 06Z on the 11th reported 65 kt S and 1003 mb according to the microfilm, COADS and MWR, but the Mariners Weather Log indicates that the intensity of the wind from that ship was 45 kt, which appears more reasonable with the reports of ships nearby. Moving northeastward at about 26 kt, the tropical storm made landfall in Nantucket, MA with winds of 50 kt at 12Z on the 11th and an hour later the center reached Cape Cod, MA with the same intensity. Nantucket Shoals, MA reported 25 kt SSW and 1001 mb at 1155Z, suggesting a central pressure of 998, which has been added to HURDAT at 12Z on the 11th. Georges Shoals, MA had a peak sustained wind of 47 kt at 13Z. The platform is elevated at 200 feet above sea level, which means that the 10-m winds were around 41 kt. Transition to an extratropical cyclone is analyzed at 18Z on the 11th, same as the original HURDAT. The

synoptic map at 18Z on the 11th clearly shows that cold, dry continental air had entrained into the circulation of Cindy. Eastport, ME reported a 10 kt NE and 1001 mb at 18Z on the 11th, suggesting a central pressure of 1000 mb, which has been added to HURDAT. Late on the 11th, Cindy made landfall as a weakening extratropical cyclone on New Brunswick, Canada. Weakening to an extratropical depression is analyzed at 12Z on July 12th. HURDAT did not show the system weakening below gale-force as an extratropical cyclone. Late on the 12th, the extratropical cyclone became disorganized, becoming difficult to assess if a closed circulation was still present after 18Z. The last position is analyzed at 18Z on the 12th, same as the original HURDAT.

Hurricane Debra [July 22-27, 1959]

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41110 07/23/1959 M= 6  5 SNBR= 894 DEBRA       XING=1 SSS=1
41110 07/22/1959 M= 6  5 SNBR= 894 DEBRA       XING=1 SSS=1
         **

(July 22nd is new to HURDAT)
41113 07/22*  0   0   0    0*  0   0   0    0*  0   0   0    0*275 912  25    0*

41115 07/23*269 921  25    0*272 926  30    0*275 931  35    0*276 937  35    0*
41115 07/23*276 917  25    0*279 923  25    0*282 929  30    0*285 935  30    0*
           *** ***          *** ***  **      *** ***  **      *** ***  **

41120 07/24*276 944  35    0*279 950  40    0*283 954  65 1007*285 953  65    0*
41120 07/24*285 941  35    0*283 946  45    0*283 950  55    0*284 952  65  985*
           *** ***          *** ***  **      *** ***  **    * *** ***      ***

41125 07/25*288 951  70  984*292 951  75    0*296 951  65    0*301 951  60    0*
41125 07/25*287 952  70  984*291 951  75  980*295 951  55  986*300 951  50    0*
           *** ***          ***          *** ***      **  *** ***      **

41130 07/26*306 951  45    0*313 952  30    0*321 954  30    0*331 956  30    0*
41130 07/26*306 951  40    0*313 952  30    0*321 954  30    0*331 956  25    0*
                    **                                                  **

41135 07/27*341 960  30    0*350 968  25    0*358 977  25    0*362 984  25    0*
41135 07/27*341 962  25    0*350 971  25    0*358 980  25    0*362 988  25    0*
               ***  **          ***              ***              ***

(July 28th has been removed from HURDAT)
41140 07/28*363 995  25    0*3641003  25    0*  0   0   0    0*  0   0   0    0*
41140 07/28*  0   0   0    0*  0   0   0    0*  0   0   0    0*  0   0   0    0*

41145 HRCTX1
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U.S. Hurricane Landfall

July 25th – 06Z – 29.1N 95.1W – 75 kt – Category 1 – 980 mb – 1012 mb – 150 nm ROCI – 25 nm RMW

Minor changes to the track and intensity shown in McAdie et al. (2009). Evidence for these alterations comes from the NHC microfilm maps, the Historical Weather Maps

series, the COADS ship database, Monthly Weather Review, Navy reconnaissance book, Surface Weather Observations, Mariners Weather Log, Jarrell et al. (1992) and NHC Storm Wallets.

July 20:

HWM and microfilm do not analyze an organized system at 12Z. HURDAT does not list an organized system on this date. Ship highlights: No gales or low pressures.

MWR: "The beginning of hurricane Debra can probably be traced back to July 15. Considerable shower and thundershower activity began about this time in the western Bahamas and over Florida, under the influence of a cold-core vortex which developed in the high troposphere and at 500 mb drifted slowly southwestward through the western Bahamas, over western Cuba, and into the east Gulf of Mexico by the 20th. The activity spread into the Gulf as the upper circulation flattened into an inverted trough and continued westward."

July 21:

HWM analyzes a spot low at 26.5N, 92.0W at 12Z. HURDAT does not list an organized system on this date. Microfilm shows a spot low at 28.5N, 87.0W at 12Z. Ship highlights: No gales or low pressures.

MWR: "The first weak surface circulation, detected as early as 1900 EST on the 20th, later developed into hurricane Debra over the northwestern Gulf of Mexico."

July 22:

HWM analyzes a spot low at 26.5N, 92.0W at 12Z. HURDAT does not list an organized system on this date. Microfilm shows a trough over the northwestern Gulf of Mexico at 12Z. Ship highlights: No gales or low pressures.

July 23:

HWM analyzes a tropical storm of at most 1005 mb at 28.2N, 92.9W at 12Z. HURDAT lists a 35 knot tropical storm at 27.5N, 93.1W at 12Z. Microfilm shows a closed low pressure of at most 1011 mb at 28.2N, 93.2W at 12Z. Ship highlights: No gales or low pressures.

MWR: "The circulation continued weak until the 23d, when winds up to 22-30 kt. accompanied showers and squalls in the northwestern Gulf and along the Louisiana and upper Texas coasts."

July 24:

HWM analyzes a tropical storm of at most 1005 mb at 28.3N, 95.2W at 12Z. HURDAT lists a 65 knot hurricane at 28.3N, 95.4W at 12Z. Microfilm shows a closed low pressure of at most 1011 mb at 28.5N, 95.8W at 12Z. Ship highlights: 40 kt SW and

1008 mb at 28.0N, 94.2W at 08Z (MWR/micro). 50 kt SW and 1009 mb at 28.0N, 95.2W at 12Z (MWR/micro). 45 kt S and 1008 mb at 27.2N, 94.3W at 18Z (MWL). Aicraft highlights: Penetration center fix measured a central pressure of 987 mb, estimated surface winds of 55 kt and an eye diameter of 15 nm at 28.3N, 95.4W at 1521Z (ATSR). Penetration center fix measured a central pressure of 985 mb and estimated surface winds of 60 kt at 28.4N, 95.2W at 19Z (ATSR).

MWR: “An indication that some intense weather was in the making in the western Gulf of Mexico came from the SS Atlantic Navigator (at 0000 GMT on the 24th at 23.7" N., 94.5" W.) which reported a northwest wind of 32 kt. with rough seas from the southwest. This was later corrected to southwest wind of 23 kt. The report indicated that a vortex was developing, which was later verified by reports from that area and to the north toward the Texas coast during the next 12 to 18 hours. A delayed observation, received at 1130 GMT on the 24th from the ship Mexican Trader (located at 28.0" N., 94.2 OW.) reporting a surface wind from the southwest at 40 kt. and pressure of 1007.5 mb, indicated additional intensification. At 1200 GMT this ship had moved about 60 miles west and the surface winds had increased to southwest 50 kt. That Debra was already a fully developed hurricane is evidenced by the radar photograph (fig. 2) taken at the Dow Chemical Plant in Freeport at 0733 CST July 24 when the set was turned on. No spiral organization had been noted on the radar scope the previous afternoon. Reconnaissance aircraft located the center of tropical storm Debra during the early forenoon of July 24. It seems likely the plane did not pass through the most severe squalls prevailing at the time.” ATSR: “DEBRA formed close to the Texas coastline and intensified rapidly within a large area of squally weather which covered almost the entire Gulf of Mexico. The 0000Z surface chart on 24 July indicated a trough oriented NNW – SSE through Galveston, Texas, which a very weak cyclonic circulation centered over the coastline and a much stronger circulation centered 300 miles southward. Accordingly, the Navy “Alfa” flight for the 24th of July was modified in order to permit early investigation of this system. At 241130Z, while the aircraft was enroute to the southernmost of the two circulations, an observation made at 240800Z was received from the ship MEXICAN TRADER located about 75 miles south of Galveston reporting as follows: “Wind southwest force 8, very rough seas and high swell, barometer 29.75 inches, heavy rain squalls with gusty winds, visibility poor obscured by sea spray.” At 241328Z, The Navy aircraft reported a radar eye located 28 degrees 07 minutes north latitude and 95 degrees 27 minutes west longitude and immediately diverted towards this point where winds up to 55 kt were reported. A Freeport, Teas, radar report bearing a date time group of 241400Z reported a closed eye at 28.3N 95.3W. The first warning was issued by this activity at 241500Z.”

July 25:

HWM analyzes a hurricane of at most 1000 mb at 29.8N, 95.5W at 12Z. HURDAT lists a 65 knot hurricane at 29.6N, 95.1W at 12Z. Microfilm shows a closed low pressure of at most 1002 mb at 29.5N, 93.7W with a frontal boundary to the west at 12Z. Ship highlights: 50 kt ESE and 1011 mb at 28.9N, 93.7W at 06Z (MWL). 984 mb at

Coast Guard Cutter Cahoone, Texas (no time given) (MWR). Land highlights: 35 kt N (gusts to 59 kt) and 999 mb at Brazos River Floodgate, Texas at 00Z (SWO). 987 mb at Freeport, Texas at 0430Z (WALLET). 70 kt W (might be an estimate)(gusts to 90 kt) at Brazos River Floodgate, Texas at 05Z (SWO). 73 kt WSW (fastest mile) (gusts to 77 kt) at Freeport, Texas at 0630Z (WALLET).986 mb at Dickinson, Texas at 1145Z (WALLET). 989 mb at Ellington AFB, Texas at 1458Z (SWO). 35 kt WSW (gusts to 51 kt) and 1002 mb at Houston, Texas at 1858Z (SWO). Aicraft highlights: Penetration center fix measured a central pressure of 988 mb at 28.8N, 95.1W at 01Z (ATSR). Radar center fix at 29.1N, 95.2W at 06Z (ATSR). "Jul – TX1 – Cat 1N – 984 mb" (Jarrell et al. (1992).

MWR: "Hurricane Debra increased further in intensity during the afternoon and evening of July 24 and passed inland on the Texas coast between Freeport and Galveston near midnight on the 24th. The lowest reported central pressure in hurricane Debra was 984.4 mb from the Coast Guard Cutter Cahoone late on July 24. Dickinson, Tex. reported 986.5 mb, the lowest reading from a land station. Highest reported wind was 70 to 78 kt with gusts to 91 kt. from Brazos Floodgates near Freeport, Tex. Tides were generally 3 to 5 feet above normal over Galveston Bay. Morgan Point, at the head, or north, end of Galveston Bay, reported the highest tide of 7.9 feet m.s.1. Rainfall was heavy throughout eastern Texas and extreme western Louisiana; Orange, Tex., reported the greatest amount, 14.42 inches. No casualties occurred in connection with Debra, but ten persons suffered minor injuries in Brazoria County, Tex. Damage in Brazoria, Galveston, and the eastern portion of Harris County, Tex., was estimated at $6,685,000 with some additional in other areas. Development so close to the coastline is rather unusual and the forecast problem was complicated by lack of ship reports, and delays and transmission errors in the few that were received. It continued slowly northward across extreme eastern Texas and rapidly lost intensity on the 25th and 26th, and finally lost its identity in central Oklahoma on the 27th." ATSR: "DEBRA moved inland near Freeport, Texas, at about 250600Z with maximum wind gusts near 90 kt. Maximum rainfall of about 15 inches was reported at Orange, Texas. No deaths or injuries were noted even though $7,000,000 damage was reported."

July 26:

HWM analyzes a tropical storm of at most 1005 mb at 32.5N, 95.5W at 12Z. HURDAT lists a 30 knot tropical depression at 32.1N, 95.4W at 12Z. Microfilm shows a closed low pressure of at most 1008 mb at 32.4N, 95.5W at 12Z. Ship highlights: No gales or low pressures.

July 27:

HWM analyzes a closed low pressure of at most 1010 mb at 35.5N, 97.5W with a weakening front to the north at 12Z. HURDAT lists a 25 knot tropical depression at 35.8N, 97.7W at 12Z. Microfilm shows a closed low pressure of at most 1008 mb at

35.5N, 98.5W with a frontal boundary to the northwest at 12Z. Ship highlights: No gales or low pressures.

July 28:

HWM and microfilm do not analyze an organized system on this date. HURDAT lists a 25 knot tropical depression at 36.4N, 100.3W at 06Z (last position). Ship highlights: No gales or low pressures.

A disturbance developed over the northeastern Gulf of Mexico around July 20th. The area of disturbed weather moved generally westward and slowly became better organized. Genesis is analyzed at 18Z on July 22nd as a 25 kt tropical depression, six hours earlier than originally shown in HURDAT. Minor track changes are made for the lifetime of this tropical cyclone. The tropical depression moved slowly to the west-northwest and became a tropical storm twelve hours later than originally shown in HURDAT. No gale force winds or equivalent low pressures on July 23rd were observed, despite substantial ship observations being available. Debra rapidly intensified on July 24th while slowly moving to the west near the northeast Texas coast. Various ships reported gale force winds, up to 50 kt, on this day. The first reconnaissance aircraft that investigated Debra measured a central pressure of 985 mb and estimated surface winds of 60 kt at 19Z on the 24th. A central pressure of 985 mb suggests maximum sustained winds of 66 kt north of 25N from the Brown et al. pressure-wind relationship. At 1521Z, the reconnaissance aircraft estimated an eye diameter of 15 nm, suggesting an RMW of about 11 nm and climatology is 22 nm. Due to slow forward speed of about 2 kt but an RMW smaller than climatology, an intensity of 65 kt is selected for 18Z on the 24th, same as the original HURDAT. A central pressure of 985 mb is added to HURDAT at 18Z on the 24th. Intensification to a hurricane is analyzed at 18Z on the 24th, six hours later than originally shown in HURDAT, which had an unrealistic 25 kt gain between 06Z and 12Z (40 to 65 kt) with no supporting observations. A central pressure of 1007 mb was present in HURDAT at 12Z on the 24th, but has been removed based on a ship report of 50 kt SW and 1009 mb at this time, and the reconnaissance aircraft measurement of a central pressure of 987 mb at 1521Z. A central pressure of 984 mb was present in HURDAT at 00Z on July 25th and it is mentioned in the MWR that it was measured by the Coast Guard Cutter Cahoone late on the 24th. Although the location of the ship was not found, the central pressure report appears reasonable and has been retained. Early on the 25th, Debra started moving to the north at a forward speed of about 5 kt. Landfall occurred at 06Z on the 25th near 29.1N 95.1W or about 20 miles northeast of Freeport, Texas, as a 75 kt hurricane. A central pressure of 986 mb was measured at Dickinson, Texas, at 1145Z on the 26th. The Ho et al. Inland Pressure Decay Model suggests a central pressure at landfall of 972 mb since the central pressure is suggested by the model to have filled

about 14 mb between landfall and the measurement at Dickinson, Texas. Nevertheless, a great portion of the eastern quadrant of the circulation was located over Galveston Bay during these six hours and it is assumed that the weakening was not as fast as indicated by Ho et al. Thus, a central pressure of 980 mb is analyzed at landfall and added to HURDAT at 06Z on the 25th. A central pressure of 980 mb suggests maximum sustained winds of 76 kt from the intensifying pressure-wind relationship. Based on both the pressure-wind relationship and surface winds of 73 kt measured at Freeport, Texas, at 0630Z, the intensity is kept at 75 kt, same as the original HURDAT. A central pressure of 986 mb is added to HURDAT at 12Z on the 25th.

Hurricane Debra continued moving northward on the 25th after landfall. The Kaplan and DeMaria inland decay model was run for 12Z and 18Z on the 25th and 00Z on July 26th. The model suggested 54 kt at 12Z, 45 kt at 18Z and 34 kt at 00Z. The highest winds observed within two hours of these times were 48 kt, 47 kt and less than 34 kt, respectively. 55 kt was selected at 12Z, 50 kt at 18Z and 40 kt at 00Z, while HURDAT originally had 65 kt, 60 kt, and 45 kt, respectively. Minor intensity changes to HURDAT. Thus, weakening to a tropical storm is analyzed at 12Z on the 25th, six hours earlier than originally shown in HURDAT. Weakening to a tropical depression occurred at 06Z on the 26th over eastern Texas, same as the original HURDAT. The track of the tropical depression veered to the northwest on July 27th while over Oklahoma. Dissipation is analyzed after 18Z on the 27th, twelve hours earlier than originally shown in HURDAT. Surface observations on July 28th indicate that the tropical cyclone had lost its closed circulation.

New Tropical Storm [August 2-6, 1959]

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37265 08/02/1959 M= 5  6 SNBR= 820 UNNAMED       XING=0 SSS=0

37265 08/02*  0   0   0    0*348 758  40    0*345 746  60    0*352 730  60    0*
37265 08/03*363 707  60    0*372 683  55    0*379 662  55    0E387 642  50    0*
37265 08/04E394 625  50    0E402 615  45    0E409 612  45    0E415 612  45    0*
37265 08/05E420 612  45    0E425 611  40    0E430 608  40    0E437 605  40    0*
37265 08/06E444 602  35    0E452 599  30    0E462 595  25    0E475 585  25    0*
37285 TS
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A new tropical storm has been added to HURDAT, not previously shown in McAdie et al. (2009). Evidence for its existence comes from the Historical Weather Map series, Microfilm, COADS ship database, Mariners Weather Log and Jack Beven's and David Roth’s suspect list.

August 1:

HWM analyzes a weakening cold front over the southeast of the United States at 12Z. Microfilm shows a closed low pressure of at most 1014 mb at 33.0N, 81.0W with a frontal boundary to the north at 12Z. Ship highlights: No gale force winds or equivalent low pressures.

August 2:

HWM analyzes a tropical storm of at most 1005 mb at 33.0N, 75.5W with weakening cold front to the north at 12Z. Microfilm shows a closed low pressure of at most 1011 mb at 34.2N, 74.5W with a frontal boundary to the north at 12Z. Ship highlights: 40 kt SW and 1012 mb at 33.1N, 75.2W at 06Z (COADS). 60 kt SW and 1007 mb at 33.8N, 74.3W at 12Z (COADS). 35 kt S and 1005 mb at 35.5N, 72.3W at 18Z (COADS).

MWL: “A weak disturbance on August 2, off the Carolinas, moved slowly northeastward and dissipated late on the 6th in the Gulf of St. Lawrence. Several ships near this storm’s center during the period August 2-4 reported 35 to 60 kt winds. The highest wind for the month [in the entire Atlantic], 60 kt from the southwest, was reported by the SS MOBILOIL on the 2nd while off the South Carolina coast near 34ºN, 74ºW.”

August 3:

HWM analyzes a tropical storm of at most 1000 mb at 37.7N, 71.2W with a cold front to the southeast and stationary front to the northeast at 12Z. Microfilm shows a closed low pressure of at most 1005 mb at 37.5N, 72.3W with a frontal boundary going through the system at 12Z. Ship highlights: 45 kt SW and 1009 mb at 34.1N, 71.0W at 00Z (COADS). 55 kt SE and 999 mb at 37.5N, 68.0W at 06Z (COADS). 45 kt N and 1004 mb at 37.5N, 68.0W at 12Z (micro). 45 kt NW at 37.8N, 66.9W at 18Z (micro). 35 kt NE and 1010 mb at 41.5N, 62.8W at 21Z (COADS).

August 4:

HWM analyzes a tropical storm of at most 995 mb at 40.5N, 60.5W with a cold front to the south and warm front to the northeast at 12Z. Microfilm shows a closed low pressure of at most 999 mb at 41.0N, 61.5W with a frontal boundary going through the system at 12Z. Ship highlights: 50 kt NW and 1008 mb at 38.7N, 64.7W at 03Z (micro). 40 kt N and 1005 mb at 40.8N, 64.7W at 06Z (COADS). 45 kt E and 997 mb at 41.1N, 61.2W at 12Z (COADS). 35 kt N and 1004 mb at 41.5N, 62.8W at 15Z (COADS). 40 kt SE and 1005 mb at 41.3N, 58.6W at 18Z (COADS). 35 kt NE and 1014 mb at 44.7N, 61.2W at 21Z (COADS).

August 5:

HWM analyzes a tropical storm of at most 1000 mb at 42.3N, 60.0W at 12Z. Microfilm shows a closed low pressure of at most 1002 mb at 42.5N, 60.7W with a frontal boundary going through the system at 12Z. Ship highlights: 45 kt SW and 995 mb at 41.0N, 61.5W at 00Z (micro). 40 kt NE and 1002 mb at 42.6N, 62.8W at 06Z (COADS). 40 kt SW and 1005 mb at 40.8N, 60.2W at 12Z (COADS/micro). 40 kt SE at 47.4N, 59.3W at 17Z (COADS). 30 kt S and 998 mb at 43.9N, 60.0W at 18Z (micro).

August 6:

HWM analyzes a closed low pressure of at most 1010 mb at 46.4N, 59.5W with a cold front to the north at 12Z. Microfilm shows a closed low pressure of at most 1008 mb at 46.8N, 59.0W with a frontal boundary going through the system at 12Z. Ship highlights: 15 kt NE and 1001 mb at 44.6N, 60.3W at 00Z (COADS). 15 kt W and 1002 mb at 43.9N, 60.0W at 06Z (micro).

A non-frontal disturbance developed off the southeast coast of the United States and rapidly intensified as it moved to the northeast. Coastal and ship observations at 06Z on August 2nd indicated that a well-defined low pressure system had formed just off North Carolina and a ship about 120 nm south of the center was reporting 40 kt winds. Possibly the same ship also reported 40 kt at 08Z on the 2nd. Genesis is analyzed at 06Z on the 2nd as a 40 kt tropical storm. The structure of the tropical cyclone indicates that it may have been more subtropical in nature with the strongest winds over the southern and eastern quadrant, especially early during its lifetime. However, the frontal features analyzed in HWM and the microfilm maps through the cyclone in the 2nd and 3rd (through 12Z) do not appears to be valid. At 12Z on the 2nd, a ship about 60 nm south of the center reported 60 kt and another ship nearby reported 45 kt. The intensity at 12Z on the 2nd is increased to 60 kt. 60 kt is also the peak intensity for this tropical storm, although it is possible that briefly it may have reached hurricane intensity. An approaching frontal boundary caused the tropical storm to accelerate to the northeast late on the 2nd. The tropical storm began to weaken on August 3rd as it began to interact with the frontal boundary. The circulation remained small with winds up to 55 kt being reported near the center on the 3rd. At 18Z on the 3rd, the tropical storm is analyzed to have transitioned into an extratropical cyclone. Synoptic data showed drier air being entrained into the center of the cyclone, with a strong dew point gradient between the eastern and western quadrant. The circulation of the extratropical storm expanded on August 4th as the forward speed decreased. Gradual weakening continued during the 4th and 5th as the extratropical cyclone was approaching eastern Nova Scotia. Weakening to an extratropical depression is analyzed at 06Z on August 6th. The extratropical depression continued to lose strength

and dissipated after 18Z on the 6th. Final position is analyzed at 18Z on the 6th. Analogs for this tropical storm are Tropical Storms Alberto, 1988 and Arthur, 2002.

Tropical Storm Edith [August 18-19, 1959]

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41150 08/17/1959 M= 3  6 SNBR= 895 EDITH       XING=0 SSS=0
41150 08/18/1959 M= 2  7 SNBR= 895 EDITH       XING=0 SSS=0
         **         *  *

41155 08/17*  0   0   0    0*  0   0   0    0*  0   0   0    0*137 563  30 1007*
41155 08/17*  0   0   0    0*  0   0   0    0*  0   0   0    0*  0   0   0    0*
                                                              *   *   *    *

41160 08/18*143 579  35    0*151 600  40    0*159 610  50    0*168 625  40    0*
41160 08/18*143 579  30 1007*151 597  35    0*159 615  40    0*166 635  35    0*
                     ** ****     ***  **          ***  **      *** ***  **

41165 08/19*172 648  35    0*172 679  35    0*172 711  30    0*  0   0   0    0*
41165 08/19*172 655  30    0*  0   0   0    0*  0   0   0    0*  0   0   0    0*
                ***  **        *  *    *        *   *   *

41170 TS
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Tropical Storm Landfall

08/18 12Z 15.9N 61.5W 40 kt Guadeloupe

Minor changes to the track and intensity shown in McAdie et al. (2009). Evidence for these alterations comes from the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Monthly Weather Review, Navy reconnaissance book, Surface Weather Observations, Mariners Weather Log, and NHC Storm Wallets.

August 15:

HWM and microfilm do not show an organized system at 12Z. HURDAT does not list an organized system on this date. Ship highlights: No gales or low pressures.

ATSR: “Tropical Storm Edith formed on an easterly wave which was located 23 degrees west longitude at 081200Z, by the Fleet Weather Central, Port Lyautey.”

August 16:

HWM analyzes a spot low at 9.5N, 54.5W at 12Z. HURDAT does not list an organized system on this date. Microfilm does not show an organized system at 12Z. Ship highlights: No gales or low pressures.

August 17:

HWM analyzes a tropical storm of at most 1010 mb at 11.6N, 56.7W at 12Z. HURDAT lists a 30 knot tropical depression at 13.7N, 56.3W at 18Z (first position). Microfilm shows a tropical wave near the Lesser Antilles at 12Z. Ship highlights: No gales or low pressures. Aircraft highlights: Penetration center fix estimated surface winds of 30 kt and measured a central pressure of 1007 mb at 14.1N, 57.7W at 2230Z (ATSR).

MWR: "Tropical storm Edith formed in an easterly wave in the Atlantic Ocean east of the Windward Islands. At 1530 EST, August 17, reconnaissance aircraft found a weak center near 13.8" N, 57.2" W. The minimum surface pressure was 1007 mb, while highest winds were 30 kt in squalls north of the center." ATSR: "This wave was carried by extrapolation and peripheral ship reports until 170000Z when a ship report indicated its location at 57 degrees west longitude. On the basis of this ship report and observations from the Windward Islands which were characteristic of an approaching easterly wave, a Navy reconnaissance flight was ordered. The flight revealed a diffuse circulation center at 1720Z with maximum winds of 30 knots in squalls to the north."

August 18:

HWM analyzes a tropical storm of at most 1010 mb at 15.9N, 61.8W at 12Z. HURDAT lists a 50 knot tropical storm at 15.9N, 61.0W at 12Z. Microfilm shows a closed low pressure of at most 1011 mb at 16.5N, 61.3W at 12Z. Ship highlights: 35 kt ENE and 1010 mb at 16.7N, 61.5W at 12Z (micro). 35 kt ENE and 1016 mb at 17.3N, 61.0W at 12Z (micro). Land highlights: 34 kt S at Raizet Airport, Guadeloupe at 1310Z (WALLET). Aircraft: Estimated surface winds of 50 kt near 16.7N, 61.2W at 13Z (ATSR).

MWR: "The storm was never well defined as it moved on a westnorthwestward course with an average speed of 20 kt, passing through the Leeward Islands in the vicinity of Guadeloupe early on the 18th. Highest winds never exceeded 48 kt." ATSR: "On 18 August, the Navy reconnaissance flight was unable to find any definite circulation; however, southeast winds of 50 knots were observed with numerous strong weather bands about 40 miles east of Guadaloupe. The first warning of EDITH was issued at 180100Z. Between 1000Z and 1100Z on 18 August, observations from the Lesser Antilles evidenced the passage of a weak cyclonic circulation between the islands of Dominica and Martinique. Subsequent to this time, warning positions were carried further to the north of this position because of the stronger winds through the Guadaloupe-Antigua area."

August 19:

HWM analyzes a spot low at 16.0N, 71.4W at 12Z. HURDAT lists a 30 knot tropical depression at 17.2N, 71.1W at 12Z. Microfilm shows a tropical wave south of Hispaniola along longitude 71W at 12Z. Ship highlights: No gales or low pressures.

MWR: “Highest winds never exceeded 48 kt and the storm dissipated just to the south of Mona Passage during the night of August 18-19. Indeed, there is considerable doubt if a complete circulation ever existed and whether this disturbance meets the specifications for a tropical storm. There were two important synoptic features associated with this storm. Very warm air was observed in the middle troposphere just prior to formation, and the wind field in the high troposphere never became favorable for high-level evacuation. There were no reports of loss of life or of damage attributable to Edith.” ATSR: “No further evidence of a cyclonic circulation in EDITH was found. The last warning was issued at 190000Z. The circulation damped out in the eastern Circulation and EDITH was followed across the Caribbean and Gulf of Mexico as an easterly wave.”

August 20:

HWM does not analyze an organized system at 12Z. HURDAT does not list an organized system on this date. Microfilm shows a tropical wave extending along 15-23N, 75-83W at 12Z. Ship highlights: 35 kt E and 1010 mb at 21.6N, 72.9W at 06Z (COADS).

August 21:

HWM and microfilm do not analyze an organized system at 12Z. Ship highlights: No gales or low pressures.

August 22:

HWM analyzes a closed low pressure of at most 1010 mb at 21.5N, 96.5W at 12Z. Microfilm does not show an organized system at 12Z. Ship highlights: No gales or low pressures.

August 23:

HWM and microfilm do not analyze an organized system at 12Z. Ship highlights: No gales or low pressures.

A tropical wave became better organized as it approached the Lesser Antilles on August 17th. Ship observations east of the Lesser Antilles are sparse, which makes it difficult to assess the organization of the disturbance between Africa and the islands. The first reconnaissance aircraft to investigate the disturbance encountered a weak but closed low-level circulation near 14.1N and 57.7W, and estimated surface winds of 30 kt and measured a central pressure of 1007 mb at 2230Z on the 17th. Surface observations at 18Z on the 17th indicate that the disturbance did not have a closed circulation and was a sharp tropical wave at this time. Thus, genesis is analyzed at 00Z on August 18th as a 30 kt tropical depression, six hours later than originally shown in HURDAT. A central pressure of 1007 mb appears in HURDAT at 18Z on the 17th and has been moved to 00Z on the 18th based on the reconnaissance data. Minor alterations were made to the track of this tropical cyclone. Intensification to a tropical storm is analyzed at 06Z on the 18th, six

hours later than originally shown in HURDAT. The next reconnaissance aircraft to investigate Edith arrived at midday on the 18th and did not formally report a low-level circulation. Nonetheless, the reconnaissance mission did find southwest and south-southwest winds at 1030Z, 12Z and 1230Z on the southern and southeastern quadrant, indicating that a weak circulation was still present. Two ships at 12Z reported 35 kt on the northern quadrant and around the same time and location, the reconnaissance aircraft estimated surface winds of 50 kt. A blend of these observations is used for an analyzed intensity of 40 kt at 12Z on the 18th, down from 50 kt originally in HURDAT, a minor intensity change. 40 kt is also the peak intensity of Edith, down from 50 kt originally in HURDAT, a minor intensity change. Landfall on the island of Guadeloupe occurred near 12Z as a 40 kt tropical storm. Two more reconnaissance missions late on the 18th were not able to find a closed low-level circulation but these may not have been in the best location for determining whether a closed circulation existed. Weakening to a tropical depression is analyzed at 00Z on August 19th, twelve hours earlier than originally shown in HURDAT. Observations over the eastern Caribbean indicate that Edith weakened to a tropical wave soon after 00Z on the 19th. The last position is analyzed at 00Z on the 19th, twelve hours earlier than the original HURDAT. The tropical wave continued westward over the Caribbean Sea passing south of the Greater Antilles and did not show any signs of redevelopment. A recent analog to this tropical storm is Tropical Storm Erika in 2009.

New Tropical Storm [August 28 – September 4, 1959]

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37265 08/28/1959 M= 8  8 SNBR= 820 UNNAMED       XING=0 SSS=0
37265 08/28*330 540  35    0*337 544  40    0*342 548  40    0*347 552  40    0*
37265 08/29*354 557  40    0*362 563  40    0*366 565  40    0*366 560  45    0*
37265 08/30*367 547  45    0*370 523  45    0*375 501  45    0*378 485  45    0*
37265 08/31*380 473  45    0*380 470  50    0*380 466  50    0*382 461  50    0*
37265 09/01*388 454  50    0*395 450  50    0*396 448  50    0*397 448  55    0*
37265 09/02*399 449  55    0*401 439  55    0*404 426  55    0*410 413  55    0*
37265 09/03*420 398  55    0E432 378  55    0E445 352  55    0E470 325  55    0*
37265 09/04*495 290  60    0E532 250  60    0E585 215  60    0*  0   0   0    0*
37285 TS
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A new tropical storm has been added to HURDAT, not previously shown in McAdie et al. (2009). Evidence for its existence comes from the Historical Weather Map series, Microfilm, COADS ship database, Mariners Weather Log and David Roth's suspect list.

August 26:

HWM analyzes a frontal boundary over the central Atlantic at 12Z. Microfilm shows a closed low pressure of at most 1014 mb at 29.0N, 53.0W at 12Z. Ship highlights: No gale force winds or equivalent low pressures.

August 27:

HWM analyzes a closed low pressure of at most 1010 mb at 30.0N, 56.0W with a warm front extending to the northeast and a cold front extending to the southwest at 12Z. Microfilm shows an elongated closed low pressure of at most 1011 mb at 30.0N, 55.0W at 12Z. Ship highlights: 35 kt NE and 1009 mb at 32.8N, 51.3W at 12Z (COADS). 35 kt E and 1015 mb at 37.5N, 50.3W at 18Z (COADS).

August 28:

HWM analyzes a closed low pressure of at most 1005 mb at 35.0N, 54.0W with a warm front to the northeast and a cold front extending to the southwest at 12Z. Microfilm shows a closed low pressure of at most 1008 mb at 33.5N, 53.0W at 12Z. Ship highlights: 35 kt ESE and 1016 mb at 37.4N, 48.7W at 00Z (COADS). 40 kt S and 1002 mb at 33.5N, 52.5W at 06Z (COADS). 25 kt W and 1002 mb at 32.9N, 54.4W at 12Z (COADS). 25 kt SW and 1002 mb at 33.7N, 54.5W at 18Z (COADS).

August 29:

HWM analyzes a closed low pressure of at most 1005 mb at 37.5N, 56.0W with a cold front to the northeast at 12Z. Microfilm shows a closed low pressure of at most 999 mb at 37.2N, 56.0W at 12Z. Ship highlights: 30 kt SW and 1002 mb at 33.3N, 55.8W at 00Z (COADS). 20 kt W and 1002 mb at 35.7N, 56.4W at 06Z (COADS). 30 kt N and 1000 mb at 37.1N, 57.0W at 12Z (COADS). 35 kt W and 1000 mb at 35.9N, 56.0W at 18Z (COADS).

August 30:

HWM analyzes a closed low pressure of at most 1010 mb at 37.5N, 50.0W with a cold front extending to the east at 12Z. Microfilm shows a closed low pressure of at most 999 mb at 37.5N, 50.0W with frontal boundary well north of cyclone at 12Z. Ship highlights: 35 kt E and 1003 mb at 37.3N, 51.5W at 06Z (COADS). 35 kt SSW and 999 mb at 37.2N, 49.5W at 12Z (COADS). 30 kt WSW and 1004 mb at 36.8N, 49.3W at 18Z (COADS).

August 31:

HWM analyzes a closed low pressure of at most 1005 mb at 39.0N, 48.0W with a cold front to the east and another approaching from the northwest at 12Z. Microfilm shows a closed low pressure of at most 1008 mb at 39.5N, 44.0W with a frontal boundary to the west at 12Z. Ship highlights: 30 kt SSW and 1005 mb at 37.8N, 46.4W at 00Z (COADS). 40 kt NW and 996 mb at 37.5N, 48.0W at 06Z (COADS).

September 1:

HWM analyzes a closed low pressure of at most 1005 mb at 39.0N, 45.5W with a weakening frontal boundary to the north at 12Z. Microfilm shows a closed low pressure of at most 1011 mb at 41.0N, 42.5W with a frontal boundary going through the cyclone

at 12Z. Ship highlights: 40 kt SE and 1017 mb at 42.4N, 38.0W at 12Z (COADS/micro). 30 kt S and 1003 mb at 39.2N, 43.8W at 18Z (COADS).

September 2:

HWM analyzes a closed low pressure of at most 1005 mb at 40.0N, 42.5W with a weakening warm front to the northwest at 12Z. Microfilm shows a closed low pressure of at most 1008 mb at 39.5N, 44.5W with a frontal boundary going through the cyclone at 12Z. Ship highlights: 55 kt W and 999 mb at 39.0N, 45.5W at 00Z (micro). 35 kt SE and 1000 mb at 40.1N, 44.2W at 06Z (COADS). 35 kt W and 1004 mb at 39.5N, 43.0W at 12Z (COADS). 45 kt SW and 998 mb at 40.1N, 41.7W at 18Z (COADS).

September 3:

HWM analyzes a closed low pressure of at most 1000 mb at 44.5N, 35.0W with a cold front to the northwest at 12Z. Microfilm shows a closed low pressure of at most 1002 mb at 45.0N, 35.0W with a frontal boundary to the west at 12Z. Ship highlights: 40 kt SW and 1011 mb at 39.9N, 41.6W at 00Z (COADS). 40 kt S and 1010 mb at 41.3N, 35.3W at 06Z (COADS/micro). 35 kt WSW and 1012 mb at 41.6N, 35.5W at 12Z (COADS). 50 kt N and 1011 mb at 49.1N, 38.4W at 18Z (micro).

September 4:

HWM analyzes a closed low pressure of at most 1000 mb at 58.0N, 22.0W with a cold front to the south and another extratropical cyclone of at most 990 mb at 61.5N, 32.0W at 12Z. Microfilm shows a closed low pressure of at most 1002 mb at 45.0N, 35.0W with a frontal boundary to the west at 12Z. Ship highlights: 60 kt S and 999 mb at 48.7N, 25.8W at 00Z (COADS). 60 kt W and 1005 mb at 48.5N, 30.5W at 06Z (COADS). 45 kt WNW and 1006 mb at 57.0N, 37.0W at 12Z (COADS). 55 kt S and 1010 mb at 58.7N, 14.6W at 18Z (COADS).

A low pressure developed along the tail-end of a frontal boundary over the central Atlantic on August 26th. The disturbance moved slowly northward during the next couple of days becoming better organized. A strong high pressure system to the north blocked its northward movement and the microfilm maps indicate that the frontal boundary dissipated by August 27th. Genesis is analyzed at 00Z on August 28th as a 35 kt tropical storm. It is likely that the system may have developed earlier but the data is inconclusive to suggest that a well-defined center was present during that time. The strong pressure gradient caused gale-force winds to be present well northeast of the center, but at 06Z on the 28th, a ship reported 40 kt S and 1002 mb about 60 nm east of the center and the intensity is increased to 40 kt. The tropical cyclone moved slowly to the northwest maintaining its intensity. The HWM on the 28th depicts the tropical cyclone as a closed low pressure with a warm front extended to the northeast and a cold front extended to the south. Synoptic data suggest instead that the environment around the cyclone was uniform with temperatures in the mid 70s, the circulation was symmetric and strongest winds were near the center - all indications that the system was tropical in nature. On August 29th, the cyclone stopped moving to the northwest and began to accelerate to the

east-northeast ahead of an approaching frontal boundary. On this day, the HWM depicts an occluding low pressure while microfilm shows no frontal features associated with the tropical cyclone. At 18Z on the 29th, a ship near the center reported 35 kt W and 1000 mb. A peripheral pressure of 1000 mb suggest sustained maximum winds over 49 kt north of 35N from the Landsea et al. (2004a) pressure-wind relationship. Due to the slow forward speed of about 5 kt, an intensity of 45 kt is selected at 18Z on the 29th. On August 30th, the tropical storm moved rapidly to the east-northeast with no change in the intensity. On this day, the HWM depicts a closed low pressure with a cold front extended to the east and southeast of the center, while microfilm shows no frontal features associated with the tropical cyclone and a cold front well to the north. Based on the synoptic data, the depiction by microfilm appears to be correct. Late on the 30th, microfilm suggests that the tropical cyclone interacted with the approaching frontal boundary and by 00Z on August 31st, a frontal boundary is drown across the center of the tropical storm. Synoptic data suggests that the environment around the system remained uniform with temperatures in the mid to high 70s, the strongest winds were near the center and the circulation was symmetric, characteristics of a tropical cyclone. A ship reported 40 kt NW and 996 mb at 06Z on the 31st. A peripheral pressure of 996 mb suggest sustained maximum winds over 55 kt north of 35N from the pressure-wind relationship. At this time, the forward speed of the cyclone had decreased to about 3 kt, thus an intensity of 50 kt is selected at 06Z on the 31st. On August 31st and September 1st, the tropical storm moved very slowly while located about halfway between Newfoundland and the Azores. Early on September 2nd, an approaching frontal boundary caused the tropical cyclone to start moving northeastward with an increase in forward speed. A ship at 00Z on the 2nd reported 55 kt W and 999 mb, and another ship at 18Z on this day reported 45 kt SW and 998 mb. An intensity of 55 kt is analyzed at 18Z on the 1st. 55 kt is the peak intensity of this storm as a tropical cyclone. Microfilm depicts a frontal boundary going through the system on the 1st and 2nd (except at 18Z), but synoptic data clearly shows that the temperatures near the center remained in the mid 70s, with colder temperatures staying well to the north and northwest of the cyclone. Furthermore, the strongest winds were located very close to the center and the circulation remained symmetrical. Early on September 3rd, a stronger frontal boundary approaching from the northwest caught up to the tropical cyclone and synoptic data suggest that transition to an extratropical cyclone occurred at 06Z on the 3rd. At this time, a temperature gradient developed across the circulation and the windfield expanded, with the strongest winds being reported away from the center. The system was an intense extratropical cyclone with winds up to 60 kt being reported by ships at 00Z and 06Z on September 4th. At 18Z on the 4th, synoptic data suggests that the extropical cyclone merged with a larger extratropical cyclone located southwest of Iceland. The final position is analyzed at 12Z on the 4th. An analog for this tropical storm is Tropical Storm Josephine, 2002.

New Tropical Storm [September 7-14, 1959]

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37265 09/07/1959 M= 8  9 SNBR= 820 UNNAMED       XING=0 SSS=0
37265 09/07*  0   0   0    0*  0   0   0    0*315 670  25    0*320 670  25    0*
37265 09/08*323 670  25    0*325 670  25    0*325 670  25    0*324 672  25    0*
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37265 09/09*323 675  25    0*324 675  25    0*330 672  30    0*336 670  30    0*
37265 09/10*341 670  30    0*345 680  30    0*350 700  35    0*360 700  35    0*
37265 09/11*373 703  35    0*384 700  35    0*395 685  40 1002E404 668  40    0*
37265 09/12E410 650  45    0E415 636  50    0E420 622  55    0E428 608  55    0*
37265 09/13E439 578  50    0E452 542  50    0E468 509  45    0E485 485  45    0*
37265 09/14E505 465  45    0*  0   0   0    0*  0   0   0    0*  0   0   0    0*
37285 TS
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A new tropical storm has been added to HURDAT, not previously shown in McAdie et al. (2009). Evidence for its existence comes from the Historical Weather Map series, Microfilm, COADS ship database, Surface Weather Observations, Mariners Weather Log and Jack Beven's and David Roth's suspect list.

September 6:

HWM analyzes a closed low pressure of at most 1015 mb at 26.0N, 73.5W at 12Z. Microfilm shows a closed low pressure of at most 1014 mb at 26.5N, 73.0W at 12Z. Ship highlights: No gale force winds or equivalent low pressures.

September 7:

HWM analyzes a stationary front over the Western Atlantic at 12Z. Microfilm shows a closed low pressure of at most 1017 mb at 31.0N, 66.0W at 12Z. Ship highlights: No gale force winds or equivalent low pressures.

September 8:

HWM analyzes a closed low pressure of at most 1015 mb at 33.0N, 65.0W with a stationary front extended from the low pressure to the northeast at 12Z. Microfilm shows a closed low pressure of at most 1011 mb at 35.5N, 66.0W at 12Z. Ship highlights: No gale force winds or equivalent low pressures.

September 9:

HWM analyzes a closed low pressure of at most 1010 mb at 32.5N, 66.5W with a weakening stationary front to the northeast at 12Z. Microfilm shows a closed low pressure of at most 1011 mb at 34.0N, 65.0W at 12Z. Ship highlights: No gale force winds or equivalent low pressures.

September 10:

HWM analyzes a closed low pressure of at most 1010 mb at 33.0N, 70.0W with a warm front to the north at 12Z. Microfilm shows a closed low pressure of at most 1011 mb at 35.0N, 69.0W at 12Z. Ship highlights: 35 kt NE and 1015 mb at 36.9N, 71.1W at 12Z (COADS). 35 kt E and 1009 mb at 37.1N, 68.0W at 18Z (COADS).

September 11:

HWM analyzes a closed low pressure of at most 1005 mb at 38.0N, 66.0W with a cold front to the west at 12Z. Microfilm shows a closed low pressure of at most 1005 mb at 40.0N, 67.0W with a frontal boundary to the west at 12Z. Ship highlights: 20 kt NE and 1003 mb at 40.3N, 69.2W at 12Z (COADS). 25 kt NW and 998 mb at 40.2N, 67.5W at 18Z (COADS). Land highlights: 34 kt NNE (max winds) and 1007 mb at Nantucket Shoals, MA at 1158Z (SWO). 40 kt N (gusts to 45 kt, max winds) and 1005 mb at Georges Shoals, MA at 18Z (SWO).

September 12:

HWM analyzes a closed low pressure of at most 1000 mb at 42.0N, 62.0W with a frontal system going through the cyclone at 12Z. Microfilm shows a closed low pressure of at most 1002 mb at 43.0N, 62.0W with a frontal boundary going through the cyclone at 12Z. Ship highlights: 15 kt NE and 1001 mb at 44.6N, 60.3W at 00Z (COADS). 40 kt ESE and 1010 mb at 41.5N, 60.4W at 00Z (COADS/micro). 40 kt SE and 1000 mb at 42.6N, 63.4W at 06Z (COADS). 50 kt N and 1007 mb at 41.7N, 64.5W at 08Z (COADS). 55 kt SSW and 1005 mb at 40.8W, 62.1W at 12Z (COADS). 40 kt N and 1000 mb at 42.7N, 61.5W at 18Z (COADS).

September 13:

HWM analyzes a closed low pressure of at most 995 mb at 46.0N, 51.0W with a frontal system going through the cyclone at 12Z. Microfilm shows a closed low pressure of at most 996 mb at 46.0N, 50.5W with a frontal boundary going through the cyclone at 12Z. Ship highlights: 40 kt SW and 1006 mb at 41.3N, 55.2W at 00Z (COADS). 25 kt NNW and 998 mb at 45.1N, 56.0W at 06Z (micro). 45 kt NNW and 1001 mb at 42.4N, 55.0W at 12Z (COADS). 35 kt N and 995 mb at 46.9N, 51.2W at 18Z (COADS). 35 kt W and 992 mb at 47.7N, 47.5W at 23Z (COADS).

September 14:

HWM analyzes an extratropical cyclone of at most 985 mb at 54.0N, 51.0W with a frontal system going through the cyclone at 12Z. Microfilm shows an extratropical cyclone of at most 987 mb at 56.5N, 52.0W at 12Z. Ship highlights: 35 kt W and 997 mb at 45.0N, 47.0W at 00Z (COADS). 35 kt SE and 992 mb at 57.4N, 42.7W at 12Z (COADS). 35 kt SW and 987 mb at 54.2N, 49.4W at 18Z (COADS).

A broad area of low pressure developed between the Bahamas and Bermuda on September 6th. The disturbance moved lowly northward becoming a 25 kt tropical depression on September 7th at 12Z. Historical Weather Maps show a stationary front just

north of the depression on the 7th but microfilm indicates that the boundary was not present, which appears correct based on the synoptic data. The tropical depression remained nearly stationary during the next two days with little change in intensity. A ship reported 35 kt far north of the center on September 9th at 18Z but nearby ships suggests that the wind report likely has a high bias. The tropical depression increased in forward speed on September 10th while moving northwestward. Intensification to a tropical storm is analyzed at 12Z on the 10th based on a ship report of 35 kt about 125 nm northwest of the center. Another ship at about the same distance northeast of the center reported 35 kt at 18Z on the 10th. The tropical storm retained a large circulation embedded within a moist environment. It is likely that it was a subtropical cyclone during its lifetime, but this cannot be confirmed without satellite imagery. An approaching frontal boundary caused the tropical cyclone to turn to the northeast on September 11th. A ship reported 5 kt SW and 1003 mb on the 11th at 12Z and another reported 20 kt NE and 1003 mb at the same time, suggesting a central pressure near 1002 mb, which has been added to HURDAT. A central pressure of 1002 mb suggests maximum sustained winds of 45 kt north of 35N from the Landsea et al. pressure-wind relationship. Due to the large circulation of the tropical storm, an intensity of 40 kt is selected at 12Z on the 11th. 40 kt is also the peak intensity of the system while it was a tropical cyclone. The elevated weather stations of Nantucket Shoals and Georges Shoals reported maximum sustained winds of 34 kt and 40 kt at 1158Z and 18Z on the 11th, respectively. Transition to an extratropical cyclone is analyzed at 18Z on the 11th based on the synoptic data, which shows that the cold front had already reached the center of the cyclone. The extratropical cyclone continued to gain in forward speed on September 12th as it passed south of Nova Scotia, Canada. Ships reported gale-force winds up to 55 kt on the 12th. Ship and coastal observations on September 13th indicate that the circulation of the extratropical cyclone expanded and the winds began to decrease. At the same time, another extratropical cyclone began to organize over northern Canada. Early on September 14th, synoptic data suggests that the two extratropical cyclones merged. This solution is consistent with the track of lows of September, 1959 in the Mariners Weather Log. The last position is analyzed at 00Z on the 14th.

Hurricane Flora [September 9-12, 1959]

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41175 09/09/1959 M= 6  7 SNBR= 896 FLORA       XING=0 SSS=0
41175 09/09/1959 M= 4 10 SNBR= 896 FLORA       XING=0 SSS=0
                    * **

41180 09/09*  0   0   0    0*168 458  25    0*180 465  25    0*195 467  25    0*
41180 09/09*  0   0   0    0*168 458  25    0*182 465  25    0*195 467  25    0*
                                             ***

41185 09/10*208 465  30 1008*220 460  35    0*231 454  40    0*243 447  45    0*
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41185 09/10*208 465  30    0*220 460  35    0*231 454  40    0*243 448  45    0*
                           *                                       ***

41190 09/11*256 439  50    0*271 427  55    0*287 413  65    0*303 398  65  994*
41190 09/11*255 442  50    0*269 436  55    0*285 426  65  994*300 407  55 1001*
            *** ***          *** ***          *** ***      *** *** ***  ** ****

41195 09/12*319 376  65    0*340 342  65    0E362 307  65    0E375 273  60    0*
41195 09/12*317 385  50    0*335 350  50    0E352 312  50    0E365 281  50  994*
            *** ***  **      *** ***  **      *** ***  **      *** ***  ** ****

(September 13th and 14th have been removed from HURDAT)
41200 09/13E387 241  55    0E418 229  50    0E450 229  50    0E465 241  45    0*
41205 09/14E470 263  45    0E484 288  45    0*  0   0   0    0*  0   0   0    0*

41210 HR
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Minor changes to the track and intensity shown in McAdie et al. (2009). Evidence for these alterations comes from the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Monthly Weather Review, Navy reconnaissance book, Surface Weather Observations, Mariners Weather Log and NHC Storm Wallets.

September 8:

HWM analyzes a closed low of at most 1010 mb at 14.0N, 46.0W at 12Z. HURDAT does not list an organized system on this date. Microfilm shows a broad area of low pressure near 11.0N, 45.0W at 12Z. Ship highlights: No gales or low pressures.

ATSR: “Hurricane FLORA had a long and nebulous period of development. Reports from the Cape Verde Islands evidenced the passage of an easterly wave or depression on the Intertropical Convergence Zone on the 6th of September with a marked wind shift and heavy precipitation.”

September 9:

HWM analyzes a closed low of at most 1010 mb at 17.0N, 48.0W at 12Z. HURDAT lists a 25 kt tropical depression at 18.0N, 46.5W at 12Z. Microfilm does not show an organized system at 12Z. Ship highlights: No gales or low pressures.

ATSR: “At 090000Z, a ship at 12.7N, 41.3W reported a westerly wind of 15 knots and rain, the first concrete evidence of a cyclonic circulation. On the 9th and 10th, FLORA moved northwest and then north around the periphery of the Azores high.”

September 10:

HWM analyzes a closed low of at most 1010 mb at 23.0N, 46.4W at 12Z. HURDAT lists a 40 kt tropical storm at 23.1N, 45.4W at 12Z. Microfilm shows a closed low pressure of at most 1008 mb at 22.0N, 46.5W at 12Z. Ship highlights: 35 kt ESE and 1008 mb at 22.8N, 45.0W at 09Z (micro). 35 kt S and 1011 mb at 22.8N, 45.0W at 12Z

(COADS). 35 kt SE and 1013 mb at 24.5N, 43.7W at 15Z (micro). Aircraft highlights: Penetration center fix measured a central pressure of 1008 mb and estimated surface winds of 25 kt at 22.1N, 46.3W at 16Z (ATSR).

MWR: “The history of the formation of Flora is rather uncertain beyond about 24 hours prior to the first advisory issued at noon EST, September 10. However, four days earlier, on the afternoon of September 6, pressure and wind in the Cape Verde Islands indicated a trough passage. This trough could not be followed from day to day through the ocean area due to a lack of reports, but if it moved at an average speed of 13 kt it would have reached the position where Flora was found on September 10 near latitude 22.1N, longitude 46.3W. Ship and aircraft reports indicated highest winds of 39 kt and minimum central pressure of 1008.1 mb.” ATSR: “Peripheral ship reports at 10000Z permitted drawing a weak circulation centered at about 21N 44W with the ITC well to the south. A Navy reconnaissance aircraft was sent out from Roosevelt Roads, Puerto Rico on the 10th of September, and near the extreme limits of endurance, encountered a closed circulation located near 22N 46W at 101600Z with maximum winds of 25 knots. First warning was issued at 101700Z with intensification expected.”

September 11:

HWM analyzes a hurricane of at most 1000 mb at 28.9N, 41.5W at 12Z. HURDAT lists a 65 kt hurricane at 28.7N, 41.3W at 12Z. Microfilm shows a closed low pressure of at most 999 mb at 29.2N, 40.9W at 12Z. Ship highlights: 35 kt SE and 1011 mb near 30.7N, 38.4W at 12Z (micro). 50 kt NNE and 1008 mb at 30.0N, 41.1W at 18Z (micro). Aircraft highlights: Penetration center fix measured a central pressure of 994 mb and estimated surface winds of 65 kt at 29.1N, 41.1W at 1445Z (MWR/ATSR). Penetration center fix measured a central pressure of 1001 mb and estimated surface winds of 60 kt at 29.4N, 40.2W at 17Z (MWR/ATSR).

MWR: “By mid-morning of September 11, aircraft found that Flora's winds had increased to barely hurricane force, 65 kt, and the minimum pressure was 994 mb. The next highest wind speed reported was 60 kt on the afternoon of the same day when central pressure had risen to 1001.0 mb.” ATSR: “Reports indicated that FLORA reached maximum intensity of 65 knots at about 111500Z close to the center of a 200 mb low (in the southeastern quadrant of that low) then weakened slowly. Then recurved sharply and accelerated about 110400Z about 600 miles in advance of the surface cold front.”

September 12:

HWM analyzes a tropical storm of at most 1000 mb at 36.5N, 30.5W with a cold front just to the northwest at 12Z. HURDAT lists a 65 knot extratropical cyclone at 36.2N, 30.7W at 12Z. Microfilm shows an extratropical cyclone at 36.0N, 31.0W with a frontal boundary extending south at 12Z. Ship highlights: 35 kt S and 1008 mb at 31.6N, 36.7W at 00Z (COADS). 35 kt S and 1005 mb at 32.6N, 34.2W at 06Z (COADS). Aircraft highlights: Penetration center fix measured a minimum pressure of 994 mb,

estimated surface winds of 40-50 kt and an eye diameter of 40 nm at 36.4N, 27.8W at 1935Z (ATSR/micro).

MWR: “On September 12, although a lower pressure of 994.2 mb was measured as the storm became extratropical, highest surface winds were about 45 kt. Flora recurved quickly to the north and northeastward before she became a threat to any land areas except the Azores islands, due to a major trough in the westerlies extending southward into the Tropics. No loss of life or property damage has been attributed to Flora.” ATSR: “An Air Force reconnaissance aircraft reported the eye of FLORA closely associated with the cold front 150 miles to the southwest of the Azores at 121935Z. FLORA then appeared to merge rapidly with the cold front, and finally dissipated off the coast of Spain.”

September 13:

HWM analyzes a tropical storm of at most 995 mb at 45.3N, 22.0W with a cold front to the south at 12Z. HURDAT lists a 50 knot extratropical cyclone at 45.0N, 22.9W at 12Z. Microfilm shows a closed low pressure of at most 996 mb at 45.5N, 22.5W at 12Z. Ship highlights: No gales or low pressures.

September 14:

HWM analyzes a closed low pressure of at most 1000 mb with a cold front to the east at 43.0N, 17.0W at 12Z. HURDAT lists a 45 knot extratropical cyclone at 48.4N, 28.8W at 06Z (last position). Microfilm shows that the low pressure had moved off the map at 12Z. Ship highlights: No gales or low pressures.

September 15:

HWM analyzes a closed low pressure of at most 1005 mb at 43.5N, 15.0W at 12Z. HURDAT does not list an organized storm on this date. Microfilm is not available on this date. Ship highlights: No gales or low pressures.

September 16:

HWM analyzes a closed low pressure of at most 1005 mb at 44.0N, 12.0W at 12Z. HURDAT does not list an organized storm on this date. Microfilm is not available on this date. Ship highlights: No gales or low pressures.

September 17:

HWM does not analyze an organized storm on this date. HURDAT does not list an organized storm on this date. Microfilm is not available on this date. Ship highlights: No gales or low pressures.

Hurricane Flora developed from a tropical wave that left the African coast early in September. Data over the eastern and central Atlantic is sparse, which makes the genesis time highly uncertain. The first position is analyzed at 06Z on September 9th as a 25 kt tropical depression, same as originally in HURDAT. It is possible that this tropical cyclone developed significantly earlier. Minor alterations were made to the track of this tropical cyclone. The most significant change occurred at 12Z on the 11th due to a couple of ship reports which indicated a more westward position. A break in the subtropical ridge allowed the tropical depression to turn northward over the central Atlantic. A central pressure of 1008 mb was present in HURDAT at 00Z on September 10th and has been removed because the reconnaissance mission that measured 1008 mb arrived at 16Z on the 10th. Intensification to a tropical storm is retained from the original HURDAT at 06Z on the 10th. It is at this time that the first gale is reported near this tropical cyclone. As mentioned earlier, the first reconnaissance aircraft reached Flora at 16Z on the 10th measuring a central pressure of 1008 mb and estimating surface winds of 25 kt. This position is over 1000 miles from the closest landmass and based on the synoptic data, it appears that the aircraft did not reach the center of the tropical cyclone. Therefore, this center fix was not used to adjust the track or intensity of the tropical cyclone. It is also interesting to note that the synoptic data shows an elongated and disorganized system, and may have not had a closed low-level circulation at this time.

On September 11th, Flora accelerated to the northeast as a frontal boundary approached from the northwest. Another reconnaissance aircraft reached the tropical cyclone at 1445Z measuring a central pressure of 994 mb and estimating surface winds of 65 kt. A central pressure of 994 mb suggests maximum surface winds of 53 kt north of 25N according to the Brown et al. pressure-wind relationship. Due to Flora's forward speed of about 20 kt and high environmental pressures, an intensity of 65 kt is selected for 12Z on the 11th, same as the original HURDAT. This is also the peak intensity of this tropical cyclone, same as the original HURDAT. It is also possible that Flora peaked as a high-end tropical storm. The reanalyzed HURDAT keeps Flora as a hurricane for only one six-hour period, compared to the original HURDAT which kept Flora at hurricane intensity between 12Z on the 11th and 12Z on the 12th. A central pressure of 994 mb was added to HURDAT at 12Z on the 11th. Synoptic data at 12Z on the 11th also indicates that the reconnaissance center fix was about a degree or so too far to the east. Another penetration center fix measured a central pressure of 1001 mb and estimated surface winds of 60 kt at 17Z on the 11th. A central pressure of 1001 mb suggests maximum surface winds of 41 kt from the north of 25N weakening subset of the pressure-wind relationship. Due to a forward speed of about 20 kt and a ship report of 50 kt at 18Z on the 11th on the weak side of Flora, an intensity of 55 kt is selected at 18Z on the 11th, 10 kt lower than originally shown in HURDAT, a minor intensity change. A central pressure of 1001 mb was added to HURDAT at 18Z on the 11th, replacing the existing 994 mb, which belongs

at the 12Z slot. It is analyzed that Flora weakened to tropical storm intensity at 18Z on the 11th, 24 hours earlier than originally shown in HURDAT. Flora continued to increase in forward speed on September 12th as it became increasingly embedded within the frontal boundary associated with a large extratropical cyclone to the north. Transition to an extratropical cyclone is analyzed at 12Z on the 12th, same as the original HURDAT. This is consistent with the synoptic data showing the development of frontal features and a temperature gradient across the cyclone. A final reconnaissance mission reached Flora at 1945Z on the 12Z measuring a central pressure of 994 mb and estimating surface winds of 40-50 kt. A central pressure of 994 mb has been added to HURDAT at 18Z on the 12th. An intensity of 50 kt is selected at 18Z on the 12th, down from 60 kt originally in HURDAT, a minor intensity change. Ship and surface observations from the Azores Islands indicate that Flora had already been absorbed by 00Z on September 13th by the larger extratropical cyclone to the north. A vort max was likely still present early on the 13th but observations indicate that the circulation was not closed. Thus, the last position is analyzed at 18Z on the 12th, 36 hours earlier than originally shown in HURDAT. Mariners Weather Log's Track of Lows for the month of September indicate that the extratropical cyclone associated with Flora absorbed the extratropical cyclone to the north but this solution appears incorrect based on the synoptic data on the 12th and 13th.

Hurricane Gracie [September 20 – October 2, 1959]

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41215 09/20/1959 M=13  8 SNBR= 897 GRACIE      XING=1 SSS=3
41215 09/20/1959 M=13 11 SNBR= 897 GRACIE      XING=1 SSS=4
                       **                          *

41220 09/20*  0   0   0    0*  0   0   0    0*197 686  25    0*199 699  25    0*
41220 09/20*  0   0   0    0*  0   0   0    0*198 683  25 1009*199 696  25 1008*
                                              *** ***     ****     ***     ****

41225 09/21*201 713  25    0*203 727  30    0*206 740  30    0*212 745  30    0*
41225 09/21*201 710  25    0*203 724  30    0*206 737  30 1011*212 741  30 1009*
                ***             ***             ***     ****     ***     ****

41230 09/22*218 741  35    0*222 736  45    0*226 732  50    0*233 730  65  997*
41230 09/22*218 741  35    0*222 736  45    0*226 732  50    0*232 730  60  997*
                                                                      **

41235 09/23*239 729  85    0*244 730  85    0*248 733  85    0*253 739  80    0*
41235 09/23*239 730  55 1000*244 732  55    0*249 735  55    0*254 740  55    0*
                ***  ** ****     ***  **      *** ***  **      *** ***  **

41240 09/24*258 746  75    0*261 750  70    0*263 753  65 1000*268 754  65    0*
41240 09/24*258 746  55 1001*262 751  55    0*265 754  55 1000*269 755  50    0*
                     ** **** *** ***  **      *** ***  **      *** ***  **

41245 09/25*273 754  65    0*278 752  65    0*281 750  65    0*280 747  65  997*
41245 09/25*274 754  45 1004*277 752  45    0*279 750  50    0*280 748  50  997*
           ***       ** **** ***      **      ***       **                 **

41250 09/26*277 744  65    0*277 740  65    0*277 736  65    0*277 732  65    0*
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41250 09/26*278 745  45 1000*278 741  50    0*278 735  55    0*279 730  60    0*
           *** ***  ** **** *** ***  **      *** ***  **      *** ***  **
41255 09/27*278 731  65    0*280 735  70    0*282 740  75    0*285 745  75    0*
41255 09/27*280 730  65  992*282 735  65    0*284 740  65    0*285 745  70    0*
           *** ***     **** ***       **      ***      **                 **
41260 09/28*287 750  80  979*289 756  85    0*290 763  90    0*294 771 100    0*
41260 09/28*285 750  75    0*287 755  80  979*289 763  90    0*294 771 105  964*
           ***      **    * *** ***  **  *** ***                       ***  ***
41265 09/29*299 779 110    0*305 787 120    0*313 796 120  950*324 804 105    0*
41265 09/29*300 781 110  957*306 791 110  958*316 798 115    0*325 806 115  951*
           *** ***      *** *** ***  **  *** *** ***        * *** *** ***  ***
41270 09/30*336 811  60    0*349 815  60    0E362 817  45    0E377 817  40    0*
41270 09/30*337 809  65    0*348 813  45    0*360 816  35    0E377 817  30    0*
           *** ***  **          ***  **     **** ***  **                 **
41275 10/01E393 810  35    0E406 791  30    0E417 767  30    0E425 743  30    0*
41275 10/01E393 810  25    0E406 791  25    0E417 770  25    0E425 748  25    0*
                     **                **          ***  **          ***  **
41280 10/02E429 716  25    0E430 680  25    0E428 634  25    0E428 592  25    0*
41280 10/02E429 720  25    0E430 680  25    0E430 634  25    0*  0   0   0   0*
                ***                        ***                 *   *   *

41285 HR SC3
41285 HR SC4GA1
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U.S. Hurricane Landfall

Sep 29th – 17Z – 32.5N 80.4W – 115 kt – Category 4 – 951 mb – 1013 mb OCI – 300 nm ROCI

Minor changes to the track and major intensity to the intensity shown in McAdie et al. (2009). Evidence for these alterations comes from the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Monthly Weather Review, Navy reconnaissance book, Surface Weather Observations, Mariners Weather Log, Schwerdt et al. (1979), Ho et al. (1987) Jarrell et al. (1992) and NHC Storm Wallets.

September 18:

HWM does not analyze an organized system at 12Z. Microfilm shows a closed low pressure of at most 1011 at 16.8N, 54.2W at 12Z. HURDAT does not list an organized system on this date. Ship highlights: No gales or low pressures.

ATSR: “Hurricane GRACIE was the most intense storm to hit the United States coastline in the 1959 season and also one of the most interesting to study because of its almost “explosive” intensification and erratic movement in its early stages. Because of the large amount of aircraft reconnaissance and other data available, a more detailed analysis of this storm is included in this section. GRACIE formed on a moderate easterly wave that

was first detected and reported near the African coastline by the Fleet Weather Central, Port Lyautey, on 11 September 1959. It was observed passing the Cape Verde Islands on the 13th and was followed westward at a speed of about 15 knots across the South Atlantic by extrapolation and peripheral ship reports. Reports indicated that this wave was attended by heavy shower activity during its entire life. At 171200Z, ship reports indicated that the wave was increasing in intensity 750 miles to the east of Antigua. Aircraft reconnaissance was planned for the following day. The Navy reconnaissance aircraft observed a partial circulation, closed except in the south quadrant, about 420 miles due east of Antigua on the 18th with surface conditions considered favorable for development. Daily reconnaissance into the suspicious area during the period 18 to 21 September showed little change in the low pressure of near 1008 mb and a small area of calm surface winds. Winds to the north of the area continued easterly 20 to 30 knots, with very little westerly winds to the south of the calm area." MWR: "The easterly wave in which Gracie developed was first noted on September 16 about midway between the Lesser Antilles and Africa. It moved westward at about 17 kt during the next 5 days eventually moving into the southeastern Bahamas. The wave was investigated daily by reconnaissance aircraft beginning on the 18th and no closed circulation was found until the 22nd. Indeed, the wave remained remarkably constant in all details and as attended by heavy shower activity from the time first noted."

September 19:

HWM analyzes a spot low at 19.0N, 64.0W at 12Z. HURDAT does not list an organized system on this date. Microfilm shows a tropical wave over the northeast Caribbean Sea at 12Z. Ship highlights: No gales or low pressures.

September 20:

HWM analyzes a closed low pressure of at most 1010 mb at 20.0N, 68.5W at 12Z. HURDAT lists a 25 knot tropical depression at 19.7N, 68.6W at 12Z (first position). Microfilm shows a sharp tropical wave over eastern Hispaniola at 12Z. Ship highlights: No gales or low pressures. Aircraft highlights: Penetration center fix measured a central pressure of 1009 mb and estimated surface winds of 28 kt at 19.8N, 68.3W at 1145Z (ATSR). Penetration center fix measured a central pressure of 1008 mb and estimated surface winds of 28 kt at 19.8N, 69.1W at 19Z (ATSR). Penetration center fix measured a central pressure of 1009 mb and estimated surface winds of 26 kt at 19.9N, 69.3W at 2045Z (ATSR).

MICRO: "NAVY THIRTEEN … Completed low level investigation involving well defined easterly wave near Lesser Antilles, no evidence of closed circulation, broken line, moderate echoes 50 mile wide oriented 1630N 6335W, 1730N 6310W, 1810N 6235W,

1640N 6147W, 1922N 6040W at 1330Z, line moving westward at 22 kt, maximum observed surface wind 35 kt, minimum observed surface pressure 1013 mb."

September 21:

HWM analyzes a closed low pressure of at most 1010 mb at 20.5N, 74.0W at 12Z. HURDAT lists a 30 knot tropical depression at 20.6N, 74.0W at 12Z. Microfilm shows a closed low pressure of at most 1011 mb at 20.5N, 74.5W at 12Z. Ship highlights: No gales or low pressures. Aircraft highlights: Penetration center fix measured a central pressure of 1011 mb and estimated surface winds of 25 kt at 20.6N, 74.0W at 1320Z (ATSR). Penetration center fix measured a central pressure of 1009 mb at 21.3N, 74.1W at 19Z (ATSR).

ATSR: "Reconnaissance reports during the afternoon and evening of the 21st definitely indicated that the direction of movement of the weak circulation was changing to northerly and development taking place."

September 22:

HWM analyzes a tropical storm of at most 1010 mb at 22.9N, 72.9W with a stationary front to the north at 12Z. HURDAT lists a 50 knot tropical storm at 22.6N, 73.2W at 12Z. Microfilm shows a closed low pressure of at most 1002 mb at 23.0N, 73.5W at 12Z. Ship highlights: 40 kt ENE and 1017 mb at 22.6N, 73.2W at 00Z (COADS). Aircraft highlights: Penetration center fix measured a central pressure of 1003 mb, estimated surface winds of 50 kt and an eye diameter of 15 nm at 23.0N, 72.8W at 1645Z (ATSR). Penetration center fix measured a central pressure of 997 mb and estimated surface winds of 75 kt at 23.3N, 73.0W at 1945Z (ATSR). Radar center fix estimated an eye diameter of 15 nm at 23.3N, 73.0W at 21Z (ATSR).

MWR: "The intensity of hurricane Gracie was as erratic as its movement. On September 22 the storm deepened rather rapidly to 997 mb. with winds 78 to 87 kt." ATSR: "At 0000Z, the 22nd, westerly winds of 20 to 25 knots were reported immediately to the south of the center. Surface pressures in the area were falling slowly, accompanied the southeastern Bahamas reported 8.40 inches of rain during the period 0000Z to 1200Z on the 22nd. The first warning of GRACIE was issued at 221600Z. Reconnaissance aircraft reported a radar eye at 1645Z. During the period from 1645Z to 2100Z, while under surveillance, winds increased from 45 knots to 75 knots, the center pressure dropped to 997 mb, and the radar eye became well developed and clearly defined. The unusually rapid intensification which took place immediately after the issuance of the first warning on GRACIE is of particular interest."

September 23:

HWM analyzes a hurricane of at most 1005 mb at 25.1N, 73.8W with a weakening front to the north at 12Z. HURDAT lists a 85 knot hurricane at 24.8N, 73.3W

at 12Z. Microfilm shows a closed low pressure of at most 1002 mb at 25.0N, 73.5W at 12Z. Ship highlights: 35 kt SE and 1011 mb at 25.2N, 74.3W at 00Z (micro). 35 kt ENE and 1015 mb at 26.1N, 74.7W at 06Z (COADS). 40 kt SE and 1013 mb at 25.5N, 72.0W at 12Z (COADS). 70 kt ESE and 1012 mb at 25.3N, 73.4W at 15Z (MWL). 65 kt SE and 1014 mb at 25.5N, 73.1W at 18Z (micro). 40 kt ESE and 1015 mb at 26.6N, 73.4W at 21Z (micro). Aircraft highlights: Penetration center fix measured a central pressure of 1000 mb and estimated an eye diameter of 18 nm at 24.1N, 73.1W at 01Z (ATSR). Radar center fix at 24.4N, 73.4W at 06Z (ATSR). Penetration center fix at 25.0N, 73.5W at 13Z (ATSR). Penetration center fix at 25.5N, 74.1W at 1830Z (ATSR). Penetration center fix measured a central pressure of 1001 mb, estimated maximum surface winds of 45 kt and an eye diameter of 12 nm at 25.8N, 74.1W at 2307Z (ATSR).

MWR: "On the 23rd and 24th, central pressure varied from 1000 to 1006 mb with winds from 45 to 65 kt." ATSR: "After intensifying rapidly to hurricane force, a peak appeared to have been reached and on the 23rd a slight decrease in the intensity of the circulation was apparent. The wind velocity dropped to approximately 65 knots and maintained this velocity for the next 48 hours."

September 24:

HWM analyzes a hurricane of at most 1000 mb at 26.5N, 75.4W at 12Z. HURDAT lists a 65 knot hurricane at 26.3N, 75.3W at 12Z. Microfilm shows a closed low pressure of at most 1008 mb at 26.5N, 75.5W at 12Z. Ship highlights: 40 kt E and 1017 mb at 26.8N, 72.8W at 00Z (COADS). 35 kt SE and 1018 mb at 26.8N, 73.1W at 15Z (micro). 35 kt S and 1011 mb at 26.7N, 74.6W at 21Z (micro). Aircraft highlights: Radar center fix at 25.7N, 74.3W at 01Z (ATSR). Penetration center fix at 26.3N, 75.3W at 0650Z (ATSR). Radar center fix at 26.6N, 75.5W at 16Z (ATSR). Penetration center fix at 26.9N, 75.5W at 1845Z (ATSR). Penetration center fix measured a central pressure of 1004 mb, estimated surface winds of 40 kt and an eye diameter of 15 nm at 27.3N, 75.4W at 2309Z (ATSR).

ATSR: "GRACIE followed a generally northwesterly track until 241000Z then moved on erratic courses at varying speeds for the next 96 hours."

September 25:

HWM analyzes a hurricane of at most 995 mb at 26.9N, 74.5W at 12Z. HURDAT lists a 65 knot hurricane at 28.1N, 75.0W at 12Z. Microfilm shows a closed low pressure of at most 1002 mb at 28.2N, 74.9W at 12Z. Ship highlights: 40 kt S and 1011 mb at 26.7N, 73.5W at 00Z (COADS). 35 kt S and 1009 mb at 26.9N, 73.2W at 06Z (COADS). 40 kt SE and 1006 mb at 28.3N, 73.0W at 09Z (micro). 40 kt S and 1009 mb at 27.7N, 72.6W at 15Z (micro). 35 kt SW and 1008 mb at 28.6N, 73.3W at 21Z (micro). Aircraft highlights: Radar center fix at 27.5N, 75.1W at 04Z (ATSR). Radar

center fix at 27.3N, 75.1W at 06Z (ATSR). Penetration center fix at 28.0N, 75.0W at 1245Z (ATSR). Penetration center fix at 28.0N, 74.6W at 1835Z (ATSR). Penetration center fix measured a central pressure of 1000 mb and estimated surface winds of 55 kt at 2230Z (ATSR).

MWR: "On the 25th the minimum barometer again dropped to 997 mb and reconnaissance aircraft reported an increase in maximum winds, the size of the storm area, and the intensity of weather around the eye." ATSR: "It made a sharp, hairpin like turn through east onto a south-southeasterly course during the day of the 25th."

September 26:

HWM analyzes a hurricane of at most 995 mb at 27.9N, 73.3W at 12Z. HURDAT lists a 65 knot hurricane at 27.7N, 73.6W at 12Z. Microfilm shows a closed low pressure of at most 1002 mb at 27.9N, 73.5W at 12Z. Ship highlights: 35 kt E and 1009 mb at 29.1N, 73.0W at 00Z (COADS). 30 kt W and 1004 mb at 26.4N, 74.5W at 06Z (micro). 40 kt S and 1011 mb at 25.6N, 72.5W at 15Z (micro). 40 kt ESE at 28.3N, 71.5W at 18Z (micro). Aircraft highlights: Radar center fix estimated an eye diameter of 40 nm at 27.8N, 73.9W at 01Z (ATSR). Penetration center fix at 27.8N, 73.4W at 13Z (ATSR). Penetration center fix at 28.1N, 72.8W at 1830Z (ATSR). Penetration center fix measured a central pressure of 992 mb, estimated surface winds of 85 kt and an eye diameter of 15 nm at 28.0N, 73.0W at 2330Z (ATSR).

ATSR: "The night of the 25th saw Gracie again intensifying and slowly turning to a northeast heading. The storm continued to intensify steadily until it crossed the east coast of the United States. On the 26th, GRACIE made an apparent 270 degree right turn to a northerly course."

September 27:

HWM analyzes a hurricane of at most 995 mb at 28.5N, 73.3W at 12Z. HURDAT lists a 75 knot hurricane at 28.2N, 74.0W at 12Z. Microfilm shows a closed low pressure of at most 996 mb at 28.5N, 74.1W at 12Z. Ship highlights: 45 kt NE and 1010 mb at 29.0N, 71.5W at 00Z (micro). 40 kt NW and 1008 mb at 27.9N, 73.8W at 03Z (micro). 35 kt SE and 1010 mb at 29.5N, 69.5W at 06Z (micro). 45 kt N and 1005 mb at 28.3N, 75.2W at 12Z (micro). 50 kt NE and 1009 mb at 30.0N, 74.6W at 15Z (MWL). 45 kt SW and 1003 mb at 27.0N, 74.0W at 18Z (micro). 45 kt W and 1003 mb at 27.0N, 74.1W at 21Z (micro). Aircraft highlights: Radar center fix at 28.2N, 72.8W at 01Z (ATSR). Radar center fix estimated an eye diameter of 9 nm at 28.3N, 73.8W at 0550Z (ATSR). Penetration center fix at 28.6N, 74.1W at 1240Z (ATSR). Penetration center fix at 28.6N, 74.4W at 1539Z (ATSR). Radar center fix at 28.4N, 74.7W at 2335Z (ATSR).

MWR: “On the 27th the central pressure decreased further to 979 mb with an almost complete wall cloud. The hurricane continued to intensify further during the next 2 days to 950 mb.” ATSR: “A left turn early on the 27th brought the storm to the northwesterly course it was to maintain most of its remaining overwater trajectory.”

September 28:

HWM analyzes a hurricane of at most 995 mb at 29.0N, 76.2W at 12Z. HURDAT lists a 90 knot hurricane at 29.0N, 76.3W at 12Z. Microfilm shows a closed low pressure of at most 996 mb at 29.0N, 76.0W at 12Z. Ship highlights: 40 kt ESE and 1007 mb at 29.5N, 73.7W at 00Z (MWL). 50 kt E and 1005 mb at 29.0N, 74.3W at 03Z (micro). 40 kt NW and 1008 mb at 27.8N, 77.3W at 06Z (micro). 35 kt NW and 1006 mb at 27.8N, 77.5W at 12Z (COADS). 60 kt SW and 1004 mb at 28.1N, 75.5W at 15Z (micro). 40 kt NNW and 1010 mb at 28.5N, 79.6W at 18Z (COADS). 40 kt NW and 1000 mb at 29.1N, 78.5W at 21Z (micro). Aircraft highlights: Penetration center fix at 28.5N, 75.1W at 0030Z (ATSR). Penetration center fix measured a central pressure of 979 mb at 28.5N, 75.2W at 04Z (ATSR). Penetration center fix at 29.0N, 76.2W at 1255Z (ATSR). Penetration center fix measured a central pressure of 971 mb, estimated surface winds of 80 kt and eye diameter of 15 nm at 29.3N, 76.8W at 1620Z (ATSR). Penetration center fix measured a central pressure of 964 mb, estimated surface winds of 90 kt and eye diameter of 7 nm at 29.7N, 77.4W at 1906Z (ATSR).

September 29:

HWM analyzes a hurricane of at most 995 mb at 31.5N, 79.4W with a weakening front to the northwest at 12Z. HURDAT lists a 120 knot hurricane at 31.3N, 79.6W at 12Z. Microfilm shows a closed low pressure of at most 1002 mb at 32.0N, 80.0W with a frontal boundary to the northwest at 12Z. Ship highlights: 35 kt NW and 1005 mb at 28.9N, 79.8W at 00Z (COADS). 40 kt NE and 1009 mb at 31.7N, 80.5W at 03Z (micro). 40 kt NW and 1009 mb at 28.3N, 79.8W at 06Z (COADS). 40 kt NE and 1000 mb at 31.7N, 80.4W at 09Z (micro). 50 kt N and 993 mb at 31.9N, 80.1W at 12Z (micro). 40 kt SE and 1012 mb at 31.5N, 76.8W at 15Z (micro). 35 kt SE and 1016 mb at 33.5N, 76.6W at 18Z (COADS). 50 kt SW and 993 mb at 31.9N, 80.4W at 21Z (micro). Land highlights: 45 kt at Hunter AFB, GA at 1316Z (SWO). 35 kt NE at Charleston, SC at 15Z (micro). 130 kt (estimated) and 965 mb (min pressure) at Edisto Beach, SC at 1635Z-1640Z (WALLET). 49 kt NW (gusts to 65 kt) at Savannah, GA at 17Z (SWO). 84 kt 5-min WSW (max wind)(gusts to 120 kt) and 960 mb at MCAAS Beaufort, SC (WALLET/MWR) at 1745Z. 42 kt (gusts to 62 kt) and 987 mb at Charleston, SC at 1816Z (WALLET). 38 kt ESE (gusts to 58 kt) and 1010 mb at Wilmington, NC at 1859Z (SWO). 50-60 kt estimated (gusts estimated to 70-80 kt) (max wind) and 973 mb (min pressure) at Orangeburg, SC at 2240Z (WALLET). 80 kt (no time given)(max wind) at

Folly Island, SC (WALLET). Aircraft highlights: Penetration center fix measured a central pressure of 957 mb, estimated surface winds of 74 kt and eye diameter of 18 nm at 30.1N, 78.3W at 0142Z (ATSR). Penetration center fix measured a central pressure of 958 mb and estimated eye diameter of 15 nm at 30.8N, 79.1W at 07Z (ATSR). Penetration center fix measured a central pressure of 951 mb at 32.5N, 80.2W at 1530Z (ATSR/WALLET). "28.08" (950.9 mb) central pressure measured by RECON – RMW 26 nmi – 12 kt forward speed – landfall pt 32.5N, 80.4W" (Ho et al. (1987). "Sep – SC3 – Cat 3 – 950 mb" (Jarrell et al. (1992). "32.6N, 80.4W – 962 mb at 32.2N, 80.2W – 951 mb Penv – RMW 10 nmi – speed 12 kt – 91 kt est max sustained 10m, 10-min wind" (Schwardt et al. (1979)).

MWR: "The center of the hurricane crossed the coast near Beaufort, S.C., near noon on September 29. The Marine Corps Auxiliary Air Station at Beaufort reported a minimum barometer reading of 950 mb, a sustained 5-minute wind of 84 kt, and gusts estimated to 120 kt. Wind was estimated as high as 152 kt. closer to the exact center of the storm and gusts as high as 130 kt. seem quite credible. After moving inland the hurricane weakened gradually as it turned northward along the Appalachians." ATSR: "GRACIE past inland near Beaufort, South Carolina, at 291615Z. Twenty-two deaths and damage estimated at 14 million dollars were caused. Fortunately, the Charleston area escaped major flood damage because GRACIE struck at low tide. The intensity of Hurricane GRACIE on passing inland may be evaluated from the following report submitted by the Marine Corps Auxiliary Air Station, Beaufort, compiled by Marine Weather Service:

a. Lowest observed surface pressure and time: 28.05 inches (950 mb.) at approximately 1230E.

b. Highest observed average hourly wind velocity and direction: 64 knots from the West-southwest (1200E – 1300E).

c. Highest observed 5 minute velocity and direction: 84 knots from the West-southwest at 1245E.

d. Highest observed gust and direction: 120 knots from the West-southwest.

e. Maximum rainfall for a six-hour period: 4.90 inches (0650E to 1250E).

f. From the hourly sea level pressures plotted from stations along the Eastern seaboard directly preceding Hurricane GRACIE, it was determined by the Marine Weather Service that the eye of the storm passed very close to the Beaufort area itself.

g. The following is an eye-witness report by Beaufort County Sheriff J.E. McTeer:

"The eye of Hurricane GRACIE passed over my home located on Coffin Point located near the town of Frogmore, South Carolina. A dead calm lasted 35 minutes. During this time, there was absolutely no wind. It quit as suddenly as it began and the sun appeared and it was extremely hot. There was a thin veil of cirro-stratus covering the entire sky. As the rear of the eye approached, you would see a very dark cloud touching the ground. The cloud appeared as fog filled with dust and flying debris. To those people not observing the dark cloud, there was no warning, whatsoever as the rear of the eye passed over us.

In seconds, the wind rose to approximately 175 miles per hour. I based this estimation on the fact that I saw a water tower containing some 10,000 gallons of water lifted twice by the force of the wind. Also, a roll of tin, weighting approximately one ton was moved over 200 feet. The heaviest winds were definitely experienced after passage of the eye. In advance of the eye, I estimated them to be from 140 – 150 miles per hour. A Mrs. Van de Linde, living at Coffin Point also, has a barometer trace recorded during the storm which could be obtained if necessary."

h. Sheriff McTeer also stated that residents of Frogmore, South Carolina (approximately 5 miles southwest of Coffin Point, South Carolina) observed the passage of the eye and that it was about five minutes in duration."

September 30:

HWM analyzes a tropical storm of at most 1000 mb at 36.5N, 82.5W with a cold front about 120 nm to the northwest at 12Z. HURDAT lists a 45 knot extratropical cyclone at 36.2N, 81.5W at 12Z. Microfilm shows a closed low pressure of at most 1002 mb at 35.5N, 82.0W along a frontal boundary at 12Z. Ship highlights: 50 kt SSW (likely too high) and 999 mb at 31.8N, 80.5W at 00Z (micro). Land highlights: 979 mb at Orangeburg, SC at 0005Z (WALLET). 45 kt NE at Congaree, SC at 0045Z (SWO). 33 kt ESE (gusts to 48 kt) and 986 mb at Columbia, SC at 03Z (SWO). 20 kt SSW and 996 mb at Columbia, SC at 06Z (SWO). 35 kt S and 1012 mb at Frying Pan, NC at 06Z (micro). 15 kt ESE and 998 mb at Hickory, SC at 1158Z (SWO).

October 1:

HWM analyzes an extratropical cyclone at 41.0N, 77.5W at 12Z. HURDAT lists a 30 knot extratropical depression at 41.7N, 76.7W at 12Z. Microfilm shows an extratropical cyclone at 41.5N, 77.5W at 12Z. Ship highlights: No gales or low pressures.

October 2:

HWM analyzes does not analyze an organized system at 12Z. HURDAT lists a 25 knot extratropical depression at 42.8N, 63.4W at 12Z. Microfilm shows a weak extratropical cyclone at 43.5N, 60.0W at 12Z. Ship highlights: No gales or low pressures.

A sharp tropical wave was located east of the Leeward Islands on September 18th. Ships in the area indicated that a closed-level circulation was not present at this time. The disturbance moved westward and a reconnaissance aircraft investigated in the afternoon of September 19th but did not find a closed-low level circulation. The tropical wave continued moving westward and while located just north of the eastern tip of Hispaniola, a reconnaissance aircraft found a closed low-level center with a central pressure of 1009 mb and estimated surface winds of 28 kt. Genesis is analyzed as a 25 kt tropical depression at 12Z on September 20th, same as originally shown in HURDAT. A central pressure of 1009 mb is added to HURDAT at 12Z on the 20th. Yet, synoptic data does not show a well-defined circulation associated with this system on the 20th and early on the 21st, and it is possible that it may have not been a tropical cyclone during that time. Minor track alterations are introduced during the lifetime of this tropical cyclone. Another reconnaissance aircraft measured a central pressure of 1008 mb and estimated surface winds 28 kt at 19Z on the 20th. A central pressure of 1008 mb has been added to HURDAT at 18Z on the 20th. The tropical depression skirted the northern coast of Hispaniola late on the 20th and early on the 21st while moving west-northwest before the steering currents started to break down late on the 21st. Aircraft reconnaissance on the 21st indicated that the disturbance remained a tropical depression with little or no intensification. An aircraft measured a central pressure of 1011 mb and estimated surface winds of 25 kt at 1320Z. A central pressure of 1011 mb has been added to HURDAT at 12Z on the 21st. Another aircraft measured a central pressure of 1009 mb and estimated surface winds of 26 kt at 19Z. A central pressure of 1009 mb has been added to HURDAT at 18Z on the 21st. Intensification to a tropical storm is analyzed at 00Z on September 22nd, same originally shown in HURDAT. A ship reported 40 kt at 00Z on the 22nd but nearby observations indicate that it likely has a high bias. Gracie intensified steadily on the 22nd while located over the eastern Bahamas. A reconnaissance aircraft reached the tropical storm at 1645Z on the 22nd measuring a central pressure of 1003 mb and estimated surface winds of 50 kt. At 1945Z, another penetration center fix measured a central pressure of 997 mb and estimated surface winds of 75 kt. An eye diameter of 15 nm was estimated at 21Z by a radar fix. A central pressure of 997 mb suggests maximum surface winds of 53 kt from the south of 25N Brown et al. pressure-wind relationship. An eye diameter of 15 nm suggests an RMW of about 11 nm and the climatological value is 18 nm. Due to an RMW smaller than climatology, estimated surface winds of 75 kt but a forward speed of about 8 kt, an intensity of 60 kt is selected for 18Z on the 22nd, down

from 65 kt originally in HURDAT, a minor intensity change. A central pressure of 997 mb was present in the original HURDAT at 18Z on the 22nd and has been retained.

On October 23rd, a reconnaissance aircraft measured a central pressure of 1000 mb and an eye diameter of 18 nm at 01Z. A central pressure of 1000 mb suggests maximum surface winds of 47 kt from the south of 25N pressure-wind relationship. An eye diameter of 18 nm suggests an RMW of about 14 nm and the climatological value is 19 nm. Since the RMW was smaller than average, an intensity of 55 kt is selected at 00Z on the 23rd, down from 85 kt originally shown in HURDAT, a major intensity change. A central pressure of 1000 mb was added to HURDAT at 00Z on the 23rd. Gracie moved slowly northwestward on the 23rd with little change in intensity. Major changes in intensity are analyzed at 06Z, 12Z and 18Z on the 23rd. HURDAT had 85 kt at 06Z and 12Z and 80 kt at 18Z, and the selected intensity at these times was 55 kt. A ship reported hurricane-force winds at 15Z and 18Z, but a reconnaissance aircraft at 2307Z estimated surface winds of 45 kt. It is likely that the ship had a high bias. The same reconnaissance aircraft also measured a central pressure of 1001 mb and an eye diameter of 12 nm. A central pressure of 1001 mb suggests maximum surface winds of 45 kt south of 25N and 42 kt north of the 25N from the pressure-wind relationship. An eye diameter of 12 nm suggests an RMW of about 9 nm and the climatological value is 20 nm. Since the RMW was smaller than average and the storm was moving at about 9 kt, an intensity of 55 kt is selected at 00Z on the 24th, down from 75 kt originally shown in HURDAT, a major intensity change. A central pressure of 1001 mb was added to HURDAT at 00Z on the 24th. The tropical cyclone continued moving northwestward on the 24th, turning to the north late on the day. A central pressure of 1000 mb was present in HURDAT at 12Z on the 24th and although there is no observation to indicate that it was a central pressure, it appears reasonable and has been retained. A central pressure of 1004 mb, estimated surface winds of 40 kt and an eye diameter of 15 nm was measured by a reconnaissance aircraft at 2309Z on the 24th. A central pressure of 1004 mb suggests maximum surface winds of 36 kt north of 25N from the pressure-wind relationship. An eye diameter of 15 nm suggests an RMW of about 12 nm and the climatological value is 20 nm. Due to an RMW smaller than climatology and ship reports of winds up to 40 kt, an intensity of 45 kt is selected at 00Z on the 25th, down from 65 kt originally shown in HURDAT, a major intensity change. A central pressure of 1004 mb was added to HURDAT at 00Z on the 25th. On the 25th, Gracie moved very slowly to the northeast and east. A central pressure of 997 mb was present in HURDAT at 18Z on the 25th and since it is in the MWR summary, it is likely to have been a measurement [but it was not found] and has been retained. A central pressure of 997 mb suggests maximum surface winds of 49 kt north of 25N from the pressure-wind relationship. An intensity of 50 kt is selected for 18Z on the 25th, down from 65 kt originally in HURDAT, a minor change.

Another reconnaissance aircraft measured a central pressure of 1000 mb and estimated surface winds of 55 kt at 2230Z on the 25th. A central pressure of 1000 mb suggests maximum surface winds of 44 kt north of 25N from the pressure-wind relationship. Since the RMW was smaller than average, an intensity of 55 kt is selected at 00Z on the 23rd, down from 85 kt originally shown in HURDAT, a major intensity change. A central pressure of 1000 mb was added to HURDAT at 00Z on the 26th. Gracie intensified on the 26th as indicated by a reconnaissance aircraft measuring a central pressure of 992 mb, estimating surface winds of 85 kt and an eye diameter of 15 nm at 2330Z. A central pressure of 992 mb suggests maximum surface winds of 56 kt north of 25N and 59 kt north of 25N intensifying from the pressure-wind relationship. An eye diameter of 15 nm suggests an RMW of about 12 nm and the climatological value is 22 nm. Since the RMW was smaller than average, an intensity of 65 kt is selected at 00Z on the 27th, same as originally shown in HURDAT. A central pressure of 992 mb was added to HURDAT at 00Z on the 27th. Intensification to a hurricane is analyzed at 00Z on the 27th, 102 hours (4.25 days) later than originally shown in HURDAT. On October 27th, Gracie started to move to the west-northwest and continued to gain in strength. A reconnaissance aircraft reached the hurricane at 04Z on October 28th measuring a central pressure of 979 mb. A central pressure of 979 mb suggests maximum surface winds of 74 kt north of 25N and 77 kt north of 25N intensifying from the pressure-wind relationship. An intensity of 80 kt is selected at 06Z on the 28th, down from 85 kt originally shown in HURDAT, a minor intensity change. A central pressure of 979 mb was present in HURDAT at 00Z on the 28th and based on the aircraft report, it was moved to 06Z. A penetration center fix at 1906Z on the 28th measured a central pressure of 964 mb, an eye diameter of 7 nm and estimated surface winds of 90 kt. A central pressure of 964 mb suggests maximum surface winds of 91 kt north of 25N and 95 kt north of 25N intensifying from the pressure-wind relationship. An eye diameter of 7 nm suggests an RMW of about 5 nm and the climatological value is 23 nm. Due to a small RMW and forward speed of about 11 kt, an intensity of 105 kt is selected at 18Z on the 28th, up from 100 kt originally shown in HURDAT, a minor intensity change. A central pressure of 964 mb was added to HURDAT at 18Z on the 28th. Intensification to a major hurricane is analyzed at 18Z on the 28th, same as originally shown in HURDAT.

The next penetration center fix measured a central pressure of 957 mb and estimated surface winds of 74 kt and an eye diameter of 18 nm at 0142Z on October 29th. A central pressure of 957 mb suggests maximum surface winds of 98 kt north of 25N and 103 kt north of 25N intensifying from the pressure-wind relationship. An eye diameter of 18 nm suggests an RMW of about 14 nm and the climatological value is 21 nm. Due to a small RMW and forward speed of about 10 kt, an intensity of 110 kt is selected at 18Z on the 28th, same as originally shown in HURDAT. A central pressure of 957 mb was added to HURDAT at 00Z on the 29th. At 07Z on the 29th, the reconnaissance aircraft measured a

central pressure of 958 mb, which have been added to HURDAT at 06Z. The final center penetration occurred at 1530Z on the 29th and the reconnaissance aircraft reported a central pressure of 951 mb. A central pressure of 951 mb suggests maximum surface winds of 104 kt north of 25N and 109 kt north of 25N intensifying from the pressure-wind relationship. Since the circulation remained small and the forward speed was about 13 kt, an intensity of 115 kt is selected at 12Z and 18Z on the 29th. HURDAT originally had 120 kt and 105 kt, respectively, a minor intensity change. The peak intensity is analyzed at 115 kt, down from 120 kt originally in HURDAT. A central pressure of 951 mb was added to HURDAT at 18Z on the 29th. A central pressure of 950 mb was present in HURDAT at 12Z on the 29th and has been removed. Landfall is analyzed at 17Z as a 115 kt hurricane near 32.5N, 80.4W, or very close to Beaufort, SC. MWR and ATSR indicate that a pressure of 950 mb was measured at the Marine Corps Air Station in Beaufort, SC. But the Storm Wallet of Gracie has data that indicates that the report was later corrected to 960 mb, which fits the observation from the Surface Weather Observation (SWO). It appears that the minimum pressure at MCAS Beaufort was originally reported at 28.05 inches (950 mb), but it was later corrected to 28.35 inches (960 mb). Furthermore, surface observations suggest that the center of Gracie passed just east of Beaufort. The central pressure of 951 mb measured by reconnaissance aircraft about an hour and a half before landfall is now shown as the landfall pressure. The highest sustained wind measured over land was 84 kt 5-min at Beaufort and 80 kt at Folly Island, SC. It is analyzed that Gracie made landfall in South Carolina as a category 4 hurricane, up from category 3 originally shown in HURDAT. The radar fixes from Charleston, SC and Fort Fisher, NC were helpful in determining the time of landfall. The Schwerdt et al. parametric hurricane wind model suggests that the highest sustained winds that impacted Georgia were 78 kt winds, but since the winds that affected the state were coming from the north and northeast moving over land, a 15% wind reduction was implemented, suggesting maximum winds of 66 kt. Therefore, Gracie is analyzed as a category 1 hurricane impact for Georgia. Hurricane Gracie weakened quickly as it progressed inland. The Kaplan and DeMaria model was run for 00Z, 06Z and 12Z on the 30th yielding 66 kt, 47 kt and 33 kt, respectively. The highest winds recorded within 2 hours of these times at these times were 50 kt, 47 kt and 33 kt, respectively. An intensity of 65 kt is selected for 00Z, 45 kt at 06Z and 35 kt at 12Z on the 30th (up from 60 kt at 00Z, down from 60 kt at 06Z, and down from 45 kt at 12Z on the 30th, originally in HURDAT. Weakening to a tropical storm is analyzed at 06Z on the 30th, six hours later than originally shown in HURDAT. An approaching cold front caused Gracie to turn to the north and later northeast on the 30th. At 18Z on the 30th, the synoptic data indicates that Gracie merged with the frontal boundary and became an extratropical cyclone. Transition to an extratropical cyclone is analyzed six hours later than originally shown in HURDAT. Weakening below tropical storm force is analyzed also at 18Z on the 30th,

twelve hours earlier than originally shown in HURDAT. The extratropical depression increased in forward speed on October 1st over the Northeast of the United States and turned to the east. Early on October 2nd, the extratropical cyclone became less organized and weakened into a trough after 12Z. Final position is at 12Z on the 2nd, six hours earlier than originally shown.

Hurricane Hannah [September 27 – October 8, 1959]

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41290 09/27/1959 M=12  9 SNBR= 898 HANNAH      XING=0 SSS=0
41290 09/27/1959 M=12 12 SNBR= 898 HANNAH      XING=0 SSS=0
                      **

41295 09/27*  0   0   0    0*  0   0   0    0*268 499  30    0*269 505  30    0*

41300 09/28*269 512  35    0*270 519  50    0*270 528  60    0*270 549  65    0*
41300 09/28*270 512  35    0*272 519  40    0*275 528  45    0*276 540  55    0*
           ***               ***       **      ***       **      *** ***  **

41305 09/29*270 573  70    0*267 583  75    0*263 593  75    0*262 611  80    0*
41305 09/29*274 554  60  996*267 572  65    0*263 590  70    0*262 610  75    0*
           *** ***  **  ***     ***  **          ***  **          ***  **

41310 09/30*262 628  85    0*263 638  90    0*267 647  90    0*277 654  95    0*
41310 09/30*262 626  80    0*264 638  85    0*269 647  90  975*279 656 105  959*
                ***  **      ***       **      ***           **  *** *** ***  ***

41315 10/01*288 661 105    0*296 671 110  959*304 681 110  959*315 689 110  959*
41315 10/01*288 664 105    0*296 672 100    0*305 681  95  967*316 690 100  963*
                ***           ***         * ***       **  *** *** *** ***  ***

41320 10/02*326 693 110  959*335 689 110  959*341 681 110  959*345 671 110  959*
41320 10/02*326 692 100    0*335 689 100    0*341 680 100    0*345 672  95  961*
                *** ***    *         ***    *     *** ***    *     ***  **  ***

41325 10/03*349 662 110  959*351 654 110  959*354 646 105  959*359 638 100    0*
41325 10/03*350 665  95    0*353 657  90    0*357 647  85  966*361 634  85    0*
           *** ***  **    * *** ***  **    * *** ***  **  *** *** ***  **

41330 10/04*364 630  95    0*367 620  90    0*370 607  85    0*371 590  90    0*
41330 10/04*364 623  85    0*367 615  90    0*369 601  85    0*371 584  85  970*
                ***  **          ***         *** ***             ***  **  ***

41335 10/05*371 570  95    0*369 546  95    0*365 517  95    0*360 478  95    0*
41335 10/05*371 565  85    0*369 541  85    0*366 515  90    0*364 481  90    0*
                ***  **          ***  **      *** ***  **      *** ***  **  ***

41340 10/06*356 440  90    0*352 411  90    0*349 381  90    0*344 347  90    0*
41340 10/06*361 445  90    0*355 411  90    0*350 381  90  971*355 347  90    0*
           *** ***           *** ***           *** ***       *** ***

41345 10/07*349 308  85    0*362 281  85    0*383 249  85    0*405 206  85    0*
41345 10/07*366 308  85    0E378 278  85    0E392 249  85    0E410 215  85    0*
           ***              **** ***         ****              **** ***

41350 10/08*437 172  80    0*483 176  65    0E530 209  50    0E573 265  40    0*
41350 10/08E450 180  80    0E490 195  80  967E530 209  70    0E560 250  65    0*
           *** ***           *** ***  **  ***           **      *** ***  **
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Minor changes to the track and major changes to the intensity shown in McAdie et al. (2009). Evidence for these alterations comes from the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Monthly Weather Review, Navy reconnaissance book, Mariners Weather Log, and NHC Storm Wallets.

September 25:

HWM and microfilm do not analyze an organized system at 12Z. HURDAT does not list an organized system on this date. Ship highlights: No gales or low pressures.

September 26:

HWM analyzes a spot low at 26.0N, 50.5W at 12Z. HURDAT does not list an organized system on this date. Microfilm does not show an organized system at 12Z. Ship highlights: No gales or low pressures.

September 27:

HWM analyzes a closed low pressure of at most 1015 mb at 26.5N, 50.0W at 12Z. HURDAT lists a 30 knot tropical depression at 26.8N, 49.9W at 12Z (first position). Microfilm does not show an organized system at 12Z. Ship highlights: No gales or low pressures.

MWR: “On September 27, when hurricane Gracie was some 300 miles off the Florida east coast, ship reports indicated the development of a broad cyclonic circulation centered in the Atlantic near latitude 27" N, longitude 50" W.” ATSR: “An easterly wave reported 300 miles west of the Cape Verde Islands by the Fleet Weather Central, Port Lyautey, on the 22nd of September gave birth to HANNAH. With only a few distant ship reports available, this wave extrapolated westward across the Atlantic, until, on the 27th, a number of ships near the northern tip of the wave reported intensification. Ship reports at 271200Z indicated a possible closed circulation at 25N 52.5W. Successive ship reports indicated slow intensification and the apparent merging of the circulation with a wave on the remnants of a trailing cold front.”

September 28:

HWM analyzes a tropical storm of at most 1005 mb at 27.1N, 52.3W at 12Z. HURDAT lists a 60 knot tropical storm at 27.0N, 52.8W at 12Z. Microfilm shows a closed low pressure of at most 1002 mb at 27.3N, 52.4W at 12Z. Ship highlights: 35 kt E and 1008 mb at 28.5N, 53.5W at 18Z (micro). Aircraft highlight: Penetration center fix measured a central pressure of 996 mb, estimated surface winds of 75 kt and an eye diameter of 10 nm at 2120Z (ATSR).

MWR: “Aircraft reconnaissance the next day found a fully developed hurricane circulation and the first advisory on Hannah was issued at 2300 GMT, September 28. The

hurricane at this time was located near 27" N, 57" W and was moving toward the west at about 14 kt with highest winds around 74 kt. Hannah increased in intensity during the next 48 hours with central pressure dropping to 959 mb and maximum winds reaching 108 kt." ATSR: "A Navy reconnaissance aircraft from Roosevelt Roads reported a radar eye at 282045Z and, less than an hour later, made a penetration reporting winds of hurricane force. The first warning was issued at 283000Z."

September 29:

HWM analyzes a hurricane of at most 995 mb at 26.2N, 59.6W at 12Z. HURDAT lists a 75 knot hurricane at 26.3N, 59.3W at 12Z. Microfilm shows a closed low pressure of at most 1008 mb at 26.0N, 58.0W at 12Z. Ship highlights: 35 kt SE and 1009 mb at 27.8N, 54.5W at 00Z (micro). 45 kt SE at 26.8N, 56.8W at 03Z (micro). 40 kt ENE and 1010 mb at 28.4N, 59.1W at 06Z (micro). 40 kt NE and 1017 mb at 29.5N, 62.9W at 12Z (COADS). 60 kt NE and 1001 mb at 26.8N, 61.5W at 18Z (micro). Aircraft highlights: Penetration center fix at 26.2N, 59.7W and estimated maximum surface winds of 80 kt at 1316Z (ATSR/micro). Penetration center fix at 26.2N, 61.3W at 1853Z (ATSR).

September 30:

HWM analyzes a hurricane of at most 995 mb at 26.4N, 64.6W at 12Z. HURDAT lists a 90 knot hurricane at 26.7N, 64.7W at 12Z. Microfilm shows a closed low pressure of at most 1005 mb at 27.0N, 64.0W at 12Z. Ship highlights: 70 kt SE and 1000 mb at 28.0N, 61.5W at 00Z (micro) (likely wrong location). 50 kt NE and 997 mb at 26.9N, 63.1W at 04Z (COADS). 50 kt SE and 996 mb at 26.9N, 63.1W at 08Z (COADS). 50 kt SE and 1005 mb at 26.9N, 63.2W at 12Z (COADS). 40 kt SE and 1010 mb at 27.6N, 63.0W at 15Z (micro). 45 kt E and 1010 mb at 29.8N, 63.9W at 18Z (COADS). 45 SE and 1010 mb at 29.5N, 63.5W at 21Z (MWL). Aircraft highlights: Penetration center fix measured a central pressure of 975 mb at 27.3N, 64.5W at 1241Z (ATSR/ ADVISORIES). Penetration center fix measured a central pressure of 959 mb at 28.0N, 65.6W at 1838Z (ATSR/ADVISORIES). Radar center fix estimated surface winds of 40 kt and an eye diameter of 9 nm at 1925Z (ATSR).

October 1:

HWM analyzes a hurricane of at most 995 mb at 30.7N, 68.5W at 12Z. HURDAT lists a 110 knot hurricane at 30.4N, 68.1W at 12Z. Microfilm shows a closed low pressure of at most 1008 mb at 30.5N, 68.5W at 12Z. Ship highlights: 35 kt SE and 1012 mb at 29.0N, 63.1W at 00Z (COADS). 35 kt W and 1014 mb at 31.7N, 79.2W at 06Z (micro). Aircraft highlights: Radar center fix at 29.1N, 67.2W at 0243Z (ATSR). Penetration center fix measured a central pressure of 967 mb at 30.5N, 68.2W at 1132Z (ATSR/micro). Penetration center fix estimated surface winds of 95 kt and a 20 nm

RMW near 31N, 68W at ~1740Z (NHRP). Penetration center fix measured a central pressure of 963 mb at 31.7N, 69.0W at 1750Z (ATSR).

MWR: “Hurricane Hannah never became a serious threat to the United States coast, or to Bermuda, and it presented no particularly difficult forecast problems. The most unusual feature of the storm was its long life and sustained intensity, somewhat similar to hurricane Carrie of 1957, A hurricane beacon developed cooperatively by the Air Force Geophysics Research Directorate and the Weather Bureau was tested in the hurricane on October 14. Some highly encouraging results were obtained since the beacon balloon remained in and transmitted signals from the eye for 24 hours on one occasion.”

October 2:

HWM analyzes a hurricane of at most 995 mb at 33.8N, 68.2W with a weakening front to the west at 12Z. HURDAT lists a 110 knot hurricane at 34.1N, 68.1W at 12Z. Microfilm shows a closed low pressure of at most 1005 mb at 34.2N, 68.1W with a frontal boundary to the west at 12Z. Ship highlights: 45 kt SE and 1009 mb at 33.5N, 66.2W at 03Z (MWL). 40 kt E and 1007 mb at 35.0N, 67.5W at 12Z (COADS). 40 kt SE and 1007 mb at 34.4N, 65.5W at 18Z (micro). 75 kt SSE at 34.8N, 65.9W at 23Z (MWL). Aircraft highlights: Radar center fix at 32.8N, 69.0W at 0035Z (ATSR). Penetration center fix estimated surface winds of 96 kt and a 23 nm RMW near 34N, 68W at ~1110Z (NHRP). Penetration center fix at 34.2N, 68.2W at 1130Z (ATSR). Penetration center fix measured a central pressure of 961 mb, estimated surface winds of 120 kt and an eye diameter of 25-35 nm at 34.3N, 67.7W at 1603Z (ATSR). Penetration center fix at 34.4N, 67.5W at 18Z (ATSR). Penetration center fix at 34.7N, 67.0W at 21Z (ATSR).

ATSR: “After detection, HANNAH increased steadily in intensity reaching a maximum wind speed of 120 knots on 2 October. The track of HANNAH was fairly regular, recurving at about 0000Z on the 2nd of October around the periphery of a 500 mb high located to the southeast of Bermuda and in advance of a cold front on the eastern United States seaboard. The storm then traveled rapidly eastward, imbedded in a strong westerly current …”

October 3:

HWM analyzes a hurricane of at most 1000 mb at 35.7N, 64.5W with a warm front to the northeast at 12Z. HURDAT lists a 105 knot hurricane at 35.4N, 64.6W at 12Z. Microfilm shows a closed low pressure of at most 1008 mb at 36.0N, 64.0W with a frontal boundary going through the system at 12Z. Ship highlights: 65 kt S and 1001 mb at 34.0N, 65.9W at 00Z (MWL). 50 kt SW and 1005 mb at 34.0N, 66.0W at 06Z (micro). 95 kt SSE at 34.2N, 65.4W at 09Z (MWL). 45 kt SW and 1009 mb at 33.4N, 64.4W at 12Z (COADS). 40 kt NE and 1008 mb at 36.7N, 66.0W at 18Z (COADS). Aircraft

highlights: Penetration center fix measured a central pressure of 966 mb at 35.7N, 64.7W at 1245Z (ATSR). Penetration center fix at 36.2N, 63.0W at 1830Z (ATSR).

October 4:

HWM analyzes a hurricane of at most 1000 mb at 37.2N, 60.2W with a warm front to the northeast at 12Z. HURDAT lists a 85 knot hurricane at 37.0N, 60.7W at 12Z. Microfilm shows a closed low pressure of at most 999 mb at 37.5N, 59.5W with a frontal boundary going through the system at 12Z. Ship highlights: 45 kt NNW and 1012 mb at 35.4N, 66.0W at 00Z (COADS). 40 kt SW and 1010 mb at 35.5N, 59.8W at 12Z (COADS). 40 kt SW at 36.0N, 57.2W at 1750Z (micro). Aircraft highlights: Penetration center fix estimated surface winds of 108 kt and a 30 nm RMW near 37N, 61W at ~1220Z (NHRP). Penetration center fix at 37.2N, 60.2W at 1250Z (ATSR). Penetration center fix measured a central pressure of 970 mb and estimated surface winds of 100 kt at 37.1N, 58.0W at 1845Z (ATSR/WALLET).

MWR: “The last advisory was issued when the hurricane was 200 miles south-southwest of the Azores on ” ATSR: “...decreasing to about 70 knots on 4 October.”

October 5:

HWM analyzes a hurricane of at most 995 mb at 36.6N, 51.8W with a cold front to the north at 12Z. HURDAT lists a 95 knot hurricane at 36.6N, 51.7W at 12Z. Microfilm shows a closed low pressure of at most 990 mb at 36.5N, 51.2W at 12Z. Ship highlights: 25 kt SSW and 999 mb at 36.8N, 54.8W at 00Z (micro). 65 kt SW and 995 mb at 34.4N, 50.8W at 06Z (COADS). 65 kt SW and 999 mb at 33.6N, 51.0W at 12Z (COADS). 50 kt W and 998 mb at 35.1N, 50.5W at 15Z (micro). 45 kt NW and 1005 mb at 34.6N, 50.4W at 18Z (micro). Aircraft highlights: Penetration center fix at 36.6N, 51.2W at 1258Z (ATSR). Radar center fix at 36.1N, 48.2W at 1745Z (ATSR).

October 6:

HWM analyzes a hurricane of at most 990 mb at 34.7N, 38.3W with a weakening cold front to the north at 12Z. HURDAT lists a 90 knot hurricane at 34.9N, 38.1W at 12Z. Microfilm shows a closed low pressure of at most 999 mb at 34.5N, 38.5W at 12Z. Ship highlights: 55 kt SSE and 1002 mb at 33.3N, 47.3W at 00Z (micro). 45 kt SW and 1007 mb at 31.7N, 40.9W at 06Z (micro). 45 kt SW and 1007 mb at 31.7N, 36.9W at 12Z (micro). 35 kt NE and 1001 mb at 36.3N, 36.6W at 18Z (COADS). Aircraft highlights: Penetration center fix measured a central pressure at 971 mb and estimated maximum surface winds of 45 kt at 34.9N, 38.0W at 1230Z (ATSR/ADVISORIES/MICRO). Radar center fix at 37.4N, 30.5W at 2345Z (ATSR).

ATSR: "...then increasing again to 120 knots on 6 October. Reports received from aircraft of Barrier Force, Atlantic Fleet while operating in the vicinity of the Azores on the 6th of October were of particular value in relocating HANNAH after a long period with little or no data."

October 7:

HWM analyzes a hurricane of at most 990 mb at 39.0N, 24.9W with a cold front to the north at 12Z. HURDAT lists a 85 knot hurricane at 38.3N, 24.9W at 12Z. Microfilm shows a closed low pressure of at most 987 mb at 39.5N, 24.9W with a trough extending southwest of the low pressure at 12Z. Ship highlights: 45 kt NNW and 990 mb at 36.9N, 31.5W at 00Z (micro). 60 kt SW and 1000 mb at 35.9N, 26.4W at 06Z (COADS). 986 mb at 39.1N, 25.4W at 12Z (COADS). 45 kt WSW and 1005 mb at 36.1N, 24.6W at 12Z (COADS). 45 kt N and 985 mb at 41.2N, 22.6W at 18Z (COADS). Land highlights: 35 kt S and 1000 mb at Santa Maria, Azores at 06Z (micro). 15 kt SSE and 991 mb at Terceira, Azores at 06Z (micro). Aircraft highlights: Radar center fix at 38.0N, 28.9W at 0330Z (ATSR).

ATSR: "…and finally appeared to merge with a second cold front in the vicinity of the Azores."

October 8:

HWM analyzes a hurricane of at most 975 mb at 53.5N, 20.5W with a cold front extending to the southeast and a weakening stationary front to the northwest connected to an extratropical cyclone at 60.0N, 32.0W at 12Z. HURDAT lists a 50 knot extratropical cyclone at 53.0N, 20.9W at 12Z. Microfilm shows an extratropical cyclone at 61.0N, 32.0W, possibly indicating that Hannah has been absorbed, at 18Z. Ship highlights: 80 kt S and 980 mb at 45.3N, 16.4W at 00Z (COADS). 55 kt NW and 979 mb at 48.2N, 19.5W at 06Z (COADS). 80 kt S and 981 mb at 53.0N, 18.0W at 12Z (COADS). 70 kt WSW and 974 mb at 54.0N, 22.5W at 14Z (COADS). 45 kt SE and 956 mb at 56.3N, 23.7W at 18Z (COADS).

October 9:

HWM analyzes an extratropical cyclone at 60.5N, 42.5W at 12Z. HURDAT does not list an organized system on this date. Microfilm shows an extratropical cyclone at 61.0N, 32.0W at 12Z. Ship highlights: 60 kt WNW and 983 mb at 53.8N, 32.7W at 00Z (COADS).

Date	Original HURDAT Central Pressure	Evidence	Changes
Sep 29 00Z		Penetration center fix: 996 mb at 2120Z on Sep 28th	996 mb
Sep 30 12Z		Penetration center fix: 975 mb at 1241Z on Sep 30th	975 mb
Sep 30 18Z		Penetration center fix: 959 mb at 1838Z on Sep 30th	959 mb
Oct 1 06Z	959 mb	No penetration center fix occurred around this time, nor a ship reported a central pressure	Removed
Oct 1 12Z	959 mb	Penetration center fix: 967 mb at 1137Z on Oct 1st	967 mb
Oct 1 18Z	959 mb	Penetration center fix: 963 mb at 1750Z on Oct 1st	963 mb
Oct 2 00Z	959 mb	No central pressure were reported around these times by penetration center fixes or ships	Removed
Oct 2 06Z			
Oct 2 12Z			
Oct 2 18Z	959 mb	Penetration center fix: 961 mb at 1603Z on Oct 2nd	961 mb
Oct 3 00Z	959 mb	No central pressure were reported around these times by penetration center fixes or ships	Removed
Oct 3 06Z			
Oct 3 12Z	959 mb	Penetration center fix: 966 mb at 1245Z on Oct 3rd	966 mb
Oct 4 18Z		Penetration center fix: 970 mb at 1845Z on Oct 4th	970 mb
Oct 6 12Z		Penetration center fix: 971 mb at 1230Z on Oct 6th	971 mb
Oct 8 06Z		Ship report: 15 kt E and 969 mb	967 mb

The development of Hannah appears to be associated with the northern portion of a tropical wave that left the African coast around September 22nd. Data over the eastern and central Atlantic is sparse and the precise time of genesis is uncertain. Late on September

26th and early on the 27th, ship observations in the periphery of the circulation indicate that the disturbance had become better organized. The first position in HURDAT is at 12Z on the 27th as a 30 kt tropical depression and it has been retained, but the genesis of the tropical cyclone may have occurred 12-24 hours earlier. Minor track alterations are introduced during the lifetime of this tropical cyclone. The most significant changes are presented on October 7th. The tropical depression moved generally westward and intensification to a tropical storm is analyzed at 00Z on September 28th, same as the original HURDAT. Hannah continued to intensify on the 28th with the first gales appearing northeast of the center at 18Z. A reconnaissance aircraft investigated the tropical storm at 2120Z on the 28th measuring a central pressure of 996 mb, estimating surface winds of 75 kt and an eye diameter of 10 nm. A central pressure of 996 mb suggests maximum surface winds of 50 kt north of 25N according to the Brown et al. pressure-wind relationship. An eye diameter of 10 nm suggests an RMW of about 8 nm and climatology is 22 nm. Due to a small RMW, forward speed of about 14 kt and estimated surface winds of 75 kt, an intensity of 55 kt is selected for 18Z on the 28th and 60 kt for 00Z on the 29th, down from 60 kt and 65 kt, respectively, originally in HURDAT, minor intensity changes. Intensification to a hurricane is analyzed at 06Z on the 29th, twelve hours later than originally shown in HURDAT. Hannah continued to intensify on the 29th and 30th as the track turned to the northwest. A reconnaissance aircraft reached the hurricane measuring a central pressure of 975 mb at 1241Z on the 30th. A central pressure of 975 mb suggests maximum surface winds of 79 kt north of 25N from the pressure-wind relationship. An intensity of 90 kt is selected for 12Z on the 30th, same as the original HURDAT. Another penetration center fix measured a central pressure of 959 mb at 1838Z on the 30th and a radar fix at 1925Z estimated an eye diameter of 9 nm. A central pressure of 959 mb suggests maximum surface winds of 96 kt north of 25N and 101 kt intensifying from the pressure-wind relationship. An eye diameter of 9 nm suggests an RMW of about 7 nm and the climatological value is 20 nm. Due to the small size of the hurricane and a forward speed of about 14 nm, an intensity of 105 kt is selected for 18Z on the 30th, up from 95 kt originally in HURDAT, a minor intensity change. Intensification to a major hurricane is analyzed at 18Z on the 30th, six hours earlier than originally in HURDAT. 105 kt is the peak intensity of this hurricane, down from 110 kt originally in HURDAT, a minor intensity change. HURDAT originally had 110 kt from October 1st at 06Z to October 3rd at 06Z.

On October 1st, the major hurricane passed about 200 nm southwest of Bermuda and started to make a turn to the north. Most of the ships stayed away from the hurricane on the 1st but a reconnaissance aircraft reached Hannah at 1132Z measuring a central pressure of 967 mb. A central pressure of 967 mb suggests maximum surface winds of 88 kt north of 25N from the pressure-wind relationship. Due to a forward speed of about 14 kt, an intensity of 95 kt is selected for 12Z on the 1st, down from 110 kt originally in

HURDAT, a minor intensity change. For some unknown reason, HURDAT had a central pressure of 959 mb from 06Z on October 1st to 12Z on October 3rd. Central pressure reports from the reconnaissance aircrafts indicated that the central pressure of Hannah fluctuated during that period, not that it remained constant, which would be very rare for a hurricane. A reconnaissance aircraft at 1750Z on the 1st reported a central pressure of 963 mb, indicating a slight deepening. A NHRP aircraft estimated surface winds of 95 kt and an RMW of 20 nm around 1740Z. A central pressure of 963 mb suggests maximum surface winds of 92 kt north of 25N and 96 kt intensifying from the pressure-wind relationship. The climatological value for the RMW is 25 nm. Due to the hurricane being smaller than climatology and a forward speed of about 14 kt, an intensity of 100 kt is selected for 18Z on the 1st, down from 110 kt originally in HURDAT, a minor intensity change. On October 2nd, Hannah turned to the northeast and slowed its forward speed. A reconnaissance aircraft measured a central pressure of 961 mb, estimated surface winds of 120 kt and an eye diameter of 25-35 nm at 1603Z. A central pressure of 961 mb suggests maximum surface winds of 94 kt north of 25N and 89 kt north of 35N from the pressure-wind relationship. An eye diameter of 25-35 nm suggests an RMW of about 19-26 nm and the climatological value is 27 nm. Due to a forward speed of about 10 kt and an RMW slightly below average, an intensity of 95 kt is selected for 18Z on the 2nd, down from 110 kt originally in HURDAT, a minor intensity change.

The structure of Hannah became less symmetric on the 3rd and 4th of October as it interacted with a frontal boundary. The circulation became stretched E-W but the synoptic observations indicate that the hurricane remained a tropical system. Early on the 3rd, Hannah made its closest approach to Bermuda passing about 170 nm northwest of the island. A couple of ships passed close to the center of Hannah on the 3rd experiencing hurricane-force winds. The next reconnaissance aircraft reached the hurricane at 1245Z measuring a central pressure of 966 mb. A central pressure of 966 mb suggests maximum surface winds of 89 kt north of 25N, 85 kt north of 25N weakening and also north of 35N from the pressure-wind relationship. Due to the slow movement of hurricane near 10 kt, the intensity is analyzed at 85 kt, down from 105 kt originally in HURDAT, a major intensity change. On October 4th, Hannah turned to the east and began to increase in forward speed. Around 1220Z, NHRP estimated surface winds of 108 kt and an RMW of 22 nm. A reconnaissance aircraft measured a central pressure of 970 kt and estimated surface winds of 100 kt at 1845Z on the 4th. A central pressure of 970 mb suggests maximum surface winds of 82 kt north of 35N from the pressure-wind relationship. Climatology suggests an RMW of 30 nm. Since the RMW was smaller than average and the forward speed was about 15 kt, an intensity of 85 kt is selected at 18Z on the 4th, down from 90 kt originally in HURDAT, a minor intensity change. On October 5th and 6th, Hannah gained in forward speed over the north Atlantic as it tracked eastward with minor intensity fluctuations. A reconnaissance aircraft reached the hurricane at 1230Z on

the 6th measuring a central pressure of 971 mb. A central pressure of 971 mb suggests maximum surface winds of 83 kt north of 25N and 81 kt north of 35N from the pressure-wind relationship. Due to a forward speed of about 25 kt, an intensity of 90 kt is selected at 18Z on the 6th, same as originally shown in HURDAT. Late on the 6th, the track of Hannah turned to the northeast around the periphery of a large extratropical cyclone north of the Azores. Transition to an extratropical cyclone occurred at 06Z on October 7th as Hannah approached the Azores. Synoptic data indicates that a significant temperature gradient had developed by this time between the eastern and western quadrants, although the structure of the cyclone remained symmetric. Transition to an extratropical cyclone is analyzed 30 hours earlier than originally shown in HURDAT. Hannah remained an intense extratropical cyclone on October 8th with a few reports of hurricane-force winds from ships near the storm. A couple of ships reported 80 kt at 00Z and 12Z on the 8th, and although the 00Z report may be suspect compared to nearby ships, the other report looks reasonable. Thus, Hannah is kept at hurricane intensity on the 8th. HURDAT originally indicated that Hannah weakened to tropical storm intensity at 12Z on the 8th. A ship near the center of Hannah reported 15 kt E and 969 mb at 06Z on the 8th, suggesting a central pressure of 967 mb. Surface observations late on October 8th and early on the 9th indicate that Hannah and the large extratropical cyclone southeast of Greenland had merged, making 18Z on the 8th the last position of Hannah, which is consistent with the original HURDAT and the map of the Track of Lows of October of the MWL. A recent analog to Hurricane Hannah is Hurricane Gordon, 2012.

Tropical Storm Irene [October 6-9, 1959]

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41360 10/06/1959 M= 4 10 SNBR= 899 IRENE       XING=1 SSS=0
41360 10/06/1959 M= 4 13 SNBR= 899 IRENE       XING=1 SSS=0
                       **

41365 10/06*  0   0   0    0*  0   0   0    0*  0   0   0    0*231 923  25    0*
41365 10/06*  0   0   0    0*  0   0   0    0*  0   0   0    0*232 925  30    0*
                                                          *** ***  **

41370 10/07*240 916  25    0*249 907  30    0*258 897  30    0*271 889  35    0*
41370 10/07*242 918  30    0*252 910  30    0*262 900  30 1003*273 890  35 1001*
           *** ***  **      *** ***                     **** *** ***     ****

41375 10/08*284 882  40    0*293 879  45    0*302 876  50 1001*311 870  30    0*
41375 10/08*284 882  35 1002*294 878  40    0*306 876  40 1000*317 870  30 1003*
                     ** **** *** ***  **      ***       ** **** ***         ****

41380 10/09*323 861  25    0*331 849  25    0*  0   0   0    0*  0   0   0    0*
41380 10/09*328 863  25    0*337 853  20    0*345 835  20    0*  0   0   0    0*
           *** ***          *** ***  **      *** ***  **
41385 TS
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U.S. Tropical Storm Landfall

10/08 10Z 30.3N 87.6W 40 kt AL

Minor changes to the track and intensity shown in McAdie et al. (2009). Evidence for these alterations comes from the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Monthly Weather Review, Navy reconnaissance book, Surface Weather Observations, Mariners Weather Log, and NHC Storm Wallets.

October 4:

HWM does not analyze an organized system at 12Z. HURDAT does not list an organized system on this date. Ship highlights: No gales or low pressures.

MWR: "Prior to the development of Irene, a short wave with surface cyclogenesis moved through the southern Plains and Texas on October 4."

October 5:

HWM analyzes a closed low pressure of at most 1010 mb at 20.5N, 92.0W at 12Z. HURDAT does not list an organized system on this date. Microfilm shows a closed low pressure of at most 1008 mb at 17.5N, 92.5W with a frontal boundary to the north at 12Z. Ship highlights: No gales or low pressures.

MWR: "This permitted the trailing cold front to move into the western Gulf of Mexico on the 5th; the front then dissipated leaving a rather sharp trough. At 500 mb, temperatures over the western Gulf were relatively warm. At, 200 mb, a weak anticyclone persisted over the surface development." ATSR: "Tropical Storm IRENE formed from a flat low pressure area in the Central Gulf of Mexico induced by a cold front which entered the Western Gulf about 1800Z on 5 October."

October 6:

HWM analyzes a spot low at 23.2N, 91.8W with a cold front to the north at 12Z. HURDAT lists a 25 knot tropical depression at 23.1N, 92.3W at 18Z (first position). Microfilm shows a spot low pressure near 22.0N, 95.0W with a frontal boundary to the north at 12Z. Ship highlights: No gales or low pressures.

MWR: "Tropical storm Irene formed on October 6 in the central portion of the Gulf of Mexico and moved north-northeastward during the next two days." ATSR: "A closed low was drawn on the 1800Z surface chart on 6 October with the ship CARL SCHMEDAN located at 22.2N and 89.3W reporting a southerly wind of 30 knots and squalls."

October 7:

HWM analyzes a closed low pressure of at most 1005 mb at 26.0N, 89.5W with a weakening cold front to the north at 12Z. HURDAT lists a 30 knot tropical depression at 25.8N, 89.7W at 12Z. Microfilm shows a closed low pressure of at most 1005 mb at 26.5N, 90.0W at 12Z. Ship highlights: 40 kt S and 1009 mb at 26.3N, 87.6W at 12Z (COADS). 35 kt SSE and 1005 mb at 26.4N, 88.8W at 15Z (micro). 35 kt SW and 1006 mb at 26.3N, 87.9W at 18Z (micro). Land highlights: 10 kt SE and 1004 mb at Burrwood, LA at 2055Z (SWO). Aircraft highlights: Penetration center fix measured a central pressure of 1003 mb and estimated maximum surface winds of 35 kt at 26.4N, 89.1W at 14Z (ATSR). Penetration center fix measured a central pressure of 1001 mb and estimated maximum surface winds of 45 kt at 27.8N, 88.5W at 19Z (ATSR). Penetration center fix measured a central pressure of 1002 mb and estimated maximum surface winds of 40 kt at 28.0N, 88.5W at 2230Z (ATSR).

ATSR: “A Navy reconnaissance aircraft flight was sent out on 7 October to investigate this apparent circulation and found a definite closed low pressure center with winds gusting to 45 knots in squalls to the north and east. On the basis of this information, the first tropical storm warning was issued at 071600Z. The lowest sea level pressure reported by reconnaissance aircraft was 1001 mb. The highest winds were gusts of 48 kt in squalls at the Pensacola Airport.”

October 8:

HWM analyzes a tropical storm of at most 1005 mb at 30.1N, 87.2W at 12Z. HURDAT lists a 50 knot tropical storm at 30.2N, 87.6W at 12Z. Microfilm shows a closed low pressure of at most 1002 mb at 30.5N, 87.7W at 12Z. Ship highlights: 25 kt SSW and 1004 mb at 27.3N, 87.0W at 00Z (COADS). 25 kt SW and 1004 mb at 29.2N, 87.5W at 06Z (micro). 30 kt SSW and 1008 mb at 28.0N, 86.4W at 12Z (COADS). Land highlights: 5 kt NE and 1004 mb at Burrwood, LA at 03Z (micro). 20 kt SE and 1003 mb at Pensacola, FL at 06Z (micro). 20 kt SSE and 1002 mb at Pensacola, FL at 0858Z (SWO). 20 kt S and 1003 mb at Pensacola, FL at 12Z (micro). 13 kt ENE and 1005 mb at Montgomery, AL at 1958Z (SWO). Aircraft highlights: Penetration center fix measured a central pressure of 1007 mb and estimated an eye diameter of 17 nm at 28.3N, 87.3W at 01Z (ATSR).

MWR: “Irene was never a well organized storm and although the center moved inland near Pensacola early on the 8th, highest tides were 4.4 feet above normal at Cedar Keys, Fla., a considerable distance east of the track and landfall.” ATSR: “The reconnaissance aircraft tracking IRENE on the night of 7-8 October was unable to find a definite eye; however, Burrwood, Louisiana, reported a triangular hole in a radar weather band at 080428Z, and Apalachicola, Florida, radar reported a center based on spiral overlay at 080800Z. IRENE passed inland just west of the city of Pensacola at 081110Z with

maximum wind gusts to 48 knots at Naval Air Station, Pensacola. The storm dissipated rapidly on moving northward. No deaths, injuries, or significant damage were reported."

October 9:

HWM analyzes a cold front over the eastern United States at 12Z. HURDAT lists a 25 knot tropical depression at 33.1N, 84.9W at 06Z (last position). Microfilm shows a frontal boundary over the eastern United States at 12Z. Ship highlights: No gales or low pressures.

Tropical Storm Irene developed from a tropical wave that reached the Gulf of Mexico on October 5th. The disturbance slowly became better organized as a frontal system entered the gulf from the northwest. A 30-kt tropical depression is analyzed to have formed at 18Z on October 6th, same as the original HURDAT. Data over the southern Gulf of Mexico is sparse and this tropical cyclone may have formed earlier than indicated. Minor track alterations are introduced for the lifetime of this tropical cyclone. The first reconnaissance aircraft to reach the system measured a central pressure of 1003 mb and estimated surface winds of 35 kt at 14Z. A central pressure of 1003 mb suggests maximum sustained surface winds of 38 kt north of 25N from the Brown et al. pressure-wind relationship. Due to low environmental pressures, an intensity of 30 kt is selected at 12Z on October 7th, same as originally shown in HURDAT. A central pressure of 1003 mb has been added to HURDAT at 12Z on the 7th. A ship reported 40 kt at 12Z on the 7th, but reports from surrounding ships indicate that it has a high wind bias. The first reliable gales were reported later in the day. Another reconnaissance aircraft measured a central pressure of 1001 mb and estimated surface winds at 45 kt at 19Z. A central pressure of 1001 mb suggests maximum surface winds of 42 kt north of 25N from the pressure-wind relationship. Due to low environmental pressures and ship reports of 35 kt winds, an intensity of 35 kt is selected at 18Z on the 7th, same as originally shown in HURDAT. A central pressure of 1001 mb has been added to HURDAT at 18Z on the 7th. Intensification to a tropical storm is analyzed at 18Z on the 7th, same as the original HURDAT. A penetration center fix at 2230Z on the 7th measured a central pressure of 1002 mb and estimated surface winds of 40 kt. A central pressure of 1002 mb suggests maximum surface winds of 40 kt north of 25N from the pressure-wind relationship. An intensity of 35 kt is selected at 00Z on October 8th, down from 40 kt originally in HURDAT, a minor intensity change. Center fixes early on the 8th were about 60 nm east of the center of Irene based on the synoptic data. The poorly-organized state of the cyclone likely contributed to the difficulty of fixing the center. Thus, these fixes have been disregarded. A minimum pressure of 1002 mb and 20 kt SSE was reported in Pensacola, FL around 09Z, indicating a central pressure of 1000 mb, which has been added to HURDAT at 12Z on the 8th, replacing the existing 1001 mb. A central pressure of 1000 mb suggests maximum surface winds of 44 kt north of 25N from the pressure-

wind relationship. An intensity of 40 kt is analyzed at 06Z and 12Z, down from 45 kt and 50 kt originally in HURDAT, minor intensity changes. 40 kt is also the peak intensity for this tropical cyclone, down from 50 kt originally in HURDAT, a minor intensity change. Irene continued north-northeast early on the 8th making landfall in Alabama with 40 kt winds near 30.3N, 87.6W or about 25 miles southwest of Pensacola, FL at 10Z. No tropical storm force winds were reported by coastal stations. The tropical storm quickly weakened to a tropical depression at 18Z on the 8th, same as the original HURDAT. Montgomery, AL reported 13 kt ENE and 1005 mb at 1958Z, which suggests a central pressure of 1003 mb, which has been added to HURDAT at 18Z on the 8th. A cold front was approaching from the northwest and caused Irene to accelerate to the northeast before being absorbed after 12Z on October 9th. The last position is analyzed at 12Z on the 9th, six hours later than originally shown in HURDAT.

Hurricane Judith [October 17-22, 1959]

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41390 10/17/1959 M= 5 11 SNBR= 900 JUDITH      XING=1 SSS=0                    L
41390 10/17/1959 M= 6 14 SNBR= 900 JUDITH      XING=1 SSS=0                    L
                       * **

41395 10/17*  0   0   0    0*  0   0   0    0*212 851  40    0*231 850  55    0*
41395 10/17*  0   0   0    0*  0   0   0    0*215 859  35    0*232 852  50    0*
                                             *** ***  **      *** ***  **

41400 10/18*247 840  65    0*259 833  55    0*267 824  45  999*270 804  40    0*
41400 10/18*248 843  65    0*258 834  60    0*267 825  55  998*270 805  45    0*
            *** ***          *** ***  **          ***  **  ***     ***  **

41405 10/19*273 772  40    0*283 736  50    0*294 700  65    0*303 664  65    0*
41405 10/19*275 772  55    0*285 736  65  993*296 700  75  988*305 662  75    0*
            ***      **      ***      **  *** ***      **  *** *** ***  **

41410 10/20*309 629  70    0*309 606  70    0*309 591  70    0*311 573  70    0*
41410 10/20*310 626  70    0*310 595  70    0*310 575  70    0*311 565  70    0*
            *** ***          *** ***          *** ***              ***

41415 10/21*313 559  60    0*315 550  60    0*317 542  50    0*325 523  40    0*
41415 10/21*313 557  60    0*315 553  55    0*317 550  50    0*318 548  40    0*
                ***              ***  **          ***          *** ***

(October 22nd is new to HURDAT)
41417 10/22*320 540  35    0*320 525  30    0*  0   0   0    0*  0   0   0    0*

41420 HR
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U.S. Tropical Storm Landfall

10/18 14Z 26.7N 82.3W 55 kt FL

Major changes to the track and minor alterations to the intensity shown in McAdie et al. (2009). Evidence for these alterations comes from the NHC microfilm maps, the

Historical Weather Maps series, the COADS ship database, Monthly Weather Review, Navy reconnaissance book, Surface Weather Observations, Mariners Weather Log and NHC Storm Wallets.

October 12:

HWM does not analyze an organized system at 12Z. HURDAT does not list an organized system on this date. Microfilm shows a tropical wave over the eastern Caribbean Sea at 12Z. Ship highlights: No gales or low pressures.

MWR: "Activity along the intertropical convergence zone continued strong throughout mid-October in the Caribbean and Central America area. Pilots reported 52-kt. squalls in the vicinity of 15N, 73W late on the 10th and early on the 11th, but the perturbation continued along the ITC with no development. During the afternoon of the 11th a new unstable easterly wave approached the Leeward Islands, and Barbados experienced heavy squalls." ATSR: "Hurricane JUDITH had its origin from an easterly wave which appeared between Barbados Island and the other Windward Islands on 11 October. As this wave moved westward into the Caribbean the "Bermuda" high bulged southward producing a strong southeasterly wind field in the area. As the wave was followed through the Caribbean, ship reports, investigative flights, and land station reports indicated considerable squally weather and winds as high as 40 knots."

October 13:

HWM does not analyze an organized system at 12Z. HURDAT does not list an organized system on this date. Microfilm shows a tropical wave over the central Caribbean Sea at 12Z. Ship highlights: No gales or low pressures.

October 14:

HWM does not analyze an organized system at 12Z. HURDAT does not list an organized system on this date. Microfilm shows a tropical wave extending from 9N-22N and 72W-77W at 12Z. Ship highlights: 40 kt E and 1010 mb at 15.2N, 72.1W at 03Z (micro). 40 kt SE and 1009 mb at 16.0N, 72.0W at 06Z (micro). 35 kt SE and 1012 mb at 17.1N, 71.3W at 18Z (COADS). Aircraft highlights: Possible penetration center fix measured a central pressure of 1004 mb and estimated surface winds of 50 kt at 14.5N, 77.5W around 20Z (micro).

October 15:

HWM does not analyze an organized system at 12Z. HURDAT does not list an organized system on this date. Microfilm shows a closed low pressure of at most 1005 mb at 15.0N, 79.3W at 12Z. Ship highlights: 35 kt ESE and 1012 mb at 16.4N, 73.0W at 00Z (COADS). 40 kt ESE and 1012 mb at 18.0N, 75.9W at 12Z (COADS).

MWR: “This wave moved steadily across the Caribbean at 15 kt and on October 15 developed a weak circulation south of Jamaica. During this same period, a tropical low pressure pattern gradually developed in the Bay of Campeche, remaining essentially stationary, while a cold front moved slowly southeastward from Texas into the western Gulf of Mexico.”

October 16:

HWM does not analyze an organized system but it depicts a stationary front over the western Gulf of Mexico at 12Z. HURDAT does not list an organized system on this date. Microfilm shows a tropical wave over the western Caribbean Sea with a spot low near 18.0N, 87.0W at 12Z. Ship highlights: No gales or low pressures.

MWR: “On the morning of October 16, the Caribbean wave had drifted into the Gulf of Honduras, the Campeche depression had weakened, and the west Gulf front had become diffused. Squalliness had decreased although moderates squalls were still occurring as far east as Jamaica. The Caribbean wave had been investigated daily by aircraft reconnaissance and, since development was thought possible when the, two disturbances eventually merged in the south-central Gulf, arrangements were made for aircraft reconnaissance in the area the following day. At both 1300 EST and 1900 EST on the 16th, all reporting stations within 500 miles of the disturbed area reported 24-hour rises in surface pressure.”

October 17:

HWM analyzes a spot low at 21.3N, 87.0W at 12Z. HURDAT lists a 40 knot tropical storm at 21.2N, 85.1W at 12Z (first position). Microfilm shows a closed low pressure of at most 1008 mb at 21.0N, 86.8W at 12Z. Ship highlights: 35 kt SE at 24.5N, 81.5W at 21Z (micro). 45 kt ESE and 999 mb at 24.4N, 83.7W at 22Z (micro). 45 kt SW and 1004 mb at 24.4N, 83.7W at 2220Z (micro). 65 kt SW and 1004 mb at 24.8N, 83.5W at 23Z (micro/MWL). Land highlights: 40 kt SE and 1018 mb at Dry Tortugas Light, FL at 21Z (micro). Aircraft highlights: Penetration center fix measured a central pressure of 1007 mb and estimated surface winds of 35 kt at 21.7N, 85.9W at 1345Z (ATSR). Penetration center fix measured a central pressure of 1006 mb and estimated surface winds of 43 kt at 22.4N, 85.9W at 1745Z (ATSR). Penetration center fix measured a central pressure of 1005 mb and estimated surface winds of 45 kt at 23.6N, 84.0W (possible new center) at 1840Z (ATSR).

MWR: “However, surface reports at 0700 EST on the 17th, as well as aircraft reconnaissance during the forenoon, indicated a complete circulation. Gale warnings were issued for the Florida Gulf coast south of Cedar Keys at 1600 EST as gradual intensification occurred during the day. In the afternoon, shortly before departing for

home base, the aircraft reported a new center apparently developing some 150 miles northeast of the old center, with 45-kt surface winds. At 1700 EST, the MV Italsole encountered a small vortex at 24.5N, 83.7W with the barometer falling rapidly from 1008.5 to 999.3 mb, and the wind increasing to 43 kt. The wind shifted gradually from east-southeast to southwest in 30 minutes. The barometer then began rising steadily. An hour or two later another ship in the same area reported winds of hurricane force. With fairly rapid intensification indicated by these ships and by aircraft and with direction of movement in doubt, hurricane warnings were issued at 2030 EST for the Florida Gulf coast from Punta Gorda to Cedar Keys."

October 18:

HWM analyzes a tropical storm of at most 1005 mb at 26.9N, 82.8W with a cold front to the northwest and another cold front to the northeast at 12Z. HURDAT lists a 45 knot tropical storm at 26.7N, 82.4W at 12Z. Microfilm shows a closed low pressure of at most 999 mb at 26.8N, 82.4W with a frontal boundary to the north at 12Z. Ship highlights: 20 kt SE and 1005 mb at 24.6N, 83.6W at 00Z (COADS). 35 kt S and 1008 mb at 24.9N, 80.3W at 12Z (COADS). Land highlights: 40 kt SSW and 1009 mb at Dry Tortugas Light, FL at 00Z (micro). 55 kt S and 1008 mb at Carysfort Reef Light, FL at 25.2N, 80.2W at 12Z (micro). 35 kt SSW (gusts to 46 kt) at Fort Myers, FL at 1317Z (WALLET). 999 mb at Boca Grande, FL at 14Z (WALLET). 39 kt SW and 1008 mb at Key West, FL at 1450Z (SWO). 45 kt SW and 1006 mb at Carysfort Reef Light, FL at 25.2N, 80.2W at 18Z (micro). Aircraft highlights: Penetration center fix measured a central pressure of 1005 mb and estimated an eye diameter of 9 nm at 25.2N, 83.7W at 00Z (ATSR). Penetration center fix measured a central pressure of 1004 mb at 25.3N, 83.5W at 02Z (ATSR). Penetration center fix measured a central pressure of 998 mb and estimated surface winds of 40 kt at 26.7N, 82.5W at 12Z (ATSR).

MWR: "The observer at Dry Tortugas, some 70 miles west of Key West, reports as follows: Late in the afternoon, Cuban fishing boats in the area came to Dry Tortugas harbor area to avoid rough water. Just before dark the wind began to pick up, and in about 5 minutes the wild increased from about 10 mph to about 50 mph and the ocean became extremely rough. The high winds (about, 50-55 mph) continued, developing waves of nearly 10 feet. The wind shifted from east to south and blew all night at about 50-55 mph, although the rain did not get above a heavy drizzle. Neither the Miami WBO radar (the new WSR-57) nor the reconnaissance aircraft radar could pick up any wall cloud around the eye during the night and thus it was difficult to track the storm center. With time, the weather bands observed on radar appeared to lose intensity as well as much of their spiral character. These radar observations and weather trends along the Florida Gulf coast indicated definite loss of intensity and hurricane warnings were changed to gale warnings at 0500 EST. The storm center reached the coast near Boca

Grande Island between 0800 and 0900 EST on the 18th, with lowest pressure 999.0 mb, and very little wind north of the center. South of the center the maximum sustained velocity at Fort Myers was south-southwest 35 kt, and gusts to 46 kt. Total rainfall was 7.57 inches and highest tides 2 feet above normal. There were no deaths but one injury. The storm crossed the Florida peninsula during the 18th, passing into the Atlantic near Fort Pierce. Gales were reported over extreme southern Florida with gusts of 48 kt at Miami. Within a few hours after the storm passed out to sea, a new center apparently developed just northeast of Great Abaco Island in the Bahamas and began to intensify, reaching hurricane force by the next morning. Again the strongest winds first appeared on the south side of the center but gradually extended completely around the storm. No explanation is available for Judith's loss of intensity in the 6- to 8-hour period prior to landfall on the Florida west coast. Re-intensification over the Atlantic took place under west-southwesterly winds of around 45 kt at 200 mb."

October 19:

HWM analyzes a hurricane of at most 1000 mb at 29.8N, 70.2W with a frontal boundary about 60 nm to the northwest at 12Z. HURDAT lists a 65 knot hurricane at 29.4N, 70.0W at 12Z. Microfilm shows a frontal boundary between the East Coast of the United States and Bermuda at 12Z. Ship highlights: 40 kt SSW and 1005 mb at 26.8N, 75.5W at 00Z (COADS). 40 kt SW and 1006 mb at 26.1N, 75.8W at 06Z (micro). 65 kt N and 996 mb at 30.2N, 71.2W at 11Z (MWL). 50 kt SW and 1011 mb at 27.8N, 68.5W at 16Z (micro). 60 kt WNW and 1013 mb at 26.6N, 68.8W at 18Z (COADS). Aircraft highlights: Penetration center fix at 27.7N, 75.3W at 03Z (ATSR). Penetration center fix measured a central pressure of 993 mb, estimated an eye diameter of 15 nm and maximum surface winds of 45 kt at 28.8N, 73.4W at 0630Z (ATSR/micro). Penetration center fix measured a central pressure of 988 mb, estimated surface winds of 70 kt and eye diameter of 12 nm at 29.6N, 70.4W at 1139Z (ATSR). Penetration center fix at 30.5N, 66.0W at 1830Z (ATSR).

ATSR: "…developed to hurricane intensity on the 19th of October."

October 20:

HWM analyzes a hurricane of at most 1000 mb at 31.5N, 58.8W with a frontal boundary about 60 nm to the northwest at 12Z. HURDAT lists a 70 knot hurricane at 30.9N, 59.1W at 12Z. Microfilm shows a closed low pressure of at most 1002 mb at 31.2N, 57.2W at 12Z. Ship highlights: No gales or low pressures. Aircraft highlights: Radar center fix at 31.0N, 62.5W at 0030Z (ATSR). Penetration center fix at 31.3N, 56.2W at 1903Z (ATSR).

October 21:

HWM analyzes a tropical storm of at most 1010 mb at 32.1N, 53.8W with a frontal boundary just to the northwest at 12Z. HURDAT lists a 50 knot tropical storm at 31.7N, 54.2W at 12Z. Microfilm shows a closed low pressure of at most 1017 mb at 32.0N, 54.0W at 12Z. Ship highlights: 35 kt S and 1001 mb at 31.7N, 54.7W at 12Z (COADS). Aircraft highlights: Penetration center fix at 32.0N, 54.5W at 1245Z (ATSR). Penetration center fix at 32.0N, 55.1W at 1832Z (ATSR/micro).

October 22:

HWM analyzes a NE-SW elongated, closed low pressure of at most 1005 mb at 31.0N, 51.0W embedded within a frontal boundary at 12Z. HURDAT does not list an organized system on this date. Microfilm shows a closed low pressure of at most 1017 mb at 31.0N, 51.0W embedded within a frontal boundary at 12Z. Ship highlights: No gales or low pressures.

ATSR: "JUDITH was forecast to move approximately parallel to the wind flow at 500 mb on a continuing east-northeasterly heading while in the Atlantic. Verification of this direction proved highly satisfactory; however, the speed was somewhat erratic. JUDITH became extra-tropical and weakened on the 28th of October after becoming involved with a cold front."

October 23:

HWM analyzes a frontal boundary over the north Atlantic at 12Z. HURDAT does not list an organized system on this date. Microfilm shows a trough of low pressure extending 27N-35N, 44W-50W at 12Z. Ship highlights: No gales or low pressures.

A strong tropical wave entered the Caribbean Sea on October 12th. As the disturbance moved westward, it became better organized and tropical storm force winds were reported over the central Caribbean Sea early on October 14th. Synoptic data is scarce over this area but it did not appear that a closed low-level circulation had developed at that time. Late on the 14th, a reconnaissance aircraft investigated the disturbance finding a central pressure of 1004 mb and maximum surface winds of 50 kt, as shown on microfilm. Although it is possible that a tropical cyclone may have formed on the 14th, synoptic data late on the 14th and 15th does not support that a well-define low level circulation was present. A few ships over the southern Caribbean Sea were reporting southwest winds on these days, but this wind pattern continued into October 16th when the disturbance had already left the area. This likely was an indication that these southwest winds were responding to the Pacific monsoon trough impinging into the

Caribbean Sea and were not associated with the disturbance. Late on the 16th, the strong tropical wave reached the Gulf of Honduras and turned to the north becoming better organized. At the same time, a stationary cold front was present over the central Gulf of Mexico. A reconnaissance aircraft reached the disturbance at 1345Z on October 17th estimating surface winds of 35 kt and measuring a central pressure of 1007 mb. This central pressure value was not added to HURDAT because ship and coastal observations indicate that the pressures were slightly lower than the reported value. The first position is analyzed at 12Z on the 17th as a 35 kt tropical storm named Judith, slightly weaker than originally shown in HURDAT. Minor track alterations are indicated during most of the lifetime of this tropical cyclone, with the only major alteration to the track occurring at 18Z on October 21st. Subsequent reconnaissance center fixes on the 17th indicate that the aircraft had trouble locating the center, which would normally suggest that the tropical cyclone was poorly organized. Nonetheless, as the tropical storm moved northeastward late on the 17th, a ship measured 45 kt SE and the pressure dropped to 999 mb around 22Z. About an hour later, around 23Z on October 17th, another ship near the center measured 65 kt SW and 1004 mb. Intensification to a hurricane is analyzed at 00Z on the 18th, same as originally shown in HURDAT. Early on the 18th, reconnaissance data suggested that Judith had a small eye of about 9 nm in diameter. The tropical cyclone continued moving northeastward on the 18th but data suggests that it started weakening soon after reaching hurricane intensity. Weakening to a tropical storm is analyzed at 06Z on the 18th, same as originally shown in HURDAT. A reconnaissance aircraft measured a central pressure of 998 mb and estimated surface winds of 40 kt at 12Z on the 18th. A central pressure of 998 mb suggests maximum surface winds of 49 kt from the north 25N Brown et al. pressure-wind relationship. Since Judith was moving at about 16 kt, an intensity of 55 kt is selected at 12Z on the 18th, up from 45 kt originally in HURDAT, a minor intensity change. A central pressure of 998 mb is added to HURDAT at 12Z on the 18th, replacing the existing 999 mb, which was measured a couple of hours later.

Around 14Z on the 18th, Judith made landfall near Boca Grande, FL with an intensity of 55 kt. This is based primarily upon the reconnaissance data a few hours before landfall. Surface observations include 55 kt at Carysfort Reef Light at 12Z, 35 kt at Fort Myers at 1317Z and 39 kt at Key West at 1450Z, consistent with an intensity of 55 kt at landfall. After landfall, the track of Judith turned east-northeast and the forward speed rapidly increased. The center of the storm made oceanfall in the Atlantic Ocean around 19Z on the 18th after just five hours overland. Judith re-intensified over the Atlantic waters while located on the warm side of a weak frontal boundary. A reconnaissance aircraft measured a central pressure of 993 mb and estimated an eye diameter of 15 nm at 0630Z on October 19th. A central pressure of 993 mb suggests maximum surface winds of 57 kt from the north of 25N intensifying pressure-wind relationship. An eye diameter of 15 nm suggests an RMW of about 11 nm and the climatological value is 23 nm. Due to a

forward speed of about 35 kt and an RMW smaller than normal, an intensity of 65 kt is selected at 06Z on the 19th, up from 50 kt originally in HURDAT, a minor intensity change. A central pressure of 993 mb is added to HURDAT at 06Z on the 19th. Re-intensification to a hurricane is analyzed six hours earlier than originally shown in HURDAT. A penetration center fix measured a central pressure of 988 mb, estimated surface winds of 70 kt and an eye diameter of 12 nm at 1139Z. A central pressure of 988 mb suggests maximum surface winds of 65 kt from the north of 25N intensifying pressure-wind relationship. An eye diameter of 12 nm suggests an RMW of about 9 nm and the climatological value is 24 nm. Due to a forward speed of about 35 kt and an RMW smaller than normal, an intensity of 75 kt is selected at 12Z on the 19th, up from 65 kt originally in HURDAT, a minor intensity change. A central pressure of 988 mb is added to HURDAT at 12Z on the 19th. 75 kt is the peak intensity of this tropical cyclone, up from 70 kt originally in HURDAT, a minor intensity change. On October 20th, Judith moved generally eastward and began to slow its forward speed. Intensity is retained at 70 kt on the 20th, as originally shown in HURDAT, based in part on a surface wind estimate of 70 kt from a reconnaissance aircraft at 20Z. Synoptic observations in the 20th were scarce with no ship reports of gale-force winds. The frontal boundary helping to cause the eastward movement of the storm remained north of the storm's circulation. Judith weakened rapidly on October 21st. Weakening below hurricane force is analyzed at 00Z on the 21st, same as originally shown in HURDAT. Weakening continued and Judith became a tropical depression around 06Z on October 22nd, becoming absorbed by a stronger frontal system after 06Z. Final position is analyzed at 06Z on the 22nd, twelve hours later than originally shown in HURDAT.

1959 - Additional Notes

1) May 29 – June 2: Historical Weather Maps show an area of low pressure developing over the central Atlantic during the last days of May. The disturbance moved slowly northward ahead of an approaching frontal boundary. A well-defined low was present but the data suggests that it was producing winds below gale force. The disturbance weakened on June 1st and became absorbed by the frontal boundary on the 2nd. Therefore, because the system did not produce gale force winds, it is not added to HURDAT. This disturbance was in Jack Beven's List of Suspects.

Day	Latitude	Longitude	Status
May 29	30N	55W	Trough
May 30	30N	55W	Tropical Depression?

May 31	31N	55W	Tropical Depression?
June 1	34N	55W	Tropical Depression?
June 2			Absorbed

2) August 24-27: A tropical wave entered the Gulf of Mexico around August 23rd and slowly became better organized. The disturbance was investigated by reconnaissance aircrafts on a couple of occasions between August 24th and 26th. The reconnaissance aircrafts reported a diffuse center on the 25th and estimated winds of 30 kt. Before landfall on the 26th, the aircraft reported estimated winds of 38 kt and a central pressure of 1004 mb. No gales were reported by ships or coastal stations. It is interesting to note that the Historical Weather Maps do not show any disturbance over the western Gulf of Mexico on these days. Therefore, because no sustained tropical storm force winds were measured, it is not added to HURDAT. This disturbance was in Jack Beven's List of Suspects.

NAVY RECON book: “From the 241200Z synoptic chart, it became apparent that one of a series of weak early waves which had been moving through the Gulf of Mexico was intensifying. Reports from the Coast Guard patrol vessel NUZY off Tampico and the Navy reconnaissance “Alfa” flight indicated a possible cyclonic circulation about 120 miles east of Tampico. A special flight was ordered to investigate this area and at 252030Z the aircraft reported an eye within a diffuse storm area with maximum observed winds of 30 knots in the south quadrant. A Navy reconnaissance aircraft made the last fix of the storm at 261300Z reporting maximum winds 38 knots in thunderstorms offshore. The storm passed inland about 10 miles south of Corpus Christi at 261500Z dissipating shortly. No winds over 20 knots were experienced by land stations at this time. The name FLORA was used by this activity to designate this storm, but not by the Weather Bureau. The Weather Bureau at New Orleans issued bulletins calling this a “weak circulation” further stating in the initial bulletin that conditions were favorable for further development. In order to avoid confusing the public and in compliance with the desires of the Chief of the Weather Bureau, the next storm of the season was also named FLORA.”

Day	Latitude	Longitude	Status
August 24	21N	94W	Tropical Depression?
August 25	23N	96W	Tropical Storm?
August 26	26N	97W	Tropical Storm?
August 27			Dissipated

3) October 21-24: Historical Weather Maps show a stationary front stretching from the eastern Gulf of Mexico into the north Atlantic on October 21st. A low pressure developed off the southeast coast of the United States on October 22nd and remained almost stationary during the next 24 hours. A ship reported 60 kt at 14Z on the 22nd. Synoptic data suggests that the low pressure retained its extratropical characteristics and the system dissipated on October 24th. Therefore, because the disturbance did not acquire tropical characteristics, it is not added to HURDAT. This disturbance was in Jack Beven's List of Suspects.

Day	Latitude	Longitude	Status
October 21	Off southeast of the United States		Stationary front
October 22	30N	79W	Extratropical
October 23	31N	77W	Extratropical
October 24			Dissipated

4) October 24-27: Historical Weather Maps show a cold front over the northeast Atlantic on October 24th and an extratropical cyclone developing on October 25th. Gale-force winds were observed on the 24th well away from the system's center. The disturbance moved westward on October 26th and became an occluded low. An approaching cold front caused the occluded cyclone to turn to the northeast and weaken on October 27th. The disturbance was absorbed on October 28th. Therefore, because it did not acquire tropical characteristics, it is not added to HURDAT. This disturbance was in Jack Beven's List of Suspects.

Day	Latitude	Longitude	Status
October 24	35N	38W	Cold front
October 25	37N	38W	Extratropical
October 26	38N	47W	Occluded
October 27	39N	41W	Occluded
October 28			Absorbed

5) October 28 – November 1: Historical Weather Maps indicate that a low pressure formed over the north-central Atlantic on October 28th. The disturbance moved generally to the northwest before merging on October 30th with a frontal boundary over the north Atlantic. COADS were obtained but produced no tropical storm force winds. Therefore, because no gale-force winds were found associated with this disturbance, it is not added to HURDAT. This disturbance was in Jack Beven and Ryan Truchelut's List of Suspects.

Day	Latitude	Longitude	Status
October 28	27N	45W	Tropical Depression?
October 29	30N	49W	Tropical Depression?
October 30	30N	49W	Merging with cold front
October 31	39N	40W	Extratropical
November 1	52N	28W	Extratropical

6) November 8-12: Historical Weather Maps show a trough over the eastern Atlantic on November 8th and 9th. The disturbance moved generally westward becoming better organized and a low pressure developed on November 10th. An approaching frontal system caused the disturbance to turn northwestward on November 11th becoming absorbed a day later. The COADS were obtained for this disturbance but no gale-force winds were found. Therefore, because the disturbance did not produce any observed tropical storm force winds, it is not added to HURDAT. This disturbance was in Jack Beven and David Roth's List of Suspects.

Day	Latitude	Longitude	Status
November 8	23N	35W	Trough
November 9	25N	39W	Trough
November 10	25N	44W	Tropical Depression?
November 11	30N	49W	Tropical Depression?
November 12			Absorbed

7) December 24-27: Historical Weather Maps show a frontal boundary over the western Atlantic. An extratropical cyclone developed on December 25th near the Bahamas producing gale-force winds and rapidly moved to the northeast maintaining its baroclinic characteristics. Therefore, because the system was likely not tropical or subtropical, it is not added to HURDAT. This disturbance was in Jack Beven's List of Suspects.

Day	Latitude	Longitude	Status
December 24	Western Atlantic		Cold front
December 25	25N	75W	Extratropical
December 26	31N	55W	Extratropical
December 27	39N	45W	Extratropical

1960 hurricane season

Unnamed Tropical Storm One [June 22-28, 1960]

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41425 06/22/1960 M= 8  1 SNBR= 901 NOT NAMED   XING=1 SSS=0
41425 06/22/1960 M= 7  1 SNBR= 901 NOT NAMED   XING=1 SSS=0
                    *

41430 06/22*  0   0   0    0*192 936  15    0*201 942  15    0*212 948  15 1008*
41430 06/22*  0   0   0    0*192 932  25    0*198 938  25    0*208 946  25    0*
                           ***  **      ***  ***  **      ***  ***  **    *

41435 06/23*223 953  20    0*235 958  25    0*247 963  35 1006*255 967  40    0*
41435 06/23*220 953  25    0*235 958  30    0*247 963  35 1006*255 967  40    0*
            ***      **                **

41440 06/24*263 970  40    0*273 973  35 1002*284 975  30    0*291 980  30    0*
41440 06/24*263 971  45    0*272 975  40 1000*282 979  35    0*290 982  30    0*
                ***  **      ***  ***  ** **** ***  ***  **      ***  ***

41445 06/25*292 988  30    0*286 990  25    0*283 984  25    0*289 979  25    0*
41445 06/25*292 984  30    0*287 985  25    0*283 984  25    0*287 982  25    0*
                ***           ***  ***                      ***  ***

41450 06/26*296 972  20    0*303 968  15    0*308 964  15    0*320 960  15    0*
41450 06/26*292 977  25    0*300 972  25    0*311 970  25    0*323 968  25    0*
            *** ***  **      ***  ***  **      ***  ***  **      ***  ***  **

41455 06/27*330 956  15    0*344 945  15    0*357 933  15    0*366 923  15    0*
41455 06/27*335 966  20    0*348 956  20    0*361 942  20    0*372 928  20    0*
            *** ***           ***  ***          ***  ***          ***  ***

41460 06/28*373 917  15    0*379 905  15    0*386 894  15    0*397 887  15    0*
41460 06/28*376 917  20    0*380 905  20    0*385 890  20    0*  0   0   0    0*
            ***           ***               ***  ***               *   *   *

(June 29th is removed from HURDAT)
41465 06/29*414 883  15    0*  0   0   0    0*  0   0   0    0*  0   0   0    0*
41465 06/29*  0   0   0    0*  0   0   0    0*  0   0   0    0*  0   0   0    0*
              *   *   *

41470 TS
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U.S. Tropical Storm Landfall

06/24 04Z 26.9N 97.4W 45 kt TX

Minor changes to the track and intensity shown in McAdie et al. (2009). Evidence for these alterations comes from the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Monthly Weather Review, Surface Weather Observations, Mariners Weather Log, Mexican surface maps, and NHC Storm Wallets.

June 21:

HWM analyzes a closed low pressure of at most 1010 mb at 20.0N, 94.5W at 12Z. HURDAT does not list an organized system on this date. Microfilm shows a closed

low pressure of at most 1008 mb at 18.5N, 93.5W at 12Z. Ship highlights: No gales or low pressures.

June 22:

HWM analyzes a spot low at 19.5N, 94.5W at 12Z. HURDAT lists a 15 knot tropical depression at 20.1N, 94.2W at 12Z. Microfilm shows a closed low pressure of at most 1008 mb at 19.0N, 94.2W at 12Z. Ship highlights: No gales or low pressures.

MWR: "A routine reconnaissance flight into the extreme southwestern Gulf of Mexico on June 22 found a large mass of weather including heavy thunderstorms and squally winds up to 35 kt. The lowest observed pressure along the reconnaissance track was 1008 mb with no circulation reported, although the Mexican coastal stations did indicate a slight circulation."

June 23:

HWM analyzes a closed low of at most 1005 mb at 24.0N, 96.0W at 12Z. HURDAT lists a 35 knot tropical storm at 24.7N, 96.3W at 12Z. Microfilm shows an elongated and closed low pressure of at most 1008 mb at 20.0N, 95.0W at 12Z. Ship highlights: Ship highlights: No gales or low pressures.

MWR: "On the morning of June 23 the 200-mb level had become more favorable for intensification and the barometer had fallen significantly along the Mexican coast from Tampico to Brownsville indicating a northerly drift of the disturbed condition. A Navy reconnaissance plane was dispatched to the area and found maximum winds of only 15 kt but sea level pressure of 1006 mb. However, it is believed the plane did not fly under the most severe weather."

June 24:

HWM analyzes a closed low of at most 1005 mb at 27.5N, 98.0W at 12Z. HURDAT lists a 30 knot tropical depression at 28.4N, 97.5W at 12Z. Microfilm shows a closed low pressure of at most 1008 mb at 28.5N, 97.8W at 12Z. Ship highlights: No gales or low pressures. Land highlights: 45 kt (gusts to 50 kt, max winds) at Padre Island Park, TX (no time given, likely early on the 24th) (WALLET). 35 kt (gusts to 50 kt, max winds) at Rockport, TX (no time given, likely early on the 24th) (WALLET). 34 kt (gusts to 45 kt, max winds) at Naval Base, TX (no time given) (WALLET). 27 kt SSE (gusts to 41 kt, max winds) and 1004 mb at Corpus Christi, TX at 0658Z (SWO). 12 kt SSW and 1002 mb (min pressure) at Kingsville, TX at 0758Z (SWO). 3 kt W and 1002 mb (min pressure) at Alice, TX at 0858Z (SWO). 15 kt SSE and 1004 kt (min pressure) at Beeville, TX at 1158Z (SWO). 15 kt N and 1004 mb (min pressure) at Cotulla, TX at 2258Z (SWO).

MWR: “During the night of June 23-24 the tropical storm moved inland, south and about 30 miles west of Corpus Christi, Texas. Rockport reported sustained winds of 40 mph with gusts to 60 and Padre Island Park 50 mph with gusts to 60. The lowest reported pressure was 1002.4 mb at Alice at 0300 CST on the 24th. Corpus Christi reported a tide of 3.5 ft above mean low water. It appears that there was no wall cloud. There was some mild curvature on the rain bands seen on airborne radar on the 23rd and the Dow Chemical Co. radar at Freeport near noon on the 23rd reported a characteristically curved rain band. Apparent cloud centers were reported by radars at Victoria and Kelly Air Force Base on several occasions. Three fishing piers were wrecked on Copano Bay; one shrimp boat sank with three lives lost, and another was beached.”

June 25:

HWM analyzes a weakening cold front over Texas at 12Z. Microfilm shows a closed low pressure of at most 1005 mb at 28.6N, 98.0W at 12Z. Ship highlights: Ship highlights: No gales or low pressures. Land highlights: 15 kt S and 1004 kt (min pressure) at Beeville, TX at 2058Z (SWO).

MWR: “The storm moved very slowly on June 24-25 attended by heavy rains of 5 to 15 inches or more from Corpus Christi to San Antonio and northeastward with considerable flooding. Port Lavaca reported 29.76 inches of rain for the period of 23-26.”

June 26:

HWM analyzes a closed low of at most 1010 mb at 30.5N, 96.5W at 12Z. HURDAT lists a 15 knot tropical depression at 30.8N, 96.4W at 12Z. Microfilm shows a closed low pressure of at most 1008 mb at 31.4N, 96.5W at 12Z. Ship highlights: No gales or low pressures.

MWR: “Tornadoes were reported on the 26th as the dying storms moved north-northeastward. Unusually heavy rains extended into Arkansas and southern Illinois. Fifteen persons apparently were drowned either in the high seas or subsequent floods. Damage, mostly from the floods, is estimated at $3,600,000.”

June 27:

HWM analyzes a closed low pressure of at most 1010 mb near 36.0N, 94.0W at 12Z. HURDAT lists a 15 knot tropical depression at 35.7N, 93.3W at 12Z. Microfilm shows a closed low pressure of at most 1011 mb at 36.0N, 93.5W at 12Z. Ship highlights: No gales or low pressures.

June 28:

HWM analyzes a weakening cold front across the central United States at 12Z. HURDAT lists a 15 knot tropical depression at 38.6N, 89.4W at 12Z. Microfilm shows a

closed low pressure of at most 1014 mb at 38.5N, 88.0W at 12Z. Ship highlights: No gales or low pressures.

June 29:

HWM and microfilm analyzes a cold front moving across the Midwest at 12Z. HURDAT does not list an organized system on this date. Ship highlights: No gales or low pressures.

A tropical wave reached the Bay of Campeche on June 20th and gradually became better organized. Although the data is scarce, coastal and ship observations indicate that the disturbance did not have a well-defined low level circulation on June 21st. Genesis is analyzed at 06Z on June 22nd as a tropical depression, same as originally shown in HURDAT. It is possible that genesis could have taken place six or twelve hours earlier. The tropical depression is initialized with an intensity of 25 kt, up from 15 kt originally in HURDAT, a minor intensity change. Minor alterations were made to the track of this tropical cyclone. The daily routine reconnaissance flight, pattern "ALPHA," into the southern Gulf of Mexico on the 22nd appears to have missed the tropical cyclone staying northeast of the center as indicated by the track of the reconnaissance aircraft. Since the aircraft did not make a center penetration, the 1008 mb in HURDAT at 18Z on the 22nd has been removed. The tropical depression moved generally to the northwest and no gales were observed by ships during its lifetime. Intensification to a tropical storm is analyzed at 12Z on June 23rd, same as originally shown in HURDAT. A central pressure of 1006 mb is present in HURDAT at 12Z on the 23rd and since it was measured by a Navy reconnaissance aircraft, it has been retained. The small tropical storm approached the coast of southern Texas late on the 23rd and early on the 24th. Sustained tropical storm force winds were recorded over portions of the coast and the highest was 45 kt at Padre Island Park, TX. An intensity of 45 kt is analyzed at 00Z on August 24th, up from 40 kt originally in HURDAT, a minor intensity change. 45 kt is the peak intensity of this tropical cyclone, up from 40 kt originally in HURDAT, a minor intensity change. Landfall occurred around 04Z on the 24th near 26.9N, 97.4W or about halfway between Brownsville and Corpus Christi as a 45 kt tropical storm. Kingsville, TX reported 12 kt SSW and 1002 mb at 0858Z on the 24th, suggesting a central pressure of 1000 mb, which has been added to HURDAT at 06Z on the 24th, replacing the existing 1002 mb. After landfall, the forward speed decreased rapidly and the tropical storm weakened to a tropical depression at 18Z on the 24th, six hours later than originally shown in HURDAT. Late on the 24th and on the 25th, the tropical depression performed a small counter-clockwise loop over south-central Texas resulting in very heavy rainfall for the area. Late on the 25th, the tropical depression turned to the northeast and increased in forward speed.

On August 26th, the tropical depression turned to the north-northeast over northeast Texas. A couple of ships were reporting winds up to 30 kt over the northwest Gulf of Mexico on the 26th but it seems that these winds were not associated with the circulation of this tropical cyclone. The intensities are boosted systematically on the 27th and 28th from 15 to 20th, as a system moving 10-15 kt and maintaining a closed circulation would have to have at least 20 kt max wind in the right front quadrant. Dissipation is analyzed after 12Z on June 28th over southern Illinois based on synoptic observations. The last position is analyzed at 12Z on the 28th, twelve hours earlier than originally shown in HURDAT.

Hurricane Abby [July 9-17, 1960]

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41475 07/10/1960 M= 7  2 SNBR= 902 ABBY        XING=0 SSS=0
41475 07/09/1960 M= 9  2 SNBR= 902 ABBY        XING=0 SSS=0
         **         *

(July 9th is new to HURDAT)
41480 07/09*  0   0   0    0*  0   0   0    0*120 558  40    0*125 570  40    0*
                                              *** ***  **      *** ***  **

41480 07/10*130 562  30    0*130 580  30    0*138 610  65    0*142 623  70    0*
41480 07/10*130 582  45    0*135 596  50    0*139 610  55 1003*141 623  55 1002*
                ***  **      *** ***  **      ***       ** **** ***       ** ****

41485 07/11*145 635  80    0*144 648  80    0*148 660  85    0*152 675  80    0*
41485 07/11*143 635  55    0*145 647  60    0*147 658  60  999*149 673  55 1004*
            ***      **      *** ***  **      *** ***  **  *** *** ***  ** ****

41490 07/12*149 690  70    0*147 705  70    0*147 720  75    0*150 732  75    0*
41490 07/12*149 689  50 1005*147 704  50 1005*147 719  50 1007*150 732  50    0*
                ***  ** ****     ***  ** ****     ***  ** ****           **

41495 07/13*152 743  75    0*151 755  65    0*148 768  50    0*147 781  40    0*
41495 07/13*152 743  50 1004*152 754  50    0*149 767  45 1008*147 781  45    0*
                     ** **** *** ***  **      *** ***  ** ****           **

41500 07/14*147 795  40    0*151 811  45    0*156 827  55    0*159 840  60    0*
41500 07/14*147 795  45 1004*151 810  50    0*156 825  55  999*159 839  55    0*
                     ** ****     ***  **          ***      ***     ***  **

41505 07/15*162 852  65    0*164 865  70    0*165 878  65    0*163 893  45    0*
41505 07/15*161 852  60  995*163 866  70    0*165 880  70    0*166 894  45    0*
            ***      **  *** *** ***              ***  **      *** ***

41510 07/16*165 906  30    0*173 916  25    0*180 925  25    0*180 937  25    0*
41510 07/16*168 906  30    0*171 916  30    0*175 927  30    0*180 940  30    0*
            ***              *** ***  **      *** ***  **          ***  **
(July 17th is new to HURDAT)
41513 07/17*185 955  30    0*192 970  30    0*200 985  30    0*  0   0   0    0*
            *** ***  **      *** ***  **      *** ***  **

41515 HR
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Tropical Storm Landfall

07/10 11Z 13.9N 60.9W 55 kt St. Lucia

Hurricane Landfall

07/15 06Z 16.3N 86.6W 70 kt Roatan, Honduras
07/15 14Z 16.5N 88.4W 70 kt Belize

Major changes to the track and intensity shown in McAdie et al. (2009). Evidence for these alterations comes from the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Monthly Weather Review, Navy reconnaissance book, Mariners Weather Log, Mexican synoptic maps and NHC Storm Wallets.

July 7:

HWM and microfilm do not show an organized system at 12Z. HURDAT does not list an organized system on this date. Ship highlights: No gales or low pressures.

ATSR: “Hurricane ABBY formed from an easterly wave, first located in the vicinity of 15N 45W at 1200Z on the 7th of July by ship reports and reconnaissance flight Delta.”

July 8:

HWM and microfilm do not show an organized system at 12Z. HURDAT does not list an organized system on this date. Ship highlights: No gales or low pressures.

July 9:

HWM analyzes a spot low at 12.0N, 56.5W at 12Z. Microfilm does not show an organized system at 12Z. HURDAT does not list an organized system on this date. Navy reconnaissance book lists the best track position at 13.1N, 56.7W at 12Z (first position). Ship highlights: 40 kt ESE and 1013 mb at 13.2N, 56.2W at 10Z (micro).

MWR: “The first indication of the disturbance which finally grew into hurricane Abby was received from a ship about 3.5º east of the island of Barbados, at 0500 EST on July 9. Showery weather was reported with east-southeast winds of near 40 kt. Some shower activity had been occurring in the Lesser Antilles, and 24-hour pressure changes were small but negative.” ATSR: “No further reports indicating the presence of this wave were received until 091000Z when the ship ADOLF LEONHARDT reported an east-southeast wind of Beaufort Force 8 to 9 and showers at 13.2N 56.2W. The initial intensification on the 9th and 10th was associated with the surface center moving under a southerly current

at 200 MB. The 200 MB charts for the 9th and 10th depicted a weak ridge east of the Lesser Antilles and a low just north of Puerto Rico."

July 10:

HWM analyzes a tropical storm of at most 1010 mb at 13.6N, 60.8W at 12Z. HURDAT lists a 65 knot hurricane at 13.8N, 61.0W at 12Z. Microfilm shows a closed low pressure of at most 1005 mb at 13.5N, 60.8W at 12Z. Navy reconnaissance book lists the best track position at 14.0N, 60.9W at 12Z. Ship highlights: 40 kt ENE and 1007 mb at 13.8N, 59.8W at 06Z (micro). Land highlights: 36 kt (gusts to 66 kt, max winds) at Martinique at 1115Z (WALLET). 48 kt ENE (gusts to 55 kt, max winds) at St. Lucia at 12Z (WALLET). Aircraft highlights: Penetration center fix estimated surface winds of 70 kt, an eye diameter of 6 nm and measured a central pressure of 1003 mb at 14.1N, 61.4W at 14Z (ATSR). Penetration center fix estimated surface winds of 70 kt, an eye diameter of 7 nm and measured a central pressure of 1003 mb at 13.9N, 62.2W at 1630Z (ATSR). Penetration center fix estimated surface winds of 50 kt and measured a central pressure of 1002 mb at 14.4N, 62.5W at 19Z (ATSR). Penetration center fix estimated surface winds of 75 kt and measured a central pressure of 1006 mb at 14.4N, 63.3W at 2258Z (ATSR).

MWR: "At 0100 est on the 10th, a report received from the SS Del Oro, located at 13.8ºN., 59.7ºW., with sea level pressure of 1007.6 mb and wind ENE 45 kt, indicated a strong easterly wave or a small vortex. A small center passed just to the north of Barbados during the next few hours. At 0800 EST July 10, an advisory was issued on tropical storm Abby, based on reports from the Leeward Islands and a few ships. The storm was moving toward the west-northwest and was forecast to reach hurricane intensity during the day. Reconnaissance aircraft were dispatched to the area and confirmed the existence of hurricane Abby by 1100 EST. Highest winds were estimated at 90-100 mph over a small area near the center. Gale warnings and a hurricane watch were ordered for the Virgin Islands and Puerto Rico and for the island of Hispaniola as the hurricane moved westward." ATSR: "On the 10th of July, the SS DEL ORO located 13.8N 59.7W reported a wind from 070 degrees of 40 knots and a pressure of 1007.6 MB at 0600Z. The island of Martinique reported gale force winds at 0830Z. A Navy reconnaissance flight, diverted from track Delta, reported spiral bands in the vicinity of St. Lucia Island at 1140Z and a radar eye over that island at 1300Z. The first official warning was issued at 101330Z. ABBY passed over St. Lucia Island with gale force winds and continued development to hurricane force as she moved into the Caribbean on a west-northwesterly heading. Deepening of the low, evident on the 10th, appeared to produce a speed divergence factor conducive to further intensification of the surface low. Later fluctuations in the strength of ABBY over the Caribbean appeared to be related to a 200 MB trough which extended into the northwestern Caribbean."

July 11:

HWM analyzes a hurricane of at most 1005 mb at 14.5N, 66.0W at 12Z. HURDAT lists a 85 knot hurricane at 14.8N, 66.0W at 12Z. Microfilm shows a closed low pressure of at most 1002 mb at 14.5N, 65.6W at 12Z. Navy reconnaissance book lists the best track position at 14.8N, 66.0W at 12Z. Ship highlights: 50 kt NE and 1005 mb at 14.4N, 64.9W at 06Z (COADS). 35 kt E and 1008 mb at 14.0N, 64.5W at 12Z (COADS). 40 kt E and 1014 mb at 15.7N, 68.3W at 18Z (COADS). 45 kt E and 1013 mb at 16.1N, 68.1W at 21Z (MWL). Aircraft highlights: Penetration center fix at 14.5N, 64.4W at 0345Z (ATSR). Radar center fix estimated an eye diameter of 9 nm at 14.6N, 64.8W at 0510Z (ATSR). Penetration center fix estimated surface winds of 85 kt, an eye diameter of 15 nm and measured a central pressure of 999 mb at 14.6N, 65.7W at 1223Z (ATSR). Penetration center fix estimated surface winds of 85 kt and measured a central pressure of 1004 mb at 14.9N, 67.3W at 18Z (ATSR).

MWR: “On July 11 and 12, the hurricane continued on a westerly course, with doubt concerning its intensity. From reconnaissance aircraft and surface ship reports, it appeared to be rather poorly organized and much of the time was barely discernible on aircraft radar. … Abby appeared to be fairly well organized when it first formed and moved into the extreme eastern Caribbean. Reconnaissance and surface reports, particularly on the 11th, 12th and 13th, indicated a very small circulation and a minimum of convective activity. This is possibly one reason for the loss of intensity. The area was covered with considerable stratified cloudiness, and radar coverage was difficult.” ATSR: “After reaching a maximum intensity of 86 knots at 1400Z on the 11th, ABBY fluctuated several times in intensity while passing through the Caribbean.”

July 12:

HWM analyzes a hurricane of at most 1005 mb at 14.5N, 72.0W at 12Z. HURDAT lists a 75 knot hurricane at 14.7N, 72.0W at 12Z. Microfilm shows a closed low pressure of at most 1011 mb at 14.3N, 72.2W at 12Z. Navy reconnaissance book lists the best track position at 14.7N, 72.0W at 12Z. Ship highlights: 47 kt E and 1014 mb at 16.5N, 67.7W at 00Z (MWL). Aircraft highlights: Penetration center fix estimated surface winds of 65 kt and measured a central pressure of 1005 mb at 14.9N, 69.0W at 01Z (ATSR). Penetration center fix measured a central pressure of 1005 mb at 15.0N, 69.9W at 0330Z (ATSR). Penetration center fix estimated surface winds of 65 kt, an eye diameter of 7 nm and measured a central pressure of 1005 mb at 14.8N, 69.6W at 05Z (ATSR). Penetration center fix estimated surface winds of 65 kt, an eye diameter of 7 nm and measured a central pressure of 1007 mb at 14.4N, 72.1W at 1256Z (ATSR). Penetration center fix at 14.9N, 73.0W at 1748Z (ATSR). Penetration center fix estimated surface winds of 70 kt,

an eye diameter of 10 nm and measured a central pressure of 1004 mb at 15.4N, 74.3W at 2350Z (ATSR).

ATSR: “At 120100Z, the maximum wind speed diminished to 65 knots then increased to 75 knots at 121600Z.”

July 13:

HWM analyzes a tropical storm of at most 1005 mb at 14.7N, 76.8W at 12Z. HURDAT lists a 50 knot tropical storm at 14.8N, 76.8W at 12Z. Microfilm shows a tropical wave or trough over the central Caribbean Sea at 12Z. Navy reconnaissance book lists the best track position at 14.9N, 76.8W at 12Z. Ship highlights: 35 kt E and 1011 mb at 14.6N, 72.8W at 00Z (COADS). 35 kt E at 16.2N, 75.2W at 06Z (micro). 40 kt SE at 16.5N, 76.1W at 12Z (micro). Aircraft highlights: Radar center fix at 15.3N, 74.4W at 01Z (ATSR). Radar center fix at 15.4N, 75.2W at 06Z (ATSR). Penetration center fix measured a central pressure of 1008 mb and estimated surface winds of 45 kt at 14.1N, 77.4W at 13Z (ATSR). Penetration center fix at 14.8N, 78.3W at 19Z (ATSR). Penetration center fix measured a central pressure of 1004 mb and estimated surface winds of 35 kt at 14.7N, 79.3W at 2346Z (ATSR).

MWR: “By the morning of the 13th, the hurricane had diminished in intensity with maximum winds estimated at 60 mph in a few squalls near the center in the northern semicircle.”

July 14:

HWM analyzes a tropical storm of at most 1005 mb at 15.4N, 82.5W at 12Z. HURDAT lists a 55 knot tropical storm at 15.6N, 82.7W at 12Z. Microfilm shows a closed low pressure of at most 1008 mb at 15.5N, 83.3W at 12Z. Navy reconnaissance book lists the best track position at 15.6N, 82.7W at 12Z. Ship highlights: 35 kt NE and 1005 mb at 15.3N, 79.5W at 00Z (micro). 35 kt ESE and 1013 mb at 17.0N, 77.1W at 03Z (MWL). Aircraft highlights: Penetration center fix measured a central pressure of 1008 mb and estimated an eye diameter of 20 nm at 15.2N, 81.5W at 07Z (ATSR). Penetration center fix measured a central pressure of 999 mb, estimated surface winds of 75 kt and an eye diameter of 7 nm at 15.6N, 82.6W at 1315Z (ATSR). Penetration center fix at 15.9N, 83.9W at 18Z (ATSR). Penetration center fix measured a central pressure of 1002 mb and estimated an eye diameter of 20 nm at 15.9N, 84.2W at 19Z (ATSR).

MWR: “By early morning of the 14th, the storm had intensified to hurricane strength with highest winds of 80 mph estimated by reconnaissance aircraft.” ATSR: “After diminishing to a low of 36 knots at 140000Z, the wind speed again increased to 76 knots at 142000Z while the storm center was passing just a few miles north of the Honduran

coast. This trough appeared to be fractured on the 140000Z chart as a portion of the trough moved eastward into Haiti. Rising 200 MB heights over the western Caribbean following this fracture were coincident with the reintensification of ABBY."

July 15:

HWM analyzes a hurricane of at most 1000 mb at 16.3N, 87.8W at 12Z. HURDAT lists a 65 knot hurricane at 16.5N, 87.8W at 12Z. Microfilm shows a closed low pressure of at most 1008 mb at 16.5N, 87.8W at 12Z. Navy reconnaissance book lists the best track position at 16.5N, 88.0W at 12Z. Ship highlights: 35 kt SE and 1008 mb at 16.4N, 87.4W at 12Z (COADS). Land highlights: 45 kt NE at Guanaja Island, Honduras at 02Z (WALLET). Aircraft highlights: Penetration center fix measured a central pressure of 995 mb, estimated surface winds of 55 kt, and an eye diameter of 15 nm at 16.1N, 85.4W at 01Z (ATSR). Radar center fix at 16.5N, 88.3W at 1324Z (ATSR). Radar center fix estimated surface winds of 55 kt and an eye diameter of 20 nm at 16.5N, 88.8W at 15Z (ATSR).

MWR: "The hurricane retained this strength but remained quite small in size as it skirted along the northern coast of Honduras, passing inland in extreme southern British Honduras early on the morning of the 15th. Advisories were discontinued after the cyclone moved inland. No loss of life has been reported in Central America. Property damage in British Honduras was light but damage to crops was quite heavy." ATSR: "ABBY passed inland over British Honduras on the 15th of July at near hurricane intensity and finally dissipated over southern Mexico."

July 16:

HWM analyzes a tropical storm at 16.5N, 92.5W at 12Z. HURDAT lists a 25 knot tropical depression at 18.0N, 92.5W at 12Z. Microfilm shows a closed low pressure of at most 1005 mb at 18.0N, 93.0W at 12Z. Navy reconnaissance book lists the best track position at 17.6N, 92.5W at 12Z (last position). Ship highlights: 40 kt and 1004 mb at 16.3N, 87.5W at 00Z (WALLET). Land highlights: 10 kt NE and 1005 mb at Villahermosa, Mexico at 12Z (micro).

MWR: "Considerable rain occurred in Central America from Honduras north-northwestward into most of southern Mexico and the Gulf of Campeche as the remnants of Abby continued west-northwestward over the land area. Reconnaissance aircraft in the southwestern Gulf of Mexico on the 16th confirmed that the radar center of circulation did not emerge over the Gulf of Campeche but remained over the rugged terrain of the Isthmus of Tehuantepec."

July 17:

HWM analyzes a spot low south of the Gulf of Tehuantepec in the eastern Pacific at 12Z. HURDAT does not list an organized system on this date. Microfilm shows a trough of low pressure of at most 1008 mb from central Mexico to western Guatemala at 12Z. Ship highlights: No gales or low pressures.

MWR: “Some remnants of Abby apparently continued across southern Mexico and developed into hurricane Celeste off the west coast.” ATSR: “It was noted that the movement of the trough remnant from ABBY into the Pacific appeared to influence the propagation of a hurricane off the west coast of Mexico. The interesting succession of storms from the Caribbean into the Pacific has been observed over several occasions.”

Date	Original HURDAT Central Pressure	Evidence	Changes
July 10 12Z		Penetration center fix: 1003 mb at 14Z on July 10th	1003 mb
July 10 18Z		Penetration center fix: 1002 mb at 19Z on July 10th	1002 mb
July 11 12Z		Penetration center fix: 999 mb at 1223Z on July 11th	999 mb
July 11 18Z		Penetration center fix: 1004 mb at 18Z on July 11th	1004 mb
July 12 00Z		Penetration center fix: 1005 mb at 01Z on July 12th	1005 mb
July 12 06Z		Penetration center fix: 1005 mb at 05Z on July 12th	1005 mb
July 12 12Z		Penetration center fix: 1007 mb at 12Z on July 12th	1007 mb
July 13 00Z		Penetration center fix: 1004 mb at 2350Z on July 12th	1004 mb
July 14 00Z		Penetration center fix: 1004 mb at 2346Z on July 13th	1004 mb
July 14 12Z		Penetration center fix: 999 mb at 1315Z on July 14th	999 mb
July 15 00Z		Penetration center fix: 995 mb at 01Z on July 15th	995 mb

A tropical wave left the African coast early in July and moved generally westward approaching the Lesser Antilles about a week later. Data over the central Atlantic is

scarce, which makes the exact time of genesis uncertain. Peripheral data early on July 9th indicate that a well-defined circulation may have already been present and the first position is analyzed at 12Z on the 9th as a 40 kt tropical storm based on a ship report of 40 kt ESE at 10Z about 60 nm north of the center. The first position is analyzed twelve hours earlier than originally shown in HURDAT. Intensification to a tropical storm is analyzed 24 hours earlier than originally shown in HURDAT, although HURDAT never showed a tropical storm stage as the intensity was increased from 30 kt at 06Z on July 10th to 65 kt at 12Z on the 10th. Minor alterations are made to the track of this tropical cyclone, except for a major change on July 10th at 00Z, two degrees to the west. The first reconnaissance aircraft to reach the center of Abby occurred at 14Z on the 10th measuring a central pressure of 1003 mb, estimating surface winds of 70 kt and an eye diameter of 7 nm. A central pressure of 1003 mb suggests maximum sustained winds of 41 kt south of 25N from the Brown et al. pressure-wind relationship. An eye diameter of 7 nm suggests an RMW of about 5 nm and the climatological value is 12 nm. Based on a forward speed of about 13 kt, an RMW smaller than normal and a visual estimate of 70 kt, an intensity of 55 kt is selected at 12Z on the 10th, down from 65 kt originally in HURDAT, a minor intensity change. A major intensity change is analyzed at 06Z on the 10th. HURDAT originally had 30 kt and the analyzed intensity is 50 kt. Around 11Z on the 10th, the center of Abby made landfall in the island of St. Lucia where sustained winds of 48 kt were measured with gusts to 55 kt. In the nearby island of Martinique, the maximum sustained winds were 36 kt with gusts to 66 kt. Late on the 10th, Abby entered the eastern Caribbean Sea and continued to move generally westward. A reconnaissance aircraft measured a central pressure of 999 mb, estimated surface winds of 85 kt and an eye diameter of 15 nm at 1223Z on July 11th. A central pressure of 999 mb suggests maximum sustained winds of 49 kt south of 25N from the pressure-wind relationship. An eye diameter of 15 nm suggests an RMW of about 12 nm and the climatological value is 13 nm. Based on a forward speed of about 12 kt, an RMW close to climatology and a visual estimate of 85 kt, an intensity of 60 kt is selected at 12Z on the 11th, down from 85 kt originally in HURDAT, a major intensity change. Later at 18Z on the 11th, a penetration center fix measured a central pressure of 1004 mb and estimated surface winds of 85 kt. A central pressure of 1004 mb suggests maximum sustained winds of 39 kt south of 25N from the pressure-wind relationship. Based on a forward speed of about 12 kt and a visual estimate of 85 kt, an intensity of 55 kt is selected at 18Z on the 11th, down from 80 kt originally in HURDAT, a major intensity change. Major intensity changes are also analyzed at 00Z and 06Z on the 11th. HURDAT originally showed 80 kt at these times and the analyzed intensities are 55 kt and 60 kt, respectively. The tropical storm continued westward on July 12th passing well south of Hispaniola. A reconnaissance aircraft reported a central pressure of 1005 mb and estimated surface winds of 65 kt at 01Z on the 12th. A central pressure of 1005 mb suggests maximum

sustained winds of 37 kt south of 25N from the pressure-wind relationship. Based on a forward speed of about 15 kt and a visual estimate of 65 kt, an intensity of 50 kt is selected at 00Z on the 12th, down from 70 kt originally in HURDAT, a major intensity change. Major changes in intensity are also analyzed at 06Z, 12Z and 18Z on the 12th. HURDAT originally showed 70 kt at 06Z, and 75 kt at 12Z and 18Z, and the analyzed intensity is 50 kt for these times. A reconnaissance aircraft reported a central pressure of 1004 mb, estimated surface winds of 70 kt and an eye diameter of 10 nm at 2350Z on the 12th. A central pressure of 1004 mb suggests maximum sustained winds of 39 kt south of 25N from the pressure-wind relationship. An eye diameter of 10 nm suggests an RMW of about 8 nm and the climatological value is 14 nm. Based on a forward speed of about 12 kt, small size of the tropical cyclone, and visual estimate of 70 kt, an intensity of 50 kt is selected at 00Z on the 12th, down from 75 kt originally in HURDAT, a major intensity change. A ship reported 80 kt at 03Z on July 13th but this appears to have a high bias based on the central pressure measured by the reconnaissance aircraft a couple of hours earlier and location of the ship. A penetration center fix reported a central pressure of 1008 mb at 13Z on the 13th but based on the center fix location, likely it was not a central pressure and therefore, not added to HURDAT. Obviously there is a significant spread in the pressure-wind derived intensity and that visually estimate by the aircraft reconnaissance crew. The revised intensities from the 10th to the 13th represent a blend of these topping out at 60 kt at 06Z and 12Z on the 11th. However, it is quite possible that the system was a minimal hurricane during part of the dates.

On July 14th, Abby began to gain in latitude as it approached Central America. A reconnaissance aircraft reported a central pressure of 1004 mb and estimated surface winds of 35 kt at 2346Z on the 13th. A central pressure of 1004 mb suggests maximum sustained winds of 39 kt south of 25N from the pressure-wind relationship. Based on a forward speed of about 14 kt and a visual estimate of 35 kt, an intensity of 45 kt is selected at 00Z on the 14th, up from 40 kt originally in HURDAT, a minor intensity change. Another reconnaissance aircraft reached Abby at 1315Z on the 14th measuring a central pressure of 999 mb, estimating surface winds of 75 kt and an eye diameter of 7 nm. A central pressure of 999 mb suggests maximum sustained winds of 49 kt south of 25N from the pressure-wind relationship. An eye diameter of 7 nm suggests an RMW of about 5 nm and the climatological value of 13 nm. Based on a forward speed of about 15 kt, an RMW smaller than normal and a visual estimate of 75 kt, an intensity of 55 kt is selected at 12Z on the 14th, same as originally shown in HURDAT. Late on the 14th and early on the 15th, the center of Abby passed very close to the northeast coast of Honduras. A penetration center fix at 01Z on the 15th measured a central pressure of 995 mb, estimated surface winds of 55 kt and an eye diameter of 15 nm. A central pressure of 995 mb suggests maximum sustained winds of 56 kt south of 25N from the pressure-wind relationship. An eye diameter of 15 nm suggests an RMW of about 12 nm and the

climatological value is 12 nm. Since Abby was moving at about 14 kt, the RMW was near the climatological value and the visual estimate was 55 kt, an intensity of 60 kt is selected at 00Z on the 15th, down from 65 kt originally in HURDAT, a minor intensity change. Intensification to a hurricane is analyzed at 06Z on the 15th, nearly five days later than originally shown in HURDAT.

Abby made landfall in the island of Roatan, Honduras as a 70 kt hurricane at 06Z and later at 14Z made another landfall as a 70 kt hurricane in southern British Honduras (today the country of Belize). MWR provides a radar image of the hurricane making landfall in British Honduras showing a small but well-formed cyclone with a closed eye. Abby weakened rapidly over mountains of Guatemala and southern Mexico. Weakening to a tropical storm is analyzed at 18Z on the 15th and to a tropical depression at 00Z on the 16th, same as originally shown in HURDAT. Surface observations over southern Mexico and Bay of Campeche indicate that the circulation of Abby remained inland on the 16th and this was corroborated by a reconnaissance aircraft mission. Nevertheless, the system was still producing 30 kt winds and it is retained as a tropical depression until 12Z on the 17th, eighteen hours later than originally shown in HURDAT. Abby is analyzed to have dissipated after 12Z on the 17th over the mountains of central Mexico. A recent analog to Abby over the eastern Caribbean Sea is Hurricane Lili, 2002, which reached 60 kt with a central pressure of 1004 mb.

Tropical Storm Brenda [July 27-31, 1960]

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41520 07/28/1960 M= 5  3 SNBR= 903 BRENDA      XING=1 SSS=0
41520 07/27/1960 M= 5  3 SNBR= 903 BRENDA      XING=1 SSS=0
         **
(July 27th is new to HURDAT)
41525 07/27*  0   0   0    0*  0   0   0    0*  0   0   0    0*277 851  30    0*
                                                  *** ***  **

41525 07/28*  0   0   0    0*  0   0   0    0*  0   0   0    0*270 860  30    0*
41525 07/28*274 855  30    0*274 854  30    0*276 853  35    0*278 853  35    0*
           *** ***  **      *** ***  **      *** ***  **      *** ***  **

41530 07/29*290 834  30    0*303 825  30    0*315 815  45    0*329 797  45    0*
41530 07/29*285 850  35    0*297 835  35    0*315 818  50 1000*328 797  55  993*
           *** ***  **      *** ***  **      *** ***  ** **** ***      **  ***

41535 07/30*346 780  50    0*370 763  45    0*395 748  45    0*416 730  45    0*
41535 07/30E346 779  55  994E370 765  50  993E387 753  50  992E405 738  50  991*
          **** ***  **  ******* ***  **  ******* ***  **  ******* ***  **  ***

41540 07/31*439 711  40    0E470 698  35    0E505 690  30    0E541 690  30    0*
41540 07/31E430 715  40  991E460 693  35  992*  0   0   0    0*  0   0   0    0*
           *** ***      *** *** ***  **  ***   *   *   *        *   *   *

(August 1st has been removed from HURDAT)
41545 08/01E578 689  30    0*  0   0   0    0*  0   0   0    0*  0   0   0    0*
41545 08/01*  0   0   0    0*  0   0   0    0*  0   0   0    0*  0   0   0    0*
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41550 TS

U.S. Tropical Storm Landfall

07/29 06Z 29.7N 83.5W 35 kt FL
07/29 21Z 33.9N 78.2W 55 kt NC

Minor changes to the track and intensity shown in McAdie et al. (2009). Evidence for these alterations comes from the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Monthly Weather Review, Navy reconnaissance book, Surface Weather Observations, Local Climatological Data, Mariners Weather Log, and NHC Storm Wallets. Major changes are to indicate genesis 24 hours earlier and extratropical transition 30 hours earlier than originally shown in HURDAT.

July 26:

HWM analyzes a spot low at 27.0N, 85.0W at 12Z. HURDAT does not list an organized system on this date. Microfilm does not show an organized system at 12Z. Ship highlights: No gales or low pressures.

ATSR: “Tropical Storm BRENDA developed slowly in the Gulf of Mexico from a somewhat complex synoptic situation. The formation of a weak, diffuse surface low was noted about 180 miles west of Fort Myers on the 26th of July. At the 500 MB level on the same date, a well-defined, easterly trough was approaching a weaker, quasi-stationary trough oriented from east to west and crossing southern Florida. From the 26th through the 30th of July, the surface low deepened very slowly while under the southeastern quadrant of a 200 MB high cell.”

July 27:

HWM analyzes a spot low at 27.0N, 86.0W at 12Z. HURDAT does not list an organized system on this date. Microfilm shows a closed low pressure of at most 1011 mb at 27.0N, 85.0W at 12Z. Ship highlights: No gales or low pressures.

MWR: “A weak cyclonic circulation that can be traced back to a position just off the southwestern Florida coast on July 27 began to deepen some 150 miles west of Tampa Bay area the next day.”

July 28:

HWM analyzes a closed low pressure of at most 1010 mb at 27.0N, 85.5W at 12Z. HURDAT lists a 30 knot tropical depression at 27.0N, 86.0W at 18Z (first position).

Microfilm shows a closed low pressure of at most 1008 mb at 28.5N, 85.0W at 12Z. Navy reconnaissance book lists the best track position at 27.3N, 85.5W at 12Z (first position). Ship highlights: 35 kt SW at 26.5N, 83.2W at 18Z (micro). Aircraft highlight: Radar center fix estimated surface winds of 40 kt at 27.5N, 85.5W at 14Z (ATSR/micro). Penetration center fix measured a minimum pressure of 1007 mb and estimated surface winds of 35 kt at 27.8N, 85.3W at 19Z (ATSR).

July 29:

HWM analyzes a tropical storm of at most 1005 mb at 31.2N, 81.2W at 12Z. HURDAT lists a 45 knot tropical storm at 31.5N, 81.5W at 12Z. Microfilm shows a closed low pressure of at most 999 mb at 31.3N, 81.8W at 12Z. Navy reconnaissance book lists the best track position at 31.5N, 81.5W at 12Z. Ship highlights: 35 kt SW and 1006 mb at 26.9N, 83.3W at 00Z (micro). 45 kt SW and 1007 mb at 31.5N, 80.0W at 12Z (COADS). 55 kt SW and 1007 mb at 30.1N, 79.3W at 13Z (COADS). 55 kt SW and 1002 mb at 31.7N, 78.5W at 18Z (COADS). Land highlights: 35 kt (max wind) W and 1011 mb at Dry Tortugas Light, FL at 00Z (micro). 8 kt SSE and 1003 mb (min pressure) at Gainesville, FL at 0558Z (SWO). 18 kt S and 1002 mb (min pressure) at Brunswick, GA at 1058Z (SWO). 12 kt NNE and 1001 mb (min pressure) at Hunter AFB, GA at 1459Z (SWO). 10 kt SSW and 997 mb (min pressure) at Myrtle Beach, FL at 2057Z (SWO). 15 kt S and 996 mb (min pressure) at Wilmington, NC at 2359Z (SWO). Aircraft highlights: Penetration center fix estimated surface winds of 45 kt at 32.6N, 80.0W at 17Z (ATSR). Penetration center fix measured a central pressure of 993 mb at 33.1N, 79.1W at 20Z (ATSR).

MWR: “By the night of July 28, pressure had dropped to near 1000 mb as the Low began accelerating and moving northeastward onto the Florida coast southwest of Cross City. Thereafter the storm continued with gradually accelerating speed along the Carolina coasts on July 29th, through the mid-Atlantic States on the 30th, finally passing through the New England States on the 31st and dissipating over southeastern Canada. The storm was not officially named until the 29th when reconnaissance aircraft indicated tropical storm structure. Earlier aircraft and surface reports indicated rather light winds over an area within 50 to 100 miles of the lowest pressure. A tropical storm is usually associated with a zone of concentrated winds near the center, but not until the Low began accelerating northeastward and had reached the coastal area of the Carolinas was this type of pattern apparent. Wind gusts in squalls to 60 mph were reported from many locations along the Atlantic coast and the central portion of the Florida Gulf coast. A gust of 65 mph was reported at Cape Cod Canal, however, the highest sustained wind at an official Weather Bureau station was 58 mph at Cape Hatteras. The storm had no opportunity to reach hurricane force as the track was mostly over land after making

landfall on the Florida coast." ATSR: "On the morning of the 29th of July, this low accelerated rapidly while moving northeastward along the Georgia and South Carolina coast. Under the influence of southwesterly flow at the 200 MB level, further intensification on the day of the 29th and continued through the morning of the 30th. The first warning on BRENDA was issued at 292000Z shortly after a Navy reconnaissance aircraft reported evidence of a tropical storm structure."

July 30:

HWM analyzes a tropical storm of at most 995 mb at 38.9N, 75.5W at 12Z. HURDAT lists a 45 knot tropical storm at 39.5N, 74.8W at 12Z. Microfilm shows a closed low pressure of at most 993 mb at 38.5N, 75.0W at 12Z. Navy reconnaissance book lists the best track position at 39.5N, 74.8W at 12Z. Ship highlights: 45 kt S and 1008 mb at 30.3N, 77.4W at 00Z (COADS). 50 kt SE and 1001 mb at 35.6N, 74.7W at 06Z (COADS). 45 kt S and 997 mb at 37.6N, 75.4W at 09Z (COADS). 50 kt SE and 1000 mb at 39.3N, 74.2W at 12Z (COADS). 50 kt W and 1002 mb at 38.6N, 74.1W at 18Z (COADS). Land highlight: 50 kt (max winds) and 1000 mb (min pressure) at Hatteras, NC (time unknown, likely early on the 30th) (CLIMO/MWR). 20 kt S and 996 mb at Cherry Point, NC at 01Z (SWO). 15 kt SE and 995 mb at Langley AFB, VA at 0555Z (SWO). 11 kt SSW and 994 mb at Salisbury, MD at 1159Z (SWO). 46 kt SE (gusts to 55 kt, max winds) at New York Shoals, NY at 1559Z (SWO). 10 kt NW and 993 mb at Belmar, NJ at 1758Z (SWO). 35 kt SSE (gusts to 42 kt, max winds) and 998 mb (min winds) at Block Island, RI at 18Z (SWO). 5 kt SW and 993 mb (min pressure) at Worcester, MA at 2358Z (SWO). 36 kt (max winds) and 993 mb (min pressure) at Middletown, CT (time unknown, likely late on the 30th) (CLIMO). Aircraft highlights: Penetration center fix at 34.6N, 77.7W at 00Z (ATSR).

ATSR: "BRENDA continued to move on a northeasterly heading and passed inland near Cape Fear, North Carolina with maximum winds of near 50 knots. On moving rapidly northward, under the steering influence of an approaching westerly trough, BRENDA became extra-tropical. The last warning was issued at 302200Z." CLIMO Hatteras: "Tropical Storm Brenda occurring on the 29th and 30th produced a total rainfall of 2.30 inches. Peak gust during this storm was 60 mph. No reported damage to boats or buildings."

July 31:

HWM analyzes a large extratropical cyclone over eastern Canada at 12Z. HURDAT lists a 30 knot extratropical depression at 50.5N, 69.0W at 12Z. Microfilm shows an extratropical cyclone at 50.5N, 69.0W at 12Z. Navy reconnaissance book lists the best track position at 45.8N, 70.8W at 04Z (last position). Ship highlights: 40 kt NE

and 1004 mb at 48.4N, 69.6W at 00Z (COADS). 35 kt WSW and 1006 mb at 43.0N, 68.3W at 12Z (COADS). Land highlights: 35 kt SW (gusts to 45 kt, max winds) at Martha's Vineyard, MA at 00Z (SWO). 38 kt SW (max winds) at Nantucket Shoals, MA at 0258Z (SWO). 10 kt S and 994 mb (min pressure) at Houlton, ME at 0558Z (SWO).

August 1:

HWM analyzes an extratropical cyclone at 62.0N, 71.0W at 12Z. HURDAT lists a 30 knot extratropical depression at 57.8N, 68.9W at 00Z (last position). Microfilm shows an extratropical cyclone at 62.5N, 75.0W at 12Z. Ship highlights: No gales or low pressures.

Date	Original HURDAT Central Pressure	Evidence	Changes
July 29 12Z		Land: 12 kt SSW and 1002 mb at Brunswick, GA at 1158Z on July 29th	1000 mb
July 29 18Z		Penetration center fix: 993 mb at 20Z on July 30th	993 mb
July 30 00Z		Land: 15 kt S and 996 mb at Wilmington, NC at 2359Z on July 29th	994 mb
July 30 06Z		Land: 15 kt SE and 995 mb at Landley AFB, VA at 0555Z on July 30th	993 mb
July 30 12Z		Land: 11 kt SSW and 994 mb at Salisbury, MD at 1159Z on July 30th	992 mb
July 30 18Z		Land: 10 kt NW and 993 mb at Belmar, NJ at 1758Z on July 30th	991 mb
July 31 00Z		Land: 5 kt SW and 993 mb at Worcester, MA at 2358Z on July 30th	991 mb
July 31 06Z		Land: 10 kt S and 994 mb at Houlton, ME at 0558Z on July 31st	992 mb

A broad area of low pressure developed over the eastern Gulf of Mexico around July 26th. The disturbance remained almost stationary over the next 48 hours as it slowly became better organized. Synoptic data late on the 27th indicates that a well-defined circulation was present and genesis is analyzed at 18Z on the 27th, 24 hours earlier than originally shown in HURDAT. The tropical depression retained a large circulation embedded within a moist environment. The strongest winds were generally located in the southeast quadrant, about 100-200 nm from the center. This suggests that the cyclone

likely had subtropical characteristics, but without satellite images, it is not possible to assess. On July 28th at 12Z, the microfilm map indicates that a reconnaissance aircraft estimated surface winds of 40 kt about 120 nm south of the center. Nearby surface observations show a ship report of 30 kt. A blend of these data is used to select an intensity of 35 kt at 12Z on the 28th. Intensification to a tropical storm is analyzed 24 hours earlier than originally shown in HURDAT. A couple of ships reported 35 kt at 18Z on the 28th. A reconnaissance aircraft made a center fix at 19Z on the 28th estimating surface winds of 35 kt and a minimum pressure of 1007 mb. The aircraft did not make a penetration fix, thus the minimum pressure is not a central pressure and not added to HURDAT. On July 29th, Brenda began to accelerate to the northeast making landfall in the Big Bend of Florida as a 35 kt tropical storm around 06Z. No tropical storm force winds were reported along the Gulf coast of Florida on the 29th, as the strongest winds were 30 kt at Tampa and 32 kt at Fort Myers. The tropical storm quickly crossed the Florida peninsula and straddled the Georgia to North Carolina coast during the remainder of the 29th. Despite the center of tropical cyclone remaining near the coast, the system gained in strength according to multiple ship observations of gale-force winds up to 55 kt. A reconnaissance aircraft measured a central pressure of 993 mb at 20Z on the 29th with the center just offshore. A central pressure of 993 mb suggests maximum surface winds of 55 kt north of 25N from the Brown et al. pressure-wind relationship. An intensity of 55 kt is selected at 18Z on the 29th, up from 45 kt originally in HURDAT, a minor intensity change. 55 kt is also the peak intensity of Brenda, up from 50 kt originally in HURDAT, a minor intensity change. There was a discrepancy between the reconnaissance center fixes around 23Z and the surface observations at 21Z on the 29th, possibly indicating that the circulation was tilted to the south with height.

Synoptic data late on the 29th indicates that Brenda was beginning to acquire extratropical characteristics with an elongated circulation on the northeast side, but the dew points around the cyclone showed little or no gradient. The center of Brenda moved briefly over the Atlantic Ocean around 18Z on the 29th and the storm made another landfall in southern North Carolina, near 33.9N, 78.2W around 21Z, as a 55 kt tropical storm. Transition to an extratropical cyclone is analyzed at 00Z on July 30th, 30 hours earlier than originally shown in HURDAT. Synoptic data clearly shows the development of frontal features and a significant gradient in the dew points between the western and eastern quadrant at that time. Early on the 30th, Cape Hatteras, NC experienced sustained winds of about 50 kt according to the Local Climatological Data and Monthly Weather Review. These were the strongest winds measured on land due to Brenda. The extratropical cyclone moved rapidly along the eastern coast of the United States affecting the Mid-Atlantic around midday on the 30th and reaching New England late in the day. Early on July 31st, the extratropical cyclone began to interact with another extratropical cyclone over eastern Canada and synoptic data suggests that both had merged by 12Z.

The merged cyclone then prescribed a slow loop over the next few days over Canada. The last position is analyzed at 06Z on the 31st, eighteen hours earlier than originally shown in HURDAT.

Hurricane Cleo [August 17-21, 1960]

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41555 08/17/1960 M= 5  4 SNBR= 904 CLEO        XING=0 SSS=0

41560 08/17*  0   0   0    0*  0   0   0    0*  0   0   0    0*244 755  35    0*
41560 08/17*  0   0   0    0*  0   0   0    0*  0   0   0    0*260 747  25    0*
                                                    *** ***  **

41565 08/18*251 745  40    0*259 734  55    0*267 727  60    0*278 718  65    0*
41565 08/18*255 743  30    0*257 735  45    0*266 727  60  997*278 718  65    0*
           *** ***  **      *** ***  **      ***           ***

41570 08/19*293 710  70    0*310 702  75    0*331 694  75    0*354 686  75    0*
41570 08/19*293 710  70    0*310 702  75    0*331 694  75  999*354 686  75  995*
                                                  ***                     ***

41575 08/20*377 678  80    0*400 668  80    0*422 654  60    0*436 634  55    0*
41575 08/20*377 678  80    0*400 668  80    0*422 652  60    0*436 634  45    0*
                                        ***                          **

41580 08/21*442 605  35    0*444 580  30    0*  0   0   0    0*  0   0   0    0*
41580 08/21*442 605  35    0*  0   0   0    0*  0   0   0    0*  0   0   0    0*
                           *   *   *

41585 HR
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Minor changes to the track and intensity shown in McAdie et al. (2009). Evidence for these alterations comes from the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Monthly Weather Review, Navy reconnaissance book, Mariners Weather Log, and NHC Storm Wallets.

August 16:

HWM analyzes a spot low at 24.0N, 73.0W at 12Z. HURDAT does not list an organized system on this date. Microfilm does not show an organized system at 12Z. Ship highlights: No gales or low pressures.

ATSR: “Developing later into a small, but relatively intense hurricane, CLEO originated in the southeastern Bahama Islands within a broad trough resulting from the juncture of an easterly wave and a trailing polar trough. As early as 1200Z on the 16th of August, considerable precipitation was noted throughout western Cuba and the Bahamas associated with an easterly wave located over eastern Cuba. This easterly wave was well defined at both the 700 and 500 MB levels. At the same time, a long wave was noted aloft extending from northern Florida off the southeastern United States seaboard.”

August 17:

HWM analyzes a spot low at 27.5N, 74.0W with a weakening front to the north at 12Z. HURDAT lists a 35 knot tropical storm at 24.4N, 75.5W at 18Z (first position). Microfilm shows a trough over the central Bahamas at 12Z. Ship highlights: No gales or low pressures.

ATSR: “By 170000Z, a closed low at both the 700 and 500 MB levels was centered in vicinity of central Cuba. At 171800Z, this low was located at the surface over the central Bahamas with another small low in the same trough about 240 miles to the north-northeast. CLEO developed from the southernmost of these two lows.”

August 18:

HWM analyzes a tropical storm of at most 1010 mb at 26.7N, 72.5W and a closed low pressure of at most 1010 mb at 29.0N, 74.5W at 12Z. HURDAT lists a 60 knot tropical storm at 26.7N, 72.7W at 12Z. Microfilm shows a closed low pressure of at most 1011 mb at 26.8N, 72.5W at 12Z. Navy reconnaissance book lists the best track position at 26.7N, 72.7W at 12Z. Ship highlights: 40 kt ENE and 1002 mb at 27.0N, 72.6W at 13Z (COADS). 45 kt NW and 1009 mb at 27.1N, 72.5W at 14Z (COADS). 40 kt SSW and 1006 mb at 26.0N, 69.9W at 16Z (micro). Aircraft highlights: Penetration center fix estimated surface winds of 75 kt and an eye diameter of 7 nm, and measured a central pressure of 997 mb at 27.2N, 72.4W at 1430Z (ATSR). Penetration center fix at 28.8N, 71.2W at 2245Z (ATSR).

MWR: “Hurricane Cleo formed in a broad area of squally weather some 350 miles northeast of Nassau, Bahamas, on August 18. From surface considerations, the formation was unique in that a marked trough with at least one circulation center present to the north of the area of formation. Thus, Cleo's development did not conform to the normal increasing easterlies and cyclonic vorticity in the north portion of the trough which usually accompany tropical cyclone development.” ATSR: “The first report indicated that CLEO had intensified to tropical storm intensity was in 181300Z observation received from the SS CHICAGO at 27.0N 72.6W: “wind from 070 degrees 40 knots, pressure 1002.0 MB, rough sea, confused swell, barometer falling straight.” At almost the same time (181300Z), a Navy reconnaissance aircraft which was enroute to investigate reported a radar eye located at 26.5N 71.4W. The first warning on CLEO was released at 181600Z.”

August 19:

HWM analyzes a hurricane of at most 1005 mb at 32.9N, 69.0W at 12Z. HURDAT lists a 75 knot hurricane at 33.1N, 69.4W at 12Z. Microfilm shows a separate

closed low pressure of at most 1008 mb at 39.5N, 72.5W with a trough extending south at 12Z. Navy reconnaissance book lists the best track position at 33.1N, 69.4W at 12Z. Ship highlights: 40 kt S and 1004 mb at 29.7N, 70.6W at 00Z (micro). 45 kt S and 1004 mb at 29.5N, 70.6W at 03Z (micro). Aircraft highlights: Penetration center fix estimated an eye diameter of 14 nm at 29.3N, 71.1W at 00Z (ATSR). Radar center fix at 31.0N, 70.2W at 06Z (ATSR). Penetration center fix measured a central pressure of 999 mb at 33.3N, 69.2W at 13Z (ATSR/WALLET). Reconnaissance aircraft estimated surface winds of 96 kt at 16Z (WALLET). Penetration center fix measured a central pressure of 995 mb at 35.7N, 68.5W at 19Z (ATSR/WALLET). Penetration center fix estimated winds of 122 kt (likely flight level) at 37.6N, 67.8W at 2319Z (WALLET).

MWR: "Hurricane Cleo remained small and moved about parallel to the Atlantic coast at an initial forward speed of 12 kt, later accelerating to 20 to 30 kt. It appears to have attained its greatest intensity as it approached southeastern New England when winds near the center were estimated at 80 kt. Except during the early and late stages of the storm, there was never a good correlation between reported winds and central pressures. Wind reports from aircraft were consistently high compared with winds calculated from sea level pressures obtained by aircraft penetrations. Some compromise has been made and this accounts for the estimate sea level pressure noted on the storm track." ATSR: "Intensifying, CLEO accelerated and moved rapidly north-northeastward following the steering current at 500 and 200 MB quite closely. Maximum surface wind speed, estimated at 96 knots, occurred at about 191600Z when CLEO was 300 miles east of Cape Hatteras. It is interesting to note that the closed circulation with the storm at this time was only 150 miles in diameter. On moving northward from this point off Cape Hatteras, the extra tropical low to the north of CLEO was in a position just south of Massachusetts. The advection of cool, drier air from the New England area into the tropical circulation in addition to the cooling effect from water, caused CLEO to weaken."

August 20:

HWM analyzes a tropical storm of at most 1015 mb at 42.0N, 65.0W with a cold front to the north at 12Z. HURDAT lists a 60 knot tropical storm at 42.2N, 65.4W at 12Z. Microfilm shows a closed low pressure of at most 1011 mb at 41.8N, 65.2W at 12Z. Navy reconnaissance book lists the best track position at 42.2N, 65.3W at 12Z. Ship highlights: 35 kt ESE and 1011 mb at 42.2N, 64.3W at 12Z (COADS). USS Edisto radar center fix at 41.8N, 65.0W at 12Z (WALLET). USS Lookout radar center fix at 42.2N, 65.2W at 12Z (WALLET). 40 kt SW and 1011 mb at 41.9N, 64.2W at 15Z (COADS). Navy ship radar center fix at 42.5N, 64.7W at 1330Z (WALLET). Navy ship radar center fix at 43.5N, 63.7W at 17Z (reported "appears to be dissipating") (WALLET). Aircraft

highlights: Penetration center fix estimated flight level winds of 100 kt at 700 mb at 38.4N, 67.5W at 0132Z (ATSR). Radar center fix at 40.0N, 66.6W at 06Z (ATSR).

ATSR: “At about 201800Z, CLEO curved rapidly to an easterly course following the steering current associated with the 500 MB ridge in the Atlantic, and passed a few miles north of Sable Island.”

August 21:

HWM analyzes a frontal boundary over eastern Canada and North Atlantic (no organized system) at 12Z. HURDAT lists a 30 knot tropical depression at 44.4N, 58.0W at 06Z (last position). Microfilm shows a closed low pressure of at most 1008 mb at 48.0N, 51.5W at 12Z. Ship highlights: No gales or low pressures.

ATSR: “It finally dissipated south of Newfoundland. The final warning on CLEO was issued at 210400Z.”

The interaction of a tropical wave and a trough over the Bahamas caused the development of a low pressure on August 17th. The disturbance rapidly gained strength and a 25 kt tropical depression is analyzed to have developed at 18Z on the 17th (originally begun as a 35 kt tropical storm). The time of genesis is the same as originally shown in HURDAT, but synoptic observations suggest that the center of the tropical cyclone was located substantially northeast of the position originally shown in HURDAT at 18Z on the 17th. It is also possible that genesis may have taken place six hours later as more than one low pressure system developed along the trough that caused the formation of this tropical cyclone. Minor track alterations are introduced during the lifetime of this tropical cyclone. The tropical depression quickly intensified on August 18th as it began to accelerate to the north-northeast. The first gale-force winds were reported at 13Z on the 18th, ship CHICAGO observed 40 kt ENE and 1002 mb. Intensification to a tropical storm is analyzed at 06Z on the 18th based on data later in the day. Intensification to a tropical storm is twelve hours later than originally shown in HURDAT. At 1430Z, a reconnaissance aircraft reported a central pressure of 997 mb, estimated surface winds of 75 kt and an eye diameter of 7 nm. A central pressure of 997 mb suggests maximum sustained winds of 49 kt from the north of 25N Brown et al. pressure-wind relationship. An eye diameter of 7 nm suggests an RMW of 5 nm and the climatological value is 22 nm. Due to an RMW smaller than average, a forward speed of about 14 kt and taking into consideration the surface wind estimate of 75 kt, an intensity of 60 kt is selected at 12Z, same as originally shown in HURDAT. A central pressure of 997 mb is added to HURDAT at 12Z on the 18th. Cleo is analyzed to have become a hurricane at 18Z on the 18th, same as originally shown in HURDAT.

On August 19th, the forward speed of Cleo continued to increase to the north-northeast as a strong low pressure system developed off the Mid-Atlantic states. The hurricane remained small and it was difficult to almost impossible to spot synoptically, but the reconnaissance aircraft had no trouble locating it. A reconnaissance aircraft measured a central pressure of 999 mb at 13Z on the 19th. A central pressure of 999 mb suggests maximum sustained winds of 45 kt from the north of 25N pressure-wind relationship. A central pressure of 999 mb is added to HURDAT at 12Z on the 19th. At 19Z on the 19th, a reconnaissance aircraft measured a central pressure of 995 mb. A central pressure of 995 mb suggests maximum sustained winds of 52 kt north of 25N and 56 kt from the north of 35N Landsea et al. pressure-wind relationship. The highest estimated surface winds were 96 kt at 16Z on the 19th according to the Navy reconnaissance book. At 12Z and 18Z, due to the extremely small size of the hurricane, fast forward speed and some weighting of the visual surface wind estimate, the intensity of 75 kt in HURDAT is retained. A central pressure of 995 mb is added to HURDAT at 18Z on the 19th. It is interesting to note that the 1960 MWR North Atlantic Hurricane Tracking chart shows central pressures values at 00Z and 12Z on the 19th and 00Z on the 20th that were obtained based on the estimated surface winds. [1960 was the first year, that we can best determine, that a rudimentary understanding of the pressure-wind relationship became available. In particular, the Kraft (1961) pressure-wind relationship was being used. Kraft (1961) uses 14 cases of tropical cyclones that reached the coast with different maximum winds (not gusts) and central pressures. These measurements were deemed to be reliable by Kraft. Based on these measurements, Kraft created a curve of maximum wind versus central pressure, and a formula is provided, $V_{max} = 14\sqrt{1013-P_{center}}$]. These values were not measured but because the actual central pressure values that were reported by the reconnaissance aircrafts did not match the winds reported, a compromise was made in 1960 between the estimated surface winds and observed surface values. These values were not included in the original HURDAT. Today we know that it is possible for a small, fast-moving tropical cyclone to produce hurricane-force winds with relatively high central pressure values. Recent examples include Hurricanes Frances, 1986 and Debby, 2000. The strong low pressure system off the Mid-Atlantic coast moved inland into southern New England late on the 19th. A reconnaissance aircraft reported winds of 122 kt at 2319Z on the 19th but it is uncertain whether these winds are surface or flight-level estimates. At 0132Z on September 20th, a reconnaissance aircraft estimated flight-level winds of 100 kt. HURDAT shows a peak intensity of 80 kt at 00Z and 06Z on the 20th as Cleo passed east of New England. Due to the lack of reliable data from the center of the hurricane, the peak intensity is retained. Later on the 20th, the track of Cleo turned to the northeast and the hurricane rapidly began to weaken. Weakening to a tropical storm is analyzed at 12Z on the 20th, same as originally shown in HURDAT. Synoptic observations early on September 21st indicate that Cleo degenerated into a trough of low

pressure just south of Newfoundland and the remnants were likely absorbed by an intense extratropical cyclone over the north Atlantic. The last position is analyzed at 00Z on the 21st, six hours earlier than originally shown in HURDAT.

Hurricane Donna [August 29 – September 14, 1960]

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39675 08/29/1960 M=17  5 SNBR= 869 DONNA       XING=1 SSS=4
39675 08/31/1960 M=15  5 SNBR= 869 DONNA       XING=1 SSS=4
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39680 08/29*  0   0   0    0*  0   0   0    0*  0   0   0    0*102 215  25    0*
39685 08/30*101 242  25    0*102 255  30    0*103 269  35    0*105 284  35    0*
(The 29th and 30th are removed from HURDAT.)

39690 08/31*108 300  35    0*109 316  35    0*110 331  35    0*114 346  35    0*
39690 08/31*108 300  25    0*109 316  30    0*110 331  35    0*114 346  40    0*
                     **                **                              **

39695 09/01*118 362  40    0*120 378  50    0*122 394  65  990*126 411  80    0*
39695 09/01*118 362  45    0*120 378  50    0*122 394  55  990*126 411  60    0*
                     **                                **              **

39700 09/02*129 428  95    0*133 443 105    0*136 458 115  980*139 476 120  973*
39700 09/02*129 428  65    0*133 443  70    0*136 458  75  980*139 476  80  973*
                     **              ***               ***             ***

39705 09/03*143 494 125    0*147 512 130    0*152 529 130  965*156 546 135  947*
39705 09/03*143 494  85    0*147 512  90    0*152 532  95  962*159 550 100    0*
                    ***               ***           *** *** *** *** *** ***  ***

39710 09/04*160 563 135    0*164 580 140    0*168 595 140  952*172 608 135    0*
39710 09/04*164 566 105    0*165 582 110    0*168 598 110  947*172 609 105    0*
           *** *** ***       *** *** ***           *** ***  ***     *** ***

39715 09/05*177 620 130    0*184 634 120    0*191 647 115  958*197 657 110    0*
39715 09/05*177 620 105  956*184 634 110  952*191 647 100  958*196 657 100  960*
                    ***  ***          ***  ***          ***      ***     ***  ***

39720 09/06*203 665 110    0*208 673 110    0*212 681 110  940*215 689 115    0*
39720 09/06*200 665 115  941*206 675 115    0*212 683 120  940*215 689 125    0*
           ***     ***  *** *** *** ***           *** ***                ***

39725 09/07*218 697 120    0*220 705 120    0*221 713 125  945*221 722 125    0*
39725 09/07*218 697 125  932*220 705 125    0*221 713 120    0*221 723 115    0*
                    ***  ***          ***               ***  ***     *** ***

39730 09/08*222 732 130    0*223 743 130    0*223 753 130  948*224 761 130  944*
39730 09/08*222 734 110  941*223 743 105    0*223 753 105  951*224 761 105    0*
                 *** ***  ***          ***               ***  ***          ***  ***

39735 09/09*224 769 130  948*227 778 130  940*232 787 130  934*237 794 125  939*
39735 09/09*226 769 105    0*229 778 110  943*232 787 115  936*237 794 110  942*
           ***     ***  *** ***     ***  ***          ***  ***          ***  ***

39740 09/10*242 801 120  932*247 807 115  932*253 813 120  938*262 817 115  950*
39740 09/10*242 801 110  938*247 807 115  930*253 813 110  940*263 818 100  950*
                    ***  ***               ***          ***  *** *** *** ***

39745 09/11*273 819 105  960*285 817 100  969*299 808  90  970*314 795  90  966*
39745 09/11*273 819  85  957*285 817  65  967*299 809  65  970*314 798  85  966*
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                    ***  ***         ***  ***     ***  **          ***  **

39750 09/12*331 780  95  958*350 769  90    0*373 748  95  965*400 731  90    0*
39750 09/12*332 781  95  955*351 768  90  958*373 748  90  958*401 733  85  959*
            *** ***      *** *** ***      ***            **  *** *** ***  **  ***

39755 09/13*431 712  75    0E466 689  60    0E500 660  55    0E531 625  45    0*
39755 09/13*430 712  65  975E470 686  60  975E500 660  60  975E531 625  60  980*
            ***      **  *** *** ***      ***          **  ***          **  ***

39760 09/14E560 582  35    0*  0   0   0    0*  0   0   0    0*  0   0   0    0*
39760 09/14E560 582  45  985E585 540  40  990E610 500  40  995*  0   0   0    0*
                     **  ******* ***  **  ******* ***  **  ***

39765 HRBFL4    DFL2 NC3     NY3 CT2 RI1 MA1 NH1 ME1
39765 HRBFL4CFL2DFL1 NC2 VA1 NY2 CT1 RI1 MA1
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Major changes to the track and to the intensity shown in Neumann et al. (1999). Evidence for these alterations comes from the Historical Weather Map series, _Monthly Weather Review_, daily Surface Weather Observations from NCDC, U.S. Weather Bureau six hourly maps available via microfilm at NHC, aircraft observations available from the Storm Wallets at NHC, the COADS ship database, Cry (1960), Harris (1963), Miller (1964), Schwerdt et al. (1979), Ho et al. (1987), Jarrell et al. (1992), Boose et al. (2001), and Dunion et al. (2003).

1st Landfall:
10/07Z: 24.8N 80.9W - 930 mb - 115 kt - 18 nmi RMW - BFL4,CFL2

2nd Landfall:
10/19Z: 26.5N 81.9W - 951 mb - 100 kt -(winds low at landfall as right front quadrant overland well before landfall of center) - 11 nmi RMW - DFL1 (as the hurricane moved across the state)

3rd Landfall:
12/04Z: 34.6N 77.4W - 955 mb - 95 kt - 26 nmi RMW - NC2,VA1

4th Landfall:
12/19Z: 40.7N 72.9W - 959 mb - 85 kt - 48 nmi RMW - NY2

5th Landfall:
12/20Z: 41.3N 72.4W - 962 mb - 80 kt - 48 nmi RMW - CT1, RI1, MA1

Aug 29- HWM indicates a low near 10.5N, 19.5W. Station highlight: No gales or low pressures. Ship highlight: No gales or low pressures. Aircraft highlight: No gales or low pressures. “The passage of an active easterly wave through the area was suggested by unusually heavy rain at Dakar, with which the crash of an airliner there on August 29 was associated and by heavy rain in the Cape Verde Islands on the 30th “ (MWR).

Aug 30- HWM indicates a closed low of at most 1010mb near 9.0N, 27.0W. HURDAT lists this as a Tropical Storm with 35kt winds at 10.3N, 26.9W at 12 UTC. Station highlight: No gales or low pressures. Ship highlight: No gales or low pressures. Aircraft highlight: No gales or low pressures. “An aircraft reported indication of a tropical disturbance near 10.0N, 24.0W” (MWR).

Aug 31- HWM indicates a storm with at most 1010mb near 11.0N, 32.8W. HURDAT lists this as a Tropical Storm with 35kt winds at 11.0N, 33.1W at 12 UTC. Station highlight: No gales or low pressures. Ship highlight: No gales or low pressures. Aircraft highlight: No gales or low pressures.

Sept 1- HWM indicates a storm with at most 1005mb near 11.5N, 39.1W. HURDAT lists this as a Category 1 hurricane with 65kt winds and a pressure of 990mb at 12.2N, 39.4W at 12 UTC. The revised HURDAT lists this as a Tropical Storm with 55kt winds and a pressure of 990mb at 12.2N, 39.4W at 12 UTC. Station highlight: No gales or low pressures. Ship highlight: No gales or low pressures. Aircraft highlight: No gales or low pressures.

Sept 2- HWM indicates a storm with at most 1000mb near 13.4N, 46.1W. HURDAT lists this as a Category 4 hurricane with 115kt winds and a pressure of 980mb at 13.6N, 45.8W at 12 UTC. The revised HURDAT lists this as a Category 1 hurricane with 75kt winds and a pressure of 980mb at 13.6N, 45.8W at 12 UTC. Station highlight: No gales or low pressures. Ship highlight: 45kt with pressure of 1004mb at 14.2N, 48.6W at 1600UTC. Aircraft highlight: Pressure of 973mb at 14.2N, 48.4W at 2001UTC. “Donna, the one major hurricane of the season and the most destructive ever to strike Florida, was detected by aerial reconnaissance on the afternoon of September 2 near 14.0N, 49.0W. Max observed surface winds at that time were 120kt and there was a well-developed eye with a central pressure of 973mb” (MWR).

Sept 3- HWM indicates a storm with at most 1000mb near 14.9N, 53.2W. HURDAT lists this as a Category 4 hurricane with 130kt winds and a pressure of 965mb at 15.2N, 52.9W at 12 UTC. The revised HURDAT lists this as a Category 2 hurricane with 95kt winds and a pressure of 962mb at 15.2N, 53.2W at 12 UTC. Station highlight: No gales or low pressures. Ship highlight: No gales or low pressures. Aircraft highlight: Pressure of 962mb at 15.3N, 53.2W at 1255 UTC; 43kt winds at 17.0N, 53.0W at 1450 UTC.

Sept 4- HWM indicates a storm with at most 995mb near 16.4N, 59.6W. HURDAT lists this as a Category 5 hurricane with 140kt winds and a pressure of 952mb at 16.8N, 59.5W at 12 UTC. The revised HURDAT lists this as a Category 3 hurricane with 110kt winds and a pressure of 947mb at 16.8N, 59.8W at 12 UTC. Station highlight: No gales or low pressures. Ship highlight: No gales or low pressures. Aircraft highlight: Pressure of 942mb at 17.0N, 60.0W at 1317 UTC; 35kt winds at 19.5N, 60.7W at 1620 UTC. “Donna continued toward the west-northwest on approximately the climatological track, but at a slightly faster-than-average rate of about 17kt. This course took the hurricane

through the northern Leeward islands during the evening of September 4 with the eye passing over Barbuda, St. Barthelemy, Sint Maarten, Anguila, and about 10 miles to the south of Anegada" (MWR). "The maximum sustained wind observed at Sint Maarten was 110kt and the lowest barometer reading 952mb, compared to earlier reports from reconnaissance of 140kt winds and dropsonde measurements of 947mb" (MWR). "Wind and tide damage was heavy in the Leeward Islands. A large percentage of the houses on Sint Maarten, Barbuda, and Anguilla were destroyed or severely damaged, with about $3.25 million in property losses, and five fatalities on Anguilla. Major damage occurred on St. Berthelemy, and on Sombrero and Virgin Gordo damage was characterized as heavy to severe to property, crops, and livestock" (CLIMDAT).

Sept 5- HWM indicates a storm with at most 995mb near 18.3N, 64.9W. HURDAT lists this as a Category 4 hurricane with 115kt winds and a pressure of 958mb at 19.1N, 64.7W at 12 UTC. The revised HURDAT lists this as a Category 3 hurricane with 100kt winds and a pressure of 958mb at 19.1N, 64.7W at 12 UTC. Station highlight: 110kts with pressure of 952mb at St. Martin (18.0N, 63.0W) (no time given). Ship highlight: 10kts with pressure of 992mb at 20.5N, 72.8W at 2300 UTC. Aircraft highlight: Pressure of 956mb at 18.1N, 62.3W at 0100 UTC; 130kts with pressure of 965mb at 19.6N, 65.3W at 1555 UTC. "Only minor damage was reported at St. Thomas, Virgin Islands, with the wind reaching a gust speed of 52kt as the storm center passed about 35 miles to the northeast on September 5. Movement continued toward the west-northwest on the 5th and highest sustained winds were 33kt at San Juan, P.R. as the hurricane passed some 85 miles north" (MWR).

Sept 6- HWM indicates a storm with at most 995mb near 21.0N, 68.2W. HURDAT lists this as a Category 3 hurricane with 110kt winds and a pressure of 940mb at 21.2N, 68.1W at 12 UTC. The revised HURDAT lists this as a Category 4 hurricane with 120kt winds and a pressure of 940mb at 21.2N, 68.3W at 12 UTC. Station highlight: No gales or low pressures. Ship highlight: 35kt SE with pressure of 1016mb at 23.2N, 64.87W at 0600 UTC. Aircraft highlight: 120kt with pressure of 932mb at 21.7N, 69.1W at 2230 UTC. "Serious floods developed over the northern and eastern portions of [Puerto Rico] on the morning of September 6. Despite the warnings, 107 persons were drowned. The greatest loss of life was at Humacao where 84 deaths occurred" (MWR). "A change in the movement of the storm occurred on the 6th with a shift of direction to the west toward the north coast of Cuba. The forward motion also slowed to 12kt and later to 7-9kt with a concurrent drop of central pressure to near 941mb and an increase in maximum surface winds to around 122kt and later to 130kt" (CLIMDAT).

Sept 7- HWM indicates a storm with at most 990mb near 21.3N, 71.4W. HURDAT lists this as a Category 4 hurricane with 125kt winds and a pressure of 945mb at 22.1N, 71.3W at 12 UTC. The revised HURDAT lists this as a Category 4 hurricane with 120kt winds at 22.1N, 71.3W at 12 UTC. Station highlight: 45-50kt at Turks Island (21.5N, 71.2W) no time given. Ship highlight: 43kt W with pressure of 985mb at 21.4N, 71.0W at 0900 UTC; 48kt W at 21.5N, 71.0W at 0600 UTC. Aircraft highlight: Pressure of 941mb at 22.1N, 73.0W at 2150 UTC; 43kt SE at 23.2N, 70.8W at 1530 UTC. "The

central pressure given by dropsonde was 940mb on the 6th and 944mb on the 7th" (MWR). "Donna moved into the southeastern Bahamas on the afternoon of the 7th, with the eye passing slightly north of Turks and Grand Caicos Islands, thence westward to the vicinity of Grand Ragged Island by the morning of the 8th" (CLIMDAT). "As Donna approached the southeastern Bahamas, maximum winds were estimated up to 150 m.p.h. Mayaguana was buffeted for 13 hours b y winds of hurricane force which reached over 100 m.p.h., at times. Heavy rain continued to accompany the storm in the Bahamas" (CLIMDAT).

Sept 8- HWM indicates a storm with at most 995mb near 22N, 75.2W. HURDAT lists this as a Category 4 hurricane with 130kt winds and a pressure of 948mb at 22.3N, 75.3W at 12 UTC. The revised HURDAT lists this as Category 3 hurricane with 105kt winds and a pressure of 951mb at 22.3N, 75.3W at 12 UTC. Station highlight: 61kt ENE at The Exumas (23.4N, 75.6W) at 1200 UTC. Ship highlight: 35kt S with pressure of 1007mb at 19.5N, 75.1W at 1200 UTC. Aircraft highlight: Pressure of 951mb at 22.2N, 75.5W at 1300 UTC; 35kt E at 23.3N, 77.0W at 2030 UTC. "The eye passed over or very near Mayaguana, Acklins Island, Fortune Island, and Ragged Island. Mayaguana …was battered by hurricane force winds for 13 hours" (MWR). "At 0700 EST on September 8, when the hurricane was located only 380 miles southeast of Miami and moving westward at about10kt the Miami wind at 500mb was still blowing from the west" (MWR). "Damage on Turks and Caicos was estimated at $288,000. Heavy rains on the southern fringes of the storm lashed at Hispaniola and Jamaica" (CLIMDAT).

Sept 9- HWM indicates a storm near 23N, 78.6W. HURDAT lists this as a Category 4 hurricane with 130kt winds and a pressure of 934mb at 23.2N, 78.7W at 12 UTC. The revised HURDAT lists this as a Category 4 hurricane with 115kt winds and a pressure of 936mb at 23.2N, 78.7W at 12 UTC. Station highlight: 65kt S at with pressure of 1004mb at Andros (24.1N, 77.5W) at 1200 UTC. Ship highlight: 87kt NNW at 24.0N, 80.0W at 1800 UTC. Aircraft highlight: 130kt with a pressure of 933mb at 23.1N, 78.3W at 0920 UTC. "On September 9, Donna skirted the northeastern coast of Cuba, bringing gales and heavy rains to much of the island, then took a west-northwest course, toward the Florida Keys" (MWR). "A progressively increasing turn to the west-northwest began during the afternoon and brought the storm center across Grand Bahama Bank well south of Andros Island to a position near 24.0N, 80.0W by 1900 EST on the 9th, thence over the middle Florida Keys between 0200 and 0300 EST on the 10th" (CLIMDAT). "Gales winds and high tides lashed the north coast of Cuba from Havana eastward. High tides also pounded portions of the south coast, and floods destroyed about 80 houses at Gibard in Oriente Province" (CLIMDAT).

Sept 10- HWN indicates a storm with at most 990mb near 25N, 81W. HURDAT lists this as a Category 4 hurricane with 120kt winds and a pressure of 938mb at 25.3N, 81.3W at 12 UTC. The revised HURDAT lists this as a Category 3 hurricane with 110kt winds and a pressure of 940mb at 25.3N, 81.3W at 12 UTC. Station highlight: Pressure of 933mb at Conch Key (24.8N, 80.9W) no time given; 111kt NW at Sombrero Key (24.6N, 81.1W) at 0630 UTC. Ship highlight: No gales or low pressures. Aircraft highlight: Pressure of

937mb at 24.7N, 80.4W at 0400 UTC; 39kt NNW at 25.8N, 83.7W at 1830 UTC. "The center crossed over the middle Keys just northeast of Marathon between 0200 and 0300 EST on September 10. The central pressure had continued to drop as the hurricane moved across the warm waters of the Florida Straits and was approximately 930mb when the center reached the Keys" (MWR). "On the Keys, the central eye extended from just north and east of Marathon shores to Lignumvitae Key" (CLIMDAT). "At Sombrero Light, west of the area of strongest winds, the fastest recorded mile was at a rate of 128 m.p.h., at 1:30 am, est., on the 10th with gusts to 150 mph. At Tavernier, to the east of the area of strongest winds, the fastest measured mile was 120mph, the limit of the anemometer. The indicator needle held sold against this maximum for at least 45 minutes. Anemometers were blown away or stations evacuated at Flamingo, Everglades, and Naples" (CLIMDAT). "The lowest atmospheric pressure measured by a calibrated aneroid barometer was 27.55 inches in Conch Key as the eye passed" (CLIMDAT). "Tides in the Everglades – Naples – Ft. Myers Beach area were estimated 4 to 7 feet above normal (slightly higher at places) and pushed into the towns, damaging streets, buildings, and docks. Beach erosion and deposition were extensive. North of Bradenton on the west coast and Palm Beach on the east coast maximum tides were mostly 1 to 3 feet above normal and in the Miami area were generally 2 to 4 feet above normal" (CLIMDAT).

Sept 11- HWM indicates a storm near 30.0N, 80.2W. HURDAT lists this as a Category 2 hurricane with 90kt winds and a pressure of 970mb at 29.9N, 80.8W at 12 UTC. The revised HURDAT lists this as a Category 1 hurricane with 65kt winds and a pressure of 970mb at 29.9N, 80.8W at 12 UTC. Station highlight: Pressure of 950mb at Fort Myers (26.2N, 81.9W) no time given; 59kt NE at Lakeland (28.0N, 81.9W) at 0235 UTC. Ship highlight: 25kt S with pressure of 976mb at 27.5N, 77.6W at 0600 UTC; 65kt WNW with pressure of 985mb at 30.5N, 79.5W at 2100 UTC. Aircraft highlight: 85kt with pressure of 968mb at 30.7N, 80.6W at 1545 UTC. "The eye passed over Naples and Fort Myers as the hurricane turned northward, moved inland, and then continued northeastward to re-enter the Atlantic just north of Daytona Beach about 0400 EST, September 11" (MWR). "Despite the trajectory over land and a filling of central pressure from 950mb at Fort Myers to 970mb on the east coast, the storm was still intense and well organized when it moved into the Atlantic again" (MWR). "Rapid intensification occurred over the ocean and when the center was about 80miles southeast of Charleston, S.C., on the afternoon of September 11, the SS Mae reported winds of 105kt and 20 to 30-foot seas" (MWR). "Damage from wind and tide was extremely heavy on the Keys and the southwest coast, varying from almost complete destruction of all but the most substantial buildings in the area from marathon to Tavernier to battered boats, dock, broken windows and water damage, and lost roofs in all but the western Keys. Extensive destruction of small houses and buildings and roof damage occurred northward to Punta Gorda. Outside these main damage areas, the wind blew over thousands of trees, shattered windows, blew off or damaged roofs and demolished many weak buildings. Wind-driven rain also added to the damage. Power and communications facilities were disrupted throughout central and south Florida" (CLIMDAT). "Some tornadoes, embedded in the forward quadrant of the storm, occurred during the afternoon of the 11th. These caused some local damage near

Clinton, North Carolina, around 5pm est., and near Elizabethtown, North Carolina, around 2pm. Several persons were injured in the storm near Clinton. Preliminary damage reports indicate property damage in N. Carolina to beaches and cities along the immediate coast and sounds affected by tides and wind near $2o million; to crops and farm property also near $20 million; to forests near $5million; to inland communities near $1million, and to bridges and highways, near $500,000" (CLIMDAT).

Sept 12- HWM indicates a storm of at most 975mb near 37.7N, 74.5W. HURDAT lists this as a Category 2 hurricane with 95kt and a pressure of 965mb at 37.3N, 74.8W at 12 UTC. The revised HURDAT lists this as a Category 2 hurricane with pressure of 958mb at 37.3N, 74.8W at 12 UTC. Station highlight: Pressure of 958mb at Belhaven (35.5N, 76.6W) at 0700-0745 UTC; 90kt at Long Island (40.8N, 73.0W) no time given. Ship highlight: 61kt SSE with pressure of 974mb at 39.7N, 72.0W at 1800 UTC; 75kt E with pressure of 991mb at 32.3N, 79.2W at 0000 UTC. Aircraft highlight: 110kt at 37.5N, 74.5W at 1320 UTC. "During its passage over North Carolina, Donna's eye was usually large with the area of calm or light variable winds ranging from 50 to 80 miles in diameter. Minimum pressures reported along this section of the track ranged from 958 to 967mb and highest winds were in the 70-90kt bracket" (MWR). "When Donna again reached the ocean, it resumed its rapid movement with a forward speed of 30-35kt, moving northeastward a short distance off the coast and crossing Long Island shortly after noon on September 12. Sustained winds reached about 90kt at several points on Long Island and 50-60kt on western Long Island and in New York City" (MWR). "During the period the hurricane was moving from North Carolina to southern New England this was as much as 50 to over 100 miles in diameter, an extreme and probably unprecedented size for a hurricane eye" (MWR). "The large eye (possibly the largest of record) was a continuing feature as Donna moved rapidly northeastward, paralleling the Middle Atlantic coast, at some 30-35kt during the morning hours of the 12th" (CLIMDAT). "Losses to property were great along the immediate shore, where wind and tide damage to boats, docks, boardwalks, cottages, and buildings were severe in some areas. Hardest hit was Ocean City, Md., where the storm was described by some old residents as the most severe in the City's history. Extensive minor property damage from wind, rain, and small stream overflow throughout inland sections was considerable in the aggregate. Trees falling on lines disrupted power and communications. Additional wind damage was chiefly to small structures, windows and roofs, and signs" (CLIMDAT). "Damages in the heavily populated Northeastern States were heavy. Unprecedented flood damage occurred in the Catskill area. The loss at Windham alone was estimated at more than $1 million. Damage to all types of boats, docks, highways, and bridges on Long Island was very heavy from flooding, high tides, and heavy seas. Many thousands of tress and limbs were blown down by high winds in the Long Island- lower Hudson Valley area, disrupting power, communications, and travel. Tide damage from coastal erosion and flooding was extensive" (CLIMDAT).

Sept 13- HWM indicates a closed low near 49.5N, 66.5W. HURDAT lists this as an Extratropical storm with 55kt winds at 50.0N, 66.0W at 12 UTC. The revised HURDAT lists this as an Extratropical storm with 60kt winds at 50.0N, 66.0W at 12 UTC. Station

highlight: Pressure of 969mb at Haverhill (42.8N, 71.1W) at 0030 UTC; 54kt SE at Portland (43.7N, 70.3W) at 0013 UTC. Ship highlight: 20kt S with pressure of 979mb at 49.6N, 65.2W at 1200 UTC; 60kt W at 47.7N, 59.3W at 1700 UTC. Aircraft highlight: No gales or low pressures. “Gradual filling and weakening occurred farther north as the center continued rapidly northeastward, moving through Maine just west of Caribou and into Canada late on September 13. Winds of hurricane force still persisted in squalls near the center until about the time it reached the Canadian border” (MWR).

Genesis for Donna is delayed 36 hours due to observations showing that the closed circulation did not exist until around 00 UTC on the 31st. Other that this major change of the track at genesis (and another discussed later for dissipation), only minor alterations of the track were introduced for all days except for the 31st through the 2nd. Unlike most tropical cyclones of the late 1950s and 1960s, central pressure values were provided in HURDAT for the 12 UTC times from the 1st until the 12th. Many of these are not based upon any observation, but were estimated. Those values that were reasonable were retained, but a few were either replaced by actual measurements of the central pressure or removed. As is clear from the Monthly Weather Review writeup, no gale force winds or low pressures were observed until the 2nd. The 990 mb central pressure listed at 12 UTC was likely not actually observed, but does suggest winds of 64 kt from the southern pressure-wind relationship. 65 kt retained, as this is consistent with what was observed on the 2nd. The Navy aircraft reached Donna on the 2nd and found 120 kt estimated surface winds, 973 mb central pressure, and a 22 nmi diameter eye at 2001 UTC. Estimated surface winds, especially in this era, are notoriously unreliable and even Navy/Air Force flight-level winds are suspect. The 973 mb pressure suggests winds of 86 kt from the southern-pressure wind relationship. 80 kt (down from 120 kt) are chosen given the larger than typical (for this central pressure and latitude - Vickery et al. 2000). The 980 mb value in HURDAT for 12 UTC on the 2nd is not based on any observations, but appears to be reasonable and is retained. The next aircraft found that the central pressure dropped to 962 mb with an 18 nmi eye at 1255 UTC on the 3rd. This pressure gives 98 mb from the southern pressure-wind relationship and the eye size is slightly larger than typical - 95 kt chosen for 12 UTC on the 3rd down from 130 kt originally. A central pressure of 947 mb late on the 3rd suggests winds of 114 kt from the southern pressure-wind relationship. 110 kt chosen for 18 UTC on the 3rd, down from 135 kt, due to slightly larger size than climatology.

The hurricane filled some as it reached the Lesser Antilles. A 952 mb central pressure at 1317 UTC on the 4th with an eye diameter of 20 nmi suggests winds of 108 kt from the southern pressure-wind relationship. 105 kt is chosen for 1200 UTC on the 4th due to slightly larger eye than climatology. The pressure oscillated some (956 mb from aircraft at

01 UTC on the 5th, 952 mb from Sint Maarten around 06 UTC, 956 mb from aircraft at 07 UTC, 958 mb from aircraft at 1245 UTC, 960 mb from aircraft at 1345 UTC, 965 mb from aircraft at 1555 UTC, and 956 mb from aircraft at 1943 UTC) during the 5th. Observed sustained winds of 110 kt from Sint Maarten early on the 5th along with a central pressure of 952 mb from the island justify a 110 kt estimate in HURDAT (down from 120 kt originally). Winds during the remainder of the 5th with pressures slightly h igher are analyzed to be 105 kt. The drop in pressure late on the 5th continued into the 6th as 941 mb was observed by aircraft at 0130 UTC, 940 mb at 1306 UTC, and 932 mb at 1835 and 2230 UTC. The 941 mb pressure suggests winds of 118 kt from the southern-pressure wind relationship. As the 21 nmi eye was larger than climatology, the reanalyzed winds were set to 115 kt, up from 110 kt originally at 00 UTC on the 6th. However, the eye contracted down to 10-14 nmi during the remainder of the 6th. The 940 mb pressure suggested winds of 119 kt, 120 kt used in HURDAT at 12 UTC up from 110 kt originally. The 932 mb readings suggest winds of 125 kt, which is used in HURDAT for 18 UTC on the 5th and 00 UTC on the 6th, up from 115 and 120 kt originally. The next available aircraft indicated some weakening with 941 mb central pressure at 2150 UTC on the 7th, which suggested 118 kt from the southern-pressure wind relationship. As the eye had expanded again to 27 nmi, 115 kt is chosen for HURDAT at 18 UTC/7th and 110 kt at 00 UTC/8th (down from 125 and 130 kt, originally). By 13 UTC on the 8th, aircraft reported that the central pressure had risen to 951 mb with an eliptical eye with axes of 30 and 20 nmi. 951 mb suggests winds of 109 kt from the southern-pressure wind relationship. Winds are chosen at 12 UTC on the 8th to be 105 kt due to the larger than climatologically expected eye, down from 130 kt originally. No reliable surface observations of central pressure and/or maximum winds were available from the Bahamas, during Donna's trek across the islands on the 8th and 9th. During the 9th, another intensification of Donna occurred, as 943 mb at 07 UTC, 933 mb at 0920 UTC, 936 mb at 13 UTC, 942 mb at 16 UTC, and 943 mb at 22 UTC were measured by aircraft reconnaissance. The 936 mb suggests winds of 122 kt from the southern pressure-wind relationship and 113 kt from the subtropical pressure-wind relationship. With the eye diameter being larger than climatological, winds are set at 115 kt at 12 UTC on the 9th - which is reduced from 130 kt originally in HURDAT.

The hurricane intensified again on the 10th as it made landfall in the Florida Keys. Aircraft central pressure was 938 mb at 0050 UTC and 937 mb at 04 UTC. 938 mb pressures suggests winds of 120 kt from the southern and 112 kt from the subtropical pressure-wind relationships. As Donna retained a 20-25 nmi diameter eye, winds were chosen to be 110 kt at 00 UTC, down from 120 kt originally. Donna made landfall over the middle Florida Keys at 24.8N 80.9W around 07 UTC on the 10th wind central pressure of 930 mb, based primarily upon a 933 mb observation from Conch Key. 930 mb suggests

winds of 127 kt from the southern and 117 kt from the subtropical pressure-wind relationships. The RMW of 18 nmi is near the average (15 nmi) for this pressure and latitude. Other factors include the slow forward speed of Donna (around 9 kt) and low environmental pressure (1009 mb). These suggest a slighly lower value than the average of the two pressure108 wind relationships, so 115 kt is estimated to be the maximum sustained winds at landfall, retaining Donna as a Category 4 for the Florida Keys (southwest Florida - "BFL"). This is in agreement with the Schwerdt et al. and Dunion et al. estimates. It is noted that the highest sustained wind was 111 kt from Sombrero Key. The close pass of Donna to the boundary between southwest and southeast Florida (at 80.85W) indicates that southeast Florida also received hurricane impacts, which are estimated to be Category 2 based upon the size and landfall location of Donna.
After passing the Keys, Donna briefly entered the Gulf of Mexico and then made landfall just north of Naples around 19 UTC on the 10th at 26.5N 81.9W with a central pressure of 949 mb observed at Naples. This pressure would suggest winds of 111 kt from the southern and 103 kt from the subtropical pressure-wind relationship, but the front right quadrant of the hurricane had already been overland for a couple of hours. Thus maximum sustained winds at second landfall are estimated to be 100 kt.
The inland decay of Donna over Florida was considered by Dunion et al. with a combination of all available observations along with the Kaplan and DeMaria model. Dunion et al. analyzed 78, 54, and 61 kt for 00, 06, and 12 (just offshore) UTC on the 11th, respectfully. Given that data not observed may cause a small low-bias in the H*Wind analysis scheme, winds in HURDAT are reanalyzed to be 85, 60, and 65 kt, down from 105, 100, and 90 kt originally. This change is consistent with the relative lack of significant structural damage over Lakeland and Orlando, that one would have had if Donna were still a Category 3 hurricane over central Florida. However, it is likely that by the time Donna reached into Northeast Florida (north of 28.2N along its track), it caused sustained Category 1 conditions. Thus it is analyzed as Category 1 for Northeast Florida ("DFL1"), down from Category 2 hurricane status for the region originally.
The central pressure for 00 and 06 UTC on the 11th were adjusted downward slightly to 957 and 967 mb (from 960 and 969 mb originally) due to 962 mb measured (at time of peak estimate winds) in Wauchula at 02 UTC.
After passing back into the Atlantic, Donna began reintensifying. A Navy reconnaissance measured 968 mb and a 50 nmi diameter eye at 1545 UTC on the 11th, which was the last aircraft to penetrate the hurricane.
HURDAT originally had 966 mb at 18 UTC on the 11th and while this was not from an observation, it appears reasonable given the reintensification of the hurricane. 966 mb suggests winds of 85 kt from the subtropical pressure-wind relationship. Winds are chosen to be 85 kt (down from 90 kt) originally due to the large reported eye.

Donna made a third landfall in the United States around 05 UTC on the 12th at 34.6N 77.4W. Lowest observed pressure was 958 mb in the eye at Bellhaven in eastern North Carolina a couple hours after landfall. Thus it is estimated that the central pressure at landfall in North Carolina was about 955 mb. This pressure suggests winds of 99 kt from the subtropical pressure-wind relationship. Because of the large eye size and relatively low (~1009 mb) environmental pressure, 95 kt is analyzed as the maximum sustained winds at North Carolina landfall. This agrees with the Schwerdt et al. assessment, but is a downgrade from Category 3 originally analyzed in HURDAT to a Category 2 (though the winds in HURDAT at 06 UTC on the 12th remain 95 kt). Highest observed winds in Virginia were 70 kt in Cape Henry, indicating that the state should be listed as having Category 1 hurricane impacts (none were indicated originally).

Donna went back out to sea for about nine more hours before making a fourth U.S. landfall in New York, at 40.7N 72.9W at 19 UTC on the 12th. Observed lowest pressure was at Brookhaven, New York with 961 mb. As the center of Donna appears to have passed just east of Brookhaven, the analyzed central pressure at landfall is 959 mb, in agreement with Ho et al. 959 mb suggests winds of 90 kt from the northern pressure-wind relationship, However, given the large size (48 nmi RMW), maximum sustained surface winds are estimated to be 85 kt at landfall. (Highest observed sustained winds were 83 kt from Block Island, RI.) Around 20 UTC on the 11th, Donna made its fifth (and final) landfall in the United States at 41.3N 72.4W along the Connecticut coastline. Winds are estimated to have dropped to 80 kt by this point. New York is analyzed to have been impacted by Category 2 winds (along the southeastern end of Long Island), which is a downgrade from Category 3 originally. Connecticut, Rhode Island, and Massachusetts are all analyzed to have been impacted by Category 1 winds, which is a downgrade from Category 2 originally for Connecticut and Rhode Island. While winds in Donna are still indicated as 65 kt at 00 UTC on the 13th, these were likely occurring offshore so that New Hampshire and Maine did not receive sustained hurricane force winds. Thus these two states are removed from listing as being impacted by Category 1 conditions. Donna transitioned to extratropical around 06 UTC on the 13th as it approached the Maine-Canada border. Ship observations late on the 13th and on the 14th allowed for analysis of a stronger extratropical storm than originally indicated. An additional 12 hours (06 and 12 UTC on the 14th) were added to HURDAT for Donna as the system was still a distinct entity until that time.

Hurricane Ethel [September 12-17, 1960]

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41685 09/14/1960 M= 4  6 SNBR= 906 ETHEL       XING=1 SSS=1
41685 09/12/1960 M= 4  8 SNBR= 906 ETHEL       XING=1 SSS=1
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(September 12th and 13th are new to HURDAT)
41687 09/12*  0   0   0    0*  0   0   0    0*  0   0   0    0*220 930  25    0*
41689 09/13*223 927  25    0*224 924  30    0*226 921  35    0*228 919  40    0*

41690 09/14*  0   0   0    0*  0   0   0    0*239 906  40    0*256 897  75    0*
41690 09/14*231 917  45    0*234 913  60    0*239 908  80    0*256 900 100  972*
            *** ***  **      *** ***  **          ***  **          *** ***  ***

41695 09/15*270 891 110  981*281 889 140    0*291 889  80    0*299 890  60    0*
41695 09/15*271 892 100  976*284 888  85    0*294 887  70  985*301 888  65  984*
            *** *** ***  *** *** ***  **      *** ***  **  *** *** ***  **  ***

41700 09/16*307 890  45    0*313 890  35    0*320 889  35    0*329 885  30    0*
41700 09/16*306 891  55    0*312 890  40    0*320 889  30 1007*329 887  25    0*
            *** ***  **      ***       **                ** ****     ***  **

41705 09/17*339 881  25    0*350 880  20    0*360 876  15    0*368 870  15    0*
41705 09/17*339 884  25    0*349 880  20    0*359 874  20    0*368 866  20    0*
                ***           ***             *** ***  **          ***  **

41710 HR MS1
41710 HR LA1MS1
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U.S. Hurricane Landfall

Sep 15th – 21Z – 30.4N 89.0W – 70 kt – Category 1 – 980 mb – 1013 mb OCI – 150 nm ROCI

Minor changes to the track and major changes to the intensity shown in McAdie et al. (2009). Evidence for these alterations comes from the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Monthly Weather Review, Navy reconnaissance book, Surface Weather Observations, Mariners Weather Log, Schwardt et al. (1979), Ho et al. (1987), and Jarrell et al. (1992) and NHC Storm Wallets.

September 12:

HWM analyzes a spot low at 22.0N, 95.0W with a weakening front just north at 12Z. HURDAT does not list an organized system on this date. Microfilm shows two areas of low pressure along a frontal boundary stretching NE-SW over the Gulf of Mexico at 12Z. Ship highlights: No gales or low pressures.

ATSR: “The incipient stage of Hurricane ETHEL was noticed as early as 8 September, when a weak trough appeared in the Gulf of Campeche. By 10 September, this trough dominated the entire western portion of the Gulf of Mexico. Two weak vortices formed, one located approximately 150 miles due east of Tampico, and the other south of the Louisiana coastline. During the following three days, the surface trough and its diffuse vortices persisted.”

September 13:

HWM analyzes a closed low pressure of at most 1010 mb at 21.0N, 94.0W with a stationary front to the northeast at 12Z. HURDAT does not list an organized system on this date. Microfilm shows a closed low pressure of at most 1009 mb at 22.0N, 91.0W with a frontal boundary to the northeast at 12Z. Ship highlights: No gales or low pressures.

ATSR: “As Hurricane DONNA progressed northward along the Eastern seaboard, a weak frontal system moved as far as the central Gulf of Mexico and dissipated by 13 September. This left a surface trough oriented northeast to southwest across the entire Gulf. Now, only the “Tampico” vortex remained, and it had drifted slowly eastward.”

September 14:

HWM analyzes a tropical storm of at most 1005 mb at 24.1N, 90.2W with a warm front to the north and northeast at 12Z. HURDAT lists a 40 knot tropical storm at 23.9N, 90.6W at 12Z (first position). Microfilm shows a large closed low pressure of at most 1008 mb at 23.5N, 91.5W at 12Z. Navy reconnaissance book lists the best track position at 24.0N, 90.5W at 12Z. Ship highlights: 35 kt NE and 1007 mb at 25.6N, 90.5W at 12Z (micro). 55 kt ENE and 987 mb at 25.1N, 90.0W at 15Z (ATSR). 35 kt S and 1002 mb at 24.9N, 89.9W at 17Z (micro). 40 kt NNE and 1002 mb at 25.7N, 90.3W at 18Z (COADS). 50 kt SSW and 1009 mb at 25.0N, 87.8W at 21Z (MWL). Aircraft highlights: Radar fix at 24.0N, 90.0W at 1435Z (MWR). Penetration center fix estimated surface winds of 130 kt, an eye diameter of 10 nm and measured a central pressure of 972 mb at 25.9N, 90.0W at 19Z (ATSR). Penetration center fix estimated surface winds of 140 kt, an eye diameter of 10 nm and measured a central pressure of 976 mb at 26.6N, 89.3W at 2212Z (ATSR).

MWR: “Hurricane Ethel developed quickly in the central Gulf of Mexico early on September 14. Its position and intensity were established by the 0930 CST report from MAMOS (Marine Automatic Meteorological Observing Station) in the central Gulf of Mexico. The hurricane moved northward and continued to intensify rapidly during the day with a central pressure of 972 mb and winds of 140 kt reported by reconnaissance aircraft that afternoon.” ATSR: “Retrogression of the 200 MB from the central to the extreme western Gulf by 140000Z placed the cyclone under a strong, divergent southwesterly current. This triggered the extremely rapid development of the low pressure center. The gradient to the northeast of the surface low began increasing slowly early on the 14th of September, and at 1200Z there were a number of ships reporting easterly to southeasterly winds of 20 to 25 knots. Reported pressures led to the conclusion that the cyclone’s central pressure at this time must have been approximately

1004 MB. This represented a drop of four MB in six hours. At 141435Z, a Braniff flight enroute from Balboa, Canal Zone to Brownsville, Texas reported a "small hurricane, well developed eye at 24N 90W." At 1500Z, the MAMOS located at 25.1N 90.0W reported winds of 55 knots from 070 degrees, and a pressure of 987 MB. The first warning on Hurricane ETHEL was issued at 141800Z on the basis of this timely report from the ocean based weather buoy. At 1745Z, a Navy reconnaissance flight reported a fix on ETHEL, located at 25.6N 90.1W. Subsequently, at 1900Z the aircraft reached the eye of the hurricane and reported maximum surface winds of 140 knots and a minimum surface pressure of 972 MB."

September 15:

HWM analyzes a tropical storm of at most 995 mb at 29.0N, 88.5W at 12Z. HURDAT lists an 80 knot hurricane at 29.1N, 88.9W at 12Z. Microfilm shows a closed low pressure of at most 987 mb at 28.8N, 88.9W at 09Z (the 12Z map is not available). Navy reconnaissance book lists the best track position at 29.3N, 88.6W at 12Z. Ship highlights: 65 kt ESE and 999 mb at 27.4N, 88.1W at 00Z (micro). 70 kt SE and 996 mb at 27.6N, 88.9W at 03Z (micro). 65 kt S and 1000 mb at 27.6N, 88.7W at 06Z (micro). 55 kt SSW and 1003 mb at 27.4N, 88.8W at 09Z (micro). 78 kt (max wind) at Venice, LA at 1015Z (WALLET). 45 kt W and 1008 mb at 27.4N, 89.1W at 12Z (COADS). 45 kt SW and 1006 mb at 28.2N, 88.0W at 15Z (micro). Land highlights: 40 kt NE and 1001 mb at Burrwood, LA at 0650Z (SWO). 35 kt NNE at Burrwood, LA at 09Z (micro). 49 kt NE (max wind) at Keesler AFB, MS at 1953Z (WALLET). 52 kt N estimated and 979 mb (min pressure) at Gulfport, MS at 21Z (WALLET). 10 kt S and 981 mb (min pressure) at Keesler AFB, MS at 2208Z (WALLET). Aircraft highlights: Penetration center fix at 27.1N, 89.2W at 00Z (ATSR). Penetration center fix at 29.3N, 88.0W at 0740Z (ATSR). Penetration center fix estimated surface winds of 60 kt, an eye diameter of 40 nm and measured a central pressure of 985 mb at 29.4N, 88.6W at 1312Z (ATSR). Penetration center fix measured a central pressure of 984 mb at 30.2N, 88.7W at 17Z (ATSR). (979 mb) measured at Gulfport, MS – RMW 22 nmi – 10 kt forward speed – landfall pt 30.3N, 89.3W" (Ho et al. (1987). "Sep – MS1 – Cat 1 – 981 mb" (Jarrell et al. (1992). "30.4N, 86.1W – 972 mb – 1015 mb Penv – RMW 18 nmi – speed 10 kt – 74 kt est max sustained 10m, 10-min wind" (Schwardt et al. (1979)).

MWR: "During the night of September 14-15, cool dry air entered the circulation and the hurricane's intensity diminished quickly. The hurricane center reached the coast near Biloxi, Miss, with the lowest pressure 981.4 mb during the afternoon of September 15 at Keesler Air Force Base. It continued to weaken as it moved northward through eastern Mississippi that night. The highest sustained wind reported by a land station was 78 kt with gusts to 90 at Venice, LA, at 0415 CST, September 15. Burrwood, LA, reported

winds of 45 kt with gusts to 60. The highest tide reported was 7 feet above mean sea level on Quarantine Bay on the east side of the Mississippi River about 0400 CST on the 15th." ATSR: " With the advent of darkness on the evening 14 September, ETHEL apparently began dissipating at a rate nearly as great as that with which she had intensified. A Navy reconnaissance flight during the night reported the radar eyes as being "open northeast through south" at 150400Z. Radar coverage became increasingly difficult during the remainder of the mission. As best as can be determined, ETHEL maintained hurricane force winds for 24 hours (141600Z to 151600Z), during which time she moved on a north-northeasterly course at a speed of approximately 15 knots. She decelerated to ten knots and assumed a more northerly course near the end of the period. Daylight reconnaissance on the morning of 15 September located ETHEL a short distance east of the Mississippi River Delta, 60 miles south of Biloxi, Mississippi. Maximum observed surface winds were reported to be 60 knots and the radar eye a "poorly defined 40 mile diameter" at this time. ETHEL passed inland just to the east of Biloxi at 152100Z. Five hours later there were no reports of winds in excess of 24 knots."

September 16:

HWM analyzes a closed low pressure of at most 1010 mb at 32.0N, 88.5W at 12Z. HURDAT lists a 35 knot tropical storm at 32.0N, 88.9W at 12Z. Microfilm shows a closed low pressure of 1008 mb at 32.0N, 88.5W at 12Z. Navy reconnaissance book lists the best track position at 32.1N, 88.8W at 12Z. Ship highlights: No gales or low pressures. Land highlights: 8 kt NE and 1008 mb at Meridian, MS at 12Z (SWO).

September 17:

HWM analyzes a closed low pressure of at most 1015 mb at 36.0N, 87.3W at 12Z. HURDAT lists a 15 knot tropical depression at 36.0N, 87.6W at 12Z. Microfilm shows a closed low pressure of at most 1014 mb at 35.7N, 87.5W at 12Z. Ship and land highlights: No gales or low pressures.

MWR: "The remnants of the storm were located in central Tennessee on the morning of September 17."

September 18:

HWM analyzes a frontal boundary over the Midwest at 12Z. Microfilm does not analyze an organized system at 12Z. HURDAT does not list an organized system on this date. Ship and land highlights: No gales or low pressures.

Hurricane Ethel had a complex development over the southern Gulf of Mexico. Monthly Weather Review indicates that the interaction between a weak trough over the Bay of Campeche and a weakening frontal boundary led to the development of a low pressure on September 10th. The disturbance slowly became better organized and ships observations indicate that a 25 kt tropical depression developed around 18Z on September 12th, 42 hours earlier than originally shown in HURDAT. Minor track alterations are introduced from the 14th through 17th for this tropical cyclone. The tropical depression initially moved slowly to the northeast and intensification to a tropical storm is analyzed at 12Z on September 13th based on ship and aircraft reconnaissance on September 14th. This is a day earlier than originally shown in HURDAT. At 1445Z on the 14th, Monthly Weather Review indicates that an aircraft (non-reconnaissance) flying from Panama to Brownville, Texas reported a hurricane with a well-defined eye. At 15Z, a buoy named "MAMOS" reported 55 kt NE and 987 mb. Intensification to a hurricane is analyzed at 12Z on the 14th, six hours earlier than originally shown in HURDAT. The intensity analyzed at 12Z on the 14th is 80 kt, up from 40 kt originally in HURDAT, a major intensity change. The first reconnaissance aircraft reached the hurricane at 19Z on the 14th measuring a central pressure of 972 mb, estimating surface winds of 130 kt and an eye diameter of 10 nm. A central pressure of 972 mb suggests maximum surface winds of 89 kt intensifying south of 25N and 86 kt intensifying north of 25N from the Brown et al. pressure-wind relationship. An eye diameter of 10 nm suggests an RMW of about 8 nm and climatology indicates 19 nm. Due to a forward speed of about 18 kt, an RMW smaller than climatology, and some weighting of the visual surface estimate, an intensity of 100 kt is selected at 18Z on the 14th, up from 75 kt originally in HURDAT, a major intensity change. A central pressure of 972 mb is added to HURDAT at 18Z on the 14th. Intensification to a major hurricane is analyzed six hours earlier than originally shown in HURDAT. Another reconnaissance aircraft reached Ethel at 2212Z measuring a central pressure of 976 mb, estimating surface winds of 140 kt and an eye diameter of 10 nm. A central pressure of 976 mb suggests maximum surface winds of 77 kt north of 25N from the pressure-wind relationship. An eye diameter of 10 nm suggests an RMW of about 8 nm and climatology indicates 20 nm. Due to a forward speed of about 18 kt, RMW smaller than climatology, and some weighting of the visual estimate, an intensity of 100 kt is selected at 00Z on September 15th, down from 110 kt originally in HURDAT, a minor intensity change. 100 kt is also the peak intensity of this tropical cyclone, down from 140 kt originally in HURDAT, a major intensity change. The 140 kt intensity originally in HURDAT at 06Z on the 15th very likely came from the 140 kt visual estimate via the aircraft reconnaissance late on the 14th. Thus, it is indicated that Hurricane Ethel did not reach category 5 as previously shown in HURDAT. A few ships reported hurricane-force winds early on the 15th as Ethel moved toward the northern Gulf coast. Gale-force winds reached the mouth of the Mississippi River early on the

15th. Burrwood, LA reported 40 kt NE and 1001 mb at 0650Z on the 15th. A reconnaissance aircraft investigated Ethel at 1312Z on the 15th and found that the hurricane had weakened significantly from late on the 14th. The aircraft reported a central pressure of 985 mb, estimated surface winds of 60 kt and an eye diameter of 40 nm. A central pressure of 985 mb suggests maximum surface winds of 63 kt weakening north of 25N from the pressure-wind relationship. An eye diameter of 40 nm suggests an RMW of about 30 nm and climatology indicates 24 nm. At 1015Z, Venice, LA reported a peak sustained wind of 78 kt. Due to a slower forward speed of about 7 kt, an RMW larger than climatology but hurricane-force winds reported a couple of hours earlier, an intensity of 70 kt is selected at 12Z on the 15th, down from 80 kt originally in HURDAT, a minor intensity change. A central pressure of 985 mb is added to HURDAT at 12Z on the 15th. A major intensity change is shown at 06Z on the 15th as HURDAT originally had 140 kt and the analyzed intensity is 85 kt.

A reconnaissance aircraft investigated Ethel at 17Z on the 15th measuring a central pressure of 984 mb. Earlier at 1525Z on this date, another reconnaissance aircraft estimated an eye diameter at 40 nm. An eye diameter of 40 nm suggests an RMW of about 30 nm and climatology indicates 24 nm. A central pressure of 984 mb suggests maximum surface winds of 68 kt north of 25N from the pressure-wind relationship. Due to the slow forward speed of about 7 kt and RMW larger than climatology, an intensity of 65 kt is selected at 18Z on the 15th, up from 60 kt originally in HURDAT, a minor intensity change. The tropical cyclone continued northward making landfall around 22Z near 30.4N, 89.0W or about halfway between Biloxi, MS and Gulfport, MS. Surface observations at Biloxi, MS clearly show that the hurricane passed just west of the city. The surface observations in the preliminary report in the storm wallets show that the pressure dropped to 979 mb at Gulfport, MS at 21Z on the 15th and 981 mb at Biloxi, MS at 23Z on the same date. Nevertheless, the observation at Gulfport, MS was not mentioned in the reports of the Monthly Weather Review or Navy reconnaissance book, leading us to believe that it was not a valid observation as it was consequently discarded. Moreover, the surface weather observations at Biloxi, MS indicate that the lowest pressure was 982.9 mb occurring at 2208Z on the 15th. But both the preliminary report of Ethel and Monthly Weather Report indicate that the lowest pressure at Biloxi, MS was 981 mb. So this value appears to have corrected downward slightly from 982.9 mb. Thus, 981 mb with a south wind of 10 kt indicates that the central pressure at landfall was 980 mb. A central pressure of 980 mb suggests maximum surface winds of 73 kt north of 25N from the pressure-wind relationship. Due to the slow forward speed of about 6 kt, an intensity of 70 kt at landfall at 22Z on the 15th. HURDAT originally indicated that Ethel made landfall as a category 1 hurricane but the intensity at 18Z on the 15th prior to landfall was 60 kt. Observations at Alabama indicate that hurricane-force winds did not affect the area and based on the surface observations, it is likely that the strongest winds

associated with Ethel were unusually present on the western quadrant, which affected Louisiana and Mississippi. Ethel rapidly weakened over Mississippi and weakening to a tropical storm is analyzed at 00Z on September 16th, six hours later than originally shown in HURDAT. The Kaplan and DeMaria model was run for 00Z, 06Z and 12Z on the 16th yielding 55 kt, 41 kt and 31 kt, respectively. The highest winds recorded at these times were below gale-force, though observations at these time were quite sparse. An intensity of 55 kt is selected at 00Z, 40 kt at 06Z, and 30 kt at 12Z on the 16th (up from 45 kt at 00Z, 35 kt at 06Z and down from 35 kt at 12Z, originally in HURDAT), all minor changes. Weakening below tropical storm force is indicated at 12Z on the 16th, six hours earlier than originally shown in HURDAT. At 12Z on the 16th, Meridian, MS reported 8 kt NE and 1008 mb suggesting a central pressure of 1007 mb, which has been added to HURDAT. The tropical depression continued weakening on the 16th and 17th ahead of an approaching frontal boundary. Dissipation is analyzed after 18Z on the 17th, same as originally shown in HURDAT.

Tropical Storm Florence [September 17-27, 1960]

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41715 09/17/1960 M=11  7 SNBR= 907 FLORENCE    XING=0 SSS=0                      L
41720 09/17*  0   0   0    0*209 640  25    0*211 648  25    0*212 658  25    0*
41720 09/17*  0   0   0    0*209 640  25    0*211 648  25    0*212 658  30    0*
                                                                  **

41725 09/18*212 668  35    0*210 679  35    0*209 690  35    0*209 702  40    0*
41725 09/18*212 668  35    0*210 679  40    0*209 690  45 1000*209 701  40 1003*
                           **               ** ****     ***     ****

41730 09/19*209 713  35    0*210 724  35    0*211 738  35    0*215 745  30    0*
41730 09/19*209 712  40 1003*210 724  40 1004*211 737  35 1006*215 747  30    0*
                ***  ** ****          ** ****     ***     ****     ***

41735 09/20*220 754  30    0*226 765  25    0*232 776  25    0*235 786  25    0*
41735 09/20*220 756  30    0*226 765  25    0*232 776  25    0*235 786  25    0*
                ***

41740 09/21*237 796  25    0*236 806  25    0*235 816  25    0*232 826  25    0*
41740 09/21*237 796  25    0*237 806  25    0*236 816  25    0*234 826  25    0*
                             ***              ***              ***

41745 09/22*227 836  25    0*221 843  25    0*220 834  25    0*227 831  25    0*
41745 09/22W228 836  25    0W223 840  25    0W220 837  25    0W223 835  25    0*
          ****              ****  ***         *    ***         ****  ***

41750 09/23*236 827  25    0*244 822  25    0*251 816  25    0*259 811  25    0*
41750 09/23W230 832  25    0W240 826  25    0*249 818  25 1005*259 811  30    0*
          **** ***           ****  ***         ***  ***     ****          **

41755 09/24*267 805  25    0*273 803  25    0*275 805  25    0*276 810  25    0*
41755 09/24*267 805  35    0*273 803  50    0*275 805  50    0*276 810  40    0*
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41760 09/25*277 818  25    0*278 829  20    0*279 839  15    0*283 848  15    0*
41760 09/25*277 818  30    0*278 829  25    0*279 839  25    0*283 848  25    0*
                     **               **               **               **

41765 09/26*289 856  15    0*295 864  15    0*301 871  15    0*308 877  15    0*
41765 09/26*289 856  25    0*295 864  20    0*301 871  20    0*308 877  15    0*
                     **               **               **

41770 09/27*318 885  15    0*325 890  15    0*  0   0   0    0*  0   0   0    0*
41770 09/27*318 885  15    0*  0   0   0    0*  0   0   0    0*  0   0   0    0*
                           *   *   *

41775 TS
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Tropical Storm Landfall

09/19 09Z 21.1N 73.1W 35 kt Great Inagua, Bahamas

Minor changes to the track and major changes to the intensity shown in McAdie et al. (2009). Evidence for these alterations comes from the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Monthly Weather Review, Navy reconnaissance book, Surface Weather Observations, Mariners Weather Log, and NHC Storm Wallets. A major alteration is to indicate that Florence weakened to a tropical wave for 36 hours.

September 16:

HWM analyzes a spot low at 18.7N, 61.4W at 12Z. HURDAT does not list an organized system on this date. Microfilm does not show an organized system at 12Z. Ship highlights: No gales or low pressures.

MWR: “An extensive shower area was noted well to the northeast of the Leeward Islands September 16 although there were no indications of a definite circulation.” ATSR: “Tropical Storm Florence developed from an easterly wave which first was detected by ship reports about 500 miles east of the Leeward Islands on the 15 of September. This wave was extrapolated westward with the aid of a few peripheral ship reports.”

September 17:

HWM analyzes a closed low pressure of at most 1010 mb at 20.9N, 65.0W at 12Z. HURDAT lists a 25 kt tropical depression at 21.1N, 64.8W at 12Z. Microfilm shows a closed low pressure of at most 1011 mb at 21.5N, 63.0W at 12Z. Navy reconnaissance book lists the best track position at 21.2N, 64.7W at 12Z (first position). Ship highlights: No gales or low pressures.

MWR: “By the morning of the 17th, pressures through the eastern Antilles had fallen 3 to 5 mb with light south and southwest winds indicating the possibility that a circulation had developed. On the evening of the 17th, reports from shipping to the north of Puerto Rico

placed a closed circulation near 21ºN, 66ºW with winds up to 35 mph." ATSR: "Subsequently, at 171800Z, three ship reports indicated a closed cyclonic circulation located at 21.4N 65.7W with rain squalls and winds of 25 knots."

September 18:

HWM analyzes a tropical storm of at most 1005 mb at 20.5N, 69.0W at 12Z. HURDAT lists a 35 knot tropical storm at 20.9N, 69.0W at 12Z. Microfilm shows a closed low pressure of at most 1005 mb at 21.0N, 69.2W at 12Z. Navy reconnaissance book lists the best track position at 20.9N, 69.0W at 12Z. 35 kt N and 1012 mb at 23.7N, 66.1W at 00Z (COADS). 35 kt SSE and 1000 mb (dubious) at 20.4N, 68.1W at 12Z (micro). 35 kt SE and 1007 mb at 21.7N, 69.1W at 18Z (COADS). Land highlights: 20 kt NE and 1005 mb at Cockburn Town, Grand Turk at 18Z (micro). 15 kt NE and 1004 mb at Cockburn Town, Grand Turk at 21Z (micro). Aircraft highlights: Penetration center fix measured a central pressure of 1000 mb and estimated surface winds of 45 kt at 20.8N, 69.7W at 1352Z (ATSR). Penetration center fix measured a central pressure of 1003 mb and estimated surface winds of 45 kt at 20.9N, 70.1W at 18Z (ATSR).

MWR: "The Low continued westward about 10 mph and reconnaissance aircraft located a broad, ill-defined center with maximum winds around 40 mph on the morning of the 18th near 21ºN, 69ºW." ATSR: "At 181352Z, a Navy reconnaissance flight located a wind and pressure center at 20.8N 69.7W with maximum surface winds of 45 knots. The first warning on FLORENCE was issued at 181600Z. FLORENCE reached her maximum intensity on the 18th of September."

September 19:

HWM analyzes a tropical storm of at most 1010 mb at 20.7N, 73.7W at 12Z. HURDAT lists a 35 knot tropical storm at 21.1N, 73.8W at 12Z. Microfilm shows a closed low pressure of at most 1008 mb at 21.5N, 73.5W at 12Z. Navy reconnaissance book lists the best track position at 21.2N, 73.5W at 12Z. Ship highlights: 35 kt E and 1005 mb at 22.1N, 70.9W at 00Z (micro). 40 kt SE and 1001 mb at 21.8N, 70.2W at 03Z (COADS). Land highlights: 10 kt ESE and 1004 mb at Cockburn Town, Grand Turk at 00Z (micro). 15 kt W and 1005 mb at Matthew Town, Bahamas at 09Z (micro). Aircraft highlights: Penetration center fix measured a central pressure of 1006 mb and estimated surface winds of 35 kt at 21.3N, 73.8W at 1330Z (ATSR). Penetration center fix estimated an eye diameter of 15 nm at 21.9N, 74.3W at 1553Z (ATSR).

ATSR: "Then dissipated on the 19th of September. The final warning was issued at 191600Z."

September 20:

HWM analyses a closed low pressure of at most 1010 mb at 22.9N, 77.5W at 12Z. HURDAT lists a 25 knot tropical depression at 23.2N, 77.6W at 12Z. Microfilm shows a spot low pressure at 23.5N, 77.6W at 12Z. Navy reconnaissance book lists the best track position at 23.4N, 77.5W at 12Z. Ship highlights: No gales or low pressures.

MWR: “Tropical Storm Florence moved on a west to westnorthwest track near 12 mph, gradually weakening until the 20th when reconnaissance aircraft found only a weak Low south of Andros Island in the Bahamas with no significant weather or strong winds.” ATSR: “The remaining weak, poorly defined low pressure cell followed an erratic track which passed between the Bahamas and Cuba.”

September 21:

HWM analyzes a spot low at 23.7N, 81.4W at 12Z. HURDAT lists a 25 knot tropical depression at 23.5N, 81.6W at 12Z. Microfilm shows a closed low pressure of at most 1011 mb at 23.8N, 80.2W at 12Z. Navy reconnaissance book lists the best track position at 23.8N, 81.6W at 12Z. Ship highlights: No gales or low pressures.

September 22:

HWM analyzes a spot low at 21.7N, 83.6W at 12Z. HURDAT lists a 25 knot tropical depression at 22.0N, 83.4W at 12Z. Microfilm shows a closed low pressure of at most 1009 mb near 21.0N, 84.0W at 12Z. Navy reconnaissance book lists the best track position at 22.1N, 83.2W at 12Z. Ship highlights: No gales or low pressures.

MWR: “The remains of Florence moved into the western end of Cuba and became nearly stationary until the evening of the 22nd when conditions became more favorable for redevelopment.” ATSR: “It made a loop over western Cuba and headed northeastward over southern Florida.”

September 23:

HWM analyzes a spot low at 23.8N, 82.8W at 12Z. HURDAT lists a 25 knot tropical depression at 25.1N, 81.6W at 12Z. Microfilm shows an elongated, closed low pressure of at most 1008 mb near 24.0N, 84.W at 12Z. Navy reconnaissance book lists the best track position at 25.3N, 81.5W at 12Z. Ship highlights: No gales or low pressures. Land highlights: 35 kt ENE (gusts to 52 kt, max wind) and 1009 mb at Vero Beach, FL at 2359Z (SWO). Aircraft highlights: Penetration center fix measured a central

pressure of 1005 mb and estimated surface winds of 22 kt at 25.5N, 81.4W at 1330Z (ATSR).

MWR: “The Low began moving northeastward and was located just off the southwestern Florida coast by the morning of the 23rd with winds up to 30 mph and widespread rain over southeastern Florida. It then became blocked by a large high pressure system along the mid-Atlantic coast after reaching the vicinity of Lake Okeechobee the evening of the 23rd and changed to a west-northwest track…” ATSR: “During its entire course, FLORENCE never developed a well defined wall cloud or eye. Redevelopment appeared imminent late on the 23rd of September. In the late afternoon of this date, a heavy spiral band of showers moved across southern Florida. Peak wind gusts to 50 knots were reported in the vicinity of Vero Beach as the depression approached the east coast of Florida. Rapid weakening took place, however, after the low pressure center doubled back across Florida and headed into the Gulf of Mexico.”

September 24:

HWM analyzes a spot low at 27.4N, 80.3W at 12Z. HURDAT lists a 25 knot tropical depression at 27.5N, 80.5W at 12Z. Microfilm shows a closed low pressure of at most 1008 mb at 27.8N, 80.5W at 12Z. Navy reconnaissance book lists the best track position at 27.7N, 80.7W at 12Z. Ship highlights: 50 kt E and 1009 mb at 27.4N, 79.9W at 06Z (COADS). 40 kt E and 1012 mb at 29.0N, 79.8W at 12Z (COADS). 40 kt SE and 1010 mb at 28.2N, 79.3W at 18Z (COADS).

September 25:

HWM analyzes a closed low pressure of at most 1010 mb at 27.4N, 84.0W at 12Z. HURDAT lists a 15 knot tropical depression at 27.9N, 83.9W at 12Z. Microfilm shows a closed low pressure of at most 1008 mb at 27.8N, 85.0W at 12Z. Navy reconnaissance book lists the best track position at 28.0N, 83.7W at 12Z. Ship highlights: No gales or low pressures.

MWR: “…drifting into the eastern Gulf of Mexico near Tampa early on the 25th.” ATSR: “Then, turning westward and northwestward across the Gulf of Mexico, it finally moved into southern Alabama where complete dissipation occurred.”

September 26:

HWM analyzes a spot low at 29.5N, 87.1W with a front to the west at 12Z. HURDAT lists a 15 knot tropical depression at 30.1N, 87.1W at 12Z. Microfilm shows a closed low pressure of at most 1011 mb at 29.4N, 87.1W at 12Z. Navy reconnaissance

book lists the best track position at 30.1N, 87.0W at 12Z. Ship highlights: No gales or low pressures.

MWR: “The Low continued quite weak over the Gulf and moved into the Pensacola area on the morning of the 26th with winds less than 25 mph but with a rather large rain area that covered the southern portions of Alabama and Georgia and northwestern Florida. Florence was never a well-defined tropical storm and maximum winds were just barely of tropical storm intensity (for only a short period) although gusts to 52 mph were reported in the Vero Beach area in a squall when the Low was nearest that station. The only significant damage in this storm was from local flooding in Florida. Rainfall totals of 3 to 6 inches or more were reported during passage of the Low on ground that was already saturated from the previous heavy rains of Donna.”

September 27:

HWM analyzes a cold front over the southeast of the United States stretching into the Gulf as Florence appears to have dissipated at 12Z. HURDAT lists a 15 knot tropical depression at 32.5N, 89.0W at 06Z (last position). Microfilm does not show an organized system at 12Z. Navy reconnaissance book lists the best track position at 31.5N, 88.2W at 12Z (last position). Ship highlights: No gales or low pressures.

A tropical wave left the African coast on the second week of September and slowly became better organized as it approached the Leeward Islands. Observations of the reconnaissance routine surveillance on the microfilm at 12Z on September 16th indicate that the tropical wave did not have a well-defined center. The tropical wave became better defined early on September 17th. The first position in HURDAT is at 06Z on the 17th as a 25 kt tropical depression located northeast of Puerto Rico. The data is scarce around the tropical depression, which makes it difficult to determine the exact time of genesis. Thus, the first position in HURDAT is retained. Minor track alterations are introduced during the lifetime of this tropical cyclone. The tropical cyclone moved westward becoming a tropical storm at 00Z on September 18th, same as originally shown in HURDAT. The first gale was reported at 00Z on the 18th on the northern quadrant of Florence. The first reconnaissance aircraft reached the tropical storm at 1352Z on the 18th measuring a central pressure of 1000 mb and estimating surface winds of 45 kt. A central pressure of 1000 mb suggests maximum surface winds of 47 kt south of 25N from the Brown et al. pressure-wind relationship. Based on an average forward speed of 11 kt, an intensity of 45 kt is selected at 12Z on the 18th, up from 35 kt originally in HURDAT, a minor intensity change. A central pressure of 1000 mb is added to HURDAT at 12Z on the 18th. Another center penetration measured a central pressure of 1003 mb and estimated surface winds of 45 kt at 18Z on the 18th. A central pressure of 1003 mb suggests maximum surface winds of 41 kt south of 25N from the pressure-wind

relationship. Based on an average forward speed of 11 kt, an intensity of 40 kt is selected at 18Z on the 18th, same as originally shown in HURDAT. A central pressure of 1003 mb is added to HURDAT at 18Z on the 18th. Early on the 19th, the tropical storm passed south of the Turks and Caicos. At 00Z, Cockburn Town, Grand Turk reported 10 kt NE and 1004 mb, suggesting a central pressure of 1003 mb, which has been added to HURDAT. Florence gradually weakened on the 19th as it continued moving westward. At 09Z on the 19th, Great Inagua, Bahamas reported 15 kt W and 1005 mb, suggesting a central pressure of 1004 mb, which has been added to HURDAT at 06Z. Around 10Z on the 19th, the center of Florence made landfall in Great Inagua, Bahamas with winds of 35 kt. A reconnaissance aircraft reached the tropical storm at 1330Z on the 19th measuring a central pressure of 1006 mb and estimating surface winds of 35 kt. A central pressure of 1006 mb suggests maximum surface winds of 35 kt south of 25N from the pressure-wind relationship. An intensity of 35 kt is selected at 12Z on the 19th, same as originally shown in HURDAT. A central pressure of 1006 mb has been added to HURDAT at 12Z on the 19th. Weakening to a tropical depression occurred at 18Z on the 19th, same as originally shown in HURDAT.

Florence continued westward to west-northwest on the 20th and 21st passing between Florida and Cuba with little change in intensity, but the tropical cyclone gradually became less organized. Synoptic observations early on September 22nd indicate that Florence degenerated into a sharp trough stretching from southern Florida into the northwest Caribbean Sea. The disturbance stayed generally over the same area for the next 24 hours. Early on September 23rd, the remnants of Florence began to become better organized as the disturbance started to move northeastward toward Florida. It is analyzed that Florence regained tropical depression status at 12Z on the 23rd while located just north of the Florida Keys. A reconnaissance aircraft investigated the system at 1330Z on the 23rd measuring a central pressure of 1005 mb and estimating surface winds of 22 kt. An intensity of 25 kt is selected at 12Z on the 23rd, same as originally shown in HURDAT. A central pressure of 1005 mb has been added to HURDAT at 12Z on the 23rd. Late on the 23rd, the tropical depression made landfall in southwest Florida and the forward speed began to decrease. At 00Z on September 24th, Vero Beach, FL reported sustained winds of 35 kt and gusts to 52 kt. Intensification to a tropical storm is indicated at 00Z on the 24th while the center was over the Florida peninsula, up from 35 kt originally in HURDAT, a minor intensity change. HURDAT originally kept Florence as a tropical depression after it weakened from a tropical storm on the 19th. At 06Z on the 24th, a couple of ships within 120 nm of the center reported gale-force winds, including 50 kt E. This last ship “77902” was located about 30 nm from the center over the eastern quadrant. Observations from “77902” before and after 06Z on the 24th are consistent with nearby ships. An intensity of 50 kt is selected at 06Z and 12Z on the 24th, up from 25 kt originally in HURDAT, a major intensity change. 50 kt is also the peak intensity of

this tropical cyclone, up from 40 kt originally in HURDAT, a minor intensity change. Florence approached the east coast of Florida around 06Z on the 24th but did not reach the Atlantic. The intensification of Florence over land is similar to Tropical Storm Fay in 2008. Late on the 24th, Florence turned to the northwest and began to weaken. Weakening to a tropical depression is analyzed at 00Z on September 25th. The center of the tropical cyclone moved back into the Gulf of Mexico around 06Z on the 25th. The tropical depression continued northwestward on the 25th and 26th, making landfall as a 20 kt tropical depression in the western Panhandle of Florida. Dissipation is analyzed after 00Z on September 27th, six hours earlier than originally shown in HURDAT.

1960 - Additional Notes

1) May 3-9: Historical Weather Maps and Microfilm show a frontal boundary over the western Atlantic on May 3rd. A low pressure developed between Bermuda and the Bahamas on May 4th but remained embedded within the frontal boundary. The disturbance drifted to the southeast and COADS showed that it began producing gales in the northern quadrant on the 4th. The extratropical cyclone started to occlude on May 5th while producing gales up to 55 kt about 250 nm north of the center. Late on May 6th, microfilm maps show that the extratropical cyclone lost its frontal boundaries and there was little temperature gradient around the system. Nonetheless, the strongest winds remained well north of the center. On May 7th, the disturbance began to weaken and dissipation occurred on May 9th as another frontal boundary approached the area. Therefore, because synoptic data suggests that the disturbance did not become a tropical cyclone or subtropical, it is not added to HURDAT. This disturbance was in Jack Beven's and David Roth's List of Suspects.

Day	Latitude	Longitude	Status
May 3	30N	78W	Frontal boundary
May 4	30N	74W	Extratropical
May 5	29N	68W	Occluded
May 6	29N	67W	Subtropical Storm?
May 7	28N	68W	Subtropical Storm?
May 8	28N	68W	Subtropical Depression?
May 9			Absorbed

2) May 26-31: Historical Weather Maps indicate that a frontal boundary moved off the east coast of the United States on May 26th. An extratropical cyclone developed along the

frontal boundary on May 27th and began to move to the northeast. Gale-force winds were observed on May 29th but Historical Weather Maps clearly show that the disturbance remained extratropical with a significant temperature gradient across the circulation. On May 30th, the extratropical cyclone weakened and dissipated the next day. The remnants were absorbed by a larger extratropical cyclone over the north Atlantic. Therefore, because the disturbance did not acquire tropical characteristics, it is not added to HURDAT. This disturbance was in Jack Beven's List of Suspects.

Day	Latitude	Longitude	Status
May 26	Northwest Atlantic		Frontal boundary
May 27	33N	66W	Extratropical
May 28	37N	61W	Extratropical
May 29	39N	56W	Extratropical
May 30	43N	51W	Extratropical
May 31			Dissipated

3) June 2-10: Historical Weather Maps show a low pressure system that meandered over the central Atlantic for about a week early in June. Synoptic data suggests that the disturbance was non-frontal and closed, likely a tropical depression, but COADS indicate that the winds remained below tropical storm force. By June 10th, the disturbance dissipated as a frontal system approached the area. Therefore, because the disturbance did not produce tropical storm force winds, it is not added to HURDAT. This disturbance was in Jack Beven's List of Suspects.

Day	Latitude	Longitude	Status
June 2	29N	59W	Tropical Depression?
June 3	30N	57W	Tropical Depression?
June 4	30N	53W	Tropical Depression?
June 5	28N	48W	Tropical Depression?
June 6	29N	44W	Tropical Depression?
June 7	29N	43W	Tropical Depression?
June 8	35N	45W	Tropical Depression?

June 9	38N	47W	Tropical Depression?
June 10			Dissipated

4) June 7-12: Historical Weather Maps indicate that a low pressure developed over the western Caribbean Sea on June 7th, likely associated with a tropical wave or an eastward incursion of the eastern Pacific monsoon trough. The disturbance was embedded within an environment of low pressure and moved very little after formation. COADS were obtained but no gale-force winds were reported, it was likely a tropical depression. Therefore, because it did not produce tropical storm force winds, it is not added to HURDAT. This disturbance was in Jack Beven's List of Suspects.

Day	Latitude	Longitude	Status
June 7	18N	86W	Tropical Depression?
June 8	18N	86W	Tropical Depression?
June 9	17N	82W	Tropical Depression?
June 10	18N	81W	Tropical Depression?
June 11	18N	85W	Tropical Depression?
June 12	18N	85W	Tropical Depression?
June 13			Dissipated

5) June 9-12: Historical Weather Maps indicate that a frontal system entered the western Atlantic on June 6th. The frontal boundary moved little over the next couple of days and an extratropical cyclone developed on June 9th. The disturbance moved generally northeastward and produced gale-force winds on June 11th when it began to occlude, but a significant temperature gradient remained present across the cyclone. On June 13th, it became embedded again within a frontal boundary as it moved into the north Atlantic. Therefore, because the disturbance did not acquire tropical characteristics, it is not added to HURDAT. This disturbance was in Jack Beven's List of Suspects.

Day	Latitude	Longitude	Status
June 9	32N	74W	Extratropical
June 10	36N	64W	Extratropical

June 11	38N	70W	Occluded
June 12	44N	60W	Occluded
June 13	49N	49W	Extratropical

6) August 26 – September 2: Historical Weather Maps show that a tropical wave left the African coast on August 26th. The disturbance moved generally westward over the next couple of days over an area of sparse ship traffic. The strong tropical wave was located about 800 nm east of the Leeward Islands on August 31st and the synoptic data in the microfilm maps shows winds up to 30 kt on the northern portion of the circulation. Data remained sparse but it appears likely that it did not have a closed circulation at this time. On September 1st, the disturbance turned northward, and COADS and microfilm indicate that it was producing gale-force winds over the northeast quadrant. Ship and routine surveillance reconnaissance data suggests that a closed circulation may have developed at 18Z on the 1st, but observations before and after this time indicate that only a sharp trough was present. The disturbance continued northward on September 2nd and a closed circulation appears to have formed late in the day but no gale-force winds were reported at this time. An approaching frontal boundary caused the disturbance to weaken on September 3rd leading to its dissipation. Therefore, although it is possible that this system may have been a tropical storm, the data available does not suggest that a well-defined circulation was present at the time the disturbance was producing gale-force winds and it is not added to HURDAT. This disturbance was in Jack Beven's List of Suspects.

Day	Latitude	Longitude	Status
August 26	14N	23W	Tropical Wave?
August 27	12N	24W	Tropical Wave?
August 28	13N	30W	Tropical Wave?
August 29	14N	40W	Tropical Wave?
August 30	17N	47W	Tropical Wave?
August 31	20N	49W	Tropical Depression?
September 1	26N	52W	Tropical Storm?
September 2	30N	51W	Tropical Storm?
September 3			Dissipated

7) September 16-19: Historical Weather Maps show a disturbance over the far eastern Atlantic on September 16th. The disturbance moved slowly westward over the next couple of days and dissipated on September 19th. COADS were obtained but no gale-force winds were reported. Therefore, because no gale-force winds were observed, it is not added to HURDAT.

Day	Latitude	Longitude	Status
September 16	24N	34W	Tropical Depression?
September 17	24N	38W	Tropical Depression?
September 18	24N	41W	Tropical Depression?
September 19			Dissipated

8) September 22-30: Historical Weather Maps and microfilm maps show a frontal boundary over the western Atlantic on September 22nd. An extratropical cyclone developed on September 23rd and COADS were obtained showing gale-force winds about 250 nm north of the center. On September 24th and early on the 25th, the circulation became elongated NE-SW and the gales remained well north of the center. Late on the 25th, synoptic data indicate that the disturbance may have become a tropical or subtropical cyclone as the circulation became more symmetric and gale-force winds were reported about 60 nm from the center. Yet, observations early on September 26th indicate that the disturbance became less organized and the gale-force winds were observed far to the northwest of the center. On September 27th and 28th, the disturbance moved slowly northward with little change in organization. On September 29th, the disturbance developed frontal features as it began to accelerate northeastward into the north Atlantic. Late on September 30th, the disturbance dissipated south of Newfoundland. Therefore, because observations indicate that the system likely remained non-tropical, it is not added to HURDAT. This disturbance was in Jack Beven and David Roth's List of Suspects.

Day	Latitude	Longitude	Status
September 22	Western Atlantic		Frontal boundary
September 23	34N	62W	Extratropical
September 24	34N	63W	Occluded
September 25	33N	64W	Subtropical Storm?
September 26	34N	67W	Subtropical Storm?
September 27	34N	71W	Subtropical Storm?
September 28	37N	71W	Subtropical Storm?
September 29	41N	67W	Extratropical
September 30	45N	51W	Extratropical

9) September 22-29: Historical Weather Maps show a tropical wave that left the African coast on September 22nd. Observations over the eastern Atlantic are scarce and the tropical wave moved generally westward over the next couple of days. Microfilm maps

show a 35 kt ship at 12Z on September 27th but observations from ships nearby indicate that it likely has a high bias. At 00Z on September 28th, HWM synoptic data indicates that a closed circulation may have developed and a couple of ships reported gale-force winds. Yet, COADS indicates that one of the gales was just 20 kt and the other ship was the same one with the high bias observed on the 27th. Observations late on the 28th show that the disturbance had degraded into a tropical wave and dissipation occurred on September 29th. Therefore, because the disturbance never had a well-defined circulation and the reported gale-force winds likely have a high bias, it is not added to HURDAT. This disturbance was in Ryan Truchelut's List of Suspects.

Day	Latitude	Longitude	Status
September 22	13N	16W	Tropical Wave?
September 23	13N	23W	Tropical Wave?
September 24	14N	25W	Tropical Wave?
September 25	14N	30W	Tropical Wave?
September 26	14N	40W	Tropical Wave?
September 27	15N	50W	Tropical Depression?
September 28	20N	56W	Tropical Storm?
September 29			Dissipated

10) October 27 – November 3: Historical Weather Maps indicate that a frontal boundary over the western Atlantic caused the development of an extratropical cyclone on October 28th. The extratropical cyclone moved generally eastward and the HWM shows that it may have become detached from the frontal boundary on November 1st. The next day, the disturbance became embedded within a frontal boundary again and later dissipated over the north Atlantic on November 3rd. Therefore, because the disturbance did not acquire tropical characteristics, it is not added to HURDAT. This disturbance was in Jack Beven's List of Suspects.

Day	Latitude	Longitude	Status
October 27	Western Atlantic		Frontal boundary
October 28	35N	72W	Extratropical
October 29	36N	72W	Extratropical
October 30	37N	67W	Extratropical
October 31	35N	60W	Extratropical
November 1	33N	57W	Subtropical Storm?
November 2	35N	46W	Extratropical
November 3			Dissipation

11) December 19-24: Historical Weather Maps show an extratropical cyclone near the eastern Azores on December 19th. COADS were obtained showing gale-force winds over the north and western quadrants but far from the center. The extratropical cyclone detached from the frontal boundary on December 20th. The disturbance moved southwestward over the next couple of days and winds weakened below gale-force. Dissipation occurred over the central Atlantic on December 24th. Therefore, because the disturbance did not acquire tropical characteristics when it was producing gale-force winds, it is not added to HURDAT. This disturbance was in David Roth's List of Suspects.

Day	Latitude	Longitude	Status
December 19	35N	22W	Extratropical
December 20	31N	28W	Occluded
December 21	28N	31W	Subtropical Depression?
December 22	26N	33W	Subtropical Depression?
December 23	23N	36W	Subtropical Depression?
December 24			Dissipation

1961 hurricane season

Hurricane Anna [July 20–25, 1961]

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41780 07/20/1961 M= 5  1 SNBR= 908 ANNA        XING=0 SSS=0
41780 07/20/1961 M= 6  1 SNBR= 908 ANNA        XING=0 SSS=0
                    *

41785 07/20*115 602  35    0*117 620  45 1002*119 638  60  999*124 657  70    0*
41785 07/20*117 602  50    0*118 620  55    0*119 638  60    0*124 656  65  999*
           ***       **      ***       **    *                 *     ***  **  ***

41790 07/21*130 672  80 1002*132 695  90  992*134 715  95    0*137 733 100    0*
41790 07/21*129 675  65 1002*132 695  75  992*134 713  80    0*136 731  85  981*
           *** ***  **                 **          ***  **      *** ***  **  ***

41795 07/22*137 747 100  984*140 766 100  982*145 782 100  976*152 797 100    0*
41795 07/22*137 748  75  984*140 765  80  982*145 782  90  976*151 799  85    0*
                ***  **          ***  **                 **      *** ***  **

41800 07/23*152 814 100  990*153 829  95    0*158 843  90  992*160 857  90    0*
41800 07/23*152 814  70  990*153 829  70    0*158 843  70  992*161 857  80  981*
                     **                 **                 **      ***      **  ***

41805 07/24*161 864  85  989*163 875  80    0*166 883  70    0*169 891  60    0*
41805 07/24*161 867  75  989*162 877  75    0*165 887  65    0*168 897  45    0*
                ***  **      *** ***  **      *** ***  **      *** ***  **

(July 25th is new to HURDAT)
41807 07/25*170 907  30    0*  0   0   0    0*  0   0   0    0*  0   0   0    0*
           *** **   **

41810 HR
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Hurricane Landfall

07/23 12Z 15.8N 84.3W 70 kt Honduras
07/24 01Z 16.1N 86.9W 75 kt Utila Island, Honduras
07/24 10Z 16.4N 88.5W 75 kt Belize

Minor changes to the track and major changes to the intensity shown in McAdie et al. (2009). Evidence for these alterations comes from the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Monthly Weather Review, Navy reconnaissance book, National Hurricane Research Project, Mexican synoptic maps, Mariners Weather Log, Fritz (1962) and NHC Storm Wallets.

July 17:

HWM and microfilm do not show an organized system at 12Z. HURDAT does not list an organized system on this date. Ship highlights: No gales or low pressures.

ATSR: “An area of suspicion was noted well to the east of this position on July 17 when Navy reconnaissance aircraft reported a mass of strong radar echoes associated with an easterly wave between 14-16N and 50-54W.”

July 18:

HWM and microfilm do not show an organized system at 12Z. HURDAT does not list an organized system on this date. Ship highlights: No gales or low pressures.

July 19:

HWM and microfilm do not show an organized system at 12Z. HURDAT does not list an organized system on this date. Ship highlights: No gales or low pressures.

ATSR: “ANNA, the first tropical storm of the 1961 hurricane season, developed just east of Windward Islands on the evening of July 19. During the 18th and 19th the Intertroical Convergence Zone shifted well north of its normal position and it appears that cyclogenesis began at its intersection with the easterly wave first noted by the Navy aircraft on the 17th. At 191200Z the vessel BENNEKON reported easterly winds of 20 knots and 7-foot seas near 15N 55W. About this time the Windward Islands began to show abnormal falls in pressure.”

July 20:

HWM analyzes a tropical storm of at most 1010 mb at 11.7N, 63.9W at 12Z. HURDAT lists a 60 knot tropical storm at 11.9N, 63.8W at 12Z. Microfilm shows a closed low pressure of at most 1011 mb at 12.0N, 63.8W at 12Z. Navy reconnaissance book lists the best track position at 11.9N, 63.8W at 12Z. Ship highlights: 40 kt SE and 1010 mb at 13.1N, 62.8W at 12Z (COADS). 50 kt SE and 1003 mb at 12.5N, 64.5W at 1550Z (micro). 40 kt ESE at 12.6N, 64.0W at 18Z (micro). Land highlights: 1002 mb (min pressure) at Grenada at 05Z (WALLET/MWR/ATSR). Aircraft highlights: Penetration center fix estimated maximum surface winds of 55 kt at 11.8N, 63.8W at 1130Z (ATSR). Penetration center fix measured a central pressure of 999 mb and estimated maximum surface winds of 85 kt at 12.2N, 65.5W at 1834Z (ATSR).

MWR: “Anna, the first tropical cyclone of the 1961 Atlantic hurricane season, developed a short distance east of the Windward Islands on the evening of July 19. An area of suspicion was first noted well to the east on July 17 as Navy reconnaissance reported an extensive area of strong radar echoes between 14-16N and 50-55W. Shipping in the area also reported numerous showers with winds generally light and variable. TIROS showed the principal concentration of weather near 12N, 43W. During the 18th and 19th the ITCs shifted well north of its normal position and cyclogenesis probably occurred at, its

intersection with the easterly wave first noted by Navy aircraft on the 17th. Following reports from the island of Grenada, indicating heavy squalls with gusts to 50 mph and pressure of 1002 mb around midnight local time on the 19th, reconnaissance aircraft located Anna in the extreme southeastern Caribbean some 75 miles north of the Venezuelan coast on the morning of July 20. By afternoon winds had increased to slightly over hurricane force. From its inception, Anna maintained a course slightly north of due west on its entire track through the Caribbean Sea with forward speed between 15 and 23 mph." ATSR: "At 200000Z the wind at Barbados had increased to 25 knots from 110 degrees, while St. Lucia reported 25 knots at 050 degrees. Coupled with considerable shower activity in the area, indications were that the easterly wave had passed Barbados and intensified. Intensification was confirmed when Granada at 200500Z reported heavy squalls with gusts to 45 knots and a 1002 mb pressure. At 201025Z a Navy reconnaissance aircraft reported a weak, diffuse eye near 12.7N 64.0W. The first official warning was issued at 201330Z. By afternoon, winds had increased to slightly over hurricane force. ANNA continued to intensify while moving through the Caribbean on a heading just north of west. Anna caused minor damage at Trinidad and Grenada but there were no casualties."

July 21:

HWM analyzes a tropical storm of at most 1000 mb at 13.1N, 71.2W at 12Z. HURDAT lists a 95 knot hurricane at 13.4N, 71.5W at 12Z. Microfilm shows a closed low pressure of at most 1005 mb at 13.5N, 71.5W at 12Z. Navy reconnaissance book lists the best track position at 13.4N, 71.5W at 12Z. Ship highlights: 50 kt NNE and 1000 mb at 13.4N, 68.2W (likely wrong location) at 06Z (micro). 35 kt E at 15.3N, 68.4W at 10Z (micro). 50 kt ENE and 1009 mb at 14.5N, 72.3W at 18Z (COADS). 40 kt E and 1011 mb at 13.9N, 70.9W at 21Z (micro). Land highlights: 40 kt (max wind) at Aruba (time unknown)(WALLET). Aircraft highlights: Penetration center fix measured a central pressure of 1002 mb and estimated an eye diameter of 13 nm at 13.1N, 67.7W at 01Z (ATSR). Penetration center fix measured a central pressure of 992 mb, estimated maximum flight level winds of 90 kt and an eye diameter of 8 nm at 13.3N, 69.8W at 07Z (ATSR). Penetration center fix measured a central pressure of 983 mb, estimated maximum surface winds of 98 kt and an RMW of 12 nm at 13.0N, 71.0W around 1730Z (NHRP). Radar center fix at 13.4N, 71.7W at 1355Z (ATSR). Penetration center fix measured a central pressure of 981 mb, estimated maximum surface winds of 110 kt and an eye diameter of 18 nm at 13.8N, 73.8W at 1910Z (ATSR).

July 22:

HWM analyzes a tropical storm of at most 1000 mb at 14.3N, 78.1W at 12Z. HURDAT lists a 100 knot hurricane at 14.5N, 78.2W at 12Z. Microfilm shows a sharp

trough or tropical wave over the southern Caribbean Sea along longitude 78W at 12Z. Navy reconnaissance book lists the best track position at 14.5N, 78.2W at 12Z. Ship highlights: 35 kt E and 1012 mb at 16.3N, 76.0W at 06Z (micro). 40 kt ENE and 1016 mb at 19.3N, 80.0W at 18Z (COADS). 40 kt NE and 1007 mb at 15.6N, 81.6W at 21Z (micro). Aircraft highlights: Penetration center fix measured a central pressure of 984 mb and estimated an eye diameter of 25 nm at 13.6N, 74.9W at 01Z (ATSR). Penetration center fix estimated maximum surface winds of 88 kt and an eye diameter of 21 nm at 14.1N, 76.6W at 07Z (ATSR). Penetration center fix measured a central pressure of 976 mb and estimated an eye diameter of 18 nm at 14.5N, 77.8W at 1030Z (ATSR). Penetration center fix at 15.1N, 80.0W at 1823Z (ATSR).

MWR: “lowest pressure 976 mb (28.62 inches) on the 22nd.” ATSR: “After maximum winds increased to 110 knots early on the 22nd.”

July 23:

HWM analyzes a tropical storm of at most 995 mb at 15.8N, 84.1W at 12Z. HURDAT lists a 90 knot hurricane at 15.8N, 84.3W at 12Z. Microfilm shows a large closed low pressure of at most 1008 mb at 14.5N, 84.5W at 12Z. Navy reconnaissance book lists the best track position at 15.8N, 84.3W at 12Z. Ship highlights: No gales or low pressures. Aircraft highlights: Penetration center fix measured a central pressure of 990 mb, estimated maximum surface winds of 55 kt (limited by darkness) and an eye diameter of 25 nm at 15.2N, 81.7W at 01Z (ATSR). Radar center fix at 15.3N, 82.7W at 06Z (ATSR). Penetration center fix measured a central pressure of 992 mb, estimated maximum surface winds of 90 kt and an eye diameter of 18 nm at 15.7N, 84.4W at 1230Z (ATSR). Penetration center fix measured a central pressure of 981 mb, estimated maximum flight level winds of 50 kt and an eye diameter of 12 nm at 16.1N, 85.2W at 16Z (ATSR). Penetration center fix estimated maximum surface winds of 85 kt and an eye diameter of 14 nm at 16.1N, 86.3W at 2122Z (ATSR). Penetration center fix measured a central pressure of 989 mb at 16.1N, 86.6W at 2352Z (ATSR).

MWR: “On the 23rd the center skirted the extreme northeastern coast of Honduras.” ATSR: “…she grazed the northern coast of Honduras.…Considerable damage was reported along the extreme northern Honduras coast with several hundred buildings damaged or destroyed and many plantations suffering heavy damage to fruit trees. One death and a dozen casualties were reported from Trujillo, Honduras, and the Bay Islands, just north of Honduras. More than 5,000 coconut trees were blown down on Utila, a small island off the Honduras coast directly in the path of Anna.”

July 24:

HWM analyzes a tropical storm of at most 1000 mb at 16.0N, 88.6W at 12Z. HURDAT lists a 70 knot hurricane at 16.6N, 88.3W at 12Z. Microfilm shows a closed low pressure of at most 1002 mb at 16.8N, 88.3W at 12Z. Navy reconnaissance book lists the best track position at 16.6N, 88.3W at 12Z. Ship highlights: 45 kt NW and 1004 mb at 16.1N, 86.4W at 00Z (micro). Land highlights: 35 kt ESE and 1008 mb at Guanaja Island, Honduras at 03Z (micro). 10 kt S and 1005 mb at Tela, Honduras at 06Z (WALLET/micro). 40 kt NE and 1009 mb at Belize City, British Honduras at 12Z (micro).

MWR: "then passed westward into the mountains of southern British Honduras the next morning." ATSR: "…before passing inland on the 24th over British Honduras and dissipating. A total of 61 fixes on Anna was made by VW-4 in a maximum reconnaissance effort.…Unofficial reports from British Honduras indicated that damage was rather extensive at Punta Gorda [16.1N, 88.6W] in extreme southeastern British Honduras. The center of Anna moved inland over the British Honduras coast, a sparsely populated area, at approximately the same point that Abby entered in July 1960. The often observed succession of storms from the Caribbean into the Pacific did not occur on this occasion."

July 25:

HMW analyzes a sport low pressure at 16.5N, 94.0W at 12Z. HURDAT does not list an organized storm on this day. Microfilm shows a closed low pressure of at most 1008 mb at 16.5N, 93.5W at 12Z. Ship highlights: No gales or low pressures.

A tropical wave left the African coast around mid-July. The disturbance moved westward and on July 17th at 1440Z, a TIROS III satellite image (MWR 1962, pg. 109) indicated that the tropical wave was organizing with some banding features in the northern and southern quadrants. This satellite image appears to be a milestone in hurricane history as for the first time a satellite image is referenced in the Monthly Weather Review. The report of a west wind at 9.7N, 46.3W at 18Z on the 17th may indicate that the low-level circulation was closed, but the data is sparse and determined to be inconclusive. A paper by Fritz (1962) indicates that the tropical wave continued to become better organized on July 18th as shown by a TIROS III satellite image at 1557Z (MWR 1962, pg. 511). Data over the central Atlantic was sparse and the time of genesis is uncertain but likely occurred earlier than July 20th at 00Z as originally shown in HURDAT. The first position, not genesis, is analyzed at 00Z on July 20th as a 50 kt tropical storm. This intensity is based on a minimum pressure of 1002 mb measured at 05Z on the 20th on the island of Grenada as the center of Anna passed to the south. The barograph in the storm wallets indicates that the pressure dropped about 12 mb in 24 hours. A peripheral pressure of 1002 mb suggests maximum surface winds greater than 43 kt from the south

of 25N Brown et al. pressure-wind relationship. Due to a forward speed of about 18 kt, an intensity of 50 kt is selected at 00Z and 55 kt at 06Z on the 20th, up from 35 kt and 45 kt, respectively, originally in HURDAT, minor intensity changes. A central pressure of 1002 mb originally in HURDAT at 06Z on the 20th has been removed since it was a not a central pressure. Minor track alterations are introduced during the lifetime of this tropical cyclone. After entering the Caribbean Sea, Anna continued slightly north of due west at a fast forward speed. The first reconnaissance aircraft to reach the tropical storm measured a central pressure of 999 mb and estimated maximum surface winds of 85 kt at 1834Z on the 20th. A central pressure of 999 mb suggests maximum surface winds of 49 kt from the south of 25N pressure-wind relationship. Due to the forward speed of about 20 kt and slightly weighting the surface estimate, an intensity of 65 kt is selected at 18Z on the 20th, down from 70 kt originally in HURDAT, a minor intensity change. A central pressure of 999 mb was present in HURDAT at 12Z on the 20th and has been moved to 18Z. Intensification to a hurricane is analyzed at 18Z on the 20th, same as originally shown in HURDAT.

Another penetration center fix occurred at 01Z on July 21st measuring a central pressure of 1002 mb and estimating an eye diameter of 13 nm. A central pressure of 1002 mb suggests maximum surface winds of 43 kt from the south of 25N pressure-wind relationship. An eye diameter of 13 nm suggests an RMW of about 10 nm and the climatological value is 12 nm. Due to the fast forward speed of about 21 kt, RMW slightly below the climatological value and data later in the day, an intensity of 65 kt is analyzed for 00Z on the 21st, down from 80 kt originally in HURDAT, a minor change. At 07Z on the 21st, the reconnaissance aircraft measured a central pressure of 992 mb, estimated flight level winds of 90 kt and an eye diameter of 8 nm. A central pressure of 992 mb suggests maximum surface winds of 61 kt from the south of 25N pressure-wind relationship. An eye diameter of 8 nm suggests an RMW of about 6 nm and the climatological value is 12 nm. Due to the fast forward speed of about 20 kt and RMW below the climatological value, an intensity of 75 kt is analyzed for 06Z on the 21st, down from 90 kt originally in HURDAT, a minor change. Early on the 21st, Anna passed north of the ABC Islands where the strongest winds reported reached 40 kt. At 1548Z on the 21st, a TIROS III satellite image (MWR 1962, pg. 109) depicts a small, well-organized tropical cyclone with an organized CDO near or over the center, located just northwest of the Guajira Peninsula in Colombia. No eye is apparent in the satellite image. This was also a milestone as the first hurricane to appear in a satellite image. Another penetration fix occurred at 1910Z on the 21st measuring a central pressure of 981 mb, estimating surface winds of 110 kt and an eye diameter of 18 nm. A central pressure of 981 mb suggests maximum surface winds of 76 kt from the south of 25N pressure-wind relationship. An eye diameter of 18 nm suggests an RMW of about 14 nm and the climatological value is 13 nm. Due to a forward speed of 18 kt, RMW close to the

climatological value and slightly weighting the surface estimate, an intensity of 85 kt is analyzed for 18Z on the 21st, down from 100 kt originally in HURDAT, a minor intensity change. A central pressure of 981 mb has been added to HURDAT at 18Z on the 21st.

On July 22nd, Anna moved away from South America and entered the central Caribbean on its way to Central America. The first aircraft to investigate the hurricane on the 22nd occurred at 01Z and measured a central pressure of 984 mb and an eye diameter of 25 nm. A central pressure of 984 mb suggests maximum surface winds of 72 kt from the south of 25N pressure-wind relationship. An eye diameter of 25 nm suggests an RMW of about 19 nm and the climatological value is 13 nm. Due to a forward speed of 18 kt and RMW larger than the climatological value, an intensity of 75 kt is analyzed for 00Z on the 22nd, down from 100 kt originally in HURDAT, a major intensity change. A central pressure of 982 mb was present in HURDAT at 06Z and has been retained as it appears reasonable (but could not be confirmed) with the data available. At 07Z, an aircraft reconnaissance estimated surface winds of 88 kt and an eye diameter of 21 nm. This flight might have measured the 982 mb central pressure present in HURDAT at 06Z on the 22nd. A central pressure of 982 mb suggests maximum surface winds of 75 kt from the south of 25N pressure-wind relationship. An eye diameter of 21 nm suggests an RMW of about 16 nm and the climatological value is 14 nm. Due to a forward speed of 18 kt and RMW close to the climatological value, an intensity of 80 kt is analyzed for 06Z on the 22nd, down from 100 kt originally in HURDAT, a major intensity change. Another penetration fix measured a central pressure of 976 mb and an eye diameter of 18 nm at 1030Z on the 22nd. A central pressure of 976 mb suggests maximum surface winds of 83 kt from the south of 25N pressure-wind relationship. An eye diameter of 18 nm suggests an RMW of about 14 nm and the climatological value is 14 nm. Due to a forward speed of 18 kt and RMW same as the climatological value, an intensity of 90 kt is analyzed for 12Z on the 22nd, down from 100 kt originally in HURDAT, a minor intensity change. 90 kt is also the peak intensity of hurricane Anna, down from 100 kt originally in HURDAT from 18Z on the 21st to 00Z on the 23rd. Hence, Anna is analyzed to have remained below major hurricane intensity during its lifetime. On July 23rd at 01Z, a reconnaissance aircraft measured a central pressure of 990 mb, estimated surface winds of 55 kt (wind estimate limited by darkness) and an eye diameter of 25 nm. A central pressure of 990 mb suggests maximum surface winds of 64 kt from the south of 25N pressure-wind relationship. An eye diameter of 25 nm suggests an RMW of about 19 nm and the climatological value is 14 nm. Due to a forward speed of 15 kt and RMW larger than the climatological value, an intensity of 70 kt is analyzed for 00Z on the 23rd, down from 100 kt originally in HURDAT, a major intensity change. Anna continued west-northwest and made landfall around 12Z in northeastern Honduras as a 70 kt hurricane. At 1230Z, a penetration fix measured a central pressure of 992 mb, estimated

surface winds of 90 kt and an eye diameter of 18 nm. A central pressure of 992 mb suggests maximum surface winds of 61 kt from the south of 25N pressure-wind relationship. An eye diameter of 18 nm suggests an RMW of about 14 nm and the climatological value is 14 nm. Due to a forward speed of 15 kt, RMW close to the climatological value and some weighting of the visual estimate, an intensity of 70 kt is analyzed for 12Z on the 22nd, down from 90 kt originally in HURDAT, a major intensity change. The center of Anna skirted the coast of Honduras for about four hours. Interaction with land apparently did not weaken Anna as a reconnaissance aircraft at 16Z measured a central pressure of 981 mb and an eye diameter of 12 nm. A central pressure of 981 mb suggests maximum surface winds of 76 kt from the south of 25N pressure-wind relationship. An eye diameter of 12 nm suggests an RMW of about 9 nm and the climatological value is 14 nm. Due to a forward speed of 14 kt and RMW smaller than the climatological value, an intensity of 80 kt is analyzed for 06Z on the 22nd, down from 90 kt originally in HURDAT, a minor intensity change. A central pressure of 981 mb has been added to HURDAT at 18Z on the 23rd. The last penetration fix occurred at 2352Z on the 23rd measuring a central pressure of 989 mb. At 2122Z, another pass estimated surface winds of 85 kt and an eye diameter of 14 nm. A central pressure of 989 mb suggests maximum surface winds of 65 kt from the south of 25N pressure-wind relationship. An eye diameter of 14 nm suggests an RMW of about 11 nm and the climatological value is 14 nm. Due to a forward speed of 10 kt and RMW smaller than the climatological value, an intensity of 75 kt is analyzed for 00Z on the 24th, down from 85 kt originally in HURDAT, a minor intensity change. The hurricane continued west-northwest affecting the Bay Islands along its path. Landfall in the island of Utila, Honduras is analyzed at 01Z on the 24th as a 75 kt hurricane. The island was reported to have sustained heavy damages. Anna maintained a west-northwest course early on the 24th and impacted Belize near 16.4N, 88.5W or about 70 nm south of Belize City, at 10Z as a 75 kt hurricane. The landfall intensity in Belize is uncertain as there were no observations near the center of Anna during the last 10 hours before landfall or after landfall. The observations in Belize available in the Storm Wallets contradict the data available as the pressure values and time observed do not match the synoptic data in microfilm and HWM, nor are mentioned in the MWR. Thus, these observations have been disregarded. Anna is analyzed to have weakened to a tropical storm over Guatemala at 18Z, same as originally shown in HURDAT. The weakening tropical cyclone kept moving west-northwest and dissipated over eastern Mexico early on July 25th. The last position is analyzed at 00Z on the 25th, six hours later than originally shown in HURDAT. The last position in the original HURDAT had Anna as a 60 kt tropical storm and the last official advisory had Anna as a hurricane over Belize. Anna was a typical fast-moving hurricane in the Caribbean Sea during the month of July. The central pressures reported over the eastern Caribbean when the tropical cyclone was moving at

its fastest were higher than typical from that expected of the Brown et al. pressure-wind relationship but this is not abnormal for the area. In 2002, Lili had a central pressure of 1004 mb and sustained winds of 60 kt over the eastern Caribbean Sea and Debby in 2000, reached hurricane intensity with only 1005 mb just north of the Leeward Islands. Both of these cyclones were also fast-moving storms.

Hurricane Betsy [September 2–15, 1961]

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41815 09/02/1961 M=11  2 SNBR= 909 BETSY       XING=0 SSS=0
41815 09/02/1961 M=14  2 SNBR= 909 BETSY       XING=0 SSS=0
                    **

41820 09/02*  0   0   0    0*133 417  40    0*138 428  40    0*143 436  40    0*
41820 09/02*  0   0   0    0*133 416  55    0*138 426  60    0*143 436  70    0*
                              ***  **          ***  **                **

41825 09/03*148 445  45    0*152 456  50    0*159 467  65    0*170 481  80  973*
41825 09/03*148 446  80    0*153 456  90    0*159 467  90  973*170 479  80    0*
                ***  **                **                **  ***     ***        *

41830 09/04*182 491  85  989*195 498  90    0*205 502  95  986*220 502 100  982*
41830 09/04*182 490  70  989*194 498  70    0*207 501  70  986*220 502  75  982*
                ***  **      ***      **      *** ***  **                **

41835 09/05*232 506 105    0*245 514 110    0*256 523 115  957*269 529 120  952*
41835 09/05*232 506  85    0*244 514  95    0*256 521 105  957*270 529 110    0*
                     **      ***      **          *** ***      ***     ***    *

41840 09/06*285 541 120    0*299 551 120  950*309 561 120  945*324 568 115  954*
41840 09/06*285 540 115  952*299 550 115    0*311 561 115  945*323 569 105  954*
                ***  ***  ***     ***        * ***     ***      ***  ***  ***

41845 09/07*331 572 105    0*337 578 100    0*342 583  95  954*346 587  90    0*
41845 09/07*331 573 105    0*337 578 100    0*342 583  95  954*346 587  90    0*
                ***

41850 09/08*350 590  90    0*353 597  90    0*356 600  90    0*359 599  90    0*
41850 09/08*350 592  90    0*353 596  85    0*355 599  85    0*359 598  75  974*
                ***               ***  **      *** ***  **          ***  **  ***

41855 09/09*361 596  90    0*362 593  90    0*366 586  90  978*376 579  90  976*
41855 09/09*360 596  75    0*363 592  75    0*366 587  75  978*372 575  80  976*
           *** ***  **      ***      **          ***  **      *** ***  **

41860 09/10*388 561  90    0*388 544  90    0*392 523  90  980*398 497  85  962*
41860 09/10*380 561  80    0*386 544  85    0*392 523  85    0*398 497  90  962*
                     **                **                **    *          **

41865 09/11*409 458  85    0*428 412  80    0*447 385  80  970*477 330  75    0*
41865 09/11E409 458  90    0E428 420  85    0E447 385  85  970E477 330  85    0*
          *          **     ****  ***  **     *          **     *          **

41870 09/12E508 265  70    0E548 205  60    0*  0   0   0    0*  0   0   0    0*
41870 09/12E508 265  75    0E540 226  70    0E565 210  70    0E580 200  70    0*
                     **          ***  **     **** ***  **     **** ***  **

(September 13rd through the 15th are new to HURDAT)
41871 09/13E585 190  70    0E590 190  70    0E595 210  65    0E602 230  65    0*
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41872 09/14E610 240  60    0E610 245  60    0E610 250  60    0E610 255  55    0*
41873 09/15E610 260  50    0*  0   0   0    0*  0   0   0    0*  0   0   0    0*

41875 HR
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Minor changes to the track and major changes to the intensity shown in McAdie et al. (2009). Major alterations to this tropical cyclone are to show transition to extratropical 24 hours earlier than originally shown in HURDAT and to add three days to its lifetime. Evidence for these alterations comes from the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Monthly Weather Review, Navy reconnaissance book, Mariners Weather Log, and NHC Storm Wallets.

August 30:

HWM analyzes a spot low pressure at 10.0N, 36.0W at 12Z. HURDAT does not list an organized storm on this day. Ship highlights: No gales or low pressures.

August 31:

HWM analyzes a spot low pressure at 11.5N, 36.5W at 12Z. HURDAT does not list an organized storm on this day. Ship highlights: No gales or low pressures.

September 1:

HWM analyzes a closed low pressure of at most 1010 mb at 11.0N, 39.4W at 12Z. HURDAT does not list an organized storm on this day. Microfilm shows a closed low pressure of at most 1011 mb along the ITCZ near 12.5N, 44.4W at 12Z. Ship highlights: No gales or low pressures.

September 2:

HWM analyzes a tropical storm of at most 1010 mb at 13.3N, 43.0W at 12Z. HURDAT lists a 40 kt tropical storm at 13.8N, 42.8W at 12Z. Microfilm does not show an organized storm at 12Z. Ship highlights: 998 mb at 13.6N, 42.2W at 08Z (MWR). 40 kt N and 1004 mb at 15.6N, 45.2W at 15Z (MWR). 40 kt NNE and 1002 mb at 15.4N, 44.7W at 23Z (micro).

MWR: “The formation of hurricane Betsy inaugurated one of the most active tropical cyclone periods in the history of the North Atlantic Ocean. No less than three other hurricanes made their appearance before Betsy dissipated. Betsy formed in the eastern tropical Atlantic apparently from a perturbation moving along the ITCZ. An observation from the SS Granheim at 0300 EST, September 2, located at 13.6N, 42.2W, with a barometer reading of “980” which is interpreted as 998.0 mb, was the first indication of Betsy. At 1000 EST the SS Charlotte Maersk at 15.6N, 45.2W, reported winds of 40 kt, and pressure of 1004 mb, steadily falling.” ATSR: “The second storm of the season,

Hurricane Betsy, interrupted a lull of more than a month in tropical storm activity. This storm apparently formed at the intersection of an easterly wave and the Intertropical Convergence Zone. The easterly wave had been reported earlier by Fleet Weather Central, Port Lyautey, and subsequently tracked across the eastern Atlantic on weather charts by Fleet Weather Facility, Miami. An observation from the SS GRANHEIM, position near 13.5N 42.0W at 020800Z, gave a surface pressure of 1009 mb – the first unusual activity in the area. A Tiros satellite at 021137Z indicated possible cyclonic activity near 15N 45W. Shortly thereafter, a second vessel, the SS CHAROLETTE MAERSK, reporting from a position 15.5N 46W, gave a surface pressure of 1004.5 mb, steadily falling, and ENE to N winds up to 40 knots in squalls."

September 3:

HWM analyzes a hurricane of at most 1000 mb at 15.5N, 46.8W at 12Z. HURDAT lists a 65 kt hurricane at 15.9N, 46.7W at 12Z. Microfilm shows a closed low pressure of at most 999 mb at 16.1N, 46.5W at 12Z. Ship highlights: 45 kt NE and 1001 mb at 15.6N, 44.3W at 01Z (micro). 50 kt ESE and 1001 mb at 15.6N, 44.6W at 03Z (micro). 50 kt SSE and 1003 mb at 15.9N, 44.3W at 06Z (micro). 45 kt NNW and 1010 mb at 14.8N, 48.7W at 12Z (micro). 40 kt E and 1009 mb at 19.0N, 46.3W at 18Z (COADS). Aircraft highlights: Penetration center fix measured a central pressure of 973 mb, estimated surface winds of 90 kt and an eye diameter of 15 nm at 16.2N, 47.1W at 14Z (ATSR).

MWR: "The first advisory was issued by the San Juan Weather Bureau at 2300 EST, September 2, for a tropical storm. A reconnaissance aircraft was dispatched to the storm area September 3 and found surface winds of 90 kt, and a central pressure of 973 mb. The track and changes of intensity of Betsy can be associated nicely with fluctuations in the westerlies. Ridges near the east coast of the United States and in the eastern Atlantic Ocean with a trough near 50W were the main features of the upper-level flow pattern during the period of the storm. This trough not only steered Betsy into higher latitudes, but also later picked up Debbie and even temporarily pulled Esther northward before the trough finally filled." ATSR: "The first warning was issued 030400Z for Tropical Storm Betsy. The disturbance came within reconnaissance range early on the 3rd and was investigated by a Navy aircraft. Maximum winds of 90 knots and a central surface pressure of 973 mb were found. Accordingly, Betsy was termed a hurricane on the 031600Z warning."

September 4:

HWM analyzes a hurricane of at most 995 mb at 20.1N, 50.1W at 12Z. HURDAT lists a 95 kt hurricane at 20.5N, 50.2W at 12Z. Microfilm shows a closed low pressure of at most 1005 mb at 20.0N, 51.0W at 12Z. Ship highlights: 35 kt ESE and 1012 mb at

19.0N, 45.9W at 00Z (COADS). 45 kt E and 1009 mb at 20.0N, 48.0W at 06Z (micro). 45 kt ENE and 1009 mb at 19.7N, 48.2W at 1230Z (micro). 45 kt SSW and 1004 mb at 19.6N, 49.8W at 15Z (micro). 50 kt SE and 1011 mb at 22.0N, 48.0W at 18Z (micro). Aircraft highlights: Penetration center fix measured a central pressure of 989 mb and estimated an eye diameter of 15 nm at 18.5N, 49.2W at 01Z (ATSR). Radar center fix at 21.8N, 50.0W at 13Z (ATSR). Penetration center fix measured a central pressure of 982 mb, estimated surface winds of 85 kt and an eye diameter of 20 nm at 22.3N, 50.3W at 2016Z (ATSR).

MWR: “A closed Low developed and intensified in the trough on September 4, weakening the ridge to the north of the storm and accordingly Betsy filled, with a central pressure rising to near 990 mb.”

September 5:

HWM analyzes a hurricane of at most 995 mb at 25.1N, 52.3W at 12Z. HURDAT lists an 115 kt hurricane at 25.6N, 52.3W at 12Z. Microfilm shows a closed low pressure of at most 1005 mb at 25.5N, 52.3W at 12Z. Ship highlights: 40 kt ESE and 1004 mb at 24.8N, 52.4W at 00Z (micro). 50 kt E and 1008 mb at 25.9N, 51.6W at 11Z (micro). 50 kt S and 1008 mb at 25.0N, 51.6W at 12Z (COADS). 45 kt SE and 1011 mb at 25.4N, 51.1W at 15Z (COADS). 50 kt ESE and 1002 mb at 27.1N, 52.2W at 18Z (micro). 50 kt SE and 1000 mb at 27.9N, 51.6W at 21Z (micro). Aircraft highlights: Penetration center fix measured a central pressure of 970 mb at 26.3N, 52.6W at 15Z (ATSR/WALLET). Penetration center fix measured a central pressure of 952 mb at 27.8N, 53.4W at 2138Z (ATSR/WALLET).

MWR: “On September 5, a short wave approached the trough and begun forcing the closed Low northeastward, resulting in height rises of the storm.”

September 6:

HWM analyzes a hurricane of at most 995 mb at 30.6N, 56.4W with a weakening stationary front far to the northwest at 12Z. HURDAT lists a 120 kt hurricane at 30.9N, 56.1W at 12Z. Microfilm shows a closed low pressure of at most 1002 mb at 31.1N, 56.2W at 12Z. Ship highlights: 40 kt SE and 1006 mb at 28.0N, 50.3W at 00Z (COADS). Aircraft highlights: Penetration center fix measured a central pressure of 950 mb at 30.5N, 55.6W at 0912Z (ATSR/WALLET). Penetration center fix measured a central pressure of 945 mb at 31.0N, 56.4W at 13Z (ATSR/WALLET). Penetration center fix measured a central pressure of 954 mb at 32.9N, 56.9W at 19Z (ATSR/WALLET).

MWR: “In response, Betsy again intensified until September 6, when the central pressure reached its lowest value, 945 mb. Surface winds at this time were estimated near 120 kt.

Betsy missed connection with the short wave on September 6, slowed almost to a standstill."

September 7:

HWM analyzes a hurricane of at most 995 mb at 33.9N, 58.3W with a weakening front to the north at 12Z. HURDAT lists a 95 kt hurricane at 34.2N, 58.3W at 12Z. Microfilm shows a closed low pressure of at most 1005 mb at 34.5N, 58.6W with a frontal boundary to the north at 12Z. Ship highlights: 40 kt NNW and 1007 mb at 34.0N, 60.6W at 12Z (micro). 40 kt NNW and 1007 mb at 34.0N, 60.8W at 15Z (micro). 35 kt NW and 1011 mb at 33.2N, 60.4W at 18Z (micro). 50 kt SSE and 1007 mb at 34.7N, 56.5W at 21Z (micro). Aircraft highlights: Penetration center fix estimated surface winds of at least 65 kt at 34.5N, 59.0W at 1245Z (ATSR/micro). Penetration center fix at 34.4N, 58.5W at 1845Z (ATSR).

September 8:

HWM analyzes a hurricane of at most 1000 mb at 35.1N, 60.0W with a warm front far to the northeast at 12Z. HURDAT lists a 90 kt hurricane at 35.6N, 60.0W at 12Z. Microfilm shows a closed low pressure of at most 1011 mb at 35.5N, 60.2W with a frontal boundary to the northeast at 12Z. Ship highlights: 55 kt S and 1012 mb at 34.3N, 56.0W at 00Z (COADS). 45 kt S and 1012 mb at 34.0N, 56.2W at 03Z (COADS). 35 kt S and 1012 mb at 33.8N, 56.5W at 06Z (COADS). 35 kt S and 1013 mb at 33.4N, 58.0W at 12Z (COADS). Aircraft highlights: Penetration center fix estimated surface winds of at least 60 kt at 35.5N, 60.1W at 12Z (ATSR/micro). Penetration center fix measured a central pressure of 974 mb at 35.5N, 59.7W at 1845Z (ATSR/micro).

ATSR: "Due to a long wave trough near 55W in the upper air flow, Betsy recurved into northerly latitudes quite early in her life cycle. She came almost to a standstill near 36N 60W on 8 September, before finally being caught in westerly flow on the same day."

September 9:

HWM analyzes a hurricane of at most 1000 mb at 36.1N, 58.7W with a warm front far to the northeast at 12Z. HURDAT lists a 90 kt hurricane at 36.6N, 58.6W at 12Z. Microfilm shows a closed low pressure of at most 1014 mb at 36.5N, 58.5W at 12Z. Ship highlights: 40 kt W and 1010 mb at 33.7N, 60.5W at 00Z (COADS). 35 kt W and 1011 mb at 33.9N, 61.0W at 03Z (micro). 35 kt S and 1008 mb at 34.4N, 58.2W at 12Z (COADS). 40 kt SW and 1011 mb at 35.5N, 55.5W at 18Z (micro). Aircraft highlights: Penetration center fix estimated maximum surface winds of at least 70 kt at 36.7N, 58.9W at 13Z (ATSR/micro). Penetration center fix at 37.6N, 57.2W at 19Z (ATSR).

MWR: “...then was picked up by another minor trough on September 9.”

September 10:

HWM analyzes a hurricane of at most 995 mb at 39.0N, 52.5W with a warm front far to the northeast at 12Z. HURDAT lists a 90 kt hurricane at 39.2N, 52.3W at 12Z. Microfilm shows a closed low pressure of at most 1008 mb at 39.5N, 51.5W at 12Z. Ship highlights: 40 kt SSW and 1009 mb at 35.0N, 55.4W at 00Z (COADS). 35 kt SW and 1013 mb at 35.2N, 53.5W at 06Z (COADS). 45 kt SSE and 1007 mb at 37.4N, 50.0W at 10Z (COADS). 50 kt S and 1006 mb at 37.4N, 51.1W at 12Z (COADS). 45 kt S and 1004 mb at 37.9N, 48.1W at 18Z (COADS). Aircraft highlights: Penetration center fix at 39.3N, 51.5W at 1438Z (ATSR). Radar center fix estimated maximum surface winds of at least 60 kt at 40.0N, 49.4W at 1850Z (ATSR/micro).

September 11:

HWM analyzes a hurricane of at most 980 mb at 44.5N, 38.8W with a weakening warm front to the northeast and cold front to the southwest at 12Z. HURDAT lists an 80 kt hurricane at 44.7N, 38.5W at 12Z. Microfilm shows a closed low pressure of at most 990 mb at 46.0N, 36.0W with a frontal boundary extending to the south at 12Z. Ship highlights: 40 kt NE and 998 mb at 43.5N, 46.8W at 00Z (COADS). 30 kt NE and 994 mb at 45.7N, 42.9W at 06Z (COADS). 85 kt SW and 996 mb at 43.9N, 34.3W at 15Z (MWL). 75 kt SW and 1006 mb at 43.8N, 34.4W at 18Z (COADS). Aircraft highlights: Penetration center fix estimated maximum surface winds of at least 55 kt at 45.5N, 36.9W at 1440Z (ATSR/micro). Penetration center fix at 47.1N, 34.1W at 1720Z (ATSR).

MWR: “Thirty-five advisories were issued on this hurricane, the last by the Washington Weather Bureau at 1100 EST, September 11. Betsy remained over the ocean and apparently no damage was sustained by vessels along her path.” ATSR: “She then moved rapidly northeastward and became extratropical. The 35th and final warning was issued at 111600Z. Betsy remained entirely at sea and resulted in no known damage.”

September 12:

HWM analyzes a large extratropical cyclone of at most 950 mb at 56.5N, 21.2W at 12Z. HURDAT lists a 60 kt extratropical cyclone at 54.8N, 20.5W at 06Z (last position). Microfilm shows an extratropical cyclone of at most 969 mb at 56.7N, 25.0W at 12Z. Ship highlights: 70 kt NW and 963 mb at 50.5N, 27.8W at 00Z (COADS). 70 kt SSW and 962 mb at 52.5N, 20.0W at 06Z (COADS). 70 kt NW and 967 mb at 55.8N, 26.7W at 12Z (COADS). 60 kt NNW and 978 mb at 56.7N, 28.4W at 18Z (COADS).

September 13:

HWM analyzes a large extratropical cyclone of at most 955 mb at 59.5N, 20.2W at 12Z. HURDAT does not list an organized storm on this day. Microfilm does not show an organized storm on this day (cyclone moving off the NE corner of the map). Ship highlights: 60 kt NNW and 981 mb at 56.9N, 29.9W at 00Z (COADS). 60 kt NNW and 981 mb at 57.1N, 31.5W at 06Z (COADS). 55 kt N and 986 mb at 57.4N, 33.5W at 12Z (COADS). 60 kt E and 973 mb at 65.3N, 20.3W at 18Z (COADS).

September 14:

HWM analyzes a large extratropical cyclone of at most 960 mb at 61.5N, 24.8W at 12Z. Ship highlights: 45 kt SE and 969 mb at 61.6N, 17.9W at 00Z (COADS). 50 kt NE and 985 mb at 66.6N, 24.6W at 06Z (COADS). 50 kt NE and 988 mb at 66.6N, 24.4W at 12Z (COADS). 60 kt NNE and 988 mb at 62.4N, 40.5W at 18Z (COADS).

September 15:

HWM analyzes two extratropical cyclones of at most 970 mb and 965 mb at 58.5N, 28.8W and 60.9N, 15.0W, respectively, at 12Z. Ship highlights: 60 kt SW and 967 mb at 55.2N, 15.0W at 00Z (COADS). 45 kt NE and 990 mb at 66.3N, 24.0W at 06Z (COADS). 50 kt NE and 992 mb at 66.3N, 24.0W at 09Z (COADS).

September 16:

HWM analyzes an extratropical cyclone of at most 980 mb at 60.9N, 15.4W at 12Z.

A strong tropical wave left the African coast during the last days of August. Ship observations over the eastern and central Atlantic are sparse, thus the time of genesis of Betsy is uncertain but may have occurred on August 31st or September 1st. The first ship to encounter the tropical cyclone reported a pressure of 998 mb at 08Z on September 2nd. Although no winds were reported with the pressure measurement, MWR does not indicate that it was a central pressure and it is analyzed as a peripheral pressure. A peripheral pressure of 998 mb suggests maximum sustained winds greater than 51 kt south of 25N from the Brown et al. pressure-wind relationship. The first position, not genesis, is analyzed at 06Z on the 2nd, same as the original HURDAT, as a 55 kt tropical storm, up from 40 kt originally in HURDAT, a minor intensity change. Minor track alterations are analyzed during the lifetime of this tropical cyclone. The first aircraft to investigate Betsy arrived at 14Z on September 13th. A penetration fix measured a central pressure of 973 mb, estimated surface winds of 90 kt and an eye diameter of 15 nm. A central pressure of 973 mb suggests maximum sustained winds of 86 kt south of 25N

from the pressure-wind relationship. An eye diameter of 15 nm suggests an RMW of 11 nm and the climatological value is 14 nm. Due to a forward speed of 18 kt and an RMW smaller than climatology, an intensity of 90 kt is selected at 12Z on the 3rd, up from 65 kt originally in HURDAT, a major intensity change. A central pressure of 973 mb was present in HURDAT at 18Z on the 3rd and based on the penetration fix at 14Z, it has been moved to 12Z on the 3rd. Intensification to a hurricane is analyzed at 18Z on the 2nd, 18 hours earlier than originally shown in HURDAT. Various ships reported tropical storm force winds on the 3rd, up to 50 kt. Reconnaissance aircraft observations on September 4th indicate that Betsy weakened as the central pressure rose and the eye diameter expanded. A penetration fix at 01Z on the 4th measured a central pressure of 989 mb and an eye diameter of 15 nm. A central pressure of 989 mb suggests maximum sustained winds of 65 kt south of 25N weakening from the pressure-wind relationship. An eye diameter of 15 nm suggests an RMW of 11 nm and the climatological value is 15 nm. Due to a forward speed of 15 kt and an RMW smaller than climatology, an intensity of 70 kt is selected at 00Z on the 4th, down from 85 kt originally in HURDAT, a minor intensity change. A central pressure of 989 mb is added to HURDAT at 00Z on the 4th. A central pressure of 986 mb was present in HURDAT at 12Z on the 4th and although it appears to have been added in without observations of the central pressure of the hurricane around that time, it seems reasonable and has been retained. A central pressure of 986 mb suggests maximum sustained winds of 70 kt south of 25N from the pressure-wind relationship. Due to a forward speed of 13 kt, an intensity of 70 kt is selected at 12Z on the 4th, down from 95 kt originally in HURDAT, a major intensity change. A penetration fix occurred at 2016Z on the 4th measuring a central pressure of 982 mb, estimating surface winds of 85 kt and an eye diameter of 20 nm. A central pressure of 982 mb suggests maximum sustained winds of 75 kt south of 25N from the pressure-wind relationship. An eye diameter of 20 nm suggests an RMW of 15 nm and the climatological value is 16 nm. Due to a forward speed of 13 kt and an RMW close to climatology, an intensity of 75 kt is selected at 18Z on the 4th, down from 100 kt originally in HURDAT, a major intensity change. A central pressure of 982 mb was present in HURDAT at 18Z on the 4th and has been retained.

On September 5th, Betsy continued on a northwest track over the central Atlantic and intensified. A central pressure of 957 mb was present in HURDAT at 12Z on the 5th and although it appears to have been added in without actual observations, it seems reasonable based on reconnaissance data later on the day and has been retained. A central pressure of 957 mb suggests maximum surface winds of 106 kt south of 25N intensifying and 103 kt north of 25N intensifying from the pressure wind-relationship. Due to a forward speed of 15 kt, an intensity of 105 kt is selected at 12Z on the 5th, down from 115 kt originally in HURDAT, a minor intensity change. Intensification to a major hurricane is analyzed at 12Z on the 5th, 18 hours later than originally shown in

HURDAT. Another penetration fix occurred at 2138Z on the 5th measuring a central pressure of 952 mb. A central pressure of 952 mb suggests maximum sustained winds of 108 kt south of 25N intensifying from the pressure-wind relationship. Due to a forward speed of 19 kt, an intensity of 115 kt is selected at 18Z on the 5th, down from 120 kt originally in HURDAT, a minor intensity change. A central pressure of 952 mb was present in HURDAT at 18Z on the 5th but it was measured closer to 00Z on September 6th, thus it has been moved to that time slot. A penetration fix at 15Z on the 5th in the Storm Wallets show a central pressure of 970 mb but this measurement has been discounted as it appears erroneous based on the central pressure already in HURDAT at 12Z on the 5th and the reconnaissance aircraft report at 2138Z on the 5th. Various ships recorded gale-force winds on the 5th, including a couple of reports of 50 kt. On September 6th, Betsy remained on a northwestward course but began to slow its forward speed. A reconnaissance aircraft reached the hurricane at 0912Z on the 6th measuring a central pressure of 950 mb. The next penetration fix occurred at 13Z on the 6th measuring a central pressure of 945 mb. A central pressure of 945 mb suggests maximum surface winds of 115 kt north of 25N intensifying from the pressure wind-relationship. Based on a forward speed of 15 kt, an intensity of 115 kt is analyzed at 12Z on the 6th, down from 120 kt originally in HURDAT, a minor intensity change. 115 kt is also the peak intensity of Betsy, down from 120 kt originally in HURDAT from 18Z on the 5th to 12Z on the 6th. A central pressure of 950 mb was present in HURDAT at 06Z on the 6th and has been removed as it was measured at 0912Z on the 6th, closer to the 12Z time slot than 06Z. A central pressure of 945 mb was present in HURDAT at 12Z on the 6th and has been retained. The last penetration fix on the 6th occurred at 19Z measuring a central pressure of 954 mb. A central pressure of 954 mb suggests maximum surface winds of 101 kt north of 25N and 97 kt weakening from the pressure wind-relationship. Based on a forward speed of 13 kt, an intensity of 105 kt is analyzed at 18Z on the 6th, down from 115 kt originally in HURDAT, a minor intensity change. A central pressure of 954 mb was present in HURDAT at 18Z on the 6th and has been retained.

On September 7th, Betsy continued to slow its forward speed as a dissipating frontal boundary approached from the north. A central pressure of 954 mb was present in HURDAT at 12Z on the 7th and there was reconnaissance investigating the hurricane around that time, thus it has been retained. A central pressure of 954 mb suggests maximum surface winds of 101 kt north of 25N from the Brown et al. pressure wind-relationship and 94 kt north of 35N from the Landsea et al. pressure wind-relationship. Based on a forward speed of 6 kt, an intensity of 95 kt is analyzed at 12Z on the 7th, same as originally shown in HURDAT. Weakening below major hurricane is analyzed at 12Z on the 7th, same as originally shown in HURDAT. Various ships reported gale-force winds on the 7th, including 50 kt at 21Z. On September 8th, the westward progression of Betsy ended and the hurricane slowly turned to the northeast late in the day. A

reconnaissance aircraft investigated Betsy at 19Z on the 8th measuring a central pressure of 974 mb. A central pressure of 974 mb suggests maximum surface winds of 79 kt north of 35N and 80 kt north of 25N from the pressure wind-relationships. Based on a forward speed of 3 kt, an intensity of 75 kt is analyzed at 18Z on the 8th, down from 90 kt originally in HURDAT, a minor intensity change. A central pressure of 974 mb is added to HURDAT at 18Z on the 8th. A TIROS III satellite image available on MWR 1962, pg. 110, shows hurricane Betsy at 2015Z on the 8th. The satellite image shows a well-organized cyclone with distinct banding to the north and south, CDO and cirrus clouds over the eastern and southern quadrants. On September 9th, Betsy continued moving to the northeast and slowly gained in forward speed. Central pressures of 978 mb and 976 mb were present in HURDAT at 12Z and 18Z, respectively, on the 9th. Reconnaissance aircrafts investigated the hurricane around those times, thus the central pressures appear reasonable (but could not be confirmed) and have been retained. A central pressure of 978 mb suggests maximum surface winds of 75 kt north of 35N from the pressure-wind relationship. Due to a forward speed of 10 kt, an intensity of 75 kt is selected at 12Z on the 9th, down from 90 kt originally in HURDAT, a minor intensity change. Also, a central pressure of 976 mb suggests maximum surface winds of 77 kt north of 35N from the pressure-wind relationship. Due to a forward speed of 17 kt, an intensity of 80 kt is selected at 18Z on the 9th, down from 80 kt originally in HURDAT, a minor intensity change.

On September 10th, Betsy was moving quite rapidly to the northeast crossing 40ºN late in the day. The environment around the system became less tropical with cool, dry air to the north and west and warm, moist air to the east and south. Reconnaissance aircrafts continued to investigate the tropical cyclone. Central pressures of 980 mb and 962 mb were present in HURDAT at 12Z and 18Z on the 10th, respectively. The central pressure of 980 mb has been removed as it appears erroneous based on the data available on the previous and subsequent days. The central pressure of 962 mb appears reasonable and has been retained. A central pressure of 962 mb suggests maximum surface winds of 88 kt north of 35N from the pressure-wind relationship. Due to a forward speed of 34 kt, an intensity of 90 kt is selected at 18Z on the 10th, up from 85 kt originally in HURDAT, a minor intensity change. Synoptic observations on September 11th at 00Z indicate that Betsy had become an extratropical cyclone 24 hours earlier than originally shown in HURDAT. The data shows a temperature gradient across the circulation as frontogenesis had occurred. Betsy passed halfway between the Azores and Newfoundland on the 11th. A central pressure of 970 mb was present in HURDAT at 12Z on the 11th, appears reasonable (but not confirmed) and has been retained. Ship observations indicate that Betsy was still a very powerful extratropical cyclone on the 11th. A ship reported 85 kt SW and 996 mb at 15Z and another reported 70 kt SW and 965 mb at 18Z. On September 12th, Betsy began to slow its forward speed south of Iceland and on September 13th,

turned to the west. Weakening below hurricane intensity is analyzed at 00Z on September 14th, 42 hours later than originally shown in HURDAT. On the 14th, an extratropical cyclone developed along Betsy's cold front and the two extratropical systems began to rotate around each other. By September 15th at 06Z, it was clear that both centers had merged, thus the final position of Betsy is analyzed at 00Z on the 15th, 60 hours later than originally shown in HURDAT.

Hurricane Carla [September 3–16, 1961]

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40375 09/03/1961 M=14  3 SNBR= 885 CARLA       XING=1 SSS=4

40380 09/03*  0   0   0    0*  0   0   0    0*125 770  25    0*129 780  25    0*
40380 09/03*  0   0   0    0*  0   0   0    0*125 770  25    0*129 780  30    0*
                                                                        **

40385 09/04*133 788  25    0*137 795  25 1007*142 801  25 1006*149 807  25 1005*
40385 09/04*133 788  30    0*137 795  30 1007*142 799  30 1004*150 805  35 1004*
                     **              **          ***  ** **** *** ***  ** ****

40390 09/05*155 814  30 1002*159 821  30  999*163 827  40  997*169 831  45  993*
40390 09/05*156 812  35 1000*159 821  40  999*163 827  50  999*169 831  55  993*
           *** ***  ** ****          **                **  ***          **

40395 09/06*174 836  50  990*181 843  55  987*188 851  65  984*191 856  70  981*
40395 09/06*174 836  60  990*181 843  65  987*189 851  75  985*191 856  80  981*
                     **              **                **  ***          **

40400 09/07*195 859  75  978*202 860  80  975*209 860  85  973*217 863  95  970*
40400 09/07*195 858  85  978*203 859  85  975*210 859  85  974*217 863  95  971*
                ***  **      *** ***  **      *** ***      ***              ***

40405 09/08*223 873 100  968*228 878 105  966*231 883 110  965*234 892 110  962*
40405 09/08*222 872 100  967*228 878 100  966*232 884  90  964*233 890  95  960*
           *** ***      ***         ***      *** *** ***  *** *** *** ***  ***

40410 09/09*237 898 110  959*240 902 110  956*246 910 110  953*249 918 110  948*
40410 09/09*237 898 100  958*241 903 100  955*246 909 100  954*251 917 110  948*
                    ***  *** *** *** ***  ***     *** ***  *** *** ***

40415 09/10*256 926 110  944*261 933 115  940*263 939 120  937*267 945 130  936*
40415 09/10*255 925 120  944*260 932 125  934*262 938 115  937*265 944 115  936*
           *** *** ***      *** *** ***  *** *** *** ***      *** *** ***

40420 09/11*270 950 140  936*272 957 150  936*276 962 145  935*280 964 125  931*
40420 09/11*269 950 115  936*272 957 115  936*276 961 115  935*282 963 120  931*
           ***      ***               ***          *** ***      *** *** ***

40425 09/12*286 968 100  940*295 972  80  955*305 974  60  975*318 974  45  979*
40425 09/12*287 967  95  940*295 972  65  955*305 976  50  974*317 976  40  979*
           *** *** ***               **          ***  **  *** ***      **

40430 09/13*328 972  40  980*335 970  35    0E343 968  30    0E362 940  30    0*
40430 09/13*329 974  35  980*345 970  35    0E355 950  40    0E365 935  35    0*
           *** ***  **      ***             *** ***  **      *** ***  **

40435 09/14E380 905  30    0E421 871  30    0E463 838  30    0E475 807  30    0*
40435 09/14E380 905  30    0E427 866  30    0E453 828  25    0E470 798  25    0*
                         *** ***          *** ***  **      *** ***  **
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40440 09/15E487 780  30    0E512 727  30    0E537 675  30    0E568 662  30    0*
40440 09/15E487 780  25    0E512 727  25    0E537 690  25    0E568 662  30    0*
                     **                **          ***  **

40445 09/16E600 650  30    0*  0   0   0    0*  0   0   0    0*  0   0   0    0*

40450 HRBTX4
40450 HRBTX4CTX3ATX1
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Major alterations to the intensity but minor track changes were made to Carla. Evidence for these alterations comes from the Historical Weather Map series, the COADS ships database, the Monthly Weather Review, NHC Microfilm of synoptic weather maps, Annual Tropical Storm Reports, Storm Wallets, North Atlantic Tropical Cyclones Report, and Tropical Cyclone Data. Evidence for these alterations also comes from Jarrell et al. (1992), Shcwerdt et al. (1979), Francis; Ho (1987), and Wiggert; Jarvinen (1986).

September 1-2: “Somewhat above normal shower activity was evident in the eastern Caribbean as early as September 1, apparently associated with a weak perturbation in the Intertropical Convergence Zone” (MWR). Ship highlights: 35kt ENE with a pressure of 1014mb at 18Z on Sept. 2nd at 18.7N, 68W (COA). Station highlights: No gales or low pressures. Aircraft highlights: No gales or low pressures.

September 3: HWM indicates a closed low near 12N, 76W. HURDAT lists this as a Tropical Depression with 25kt winds at 12.5N, 77W at 12Z. The MWR North Atlantic Tropical Cyclones chart showed a center at 12.5N, 77W (am) and at 14.5N, 78.9W (pm). Ship highlights: No gales or low pressures. Station highlights: No gales or low pressures. Aircraft highlights: No gales or low pressures. “The first indication of intensification and a closed circulation was noted on the 0700 EST September 3 surface chart and abnormal pressure and shower activity were mentioned in the tropical weather summary on that date” (MWR).

September 4: HWM indicates a closed low of at most 1005mb near 14N, 80W. The MWR North Atlantic Tropical Cyclones chart showed a center at 14N, 80W (am) and at 15.5N, 81W (pm). Station highlights: No gales or low pressures. Ship highlights: 15kt NNW with a pressure of 1004mb at 14.8N, 81.7W at 22Z (COA). Aircraft highlights: a central pressure of 1004mb at 15.4N, 80.8W at 2125Z (storm wallets); 35kt SE at 16N, 76W at 1930Z (microfilm). “At 0700 EST on September 4 the circulation had increased to depression intensity (winds 32 to 38mph) and the light north-northeast wind at San Andres Island the evening before had shifted to westerly 12mph and the barometer, while still below normal, had risen slightly” (MWR).

September 5: HWM indicates a tropical storm with a pressure of at most 1000mb near 15N, 83W. The MWR North Atlantic Tropical Cyclones chart showed a center at 16.2N, 82.5W (am) and at 17.5N, 84W (pm). Station highlights: No gales or low pressures. Ship highlights: 30kt E with a pressure of 1002mb at 15.7N, 81.4W at 00Z (COA); 35kt E with a pressure of 1009mb at 18.5N, 79.2W at 06Z (COA). Aircraft highlights: a central

pressure of 998mb at 16.4N, 82.8W at 1312Z (storm wallets); 45kt at 1320Z (no location given) (Annual TS report).

September 6: HWM indicates a hurricane with a pressure of at most 990mb near 18.5N, 85W. The MWR North Atlantic Tropical Cyclones chart showed a center at 18.9N, 85.1W (am) and at 20N, 85.9W (pm). Station highlights: No gales or low pressures. Ship highlights: 35kt SSE with a pressure of 994mb at 20.5N, 84.2W at 18Z (microfilm); 45kt NNW with a pressure of 996mb at 17.5N, 86.5W at 21Z (storm wallets). Aircraft highlights: a central pressure of 978mb at 19.2N, 85.8W at 2030Z (storm wallets); 70kt SW with a pressure of 999mb at 18.2N, 85W at 2130Z (microfilm). "During the next several days Carla continued a slow but remarkably steady intensification (fig. 9) reaching hurricane forced on the morning of the 6th …" (MWR).

September 7: HWM indicates a hurricane with a pressure of at most 985mb near 20.1N, 86W. The MWR North Atlantic Tropical Cyclones chart showed a center at 21N, 85.5W (am) and at 22.5N, 87W (pm). Station highlights: No gales or low pressures. Ship highlights: 60kt SSW with a pressure of 993mb at 19.7N, 84.9W at 09Z (COA). Aircraft highlights: a pressure of 967mb at 22.2N, 87.2W at 2230Z (storm wallets); 95kt NE at 22N, 87W at 1830Z (Annual TS report).

September 8: HWM indicates a hurricane with a pressure of at most 975mb near 22.5N, 88W. The MWR North Atlantic Tropical Cyclones chart showed a center at 23.1N, 88.1W (am) and at 23.9N, 89.5W. Station highlights: No gales or low pressures. Ship highlights: 50kt NW with a pressure of 977mb at 22.9N, 88.8W at 12Z (COA). Aircraft highlights: a central pressure of 961mb at 23.3N, 88.5W at 13Z (storm wallets); 50kt NNE at 23N, 90.5W at 1130Z (Annual TS report). "High tides began affecting the upper Texas coast on September 8 and waves and tides continued to batter the Texas coast with ever increasing fury until the center moved inland three days later" (MWR).

September 9: HWM indicates a hurricane with a pressure of at most 980mb near 24N, 91W. The MWR North Atlantic Tropical Cyclones chart showed a center at 24.5N, 91W (am) and at 25.5N, 92.5W (pm). Station highlights: No gales or low pressures. Ship highlights: 45kt SW with a pressure of 987mb at 23N, 90.9W at 12Z (COA); 60kt E with a pressure of 996mb at 26.9N, 91.1W at 18Z (COA). Aircraft highlights: a central pressure of 954mb at 24.6N, 90.8W at 1130Z (storm wallets); 70kt E with a central pressure of 993mb at 27N, 92W at 2330Z (microfilm).

September 10: HWM indicates a hurricane with a pressure of at most 980mb near 26N, 94W. The MWR North Atlantic Tropical Cyclones chart showed a center at 26.5N, 93.9W (am) and at 27.1N, 95W (pm). Station highlights: Ship highlights: 50kt W with a pressure of 984mb at 25.1N, 95.1W at 18Z (COA); 70kt ESE with a pressure of 990mb at 28.4N, 93.3W at 18Z (COA). Aircraft highlights: 934mb at 26.2N, 93.4W at 06Z (Annual TS Report); flight level winds of 130kt and a pressure of 936mb at 27N, 94.1W at 19Z (storm wallets); 110kt with a central pressure of 938mb at 25.6N, 92.3W at 03Z (Annual TS report).

September 11: HWM indicates a hurricane with a pressure of at most 980mb near 27.5N, 96.2W. The MWR North Atlantic Tropical Cyclones chart showed a center at 27.8N, 96W (am) and at 29.9N, 96.8W (pm). Station highlights: ≤ 935mb at Port Lavaca (28.6N, 96.6W) at 2145Z (TC Data); 126kt NE at Port Lavaca (no time given) (North Atlantic TC). Ship highlights: 75kt ESE with a pressure of 987mb at 28.4N, 93.5W at 00Z (COA); 95kt SE with a pressure of 991mb at 28.5N, 93.6W at 06Z (COA). Aircraft highlights: 120kt at 28.2N, 96.4W at 1810Z (Annual TS report). "The center of Carla was under surveillance for some 48 hours by three land-based radars located at Brownsville, Galveston, and Lake Charles. All radars showed a strong cycloidal track during the period preceding landfall. The New Orleans hurricane center described Carla as one of the largest, most intense and destructive hurricanes ever to strike the United States Gulf coast. Carla's center moved inland over the Port O'Conner-Port Lavaca area on the central Texas coast during the afternoon of September 11 (fig.11). Sustained hurricane force winds were reported from Corpus Christi to Galveston and hurricane gusts were felt along almost the entire length of Texas coast" (MWR). "Highest tides were 16.6ft MSL at Port Lavaca, 14.5ft MSL at Port O'Connor, 15.2ft MSL at Matagorda, and 14.8ft MSL on the upper Houston ship channel" (MWR). "Peak gusts of 175mph were estimated at Port Lavaca. A gust of 153mph was observed on the anemometer of the Bauer Dredging Co. before the instrument failed. The lowest reported pressure at Port Lavaca was 27.62 in (935mb) and it remained at that value from 1545 to 1735 CST. Available information indicates the needle was below the scale during that period" (MWR). "Early in the afternoon of the 11th the center moved over the northeastern tip of Matagorda Island and inland over the Port Lavaca – Port O'Conner area. Reconnaissance aircraft indicated a central pressure of 27.50 in [931mb] just prior to its crossing the coast. The eye of the hurricane, approximately 30miles in diameter, (fig 1) moved into the Port O'Conner area about 1400 CST of the 11th. The leading edge of the eye reached Port Lavaca at 1545 CST. Carla moved slowly, and was almost stationary at times as she approached the middle Texas Coast. From Port Lavaca, the storm followed a northwesterly course, that carried the center over Inez, Yoakum, and Waelder, No well defined "eye" was apparent after the storm moved out the Waelder area about 0100 CST on the 12th, and it began to weaken rapidly as it followed a more northerly course, passing near Austin, Waco, and Fort Worth" (N. Atlantic TC). "Gusts of hurricane force were reported for the Texas coast from Port Arthur to north of Brownsville, a distance of over 300 miles. The highest wind was reported at Port Lavaca with a peak gust estimated at 175mph at Bauer Dredging Company on bay front. At 1414 CST at this location a wind gust of 153 mph was observed on the anemometer before the instrument failed. Matagorda reported a gust of 160mph and gusts of 150mph were estimated at Aransas Pass, Austwell, Edna, Port Aransas, and Victoria. Sustained winds (fasted mile) were reported as 145 at Matagorda and Port Lavaca. Aransas Pass and Victoria estimated fastest miles of 135 and 110, respectively. In Louisiana sustained winds were generally less than 50mph. Peak gusts of 75, 60, and 58mph were reported at Chauvin, Cameron, and Lake Charles, respectively" (N. Atlantic TC). "A low pressure of 27.62 in was reported by the Bauer Dredging Company at Port Lavaca from a recently calibrated barometer before the needle went below the scale. Other low pressures were 27.91 in at Victoria and 28.60 in at Matagorda.

Austin, Fort Worth, and Waco reported their lowest pressures of record: 28.76, 28.94, and 28.91 in, respectively" (N. Atlantic TC). "…Its lowest central pressure (931mb) on the afternoon of the 11th" (MWR).

September 12: HWM indicates a tropical storm with a pressure of at most 985mb near 30N, 97W. The MWR North Atlantic Tropical Cyclones chart showed a center at 31N, 97W (am) and at 33N, 97W (pm). Station highlights: a pressure of 945mb at Victoria (28.8N, 96.6W at 23Z (TC Data); 45kt ESE at Houston AP (30N, 95.4W) at 0258Z (TC Data). Ship highlights: 65kt S with a pressure of 994mb at 28.2N, 94.2W at 00Z (COA). Aircraft highlights: No gales or low pressures.

September 13: HWM indicates a tropical storm with a pressure of at most 995mb near 34.9N, 95.1W. The MWR North Atlantic Tropical Cyclones chart showed a center at 35N, 97W (am). "Total damage in Texas was estimated at $300million, two-thirds to property and one-third to crops. Fatalities were 34 in Texas, 6 in Louisiana, 5 in Kansas, and 1 in Missouri. Of the 34 dead in Texas 8 were killed in a tornado which swept across Galveston from the Gulf as the hurricane there was subsiding. Eight tornadoes in all were associated with Carla in Texas and 10 in Louisiana. Persons injured in Texas totaled 465; 1,915 homes, 568 farm buildings, and 415 other buildings were destroyed; 7,398 homes, 1,382 farm buildings, and 1,219 other buildings received major damage; and 43,325 homes, 4,238 farm buildings, and 9,268 other buildings received minor damage" (MWR). "Increasing its forward movement it began a recurve northeastward and by the morning of the 13th, it became extratropical and was located over east-central Oklahoma. Continuing to pick up speed it moved northeastward toward the Great Lakes at about 35mph, reaching Lake Huron on the 14th. Extensive flooding from heavy rains was reported from areas along the storm's path" (N. Atlantic TC).

No changes were made to the timing of genesis of this system. Minor changes to the track were made throughout the existence of Carla. However, major alterations were made to the intensity of Carla, especially on the days HURDAT had the storm at its peak. From September 3 at 18Z to September 7 at 06Z, the intensity was raised about 10kts from what was documented in HURDAT at each six hour period. These 10kt changes were based upon nearby ship and aircraft observations that recorded higher winds than what was being mentioned in HURDAT. Intensification to a tropical storm is now indicated to be around 18Z on the 4th, eighteen hours earlier than genesis as a 40kt tropical storm originally. Basis for this comes from an aircraft ob showing 35kt at 18Z on the 4th and an aircraft ob at 2125Z on the 5th having a pressure of 1004mb which translates to 39kt from the Brown et al. south of 25N pressure-wind relationship. On the 8th at 12Z, the intensity was lowered significantly from 110kt to 90kt. Two Navy aircrafts recording central pressures of 966mb and 961mb at 10Z and 13Z, respectively, suggest the pressure at 12Z was about 964mb. According to the Brown et al. south of 25N pressure-wind relationship, 964mb gives 96kt and 97kt from the intensifying subset. However, Carla had a very large eye (an RMW of 35nm) hence the intensity was lowered to 90kt. The intensities continued to be lowered by about 10kts from the original throughout the 8th

and 9th because Carla remained slow and steady state and the eye continued to be very large. A central pressure of 934mb recorded by a Navy aircraft on the 10th at 06Z gives 129kt from the Brown et al. south of 25N(intensifying) and 126kt north of 25N pressure-wind relationship (intensifying). This suggested a peak intensity of 125kt, 24 hours before the original peak intensity of 150kt was mentioned in HURDAT.

Carla made landfall around on September 11 around 20Z near 28.3N, 96.4W on the northeastern tip of Matagorda Island and inland over Port Lavaca - Port O'Conner area. Peak 30 second winds were 120kt at Matagorda and Port Lavaca. Jarrell et al. (1992), Francis; Ho (1987), and Wiggert; Jarvinen (1986) all mention a central pressure at landfall of 931mb. The lowest pressure found on the 11th was 941mb recorded by a Navy aircraft at around 1810Z. However, a pressure of 935mb was recorded at Port Lavaca, which would suggest it was deeper at the coast and would be consistent with a pressure of 931mb. Carla still had a large eye, with a 30nm RMW (as suggested by Francis; Ho (1987) and Wiggert; Jarvinen (1986)) hence 115kt was chosen as the landfall intensity which keeps it a Category 4 hurricane at landfall in central Texas. The landfall characterization – "BTX4" – of a Category 4 for the central Texas coast remains unchanged. A landfall characterization – "ATX1" – of a Category 1 for the southern Texas coast was added (winds of about 72kt) and a landfall characterization - "CTX3" – of a Category 3 hurricane for the northern Texas coast was also added (winds of about 112kt). Runs of the Kaplan and DeMaria inland decay wind model (1995) suggests winds of 85kt at 00Z on the 12th, 56kt at 06Z, 39kt at 12Z, and 29kt at 18Z. Winds were selected to be slightly higher than the model for HURDAT because Carla was a very large storm and large storms tend to weaken at a slower pace. Even though the winds were selected to be higher than the model, they were still lower than what was previously mentioned in HURDAT: 95kt at 00Z (originally 100kt), 65kt at 06Z (originally 80kt), 50kt at 12Z (originally 60kt), and 40kt at 18Z (originally 45kt). Transition into Extratropical storm and dissipation remained unchanged.

Hurricane Debbie [September 5–18, 1961]

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40875 09/06/1961 M=11  4 SNBR= 894 DEBBIE      XING=0 SSS=0
40875 09/05/1961 M=14  4 SNBR= 894 DEBBIE      XING=0 SSS=0
         **        **

(September 5th is new to HURDAT)
40880 09/05*  0   0   0    0*  0   0   0    0*135 177  30    0*141 193  30    0*
                                             *** ***  **      *** ***  **

40880 09/06*  0   0   0    0*  0   0   0    0*  0   0   0    0*151 241  50    0*
40880 09/06*146 207  30    0*149 220  35    0*150 232  40    0*151 244  50    0*
           *** ***  **      *** ***  **      *** ***  **          ***

40885 09/07*152 254  65    0*154 267  70    0*157 281  70    0*161 294  70    0*
40885 09/07*152 256  65    0*154 268  70    0*157 281  70    0*161 294  70    0*
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40890 09/08*165 307  70    0*170 320  70    0*175 332  70    0*180 345  70    0*
40895 09/09*185 357  70    0*191 370  70    0*197 382  70    0*204 394  70    0*
40900 09/10*212 406  70    0*220 418  70    0*228 430  75    0*238 441  75    0*

40905 09/11*250 450  80    0*266 457  90    0*279 459 100  976*293 459 105    0*
40905 09/11*250 450  75    0*265 457  75    0*279 460  80    0*292 461  80  976*
                     **      ***       **                **    * *** ***  **  ***

40910 09/12*305 459 105    0*315 459 105    0*322 458 105  975*330 456 105    0*
40910 09/12*304 461  80    0*315 460  75    0*323 458  75  975*331 456  75    0*
           *** ***  **          ***  **                **  *** ***       **

40915 09/13*339 453 100    0*347 451  85  980*352 442  75    0*355 431  70    0*
40915 09/13*339 454  70    0*346 450  70  980*351 442  70    0*355 430  70    0*
                ***  **      *** ***  **      ***       **          ***  **

40920 09/14*359 411  70    0*362 389  70    0*366 365  70    0*370 341  70    0*
40920 09/14*359 413  70    0*362 394  70    0*365 370  70    0*370 344  70    0*
                ***             ***           *** ***             ***

40925 09/15*378 310  70    0*395 264  70    0*417 222  70    0*446 182  70    0*
40925 09/15E378 310  70    0E395 264  70    0E417 222  70    0E446 182  70    0*
          *                  *                 *                 *

40930 09/16*480 148  70    0*519 116  70  970*557  85  70    0*  0   0   0    0*
40930 09/16E480 148  70    0E517 116  75    0E560  85  75  961E605  58  75    0*
          *                  *         **     ****          *******  **  **

(September 17th and 18th are new to HURDAT)
40931 09/17E640  30  70    0E6603600  65    0E6703580  55    0E6753540  45    0*
40933 09/18E6803480  40    0E6853420  35    0E6903350  35    0E6953270  30    0*

40935 HR
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Tropical Storm Landfall

09/05 13Z 15.0N 23.4W 40 kt Santiago Island, Cape Verde Islands

Minor changes to the track and major changes to the intensity shown in McAdie et al. (2009). A major alteration is to show that the system was an extratropical cyclone for four days and to add two additional days to the track of the cyclone. Evidence for these alterations comes from the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Monthly Weather Review, Navy reconnaissance book, Mariners Weather Log, Met Éireann (Irish National Meteorological Service), Erickson (1963), Hickey and Connolly-Johnson (2012), and NHC Storm Wallets.

September 5:

HWM analyzes a closed low pressure of at most 1010 mb at 13.0N, 17.5W at 12Z. HURDAT does not list an organized storm on this day. Microfilm shows a tropical wave near the Cape Verde Islands along longitude 24W at 12Z. Ship highlights: No gales or low pressures.

MWR: “Hurricane Debbie probably developed between the Cape Verde Islands and Africa. Pressures in that area fell to well below their normal values with evidence of cyclonic circulation during the first few days of September.”

September 6:

HWM analyzes a closed low pressure of at most 1010 mb at 14.2N, 23.2W at 12Z. HURDAT lists a 50 kt tropical storm at 15.1N, 24.1W at 18Z (first position). Microfilm shows a closed low pressure of at most 1011 mb at 14.5N, 22.5W at 12Z. Ship highlights: 50 kt ENE and 994 mb (observation or location possibly erroneous) at 14.5N, 20.7W at 06Z (COADS). 30 kt N and 1004 mb at 14.8N, 27.2W at 19Z (WALLET/ERICKSON).

ATSR: “Although below-normal surface pressures has been observed near the Cape Verde Islands since the beginning of September, it was not until the 6th that ship and land station reports indicated that Debbie had formed. A Pan-American Airways report revealed an “active” tropical depression at 13N 23W at 061300Z.”

September 7:

HWM analyzes a hurricane of at most 1000 mb at 15.3N, 28.4W at 12Z. HURDAT lists a 70 kt hurricane at 15.7N, 28.1W at 12Z. Microfilm shows a closed low pressure of at most 1011 mb at 15.5N, 28.0W at 12Z. Ship highlights: 50 kt WNW and 995 mb at 14.8N, 26.3W at 01Z (micro/ERICKSON). 45 kt WSW and 1001 mb at 14.8N, 25.6W at 03Z (micro/ERICKSON). 45 kt S and 1004 mb at 14.8N, 25.0W at 06Z (micro/ERICKSON). 35 kt S and 1008 mb at 14.2N, 23.5W at 09Z (micro/ERICKSON).

MWR: “Late on the 6th and early on the 7th, several reports from the SS C. Maersk indicated that a storm, probably already of hurricane intensity, existed near 15ºN, 25ºW. The storm moved west-northwestward for the next several days but there were no observations in the area and it was not possible to locate the center accurately.” ATSR: “…and at 070000Z the first warning on the disturbance was issued by Fleet Weather Central, Port Lyautey. On the initial warning, it was termed a tropical depression but unnamed. Early on the 7th the SS CHARLOTTE MAERSK, which had done yeoman service in sending initial reports on Betsy, radioed an observation from 15N 26W giving a west wind of 40 knots, 15 to 20 foot seas, and a surface pressure of 996 mb. Fleet Weather Facility, Miami assumed the forecast responsibility on the depression at 071600Z and at 072200Z the first regularly numbered, named warning was issued.”

September 8:

HWM analyzes a hurricane of at most 995 mb at 18.3N, 33.3W at 12Z. HURDAT lists a 70 kt hurricane at 18.0N, 34.5W at 12Z. Microfilm shows a weather bulletin over the location of the tropical cyclone at 12Z. Ship highlights: No gales or low pressures.

ATSR: “Late on the 7th Debbie was determined to be of tropical storm intensity. Beyond range of reconnaissance aircraft and with a lack of ship reports from the 7th to the 10th, no amplifying data on Debbie was available for three days. The positions and forecasts were based largely on climatology. The storm was positioned on a more westerly track then proved to be the case.”

September 9:

HWM analyzes a hurricane of at most 995 mb at 19.4N, 38.2W at 12Z. HURDAT lists a 70 kt hurricane at 19.7N, 38.2W at 12Z. Microfilm shows a weather bulletin over the location of the tropical cyclone at 12Z. Ship highlights: No gales or low pressures.

September 10:

HWM analyzes a hurricane of at most 995 mb at 22.3N, 43.3W at 12Z. HURDAT lists a 75 kt hurricane at 22.8N, 43.0W at 12Z. Microfilm shows a closed low pressure of at most 1011 mb at 26.5N, 40.9W at 12Z. Ship highlights: No gales or low pressures.

MWR: “However, on September 10 TIROS photographs indicated that the center was near 25ºN, 45ºW. This estimate was less than 200 miles from the actual center.” ATSR: “The first indication that Debbie had taken a more northerly course than anticipated was at 101904Z when the Tiros satellite photographs placed the center much farther north.”

September 11:

HWM analyzes a hurricane of at most 995 mb at 27.3N, 45.9W with a weakening front to the north at 12Z. HURDAT lists a 100 kt hurricane at 27.9N, 45.9W at 12Z. Microfilm shows a closed low pressure of at most 1002 mb at 28.5N, 47.0W at 12Z. Ship highlights: 50 kt NE and 1000 mb at 25.5N, 45.9W at 00Z (micro). 55 kt NE and 1001 mb at 28.4N, 47.1W at 10Z (COADS). 50 kt NE at 30.1N, 47.0W at 13Z (micro). 60 kt NNW and 987 mb at 28.3N, 46.7W at 15Z (micro). 60 kt WNW and 999 mb at 27.9N, 46.2W at 18Z (COADS). Aircraft highlights: Penetration center fix measured a central pressure of 976 mb, estimated surface winds of 100 kt and an eye diameter of 45 nm at 28.8N, 46.2W at 1615Z (ATSR) [values not consistent with storm summary].

MWR: “From September 11 through 14 the center was within range of hurricane reconnaissance planes and during this time it moved northward.” ATSR: “Shortly

thereafter, at 110000Z, a ship report from 25.5N 45.7W revealed for certain that Debbie's true position was further north and that she was proceeding on a northerly course. Early on the 11th a Navy reconnaissance aircraft discovered Debbie to be a full blown hurricane with maximum winds of 120 kt and a central pressure of 975 mb. The storm moved steadily northward under the influence of the same long wave trough that had steered Betsy."

September 12:

HWM analyzes a hurricane of at most 995 mb at 32.2N, 46.0W with a warm front far to the northeast at 12Z. HURDAT lists a 105 kt hurricane at 32.2N, 45.8W at 12Z. Microfilm shows a closed low pressure of at most 996 mb at 32.5N, 46.0W at 12Z. Ship highlights: 60 kt E and 1005 mb at 31.4N, 45.0W at 00Z (micro). 45 kt N and 1002 mb at 32.4N, 47.4W at 06Z (COADS). 75 kt E and 995 mb at 33.0N, 46.2W at 12Z (micro). 45 kt WNW and 1000 mb at 32.4N, 46.3W at 18Z (micro). Aircraft highlights: Penetration center fix measured a central pressure of 975 mb and estimated an eye diameter of 80 nm at 32.5N, 45.7W at 1315Z (ATSR).

MWR: "... This agrees well with earlier reconnaissance reports of 975 mb while the hurricane was in the central Atlantic."

September 13:

HWM analyzes a hurricane of at most 1000 mb at 35.1N, 44.2W with a cold front far to the north at 12Z. HURDAT lists a 75 kt hurricane at 35.2N, 44.2W at 12Z. Microfilm shows a closed low pressure of at most 1002 mb at 35.8N, 43.8W at 12Z. Ship highlights: 50 kt NNW and 1003 mb at 33.6N, 47.3W at 00Z (COADS). 50 kt NW and 1004 mb at 33.9N, 47.1W at 06Z (COADS). 50 kt NW and 1009 mb at 34.1N, 46.8W at 12Z (COADS). 50 kt SSW and 1009 mb at 33.7N, 41.1W at 18Z (micro). 60 kt SE and 1012 mb at 37.5N, 41.1W at 21Z (micro). Aircraft highlights: Penetration center fix at 34.9N, 44.9W at 0901Z (ATSR). Penetration center fix at 35.2N, 44.0W at 13Z (ATSR).

MWR: "... and turned sharply east-northeastward on the 13th." ATSR: "On the 13th she turned sharply east-northeast."

September 14:

HWM analyzes a hurricane of at most 990 mb at 36.5N, 36.8W with a weakening cold front to the northwest at 12Z. HURDAT lists a 70 kt hurricane at 36.6N, 36.5W at 12Z. Microfilm shows a closed low pressure of at most 996 mb at 37.0N, 37.0W at 12Z. Ship highlights: 50 kt SW and 1002 mb at 34.3N, 40.3W at 00Z (COADS). 60 kt SSE and 1012 mb at 38.2N, 35.8W at 02Z (micro). 50 kt SW and 1009 mb at 33.7N, 42.8W at 06Z

(micro). 45 kt SSW and 1010 mb at 34.0N, 35.9W at 09Z (micro). 70 kt S and 1000 mb at 35.8N, 35.3W at 12Z (COADS). 95 kt SW and 992 mb at 35.7N, 35.6W at 15Z (COADS). 70 kt W and 1002 mb at 35.7N, 35.5W at 18Z (COADS). Aircraft highlights: Penetration center fix at 37.0N, 35.0W at 1653Z (ATSR).

September 15:

HWM analyzes a hurricane of at most 985 mb at 41.5N, 22.5W with a warm front to the northeast and cold front to the south at 12Z. HURDAT lists a 70 kt hurricane at 41.7N, 22.2W at 12Z. Microfilm shows a trough along longitude 22W extending from a large extratropical cyclone of at most 981 mb at 57.5N, 27.0W to 33N at 12Z. Ship highlights: 45 kt SSW and 1010 mb at 35.4N, 29.9W at 00Z (COADS). 55 kt SW and 1007 mb at 38.6N, 29.0W at 06Z (micro). 35 kt SSW and 999 mb at 41.1N, 22.0W at 12Z (HWM). 45 kt S and 985 mb at 45.3N, 16.3W at 18Z (COADS).

MWR: "... passing through the Azores during the night of September 14-15." ATSR: "…raced through the Azores on the night of the 14th-15th."

September 16:

HWM analyzes a hurricane of at most 960 mb at 55.5N, 10.0W with a warm front to the northeast and cold front to the east and southeast at 12Z. HURDAT lists a 70 kt hurricane at 55.7N, 8.5W at 12Z (last position). Microfilm shows a closed low pressure of at most 990 mb at 54.5N, 13.0W at 12Z. Ship highlights: 50 kt S and 990 mb at 45.5N, 11.5W at 00Z (COADS). 60 kt W and 976 mb at 50.6N, 13.7W at 05Z (MWL). 45 kt NW and 983 mb at 50.2N, 13.2W at 06Z (COADS). Land highlights: 961 mb at Belmullet, Ireland around 11Z-12Z (Met Eirean). 66 kt (10-min max wind) and gusts to 98 kt 10-min at Malin Head, Ireland at 13Z (Met Eirean/Hickey/Connolly-Johnson).

MWR: "It then accelerated and turned northward, passing along the western coasts of Ireland and Scotland on the 16th. The lowest available pressure was 970 mb reported by a ship a short distance from the center and offshore from Ireland. Gusts reached 106 mph at Ballykelly and 104 mph at Tiree and Snaefill. An Associated Press account of the hurricane from Longon follows: "The edge of Hurricane Debbie battered the British Isles Saturday night and left 11 or more dead and at least 50 injured. Flooding caused heavy damage in Ireland, Scotland, and Wales. Coastal areas of western Scotland were inundated by pounding surf whipped up by winds of 106 mph. Shipping and airplane traffic was disrupted. Coastal radio stations reported the airwaves were jammed with calls for help from small ships and fishing craft. Weathermen reported strong winds from northern Norway to the Bay of Biscay." ATSR: "…and finally grazed the coasts of Ireland and Scotland on the 16th. In Ireland and Scotland, Debbie caused heavy damage to shipping and the coastal sections and claimed 11 lives."

September 17:

HWM analyzes a large extratropical cyclone of at most 975 mb at 67.5N, 3.0E at 12Z. HURDAT does not list an organized storm on this day. Microfilm does not show an organized storm on this day (cyclone moving off the NE corner of the map). Ship highlights: 55 kt SW and 979 mb at 58.8N, 3.7W at 00Z (COADS). Land highlights: 45 kt SW and 991 mb at Rorvik, Norway at 12Z (HWM).

September 18:

HWM analyzes a broad extratropical cyclone of at most 985 mb at 68.0N, 30.0E at 12Z. HURDAT does not list an organized storm on this day. Microfilm is not available on this date. No gales or low pressures.

A vigorous tropical wave developed over central Africa around September 1st. The disturbance moved westward and became better organized still over western Africa. A paper by Erickson (MWR 1963, pg. 61) details the early history of this tropical system and provides excellent data on its formation and development. Surface observations over western Africa indicate that the tropical wave developed a well-defined, low-level circulation while still over land. Genesis is analyzed at 12Z on September 5th as a 30 kt tropical depression, just off the African coast, 30 hours earlier than originally shown in HURDAT. Minor track alterations are introduced during the lifetime of this tropical cyclone. The tropical depression moved westward on September 6th and gained strength. A ship reported 50 kt NE and 994 mb at 06Z on the 6th and although it is possible that the observation is correct, the position reported contradicts the other ship and coastal observations, thus it has been disregarded. Intensification to a tropical storm is analyzed at 06Z on the 6th based on data from the ship Charlotte Maersk later in the day and on September 7th. Originally HURDAT showed an initial intensity as a 50 kt tropical storm at 18Z on the 6th, also the original first position. Debbie made landfall in the island of Santiago, Cape Verde Islands, at 13Z on the 6th as a 40 kt tropical storm. Late on the 6th, the ship Charlotte Maersk was moving eastward near 15N, 27W and began to report lowering pressures and an increase in the winds. At 01Z on the 7th, the ship reported 50 kt WNW and 995 mb; the strongest winds experienced by the ship and also the lowest pressure. A peripheral pressure of 995 mb suggest maximum sustained winds greater than 56 kt from the Brown et al. pressure-wind relationship. Intensification to a hurricane is analyzed at 00Z on the 7th, same as originally shown in HURDAT. A TIROS III satellite image (MWR 1963, pg. 64) at 1913Z on the 7th shows hurricane Debbie in the southwest corner and an eye is apparent. It is possible that Debbie may have been stronger than analyzed (70 kt), but there is no other data to suggest increasing the winds from the values already in HURDAT, nor can an intensity assessment be made from the satellite image. Observations over the eastern Atlantic were very sparse as the hurricane moved

away from the Cape Verde Islands. No ships passed near Debbie from September 8th through the 10th. No changes to the intensity or track were made from the 8th through the 10th. A TIROS III satellite image (MWR 1962, pg. 111) at 1907Z on the 10th shows hurricane Debbie in a better angle to judge its organization. The hurricane has a well-organized CDO but convection is restricted on the western and southern quadrants, it appears that southwesterly shear is affecting the storm. At 18Z on the 10th, HURDAT originally showed an intensity of 75 kt and this is retained.

On September 11th, Debbie entered an area of heavier shipping traffic in the central Atlantic and gale-force winds were reported, including 60 kt at 15Z and 18Z. Also on the 11th, the hurricane turned to the north feeling the weakness left behind by the trough that picked up Betsy a couple of days before. The first reconnaissance aircraft reached the hurricane at 1615Z on the 11th measured a central pressure of 976 mb, estimated surface winds of 100 kt and an eye diameter of 45 nm. It is worth mentioning that these values differ slightly from those mentioned in the storm summary of the Navy book (ATSR). A central pressure of 976 mb suggests maximum sustained winds of 77 kt from the north of 25N pressure-wind relationship. An eye diameter of 45 nm suggests an RMW of 34 nm and the climatological value is 23 nm. Due to a forward speed of 14 kt, an RMW greater than the climatological value, and slightly weighting in the surface estimate, an intensity of 80 kt is selected at 18Z on the 11th, down from 105 kt originally in HURDAT, a major intensity change. A central pressure of 976 mb was present in HURDAT at 12Z on the 11th and based on the time of the penetration fix, it has been moved to the 18Z time slot on the 11th. 80 kt is also the peak intensity of this tropical cyclone, down from 105 kt originally in HURDAT, a major intensity change. It is analyzed that Debbie did not reach major hurricane intensity during its lifetime. Yet, it is possible that Debbie may have peaked in intensity earlier in its life and by the time the reconnaissance aircraft reached the hurricane, it had already weakened. An analog could be hurricane Julia in 2010 that peaked in intensity east of 35W and was a category 1 hurricane when it reached 45W. The next aircraft to investigate Debbie arrived at 1315Z on September 12th estimating a central pressure of 975 mb and an eye diameter of 80 nm. A central pressure of 975 mb suggests maximum sustained winds of 79 kt from the north of 25N pressure-wind relationship. An eye diameter of 80 nm suggests an RMW of 60 nm and the climatological value is 27 nm. Due to a forward speed of 8 kt and an RMW greater than the climatological value, an intensity of 75 kt is selected at 12Z on the 12th, down from 105 kt originally in HURDAT, a major intensity change. A central pressure of 975 mb was present in HURDAT at 12Z on the 12th and it has been retained. Various ships reported gale-force winds on the 12th and a ship even reported hurricane-force winds, 75 kt E and 995 mb at 12Z.

On September 13th, Debbie turned to the east-northeast. A central pressure of 980 mb is present in HURDAT at 06Z on the 13th and reconnaissance data shows that aircrafts were present around this time, thus the central pressure has been retained even though it could not be confirmed. A central pressure of 980 mb suggests maximum sustained winds of 73 kt from the Brown et al. north of 35N south of 25N pressure-wind relationship and also 73 kt north of 25N from the Landsea et al. pressure-wind relationship. Due to a forward speed of 10 kt and a large RMW, an intensity of 70 kt is selected at 06Z on the 13th, down from 85 kt originally in HURDAT, a minor intensity change. Various ships reported tropical storm force winds, up to 60 kt. A great satellite image of hurricane Debbie made the cover of Mariners Weather Log, Volume 5, Number 6, November 1961. The satellite image was taken at 1416Z on the 13th by the Mercury spacecraft 12 minutes after launch at an altitude of 90 miles. In the satellite image, Debbie appears as a well-organized hurricane with what seems to be a large eye surrounded by a symmetric CDO. On September 14th, the hurricane continued east-northeast gaining in forward speed with no appreciable changes in intensity. Many ships reported gale-force winds and a couple even recorded hurricane-force winds. A ship reported 95 kt at 15Z but this observation appears dubious and was disregarded. Late on the 14th, Debbie began to become extratropical as dry, cool air entered the circulation. Synoptic data at 00Z on September 15th indicate that Debbie became an extratropical cyclone as a temperature gradient was present between the eastern and western quadrants and frontogenesis had taken place. HURDAT did not show Debbie becoming an extratropical cyclone despite reaching 55ºN. The strong extratropical cyclone crossed the Azores around 04Z as it raced to the northeast. Early on September 16th, Debbie approached Ireland and the United Kingdom producing hurricane-force winds and damaging storm surge. A central pressure of 970 mb was present in HURDAT at 06Z on the 16th and has been removed as a ship near the center reported 25 kt SE and 963 mb at this time. Debbie made landfall in Ireland around 11Z and the lowest pressure recorded was 961 mb at Belmullet. This was likely a central pressure based on the track of the extratropical cyclone; thus, it has been added to HURDAT at 12Z on the 16th. The strongest winds recorded in Ireland were 66 kt 10-min (74 kt 1-min). An intensity of 75 kt is analyzed at 06Z and 12Z on the 16th, up from 70 kt originally in HURDAT, a minor intensity change. On September 17th, the extratropical cyclone turned to the northeast and east as it approached Norway. Weakening below hurricane intensity is analyzed at 12Z on the 17th. HWM indicates that gale-force winds affected Norway. On September 18th, the system moved over northern Norway and northwestern Russia. Surface observations indicate that the extratropical cyclone weakened into an elongated trough and the last position is analyzed at 18Z on the 18th, 54 hours later than originally shown in HURDAT.

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42025 09/10/1961 M=18  5 SNBR= 912 ESTHER      XING=1 SSS=0
42025 09/10/1961 M=17  5 SNBR= 912 ESTHER      XING=1 SSS=0
                    **

42030 09/10*  0   0   0    0*  0   0   0    0*  0   0   0    0*117 321  25    0*
42030 09/10*  0   0   0    0*  0   0   0    0*112 310  35    0*117 325  35    0*
                                             *** ***  **          ***  **

42035 09/11*124 339  25    0*135 353  25    0*144 367  35    0*152 381  40    0*
42035 09/11*124 339  40    0*134 353  45    0*144 367  50    0*152 381  55    0*
                     **      ***  ***  **                **                **

42040 09/12*160 394  50    0*168 408  65    0*176 420  65  975*184 431  70  967*
42040 09/12*160 394  60    0*168 407  70    0*176 420  80  975*184 431  90  967*
                     **          ***  **                **                **

42045 09/13*191 442  75    0*196 453  90  969*198 464 105  970*200 474 110  983*
42045 09/13*190 442  90    0*194 453  90  969*196 464  90  970*198 474  90    0*
           ***       **      ***            ***       **      ***       **    *

42050 09/14*201 484 110    0*202 494 110    0*203 505 110  975*205 513 110  966*
42050 09/14*200 484  90    0*202 494  95  962*203 504  95    0*205 513  90  965*
           ***       **                ** ***     ***  **    *           **  ***

42055 09/15*207 521 110  965*211 534 110  965*216 547 110  966*218 561 110  961*
42055 09/15*208 523  90  965*212 536  90  968*216 549  90  966*218 562  95  961*
           *** ***  **      ***  ***  ** ***     ***  **          ***  **

42060 09/16*220 574 110  960*223 587 105  956*227 600 105  949*233 613 105  944*
42060 09/16*220 575  95  960*223 589 105  956*227 603 115  948*233 615 130  935*
                ***  **          ***            *** ***  ***     *** ***  ***

42065 09/17*238 626 105  939*241 639 110  934*244 652 110  930*248 662 115  927*
42065 09/17*238 627 125  939*241 639 130  934*244 651 135  928*249 662 135  927*
                *** ***              ***           *** ***  *** ***      ***

42070 09/18*254 669 120  928*261 678 120  932*270 686 125  938*280 694 125  944*
42070 09/18*254 670 135  928*261 679 125  933*269 687 120  936*279 695 115  943*
                *** ***          *** ***  *** *** *** ***  *** *** *** ***  ***

42075 09/19*290 701 125  948*300 710 125  945*310 719 125  942*320 726 125  950*
42075 09/19*290 702 120  936*300 710 115  943*309 719 115  940*319 727 105  950*
                *** ***  ***         ***  *** ***      ***  *** *** *** ***

42080 09/20*330 731 120  947*340 734 120  957*350 733 120  949*363 730 120  955*
42080 09/20*329 731 105  952*339 732 100  956*350 733 105  948*363 730 100  953*
           ***      ***  *** *** *** ***  ***          ***                ***  ***

42085 09/21*378 725 115  968*392 718 110  972*404 711 110  978*409 707 105    0*
42085 09/21*378 726  90  962*392 722  85  968*404 715  75  972*408 707  75    0*
                ***  **  ***     ***  **  ***     ***  **  *** ***       **

42090 09/22*409 701  60    0*409 691  50    0*408 679  45  990*404 666  50    0*
42090 09/22*408 700  75    0*407 691  70    0*402 679  65  989*396 664  60    0*
           *** ***  **      ***       **      ***       **  *** *** ***  **

42095 09/23*397 654  60  993*388 648  60    0*379 649  60    0*370 653  60    0*
42095 09/23*388 652  60  993*379 648  55    0*370 650  50    0*362 655  45    0*
           *** ***          ***       **      *** ***  **      *** ***  **

42100 09/24*361 659  55    0*356 666  55    0*357 674  50    0*361 684  50    0*
42100 09/24*359 661  45  995*356 667  45    0*357 674  45    0*360 684  50    0*
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            *** ***  **  ***     ***  **               **      ***

42105 09/25*367 695  45    0*374 702  45  993*381 705  45    0*389 705  45    0*
42105 09/25*363 694  50  993*369 702  50    0*379 708  50  990*389 710  50  990*
            *** ***  **  *** ***      **    * *** ***  **  ***     ***  **  ***

42110 09/26*400 703  40  996*422 701  35    0*447 698  30 1002*466 692  30    0*
42110 09/26*400 710  50    0*417 705  50    0*440 698  35 1002*470 692  25    0*
                ***  **    * *** ***  **      ***      **       ***      **

(September 27th has been removed from HURDAT)
42115 09/27E482 683  30    0E500 670  30    0*  0   0   0    0*  0   0   0    0*
42115 09/27*  0   0   0    0*  0   0   0    0*  0   0   0    0*  0   0   0    0*
              *   *   *        *   *   *

42120 HR
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U.S. Tropical Storm Landfall

09/26 05Z 41.4N 70.6W 50 kt MA
09/26 06Z 41.6N 70.5W 50 kt MA
09/26 11Z 43.8N 69.9W 35 kt ME

U.S. Tropical Storm Impact

09/21 08Z 39.6N 72.0W 40 kt New Jersey
09/21 12Z 40.4N 71.5W 60 kt New York
09/21 15Z 40.6N 71.1W 60 kt Rhode Island
09/21 15Z 40.6N 71.1W 50 kt Connecticut

Minor changes to the track and major changes to the intensity shown in McAdie et al. (2009). Evidence for these alterations comes from the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Monthly Weather Review, Navy reconnaissance book, Mariners Weather Log, National Hurricane Research Project, Local Climatological Data and NHC Storm Wallets.

September 9:

HWM analyzes a spot low pressure at 10.0N, 21.2W at 12Z. HURDAT does not list an organized storm on this day. Microfilm is not available on this date. Ship highlights: No gales or low pressures.

September 10:

HWM analyzes a closed low pressure of at most 1010 mb at 9.4N, 30.2W at 12Z. HURDAT lists a 25 kt tropical depression at 11.7N, 32.1W at 18Z (first position). Microfilm is not available on this date. Ship highlights: No gales or low pressures.

ATSR: “Hurricane Esther formed in the eastern Atlantic and probably developed from a perturbation along the Intertropical Convergence Zone. Early indication of the existence

of the tropical disturbance was provided by the weather satellite Tiros III at 1904Z on 10 September."

September 11:

HWM analyzes a tropical storm of at most 1005 mb at 13.3N, 37.8W at 12Z. HURDAT lists a 35 kt tropical storm at 14.4N, 36.7W at 12Z. Microfilm is not available on this date. Ship highlights: No gales or low pressures.

MWR: "On September 11, with Carla moving inland in Texas and Betsy and Debbie still threatening shipping in the Atlantic, evidence of a new disturbance began to appear. At 1330 EST on that date, pictures from the TIROS III satellite showed a vortex near 15ºN, 38ºW." ATSR: "The following day, the Tiros III nephanalysis (111820Z) indicated a possible vortex."

September 12:

HWM analyzes a hurricane of at most 995 mb at 17.3N, 42.1W at 12Z. HURDAT lists a 65 kt hurricane at 17.6N, 42.0W at 12Z. Microfilm shows a spot low at 14.3N, 44.0W at 12Z. Ship highlights: 30 kt NW and 1000 mb at 18.2N, 45.2W at 21Z (micro). Aircraft highlights: Penetration center fix measured a central pressure of 967 mb, estimated surface winds of 110 kt and an eye diameter of 40 nm at 18.8N, 43.6W at 2010Z (ATSR).

MWR: "A reconnaissance flight was therefore dispatched to the area on September 12. It revealed that Esther had formed and was of full hurricane intensity with a central pressure of 967 mb. The first advisory at 1730 EST placed the center at 19ºN, 44ºW moving toward the northwest at 15 kt, accompanied by 110-kt winds. The intensity at this time suggests that Esther undoubtedly reached hurricane strength by September 11. In fact, a "possible" vortex near 11ºN 30ºW in the TIROS III nephanalysis for 1412 EST, September 10 may have represented near hurricane intensity." ATSR: "A reconnaissance aircraft was dispatched on the morning of the 12th after estimating the position of the vortex to be within range of Roosevelt Roads, Puerto Rico. The aircraft located the eye near 18-45N 43-32W at 2010Z on 12 September and reported winds of 110 knots and a central pressure of 967 mb. The initial warning on Hurricane Esther was issued at 2230Z on 12 September. During the period of 12-17 September an anticyclone was building to the north, causing Esther to move in a fairly steady course to the west-northwest."

September 13:

HWM analyzes a hurricane of at most 995 mb at 19.2N, 46.4W at 12Z. HURDAT lists a 105 kt hurricane at 19.8N, 46.4W at 12Z. Microfilm shows a closed low pressure of at most 1002 mb at 19.7N, 46.5W at 12Z. Ship highlights: 80 kt WNW and 978 mb at

18.4N, 44.9W at 00Z (micro). 60 kt NE and 1003 mb at 20.1N, 45.1W at 06Z (COADS). 45 kt E and 1009 mb at 20.7N, 44.6W at 12Z (COADS). 40 kt ESE and 1013 mb at 21.5N, 43.5W at 18Z (COADS). Aircraft highlights: Penetration center fix measured a central pressure of 969 mb, estimated surface winds of 100 kt and an eye diameter of 40 nm at 18.8N, 43.6W at 09Z (ATSR). Radar center fix at 19.6N, 47.1W at 1810Z (ATSR).

MWR: “On the 13th and 14th surface pressure to the north of Esther began to rise as Debbie headed toward the Azores and a building anticyclone moved eastward from the vicinity of Bermuda. As a result, Esther was deflected to a west-northwestward course for the next few days. Also, as often happens under the influence of the increased gradient accompanying the passage of a High to the north of a hurricane, a gradual intensification began.”

September 14:

HWM analyzes a hurricane of at most 995 mb at 20.2N, 50.6W at 12Z. HURDAT lists a 110 kt hurricane at 20.3N, 50.5W at 12Z. Microfilm shows a closed low pressure of at most 1008 mb at 20.5N, 50.6W at 12Z. Ship highlights: 35 kt W and 1008 mb at 18.7N, 52.2W at 19Z (micro). Aircraft highlights: Penetration center fix measured a central pressure of 962 mb and estimated an eye diameter of 40 nm at 20.3N, 49.8W at 07Z (ATSR). Penetration center fix measured a central pressure of 965 mb at 20.4N, 51.1W at 2017Z (ATSR/micro).

September 15:

HWM analyzes a hurricane of at most 995 mb at 21.4N, 54.5W at 12Z. HURDAT lists a 110 kt hurricane at 21.6N, 54.7W at 12Z. Microfilm does not provide an analysis in the area at 12Z. Ship highlights: 35 kt E and 1018 mb at 24.8N, 52.8W at 12Z (COADS). 45 kt E and 1016 mb at 24.0N, 52.8W at 18Z (COADS). Aircraft highlights: Penetration center fix measured a central pressure of 968 mb at 21.3N, 54.0W at 07Z (ATSR). Penetration center fix measured a central pressure of 966 mb, estimated maximum surface winds of 100 kt and an eye diameter of 30 nm at 21.6N, 55.0W at 13Z (ATSR). Penetration center fix at 21.8N, 56.2W at 19Z (ATSR).

September 16:

HWM analyzes a hurricane of at most 990 mb at 23.3N, 60.0W with a stationary front far to the northwest at 12Z. HURDAT lists a 105 kt hurricane at 22.7N, 60.0W at 12Z. Microfilm does not provide an analysis in the area at 12Z. Ship highlights: No gales or low pressures. Aircraft highlights: Penetration center fix measured a central pressure of 960 mb and estimated an eye diameter of 30 nm at 22.0N, 57.8W at 01Z (ATSR). Penetration center fix at 22.5N, 59.5W at 07Z (ATSR). Penetration center fix measured a

central pressure of 948 mb, estimated surface winds of 120 kt and an eye diameter of 20 nm at 22.8N, 60.5W at 1255Z (ATSR). Penetration center fix measured a central pressure of 935 mb, estimated surface winds of 128 kt and an RMW of 13 nm near ~23.0N, ~60.0W around 18Z (NHRP). Penetration center fix measured a central pressure of 936 mb, estimated surface winds of 100 kt and an eye diameter of 20 nm at 23.3N, 61.5W at 1830Z (ATSR). Penetration center fix at 23.6N, 62.6W at 2330Z (ATSR).

September 17:

HWM analyzes a hurricane of at most 990 mb at 24.2N, 65.3W with a frontal boundary far to the northwest at 12Z. HURDAT lists a 110 kt hurricane at 24.4N, 65.2W at 12Z. Microfilm shows a closed low pressure of at most 1002 mb at 24.5N, 66.0W at 12Z. Ship highlights: 40 kt SE and 1013 mb at 27.4N, 62.8W at 12Z (COADS). 40 kt W and 1008 mb at 22.5N, 68.9W at 15Z (micro). 45 kt W and 1004 mb at 22.8N, 68.1W at 18Z (COADS). 45 kt W and 1001 mb at 23.0N, 68.1W at 21Z (MWL). Aircraft highlights: Penetration center fix measured an eye diameter of 17 nm at 24.1N, 64.1W at 07Z (ATSR). Penetration center fix measured a central pressure of 928 mb, estimated surface winds of 80 kt and an eye diameter of 18 nm at 24.5N, 65.5W at 1313Z (ATSR/micro). Penetration center fix measured a central pressure of 940 mb, estimated surface winds of 112 kt and an RMW of 10 nm at 24.0N, 65.0W around 1420Z (NHRP). Penetration center fix measured a central pressure of 927 mb, estimated surface winds of 120 kt and an eye diameter of 15 nm at 25.0N, 66.4W at 19Z (ATSR). Radar center fix estimated an eye diameter of 17 nm at 25.4N, 66.9W at 2346Z (ATSR).

MWR: “By the 17th, the central pressure had dropped to 927 mb. According to the various formulae relating central pressure and maximum wind, this would support 150- to 175-kt squalls. Since the storm path was well to the north of the Virgin Islands, Puerto Rico, and the Bahamas, effects in these areas consisted mostly of increased surf and large swells.” ATSR: “Gradual intensification was indicated when, on the 17th, a reconnaissance aircraft reported a central pressure of 927 mb.”

September 18:

HWM analyzes a hurricane of at most 990 mb at 26.5N, 68.6W with a weakening stationary front to the northwest at 12Z. HURDAT lists a 125 kt hurricane at 27.0N, 68.6W at 12Z. Microfilm shows a closed low pressure of at most 1002 mb at 27.0N, 68.8W at 12Z. Ship highlights: 50 kt SE and 1012 mb at 27.2N, 64.1W at 00Z (COADS). 55 kt SE and 1010 mb at 27.2N, 64.7W at 06Z (COADS). 40 kt SSW and 1006 mb at 23.9N, 66.3W at 09Z (MWL). 55 kt SE and 1010 mb at 27.1N, 65.5W at 12Z (COADS). 55 kt E and 1014 mb at 30.3N, 66.2W at 15Z (COADS). 55 kt E and 1006 mb at 30.0N, 69.3W at 18Z (COADS). 45 kt SSE and 1013 mb at 29.6N, 65.0W at 21Z (micro).

Aircraft highlights: Penetration center fix measured a central pressure of 928 mb, estimated flight level winds of 80 kt and an eye diameter of 16 nm at 25.6N, 67.5W at 0130Z (ATSR). Penetration center fix measured a central pressure of 933 mb, estimated an eye diameter of 16 nm at 26.0N, 68.3W at 07Z (ATSR). Penetration center fix measured a central pressure of 936 mb and estimated surface winds of 140 kt at 27.0N, 68.8W at 13Z (ATSR/WALLET). Penetration center fix measured a central pressure of 946 mb and estimated an eye diameter of 40 nm at 27.6N, 69.4W at 16Z (ATSR/WALLET). Penetration center fix measured a central pressure of 943 mb at 28.2N, 69.8W at 19Z (ATSR/WALLET). Penetration center fix measured a central pressure of 936 mb at 28.7N, 69.9W at 22Z (ATSR).

ATSR: “The track changed to a more northwesterly direction on the morning of the 18th as Esther headed toward Cape Hatteras.”

September 19:

HWM analyzes a hurricane of at most 990 mb at 30.6N, 71.5W with a warm front far to the north at 12Z. HURDAT lists a 125 kt hurricane at 31.0N, 71.9W at 12Z. Microfilm shows a closed low pressure of at most 1002 mb at 31.0N, 72.0W at 12Z. Ship highlights: 55 kt E and 1003 mb at 30.0N, 68.7W at 00Z (COADS). 55 kt SSE and 1008 mb at 31.4N, 68.1W at 06Z (COADS). 50 kt SE and 1010 mb at 31.3N, 67.6W at 12Z (COADS). 40 kt NNE and 1008 mb at 33.2N, 74.7W at 15Z (micro). 55 kt NW at 30.9N, 74.7W at 18Z (micro). Aircraft highlights: Penetration center fix measured a central pressure of 950 mb and estimated an eye diameter of 25 nm at 29.4N, 70.4W at 01Z (ATSR). Penetration center fix measured a central pressure of 943 mb at 29.8N, 71.1W at 0430Z (ATSR). Penetration center fix measured a central pressure of 948 mb at 30.0N, 71.4W at 07Z (ATSR). Penetration center fix measured a central pressure of 940 mb and estimated an eye diameter of 35 nm at 30.4N, 71.8W at 1030Z (WALLET). Penetration center fix measured a central pressure of 943 mb, estimated flight level winds of 105 kt and an eye diameter of 35 nm at 30.8N, 71.9W at 13Z (WALLET). Penetration center fix measured a central pressure of 949 mb and estimated surface winds of 100 kt at 31.4N, 72.3W at 1545Z (ATSR). Penetration center fix measured a central pressure of 951 at 32.0N, 72.7W at 19Z (WALLET). Penetration center fix measured a central pressure of 945 mb, estimated flight level winds of 95 kt and an eye diameter of 35 nm at 32.5N, 72.9W at 2155Z (WALLET).

September 20:

HWM analyzes a hurricane of at most 990 mb at 35.0N, 73.2W with a weakening warm front to the north at 12Z. HURDAT lists a 120 kt hurricane at 35.0N, 73.3W at 12Z. Microfilm shows a closed low pressure of at most 999 mb at 35.0N, 73.2W at 12Z. Ship

highlights: 55 kt NNE and 1004 mb at 34.0N, 75.4W at 00Z (COADS). 55 kt NW and 1004 mb at 31.5N, 74.5W at 03Z (micro). 45 kt SE and 1007 mb at 35.0N, 70.0W at 06Z (COADS). 45 kt WNW and 1005 mb at 31.8N, 74.3W at 09Z (micro). 70 kt SE at 36.4N, 70.1W at 12Z (micro). 45 kt S and 1003 mb at 33.9N, 70.2W at 15Z (micro). 70 kt ESE and 1006 mb at 36.5N, 69.1W at 18Z (micro). 40 kt NNW and 1006 mb at 37.5N, 76.1W at 21Z (COADS). Land highlights: 37 kt NNE and 1011 mb at Frying Pan Shoals, NC at 00Z (SWO). 28 kt N (31 kt peak) and 999 mb at Cape Hatteras, NC at 0955Z (SWO/CLIMO). 40 kt N and 1001 mb at Diamond Shoals, NC at 06Z (micro). 25 kt NW and 1003 mb at 35.2N, 75.3W at Diamond Shoals, NC at 18Z (micro). Aircraft highlights: Penetration center fix measured a central pressure of 952 mb, estimated flight level winds of 95 kt and an eye diameter of 25-35 nm at 33.2N, 73.1W at 01Z (ATSR). Penetration center fix measured a central pressure of 957 mb at 33.7N, 73.2W at 04Z (ATSR). Penetration center fix measured a central pressure of 956 mb at 33.9N, 73.2W at 07Z (ATSR). Penetration center fix measured a central pressure of 948 mb, estimated flight level winds of 115 kt and an eye diameter of 32 nm at 35.1N, 73.3W at 1215Z (ATSR). Penetration center fix measured a central pressure of 953 mb and estimated an eye diameter of 25-40 nm at 35.9N, 72.9W at 1544Z (WALLET). Radar center fix at 36.8N, 72.8W at 1845Z (ATSR). Penetration center fix estimated surface winds of at least 65 kt at 37.7N, 72.3W at 23Z (ATSR).

MWR: “A gradual curving to the north and subsequently to the north-northeast took the center about 120 miles to the east of Cape Hatteras on the morning of the 20th.” ATSR: “After 1000Z on the 20th, when the center was approximately 130 miles east-southeast of Cape Hatteras, the hurricane began to recurve to the north-northeast. The track was nearly parallel to the east coast of the United States for the next 24 hours.”

September 21:

HWM analyzes a hurricane of at most 990 mb at 40.0N, 71.2W at 12Z. HURDAT lists a 110 kt hurricane at 40.4N, 71.1W at 12Z. Microfilm shows a closed low pressure of at most 996 mb at 40.5N, 71.2W at 12Z. Ship highlights: 65 kt NE and 991 mb at 38.9N, 73.2W at 00Z (COADS). 45 kt SW and 1004 mb at 36.0N, 70.1W at 03Z (micro). 70 kt NW and 998 mb at 38.0N, 73.8W at 06Z (COADS). 55 kt W and 1003 mb at 38.1N, 72.4W at 12Z (COADS). 60 kt NW and 992 mb at 40.5N, 72.1W at 18Z (COADS). Land highlights: 988 mb at Block Island, RI (time unknown) (CLIMO). 40 kt NW (gusts to 51 kt) and 1001 mb at Atlantic City, NJ at 0756Z (SWO). 41 kt NNE (gusts to 55 kt) and 998 mb at 0958Z (SWO). 41 kt NNE (gusts to 72 kt) at Block Island, RI at 10Z (SWO). 42 kt NE and 991 mb at Block Island, RI at 12Z (SWO). 48 kt N (gusts to 60 kt) at Calverton, NY at 13Z (SWO). 50 kt N (gusts to 63 kt) at Calverton, NY at 15Z (SWO). 33 kt NNE and 989 mb at Block Island, RI at 18Z (SWO). Aircraft highlights:

Penetration center fix measured a central pressure of 962 mb at 37.9N, 72.4W at 01Z (ATSR). Penetration center fix measured a central pressure of 968 mb at 38.4N, 72.2W at 0355Z (ATSR). Penetration center fix measured a central pressure of 970 mb at 40.0N, 71.9W at 1030Z (ATSR). Penetration center fix measured a central pressure of 974 mb at 40.2N, 71.6W at 13Z (ATSR). Radar center fix at 40.8N, 71.3W at 19Z (ATSR).

MWR: "…and to about 35 miles south-southeast of Block Island, RI, 24 hours later. Gales swept the coastal strip from the Outer Banks of North Carolina to New Jersey and, early on September 21, winds reached hurricane force from eastern Long Island to Block Island. Gusts hit 40 kt at Ocean City, MD, and 60 kt at Atlantic City, NJ. Montauk Point, RI, and Block Island, which were nearer the storm center, reported peak gusts of 94 kt and 72 kt, respectively, at 0500 EST on the 21st Cape Cod also experienced hurricane force gusts. Fortunately for New England, Esther weakened markedly in passing over colder waters north of 35ºN, and also took a sharp eastward turn on the afternoon of September 21. This turn was the beginning of a large clockwise loop which carried the center southward almost to the latitude of Cape Hatteras then back to intersect the original path near Nantucket Island four days later." ATSR: "As Esther deceased in intensity the track changed to the east on the morning of the 21st and eventually completed a large clockwise loop."

September 22:

HWM analyzes a tropical storm of at most 995 mb at 40.2N, 67.2W with a weakening stationary front far to the northwest and a warm front far to the east at 12Z. HURDAT lists a 45 kt tropical storm at 40.8N, 67.9W at 12Z. Microfilm shows a closed low pressure of at most 996 mb at 39.8.N, 67.0W at 12Z. Ship highlights: 50 kt W and 991 mb at 39.6N, 71.1W at 00Z (COADS). 70 kt WSW and 993 mb at 39.5N, 69.0W at 06Z (COADS). 40 kt W and 1002 mb at 38.8N, 68.2W at 12Z (COADS). 20 kt SE and 991 mb at 39.6N, 67.3W at 12Z (COADS). 50 kt NNW and 1001 mb at 39.2N, 68.5W at 18Z (COADS). Land highlights: 8 kt N and 995 mb at Nantucket Light, MA at 00Z (SWO). 8 kt N and 997 mb at Nantucket Light, MA at 06Z (SWO).

MWR: "The storm was producing only 35- to 45-kt squalls on the 22nd, but showed some regeneration over the warmer waters at the southernmost part of the loop and when it moved northward again passed Cape Cod maximum winds where 50 to 60 knots."

September 23:

HWM analyzes a tropical storm of at most 1000 mb at 38.4N, 64.7W with a cold front far to the northwest and weakening warm front to the northeast at 12Z. HURDAT lists a 60 kt tropical storm at 37.9N, 64.9W at 12Z. Microfilm shows a closed low pressure of at most 993 mb at 37.0N, 65.5W at 12Z. Ship highlights: 993 mb at 38.3N, 65.1W at 00Z

(COADS). 35 kt W and 998 mb at 36.1N, 66.3W at 00Z (COADS). 45 kt N and 1005 mb at 39.5N, 67.3W at 06Z (COADS). 45 kt NW and 1014 mb at 30.6N, 70.0W at 12Z (COADS). 40 kt NNW and 1005 mb at 36.0N, 69.6W at 18Z (micro).

September 24:

HWM analyzes a tropical storm of at most 1005 mb at 35.3N, 67.7W with a cold front to the north at 12Z. HURDAT lists a 50 kt tropical storm at 35.7N, 67.4W at 12Z. Microfilm shows a closed low pressure of at most 1008 mb at 35.0N, 68.0W with a frontal boundary to the northwest at 12Z. Ship highlights: 20 kt NNE and 997 mb at 36.2N, 66.8W at 00Z (COADS). 35 kt NW and 1005 mb at 35.6N, 68.7W at 00Z (COADS). 40 kt NE and 1013 mb at 39.0N, 69.0W at 06Z (COADS). 40 kt E and 1013 mb at 39.1N, 67.7W at 12Z (COADS). 50 kt W and 1009 mb at 35.3N, 65.8W at 18Z (COADS).

September 25:

HWM analyzes a tropical storm of at most 1000 mb at 37.7N, 70.3W with a frontal boundary to the north at 12Z. HURDAT lists a 45 kt tropical storm at 38.1N, 70.5W at 12Z. Microfilm shows a closed low pressure of at most 999 mb at 38.0N, 70.5W at 12Z. Ship highlights: 20 kt S and 995 mb at 36.1N, 68.6W at 00Z (COADS). 40 kt NE and 998 mb at 37.3N, 70.2W at 00Z (COADS). 50 kt SE and 994 mb at 37.2N, 69.9W at 06Z (COADS). 30 kt NW and 990 mb at 37.9N, 71.3W at 12Z (COADS). 50 kt SSE and 1000 mb at 37.9N, 70.0W at 12Z (micro). 45 kt E and 999 mb at 39.5N, 71.2W at 18Z (COADS). 25 kt WSW and 993 mb at 38.0N, 71.1W at 18Z (micro).

September 26:

HWM analyzes a closed low pressure of at most 1005 mb at 44.2N, 70.5W in the warm sector of an extratropical cyclone of at most 1005 mb at 45.0N, 79.5W at 12Z. HURDAT lists a 30 kt tropical storm at 44.7N, 69.8W at 12Z. Microfilm shows a closed low pressure of at most 1002 mb at 44.7N, 70.3W with an extratropical cyclone to the west at 12Z. Ship highlights: 40 kt S and 997 mb at 39.2N, 70.0W at 00Z (COADS). 20 kt SW and 997 mb at 39.0N, 70.0W at 00Z (COADS). 40 kt SW and 1008 mb at 39.5N, 68.5W at 06Z (COADS). 55 kt SW and 1013 mb at 41.0N, 66.5W at 12Z (COADS). 35 kt SW and 1018 mb at 40.9N, 65.4W at 18Z (COADS). Land highlights: 40 kt SSE and 1002 mb at Nantucket Light, MA at 00Z (SWO). 55 kt SSW and 999 mb at Nantucket Light, MA at 06Z (SWO). 4 kt NE and 1004 mb at Augusta, ME at 1158Z (SWO). 8 kt SSW and 1002 mb at Loring AFB, ME at 2055Z (SWO).

MWR: “The storm accelerated northward through Maine on the 26th, gradually weakened, and turned northeastward toward Labrador as a frontal disturbance. No deaths

have been attributed to Esther. Property damage totaled 5,000,000 to 10,000,000 dollars." ATSR: "The storm became extratropical over Maine on the 26th. The Joint Hurricane Warning Center promulgated a total of 40 warnings on Esther during the period 12-21 September. In addition to aircraft reconnaissance, land-based radars located at Hatteras, Wilmington, Norfolk, Wallops Island, New York City, and Nantucket participated in the tracking of the hurricane from a position approximately 200 miles to the southeast of Cape Hatteras until the start of the loop. Gale force winds, rain and storm surge caused considerable damage along the eastern seaboard from the Virginia Capes to Nantucket Island. Storm surges ranged up to 5 feet above normal in some areas. Esther was the subject of a large scale cloud seeding experiment which was conducted jointly by the Navy, Weather Bureau and Air Force."

September 27:

HWM analyzes an extratropical cyclone of at most 1000 mb at 53.0N, 57.0W at 12Z. HURDAT lists a 30 kt extratropical depression at 50.0N, 67.0W at 12Z. Microfilm shows an extratropical cyclone of at most 1005 mb at 52.0N, 57.0W at 12Z. Ship highlights: No gales or low pressures. Land highlights: 5 kt SSE and 1004 mb at Sainte Angele de Merici, Canada at 00Z (micro).

Hurricane Esther developed from a tropical wave that left the African coast around September 8th. The strong disturbance rapidly became better organized and based on a TIROS III satellite image on September 10th at 1912Z (MWR 1962, pg. 111), the system is upgraded to a tropical storm at 12Z on the 10th, 24 hours earlier than originally shown in HURDAT. Genesis likely occurred on September 9th or early on the 10th, but the synoptic data is sparse over the eastern Atlantic. Minor track changes are analyzed during the lifetime of Esther. The first position in HURDAT was at 18Z on the 10th as a 25 kt tropical depression. The satellite image clearly indicates that the tropical cyclone had attained tropical storm intensity at this time and even our analysis of 35 kt may be conservative. The tropical storm initially moved northwestward under the influence of a mid-upper level trough which had steered Debbie to the north over the central Atlantic. By September 13th, an anticyclone was strengthening north of Esther causing the tropical cyclone to turn to the west-northwest while moving at a steady pace of about 12 kt. Conducive environmental conditions allowed the tropical storm to intensify and Esther is analyzed to have become a hurricane at 06Z on September 12th, same as originally shown in HURDAT. A central pressure of 975 mb was present in HURDAT at 12Z on the 12th and has been retained as it appears reasonable, although it seems to have been added in and not based on actual observations. The first reconnaissance hurricane reached the hurricane at 2010Z on the 12th measuring a central pressure of 967 mb, estimating surface winds of 110 kt and an eye diameter of 40 nm. A central pressure of 967 mb

suggests maximum sustained winds of 93 kt south of 25N Brown et al. pressure-wind relationship and 95 kt intensifying from the pressure-wind relationship. An eye diameter of 40 nm suggests an RMW of 30 nm and climatology indicates 14 nm. Based on a forward speed of 13 kt and an RMW larger than climatology, an intensity of 90 kt is selected for 18Z on the 12th, up from 70 kt originally shown in HURDAT, a major intensity change. (Central pressures values for almost every 6 hour period were present in the original HURDAT between September 12th at 12Z and September 26th at 12Z. Some of these were obviously analyses that were added in, not based upon actual observations. Thus, based on proceeding and subsequent actual observations, some were retained, others removed and new central pressure values added. Detailed information on these changes can be found in the table at the end.)

A ship at 00Z on September 13th reported 80 kt WNW and 978 mb. Reconnaissance aircraft on the 13th indicated that Esther had stopped intensifying as the central pressure remained steady near 970 mb. A penetration fix at 09Z on the 12th measured a central pressure of 969 mb, estimated surface winds of 100 kt and an eye diameter of 40 nm. A central pressure of 969 mb suggests maximum sustained winds of 91 kt south of 25N from the pressure-wind relationship. An eye diameter of 40 nm suggests an RMW of 30 nm and climatology indicates 15 nm. Based on a forward speed of 12 kt, an RMW larger than climatology but lightly weighing in the surface wind estimate, an intensity of 90 kt is selected for 06Z on the 13th, same as originally shown in HURDAT. On September 14th, the synoptic observations become sparse as ships avoided the hurricane. A reconnaissance aircraft measured a central pressure of 962 mb at 07Z. A central pressure of 962 mb suggests maximum sustained winds of 99 kt south of 25N and 100 kt intensifying from the pressure-wind relationship. An eye diameter of 40 nm suggests an RMW of 30 nm and climatology indicates 15 nm. Based on a forward speed of 10 kt and an RMW larger than climatology, an intensity of 95 kt is selected for 06Z on the 14th, down from 110 kt originally shown in HURDAT, a minor intensity change. Another penetration fix at 2017Z on the 14th measured a central pressure of 965 mb suggesting maximum sustained winds of 96 kt south of 25N from the pressure-wind estimate. An intensity of 90 kt is selected for 18Z on the 14th, down from 110 kt originally in HURDAT, a major intensity change. On September 15th, the intensity of Esther remained generally steady according to the reports from the reconnaissance aircrafts. Ships continued to avoid getting too close to the hurricane and remained in the periphery. A penetration fix measured a central pressure of 966 mb, estimated surface winds of 100 kt and an eye diameter of 30 nm at 13Z on the 15th. A central pressure of 966 mb suggests maximum sustained winds of 94 kt south of 25N from the pressure-wind relationship. An eye diameter of 30 nm suggests an RMW of 23 nm and climatology indicates 15 nm. Based on a forward speed of 13 kt and an RMW larger than climatology, an intensity of 90 kt is selected for 12Z on the 15th, down from 110 kt originally in

HURDAT, a major intensity change. A central pressure of 961 mb was in HURDAT at 18Z on the 15th. This value appears reasonable with aircraft reconnaissance reports and has been retained. A central pressure of 961 mb suggests maximum sustained winds of 101 kt intensifying south of 25N from the pressure-wind relationship. Based on a forward speed of 14 kt, an intensity of 95 kt is selected for 18Z on the 15th, down from 110 kt originally in HURDAT, a minor intensity change.

On September 16th, Esther began to intensify rapidly as the central pressure decreased and eye diameter contracted. A reconnaissance aircraft measured a central pressure of 960 mb and an eye diameter of 30 nm at 01Z on the 16th. A central pressure of 960 mb suggests maximum sustained winds of 101 kt south of 25N from the pressure-wind relationship. An eye diameter of 30 nm suggests an RMW of 23 nm and climatology indicates 15 nm. Based on a forward speed of 15 kt and an RMW larger than climatology, an intensity of 95 kt is selected for 00Z on the 16th, down from 110 kt originally in HURDAT, a minor intensity change. A central pressure of 956 mb was present in HURDAT at 06Z on the 16th and appears reasonable, thus it has been retained. A central pressure of 956 mb suggests maximum sustained winds of 105 kt south of 25N from the pressure-wind relationship. An intensity of 105 kt is selected at 06Z on the 16th, same as originally shown in HURDAT. Intensification to a major hurricane is analyzed at 06Z on the 16th, 66 hours later than originally shown in HURDAT. Another penetration fix measured a central pressure of 948 mb, estimated surface winds of 120 kt and an eye diameter of 20 nm at 1255Z on the 16th. A central pressure of 948 mb suggests maximum sustained winds of 115 kt intensifying south of 25N from the pressure-wind relationship. An eye diameter of 20 nm suggests an RMW of 15 nm, same as climatology. Based on a forward speed of 14 kt and an RMW same as climatology, an intensity of 115 kt is selected for 12Z on the 16th, up from 105 kt originally in HURDAT, a minor intensity change. A penetration fix around 18Z on the 16th measured a central pressure of 935 mb, estimated surface winds of 128 kt and an RMW of 13 nm. A central pressure of 935 mb suggests maximum sustained winds of 128 kt intensifying south of 25N from the pressure-wind relationship. Climatology indicates an RMW of 14 nm. Based on a forward speed of 13 kt and an RMW close to climatology, an intensity of 130 kt is selected for 18Z on the 16th, up from 105 kt originally in HURDAT, a major intensity change.

On September 17th, Esther was a powerful hurricane between Puerto Rico and Bermuda. An approaching trough caused the ridge to the north to weaken allowing the hurricane to take more northwestward track. Central pressures of 939 mb and 934 mb were present in HURDAT at 00Z and 06Z on the 17th. Both values appear reasonable and have been retained. A penetration fix at 1313Z on the 17th measured a central pressure of 928 mb, estimated surface winds of 80 kt and an eye diameter of 18 nm. An eye diameter of 18

nm suggests an RMW of 14 nm and climatology indicates 15 nm. A central pressure of 928 mb suggests maximum sustained winds of 134 kt intensifying south of 25N and 131 kt intensifying north of 25N from the pressure-wind relationship. Based on a forward speed of 11 kt and an RMW close to climatology, an intensity of 135 kt is selected for 12Z on the 17th, up from 110 kt originally in HURDAT, a major intensity change. 135 kt is the peak intensity of Hurricane Esther, up from 125 kt originally in HURDAT from 12Z on the 18th to 18Z on the 19th. A relative minimum of 125 kt is assessed at 00Z on the 17th consistent with the likely estimated central pressure. Another penetration fix at 19Z on the 17th measured a central pressure of 927 mb, estimated surface winds of 120 kt and an eye diameter of 15 nm. An eye diameter of 15 nm suggests an RMW of 11 nm and climatology indicates 15 nm. A central pressure of 927 mb suggests maximum sustained winds of 133 kt south of 25N and 126 kt north of 25N from the pressure-wind relationship. Based on a forward speed of 10 kt and an RMW smaller than climatology, an intensity of 135 kt is selected for 18Z on the 17th, up from 115 kt originally in HURDAT, a major intensity change. On September 18th, Esther continued on a northwestward track passing between Bermuda and the Bahamas. Ships on the 18th remained in the periphery of the hurricane and the highest winds reported were 55 kt. Reconnaissance aircraft continued to routinely penetrate the center of Esther. The first penetration fix on the 18th occurred at 0130Z measuring a central pressure of 928 mb, estimating flight level winds of 80 kt and an eye diameter of 16 nm. An eye diameter of 16 nm suggests an RMW of 12 nm and climatology indicates 15 nm. A central pressure of 928 mb suggests maximum sustained winds of 132 kt south of 25N and 125 kt north of 25N from the pressure-wind relationship. Based on a forward speed of 10 kt and an RMW smaller than climatology, an intensity of 135 kt is selected for 00Z on the 18th, up from 120 kt originally in HURDAT, a minor intensity change. A penetration fix at 07Z on the 18th measured a central pressure of 933 mb and an eye diameter of 16 nm. An eye diameter of 16 nm suggests an RMW of 12 nm and climatology indicates 15 nm. A central pressure of 933 mb suggests maximum sustained winds of 116 kt weakening north of 25N and 122 kt weakening south of 25N from the pressure-wind relationship. Based on a forward speed of 11 kt and an RMW smaller than climatology, an intensity of 125 kt is selected for 06Z on the 18th, up from 120 kt originally in HURDAT, a minor intensity change. Another penetration fix at 13Z on the 18th measured a central pressure of 936 mb and estimated surface winds of 140 kt. A central pressure of 936 mb suggests maximum sustained winds of 118 kt north of 25N from the pressure-wind relationship. Based on a forward speed of 14 kt, an intensity of 120 kt is selected for 12Z on the 18th, down from 125 kt originally in HURDAT, a minor intensity change. Another penetration fix at 19Z on the 18th measured a central pressure of 943 mb. At 16Z, a reconnaissance aircraft estimated an eye diameter of 40 nm. A central pressure of 943 mb suggests maximum sustained winds of 112 kt north of 25N and 107 kt weakening from the

pressure-wind relationship. An eye diameter of 40 nm suggests an RMW of 30 nm and climatology indicates 17 nm. Based on a forward speed of 13 kt and an RMW larger than climatology, an intensity of 115 kt is selected for 18Z on the 18th, down from 125 kt originally in HURDAT, a minor intensity change. Given the rather sudden increase in size and moderate filling of the central pressure, Esther may have undergone through a concentric eyewall cycle.

On September 19th, Esther was still a major hurricane on a northwestward track toward the East Coast of the United States. A penetration fix at 22Z on the 18th measured a central pressure of 936 mb. A central pressure of 936 mb suggests maximum sustained winds of 118 kt north of 25N and 124 kt intensifying from the pressure-wind relationship. Based on a forward speed of 13 kt, an intensity of 120 kt is selected for 00Z on the 19th, down from 125 kt originally in HURDAT, a minor intensity change. Another reconnaissance aircraft at 0430Z on the 19th measured a central pressure of 943 mb. A central pressure of 943 mb suggests maximum sustained winds of 112 kt north of 25N from the pressure-wind relationship. An intensity of 115 kt is selected for 06Z on the 19th, down from 125 kt originally in HURDAT, a minor intensity change. At 1030Z on the 19th, a reconnaissance aircraft measured a central pressure of 940 mb and estimated an eye diameter of 35 nm. A central pressure of 940 mb suggests maximum sustained winds of 115 kt north of 25N from the pressure-wind relationship. An eye diameter of 35 nm suggests an RMW of 26 nm and climatology indicates 19 nm. Due to a forward speed of 13 kt and an RMW larger than climatology, an intensity of 115 kt is selected for 12Z on the 19th, down from 125 kt originally in HURDAT, a minor intensity change. A penetration fix at 1545Z on the 19th measured a central pressure of 949 kt and estimated surface winds of 100 kt. At 19Z on the 19th, a central pressure of 951 mb was measured. A blend of these measurements gives 950 mb, which was already in HURDAT at 18Z and has been retained. A central pressure of 950 mb suggests maximum sustained winds of 105 kt north of 25N from the pressure-wind relationship. An intensity of 105 kt is selected for 18Z on the 19th, down from 125 kt originally in HURDAT, a major intensity change. Early on September 20th, Esther turned to the north passing about 110 nm east of Cape Hatteras, North Carolina. The Schwerdt et al. parametric hurricane wind model suggests that the highest sustained winds that impacted North Carolina were 40 kt in the Outer Banks. Surface observations show tropical force winds near the coast, especially at elevated sites, but the highest sustained winds measured at Cape Hatteras were 31 kt. Thus, North Carolina is not added to the list of states impacted by tropical storm force winds, although it is possible that somewhere along the Outer Banks winds may have reached gale-force on the 20th. Esther entered an area of heavier shipping traffic on the 21st along the East Coast of the United States and various ships reported tropical storm force winds, there was even a ship that experienced hurricane-force winds (70 kt) at 12Z and 18Z. At 01Z on the 21th, a reconnaissance aircraft measured a central pressure of 952

mb, estimated flight level winds of 95 kt and an elongated eye diameter of 25-35 nm. A central pressure of 952 mb suggests maximum sustained winds of 103 kt north of 25N from the pressure-wind relationship. An eye diameter of 25-35 nm suggests an RMW of 19-26 nm and climatology indicates 24 nm. Due to a forward speed of 10 kt and an RMW close to climatology, an intensity of 105 kt is selected for 00Z on the 20th, down from 120 kt originally in HURDAT, a minor intensity change. At 07Z on the 21th, a reconnaissance aircraft measured a central pressure of 956 mb. A central pressure of 956 mb suggests maximum sustained winds of 99 kt north of 25N from the Brown et al. pressure-wind relationship and 93 kt north of 35N from the Landsea et al. pressure-wind relationship. Due to a forward speed of 11 kt, an intensity of 100 kt is selected for 06Z on the 20th, down from 120 kt originally in HURDAT, a major intensity change. A reconnaissance aircraft measured a central pressure of 948 mb, estimated flight level winds of 115 kt and an eye diameter of 32 nm at 1215Z on the 20th. A central pressure of 948 mb suggests maximum sustained winds of 107 kt north of 25N and 112 kt intensifying from the Brown et al. pressure-wind relationship and 98 kt north of 35N from the Landsea et al. pressure-wind relationship. An eye diameter of 32 nm suggests an RMW of 24 nm and climatology indicates 25 nm. Due to a forward speed of 13 kt and an RMW close to climatology, an intensity of 105 kt is selected for 12Z on the 20th, down from 120 kt originally in HURDAT, a minor intensity change. Another penetration fix measured a central pressure of 953 mb at 1544Z on the 20th. A central pressure of 953 mb suggests maximum sustained winds of 95 kt north of 35N from the Landsea et al. pressure-wind relationship. Due to a forward speed of 16 kt, an intensity of 100 kt is selected for 18Z on the 20th, down from 120 kt originally in HURDAT, a major intensity change.

On September 21st, Esther approached the Northeast of the United States before slowing its forward speed and turning to the east. The Schwerdt et al. parametric hurricane wind model suggests that the highest sustained winds that impacted New Jersey on the 21st were 39 kt. The model also suggests that New York experienced 59 kt winds, also 59 kt in Rhode Island and 52 kt in Connecticut. It is possible that higher winds could have affected the coast as the RMW used in the formula was the last available, reported at 1544Z on the 20th, and by the 21st, the RMW was likely larger. The highest sustained winds reported in New Jersey were 40 kt measured at Atlantic City at 0756Z and Newark at 1039Z on the 21st. The highest sustained winds in New York were 50 kt at Calverton at 15Z on the 21st. The highest sustained winds in Connecticut were 41 kt at Bridgeport at 0958Z on the 21st. And the highest sustained winds in Rhode Island were 42 kt at Block Island at 12Z on the 21st. Thus, New Jersey is added as a tropical storm impact with 40 kt winds, New York and Rhode Island with 60 kt winds, and Connecticut with 50 kt winds. The center of the hurricane passed about 30 nm south of Martha’s Vineyard around 18Z on the 21st. A reconnaissance aircraft measured a central pressure of 962 mb

at 01Z on the 21th. A central pressure of 962 mb suggests maximum sustained winds of 88 kt north of 35N from the pressure-wind relationship. Due to a forward speed of 15 kt, an intensity of 90 kt is selected for 00Z on the 21st, down from 115 kt originally in HURDAT, a major intensity change. Weakening below major hurricane status is analyzed at 06Z on the 21st, 24 hours earlier than originally shown in HURDAT. Another penetration fix measured a central pressure of 968 mb at 0355Z on the 21th. A central pressure of 968 mb suggests maximum sustained winds of 84 kt north of 35N from the pressure-wind relationship. Due to a forward speed of 15 kt, an intensity of 85 kt is selected for 06Z on the 21st, down from 110 kt originally in HURDAT, a major intensity change. A penetration fix at 1030Z on the 21st measured a central pressure of 970 kt. At 13Z on the 21st, a central pressure of 974 mb was measured. A blend of these measured gives 972 mb. A central pressure of 972 mb suggests maximum sustained winds of 80 kt north of 35N from the pressure-wind relationship. Due to a forward speed of 9 kt, an intensity of 75 kt is selected for 12Z on the 21st, down from 110 kt originally in HURDAT, a major intensity change. The last aircraft reconnaissance occurred late on the 21st. HURDAT originally showed an unrealistic drop in intensity from 105 kt at 18Z on the 21st to 60 kt at 00Z on September 22nd. Synoptic observations on the 22nd indicate that Esther moved southeastward, away from the Northeast of the United States. The hurricane continued to slowly lose strength and is analyzed to have weakened to a tropical storm at 18Z on the 22nd, 18 hours later than originally shown in HURDAT. Official advisories were ended at 16Z on the 22nd by the Boston Weather Bureau citing that the cyclone was no longer tropical. Ship and coastal observations do show a slight temperature gradient across Esther but the cyclone remained symmetric and no frontal boundaries developed, indicating that the system retained its tropical characteristics. Major intensity changes are analyzed at 06Z and 12Z on the 22nd. Intensities of 70 kt and 65 kt are selected, respectively, based upon a ship report of 70 kt at 06Z, and HURDAT originally showed 50 kt and 45 kt, respectively.

On September 23rd, Esther moved southward and southwestward toward warmer waters and the temperature gradient gradually disappeared. The intensity of the cyclone continued to decrease reaching 45 kt at 18Z on the 23rd, down from 60 kt originally in HURDAT, a minor intensity change. Various ships reported gale-force winds, including 45 kt at 06Z and 12Z. On September 24th, Esther turned to the west and northwest and began to regain strength late on the day. A ship reported 50 kt at 18Z on the 24th. On September 25th, Esther turned to the north and once again took aim at the New England coast, although much weaker than a couple of days ago. Advisories were reinitiated by the Boston Weather Bureau at 14Z on the 25th announcing the approaching storm. Various ships reported tropical storm force winds, including 50 kt at 06Z and 12Z. The intensity of Esther remained at 50 kt on the 25th, 5 kt higher than originally shown in HURDAT, minor intensity changes. On September 26th, Esther finished a long,

clockwise loop that began late on the 21st. The tropical storm made landfall in Martha's Vineyard at 05Z on the 26th with 50 kt winds. An hour later, the center reached Cape Cod with the same intensity. Surface observations indicate that the strongest winds were located on the eastern quadrant. Cities in Massachusetts on the western quadrant did not experience tropical storm force winds based on the surface reports. The strongest winds were 55 kt, measured at Nantucket Light, MA, an elevated site of about 60 ft, at 06Z on the 26th. The winds reduced to 10 m are about 53 kt. An approaching extratropical cyclone from the west caused Esther to accelerate to the north and landfall in Maine is analyzed at 11Z on the 26th as a 35 kt tropical storm. Over land, Esther weakened to a tropical depression at 18Z on the 26th, six hours later than originally shown in HURDAT. Surface observations at 00Z on September 27th indicate that the strong extratropical cyclone had absorbed Esther and the last position is analyzed at 18Z on the 26th. Thus, dissipation is analyzed 12 hours earlier than originally shown in HURDAT. Moreover, it is analyzed that Esther did not become extratropical before being absorbed, as previously shown in HURDAT.

Date	Original HURDAT Central Pressure	Evidence	Changes
Sep 12 12Z	975 mb	First central pressure report was later in the day but appears reasonable	Retained
Sep 12 18Z	967 mb	Penetration center fix: 967 mb at 2010Z on Sep 12th	
Sep 13 06Z		Penetration center fix: 969 mb at 09Z on Sep 13th	969 mb
Sep 13 12Z	970 mb	No central pressure report but appears reasonable	Retained
Sep 13 18Z	983 mb	No central pressure reports around 18Z, but central pressure reports at 09Z on the 13th and 07Z on the 14th suggest that it is likely erroneous	Removed
Sep 14 06Z		Penetration center fix: 962 mb at 07Z on Sep 14th	962 mb
Sep 14 12Z	975 mb	No central pressure reports around 18Z, but central pressure reports at 07Z and 2017Z on the 14th suggest that it is likely erroneous	Removed
Sep 14 18Z	966 mb	Penetration center fix: 965 mb at 2017Z on Sep 14th	965 mb

Sep 15 00Z	965 mb	No central pressure report but appears reasonable	Retained
Sep 15 06Z	965 mb	Penetration center fix: 968 mb at 07Z on Sep 15th	968 mb
Sep 15 12Z	966 mb	Penetration center fix: 966 mb at 13Z on Sep 15th	Retained
Sep 15 18Z	961 mb	No central pressure report but appears reasonable	
Sep 16 00Z	960 mb	Penetration center fix: 960 mb at 01Z on Sep 16th	
Sep 16 06Z	956 mb	No central pressure report but appears reasonable	
Sep 16 12Z	949 mb	Penetration center fix: 948 mb at 1255Z on Sep 16th	948 mb
Sep 16 18Z	944 mb	Penetration center fix: 935 mb at ~18Z on Sep 16th	935 mb
Sep 17 00Z	939 mb	No central pressure report but appears reasonable	Retained
Sep 17 06Z	934 mb		
Sep 17 12Z	930 mb	Penetration center fix: 928 mb at 1333Z on Sep 17th	928 mb
Sep 17 18Z	927 mb	Penetration center fixes: 927 mb at 19Z on Sep 17th	Retained
Sep 18 00Z	928 mb	Penetration center fixes: 928 mb at 0130Z on Sep 18th	
Sep 18 06Z	933 mb	Penetration center fix: 933 mb at 07Z on Sep 18th	
Sep 18 12Z	938 mb	Penetration center fix: 936 mb at 13Z on Sep 18th	936 mb
Sep 18 18Z	944 mb	Penetration center fix: 943 mb at 19Z on Sep 18th	943 mb
Sep 19 00Z	948 mb	Penetration center fix: 936 mb at 22Z on Sep 19th	936 mb
Sep 19 06Z	945 mb	Penetration center fix: 943 mb at 0430Z on Sep 19th	943 mb
Sep 19 12Z	942 mb	Penetration center fix: 940 mb at 1030Z on Sep 19th	940 mb
Sep 19 18Z	950 mb	Penetration center fix: 949 mb at 1545Z and 951 mb at 19Z on Sep 19th	Retained
Sep 20 00Z	947 mb	Penetration center fix: 952 mb at 01Z on Sep 20th	952 mb
Sep 20 06Z	957 mb	Penetration center fix: 956 mb at 07Z on Sep 20th	956 mb

Sep 20 12Z	949 mb	Penetration center fix: 948 mb at 1215Z on Sep 20th	948 mb
Sep 20 18Z	955 mb	Penetration center fix: 953 mb at 1544Z on Sep 20th	953 mb
Sep 21 00Z	968 mb	Penetration center fix: 962 mb at 01Z on Sep 21st	962 mb
Sep 21 06Z	972 mb	Penetration center fix: 968 mb at 0355Z on Sep 21st	968 mb
Sep 21 12Z	978 mb	Penetration center fix: 970 mb at 1030Z and 974 mb at 13Z on Sep 21st	972 mb
Sep 22 12Z	990 mb	Ship: 20 kt SE and 991 mb at 12Z on Sep 22nd	989 mb
Sep 23 00Z	993 mb	No central pressure report but looks reasonable	Retained
Sep 24 00Z		Ship: 20 kt NNE and 997 mb at 00Z on Sep 24th	995 mb
Sep 25 00Z		Ship: 30 kt N and 996 mb at 12Z on Sep 25th	993 mb
Sep 25 06Z	993 mb	A ship report near the center of 50 kt SE and 994 mb at 06Z on Sep 25 suggest a lower central pressure	Removed
Sep 25 12Z		Ship: 30 kt NW and 993 mb at 12Z on Sep 25th	990 mb
Sep 25 18Z		Ship: 25 kt WSW and 993 mb at 18Z on Sep 25th	990 mb
Sep 26 00Z	996 mb	A ship report near the center of 40 kt S and 997 mb at 00Z on Sep 26th suggest a lower central pressure	Removed
Sep 26 12Z	1002 mb	Portland, ME: 10 kt WSW and 1004 mb at 12Z on Sep 26th	Retained

Unnamed Tropical Storm [September 12–15, 1961]

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42125 09/12/1961 M= 4  6 SNBR= 913 NOT NAMED   XING=1 SSS=0

42130 09/12*  0   0   0    0*  0   0   0    0*258 780  25    0*260 780  30    0*
42130 09/12*  0   0   0    0*  0   0   0    0*258 780  25    0*260 780  25    0*
                                                                        **

42135 09/13*262 781  30    0*270 781  30    0*286 782  30    0*300 782  30    0*
42135 09/13*264 781  25    0*270 781  25    0*282 782  30    0*296 782  30    0*
          ***      **                **      ***                 ***

42140 09/14*317 782  30    0*330 781  30    0*347 779  35    0*367 768  35    0*
42140 09/14*313 782  35    0*330 781  35    0*347 778  35    0*367 768  40    0*
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            ***      **                **          ***                    **

42145 09/15*387 754  35    0*407 735  35    0*441 701  35    0*476 630  30    0*
42145 09/15*387 754  50 1001*410 735  55  999E441 701  60  995*  0   0   0    0*
                     ** **** ***      **  ****         **  ***   *   *   *

42150 TS
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U.S. Tropical Storm Landfall

09/14 09Z 33.8N 78.0W 35 kt NC

Minor changes to the track and major changes to the intensity shown in McAdie et al. (2009). Another major change is to introduce a short extratropical phase. Evidence for these alterations comes from the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Monthly Weather Review, Mariners Weather Log, Surface Weather Observations, Local Climatological Data, National Hurricane Research Project Storm Data, Fay (1962) and NHC Storm Wallets.
September 10:

HWM analyzes a trough or tropical wave over the Windward Passage along longitude 74W at 12Z. HURDAT does not list an organized storm on this day. Microfilm shows a trough or tropical wave north of Hispaniola along longitude 71W at 12Z. Ship highlights: No gales or low pressures.

FAY: “During the period from September 9 to 12, 1961, T1ROS III was well oriented for photographing the area south and east of Florida. On each of these days, nephanalyses from the photographs indicated a vortex present just east of the Bahamas. It is not possible to determine in what portion of the atmosphere these vortices were located, nor even if they were one and the same.”

September 11:

HWM analyzes a spot low pressure at 23.0N, 72.2W at 12Z. HURDAT does not list an organized storm on this day. Microfilm shows a trough or tropical wave over the central Bahamas at 12Z. Ship highlights: No gales or low pressures.

September 12:

HWM analyzes a spot low pressure at 25.8N, 77.1W at 12Z. HURDAT lists a 25 kt tropical depression at 25.8N, 78.0W at 12Z (first position). Microfilm shows an elongated, closed low pressure of at most 1013 mb near 25.0N, 78.0W at 12Z. Fay (1962) estimates the position of the center from a TIROS III satellite image at 23.5N, 73.0W at 1935Z. Ship highlights: No gales or low pressures.

September 13:

HWM analyzes a spot low pressure at 27.5N, 78.3W at 12Z. HURDAT lists a 30 kt tropical depression at 28.6N, 78.2W at 12Z. Microfilm shows an elongated, closed low pressure of at most 1013 mb near 28.0N, 78.6W at 12Z. Ship highlights: No gales or low pressures.

FAY: “By September 13 surface reports clearly indicated a cyclonic circulation east of Florida, and the edge of the circulation was again photographed by TIROS III (fig. 4), but wide the clouds appear quite dense, the cyclonic circulation is not clearly defined in the reproduction.”

September 14:

HWM analyzes a closed low pressure of at most 1010 mb at 34.0N, 77.8W with a cold front well to the west at 12Z. HURDAT lists a 35 kt tropical storm at 34.7N, 77.9W at 12Z. Microfilm shows a closed low pressure of at most 1008 mb at 33.5N, 77.0W at 12Z. Ship highlights: 35 kt ESE and 1015 mb at 31.0N, 77.0W at 00Z (COADS). 5 kt NE and 1003 mb at 37.1N, 76.3W at 37.1N, 76.3W at 21Z (COADS). Land highlights: 35 kt SE and 1012 mb at Frying Pan, NC at 06Z (micro). 18 kt SSW (gusts to 32 kt) and 1002 mb at Elizabeth City, NC at 19Z (SWO)

FAY: “The photographs from subsequent orbital passes over the storm on September 14 and 15 failed to show any circulation in the general cloudiness in which it was imbedded. The tropical cyclone crossed the coast of North Carolina just east of Wilmington at about 0600 EST, September 14. At this time it was traveling toward the north-northeast at about 18 kt. The cyclone never moved far from the coastline and perhaps in this way maintained its tropical characteristics.”

September 15:

HWM analyzes a closed low pressure of at most 995 mb at 44.5N, 69.5W with a cold front just to the west at 12Z. HURDAT lists a 35 kt tropical storm at 44.1N, 70.1W at 12Z. Microfilm shows a closed low pressure of at most 987 mb at 54.0N, 69.0W with a frontal boundary to the south (appears that the tropical cyclone has been absorbed) at 12Z. Ship highlights: 50 kt S and 1008 mb at 38.1N, 73.5W at 00Z (COADS). 35 kt SW and 1009 mb at 37.5N, 74.6W at 06Z (COADS). Land highlights: Gusts to 60 kt at Point Judith, RI (no time given) (SD). 70 kt (1-min) at Eastport, ME (no time given) (FAY, 1962). 8 kt NW and 1003 mb at Atlantic City, NJ at 0258Z (SWO). 34 kt SSE and 1010 mb at Nantucket Shoals, MA at 0555Z (SWO). 4 kt SE and 1000 mb at Worcester, MA at 0758Z (SWO). 36 kt S (gusts to 45 kt) at Providence, RI at 0810Z (SWO/CLIMO). 6 kt S

and 996 mb at Brunswick, ME at 1158Z (SWO). Gusts to 70 kt at Saint John, Canada at 16Z (FAY, 1962).

FAY: “From the forecast point of view, one of the problems was the acceleration which was continuous for the 27 hours when it was within the continental limits of the United States. During the find 2 hours it was moving at 60 kt. While the central pressure continued to decrease as the cyclone moved northward, the reported winds dropped off alter it pressed Cape Hatteras. Highest gusts there were 38 kt, while Atlantic City recorded no winds of over 15 kt. By the time it reached Long Island, winds had again increased to 38 kt, which was recorded at Suffolk County Air Force Base as the center passed by. At about this time the Research Vessel Eugenie VIII, of the Woods Hole Oceanographic Institution was about 80 mi south-southeast of Block Island, R.I., and some 110 mi from the storm center. The captain, a man with long experience in small boats at sea, estimated winds of 50 kt and reported the sea condition as "very rough" and had some difficulty in bringing the vessel about to run before the wind. Point Judith, R.I., recorded gusts to 61 kt. and at Quonset Point, R.I., the carrier Lake Champlain parted her lines and drifted away from the dock. An airplane at the Groton (Conn.) Airport tore loose from three 1550-lb test nylon lines. At 0500 EST wave heights of 16 ft. were measured at a tower off the south coast of Martha’s Vineyard. For a minimum duration of 3 hours, which is probably a maximum in this case, a sustained wind of 55 kt is required to produce this wave height; for a 2-hour minimum duration, winds over 70 kt are required. The winds caused a storm surge of 4.1 ft. in Narragansett' Bay. Fortunately the surge arrived at time of low tide, so no serious damage resulted. Highest winds and most damage to power lines occurred as the storm sped across eastern Maine. At Beals, Maine, a waterspout was reported, and apparently moved onshore where a new 26 ft by 52 ft boatshop was lifted from its foundation and moved 15 ft. Winds at' the top of an 800-ft. radio tower at Cutler, Maine, were recorded at 100 mph, while the surface winds were up to 70 mph. There was some evidence of a tornado in the Machias area; most trees were blown down from south to north, while a few were noted to have fallen from west to east and east to west. The triple register at Eastport, Maine, showed a 2-minute wind speed of close to 60 mph (52 kt) and 1-minute speed of about 80 mph (70 kt). There seems little doubt that the winds reached hurricane force at least occasionally during the time the storm moved across New England. Saint John, New Brunswick, reported gusts to 62 kt at 1000 EST, and to 70 kt at 1100. All the highest winds reported were from the south to southwest.”

The unnamed tropical storm developed from a tropical wave that left the African coast early in September. The disturbance did not show signs of organization while crossing the eastern and central Atlantic. A paper by Richard Fay (MWR 1962, pg. 351) titled “Northbound Tropical Cyclone” shows a nephanalysis (fig. 1) of a TIROS III satellite image of September 9th while the system was north of Hispaniola. The nephanalysis suggests that the convection was located over the developed northern and eastern quadrant of the circulation. However, surface observations indicated that no closed circulation at the surface existed on that day. Surface observations show that a tropical wave reached the Bahamas on September 11th and slowly a well-defined low-level center. Genesis is analyzed at 12Z on September 12th as a 25 kt tropical depression, same as originally shown in HURDAT. Minor track alterations are introduced during the lifetime of this tropical cyclone. Fig. 3 (Fay 1962) shows a TIROS III satellite image from September 12th at 1935Z. The weak tropical depression moved northward slowly gaining in forward speed on the 13th. Synoptic data on the 13th indicated that the winds remained below gale-force and the highest reported were 30 kt at 18Z. At 00Z on September 14th, a ship close to the tropical cyclone reported 35 kt. Thus, the tropical depression is upgraded to a tropical storm, twelve hours earlier than originally shown in HURDAT. Frying Pan Shoals, NC, an elevated station, reported 35 kt at 06Z. The tropical storm continued northward early on the 14th, later turning to the northeast after crossing the coast. Landfall is analyzed near Wilmington, NC as a 35 kt tropical storm at 09Z on the 14th. The radar image from Hatteras, NC, on the 14th at 1630Z in the Fay report (MWR 1962, pg. 355) shows a weak low pressure with convection around the center. At the same time, a strong extratropical cyclone, remnants of Hurricane Carla, was located over the Great Lakes and moving northeastward. The small tropical storm, under the influence of the extratropical cyclone, accelerated over the East Coast of the United States and intensified. The radar image from Atlantic City, NJ, on September 15th at 0330Z shows a well-organized tropical cyclone with convection around the center. A ship reported 50 kt at 00Z on the 15th and the intensity is increased to 50 kt at this time, up from 35 kt originally in HURDAT, a minor intensity change. 8 kt NW and 1003 mb were reported at Atlantic City, NJ, at 0258Z, suggesting a central pressure of 1001 mb, which has been added to HURDAT at 00Z on the 15th. Early on the 15th, the cold front associated with the extratropical cyclone was approaching the center of the small tropical cyclone. Despite its fast forward speed, surface observations indicate that the center remained closed early on the 15th. By 06Z on the 15th, the center of the tropical storm was just north of New York City, NY, based on the synoptic data. It is unclear from the surface observations if the circulation was still closed at this time. Fay (1962) mentions a research vessel located near 40.3N, 70.8W and the captain estimated sustained winds of 50 kt and rough conditions, and although it does not mention a time, based on the track of the tropical cyclone, it appears that the estimate was around 06Z on the 15th. An intensity

of 55 kt is selected at 06Z on the 15th, up from 35 kt originally in HURDAT, a major intensity change. 55 kt is also the peak intensity of this system as a tropical cyclone, up from 35 kt originally in HURDAT, a major intensity change. 4 kt SE and 1000 mb were reported at Worcester, MA, at 0555Z, suggesting a central pressure of 999 mb, which has been added to HURDAT at 06Z on the 15th. By 12Z on the 15th, the surface observations suggest that the cold front had caught up to the tropical cyclone and the system was embedded within the frontal boundary, thus losing its tropical characteristics. Transition to an extratropical cyclone is analyzed at 12Z on the 15th. An intensity of 60 kt is selected at 12Z on the 15th, up from 35 kt originally in HURDAT. 6 kt S and 996 mb were reported at Brunswick, ME, at 1158Z, suggesting a central pressure of 995 mb, which has been added to HURDAT at 12Z on the 15th. Surface observations at 18Z on the 15th indicate that the weaker extratropical cyclone had been absorbed by the larger extratropical cyclone to the north. At about the same time, Eastport, ME experienced 1-min winds of 70 kt indicating that even though the system was absorbed, the larger extratropical cyclone contained quite vigorous winds. Thus, the last position is analyzed at 12Z on the 15th, six hours earlier than originally shown in HURDAT.

Hurricane Frances [September 30 – October 10, 1961]

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42155 09/30/1961 M=11  7 SNBR= 914 FRANCES     XING=0 SSS=0

42160 09/30*  0   0   0    0*160 570  30    0*161 587  35 1007*162 595  45 1006*
42160 09/30*  0   0   0    0*160 580  35    0*161 588  45    0*162 596  55 1005*
                           ***  **          ***  **    *          **  ****

42165 10/01*162 603  45    0*162 611  40    0*160 621  40 1004*159 631  40    0*
42165 10/01*162 604  55    0*162 612  50    0*160 623  45    0*159 633  40    0*
               ***  **          ***  **          ***  **    *     ***

42170 10/02*161 640  40 1010*162 650  45    0*164 661  50 1011*170 671  50 1010*
42170 10/02*160 642  40 1010*161 651  45    0*163 660  45 1011*170 670  45 1010*
               ***          *** ***          *** ***  **          ***  **

42175 10/03*178 679  50    0*185 686  50    0*192 691  50 1010*206 697  55    0*
42175 10/03*178 679  45    0*186 687  45    0*194 692  50    0*205 696  50    0*
                    **      *** ***  **      *** ***        * *** ***  **

42180 10/04*220 703  55 1005*230 707  60    0*243 713  65  999*254 716  70    0*
42180 10/04*218 702  55 1005*230 707  60    0*242 713  65  999*254 716  65    0*
           *** ***                           ***                       **

42185 10/05*269 712  75  997*274 711  80  991*287 707  85  974*292 703  90    0*
42185 10/05*265 718  65  997*275 714  75  991*284 709  90  973*291 703 100  963*
           *** ***  **      *** ***  **      *** ***  **  *** ***     ***  ***

42190 10/06*300 695  95  960*305 688 100    0*312 682 105  968*322 674 105  954*
42190 10/06*298 695 105  960*305 688 105    0*313 682 110    0*321 674 110  954*
           ***     ***               ***      ***     ***    * ***     ***

42195 10/07*329 663 110  948*340 651 110    0*355 645 110    0*366 642 110    0*
42195 10/07*330 663 115  948*340 652 115    0*352 645 115    0*365 642 110    0*
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            ***     ***          *** ***      ***     ***      ***

42200 10/08*385 642 105    0*392 647 100    0*401 652  95    0*412 660  70    0*
42200 10/08*379 642 105    0*391 647  95    0*401 652  80    0E412 660  70    0*
            ***               ***       **                ** *
42205 10/09*422 665  65    0*431 674  50    0E435 678  40    0E444 658  40    0*
42205 10/09E422 670  60    0E431 678  50    0E435 680  45    0E442 670  40    0*
           *    ***  **     *    ***             ***  **      *** ***
42210 10/10E450 640  35    0E460 592  35    0*  0   0   0    0*  0   0   0    0*
42210 10/10E448 645  35    0E453 605  35    0*  0   0   0    0*  0   0   0    0*
            ***  ***          *** ***
42215 HR
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Tropical Storm Landfall:

10/01 08Z 16.1N 61.6W 50 kt Guadeloupe
10/03 05Z 18.3N 68.5W 45 kt Dominican Republic

Minor changes to the track and intensity shown in McAdie et al. (2009). Evidence for these alterations comes from the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Monthly Weather Review, Navy reconnaissance book, Mariners Weather Log, Advisories and NHC Storm Wallets.

September 28:

HWM analyzes a spot low pressure at 14.0N, 52.5W at 12Z. HURDAT does not list an organized system on this date. Microfilm does not show an organized system at 12Z. Ship highlights: No gales or low pressures.

September 29:

HWM analyzes a spot low pressure at 15.0N, 55.5W at 12Z. HURDAT does not list an organized system on this date. Microfilm does not show an organized system at 12Z. Ship highlights: No gales or low pressures.

ATSR: “On the 29th of September, considerable shower activity and shifting winds indicated the possibility of a disturbed area just east of the Lesser Antilles.”

September 30:

HWM analyzes a tropical storm at 16.0N, 58.5W at 12Z. HURDAT lists a 35 kt tropical storm at 16.1N, 58.7W at 12Z. Microfilm shows a tropical wave extended between 12-22N, 59W at 12Z. Ship highlights: No gales or low pressures. Aircraft highlights: Penetration center fix measured a central pressure of 1007 mb and estimated surface winds of 70 kt at 16.2N, 59.9W at 17Z (WALLET). Penetration center fix measured a

central pressure of 1005 mb and estimated surface winds of 70 kt at 16.1N, 59.9W at 19Z (WALLET).

MWR: “Although there were slight indications of a disturbed area east of the Antilles as early as September 28, it was not until the morning of the 30th that aircraft reconnaissance confirmed the development of tropical storm Frances. On this date the storm was very poorly organized with a sea level pressure no lower than 1005 mb (29.68 inches).” ATSR: “Early on the 30th, a Navy reconnaissance plane investigated the area and found a poorly defined storm with very little radar presentation. It did find up to 70 knots of wind in a few squalls. Consequently, warning number one on Tropical Storm Frances was issued at 301930Z.”

October 1:

HWM analyzes a tropical storm of at most 1010 mb at 15.2N, 61.9W at 12Z. HURDAT lists a 40 kt tropical storm at 16.0N, 62.1W at 12Z. Microfilm shows a closed low pressure of at most 1014 mb at 16.0N, 62.0W at 12Z. Ship highlights: 60 kt ESE and 1012 mb at 16.4N, 60.8W at 04Z (micro/WALLET/MWR). 45 kt SSE and 1002 mb (low pressure bias) at 15.6N, 61.7W at 12Z (micro). Aircraft highlights: Radar center fix at 16.2N, 60.9W at 0445Z (ATSR). Penetration center fix measured a central pressure of 1012 mb and estimated surface winds of 35 kt at 15.9N, 62.8W at 1455Z (ATSR). Penetration center fix measured a central pressure of 1010 mb, estimated surface winds of 35 kt and an eye diameter of 25 nm at 16.2N, 63.8W at 2130Z (WALLET).

MWR: “Tropical storm Frances passed between the islands of Marie Galante and Guadaloupe, French Antilles between 0000 and 0100 EST on October 1. At 0100 EST, the Netherlands steamship Viajero near 16.4 north, 60.8 west just off the island of La Desirade, French Antilles, reported 60 knots winds from 120° during a heavy squall. At 0230 EST an amateur radio operator at Guadeloupe reported wind gusting to 50 to 60 miles per hour from the south. In the passage from Guadeloupe, French Antilles, to Dominica, West Indies Federation, the appears that the wind field was completely distorted by the 6000 foot mountains on Dominica and the 5000 foot range on Guadeloupe. The occasionally happens to tropical storms passing between or over these two islands while in the developmental stage. Frances never recovered its earlier intensity while in the Caribbean. Indeed, it was here the forecasters were confronted with a most difficult problem. Reconnaissance planes were able to follow and an area of weather and relative calm moving westward, while other planes were tracking a very weak circulation moving northwestward toward the extreme eastern portion of Hispaniola. That latter turn out to be the most important and the one that eventually intensified. The absence of a good divergence field at high levels was noted during this period and perhaps this was the paramount reason for the slow development and the

disorganized state of the storm. ATSR: “Already diffuse, the storm became completely disorganized as it headed westward and passed between the mountainous islands of Guadeloupe and Dominica early on 1 October. This lack of organization presented a serious forecasting and reconnaissance problem as the storm entered the Caribbean. Seemingly, Frances split into two separate areas of weather or circulations. One circulation moved westward and did not develop, another moved northwestward, passed over eastern Hispaniola and finally intensified. Lack of a good outflow mechanism in the upper air flow in the area of the storm is thought to have contributed to Frances' slow development.”

October 2:

HWM analyzes a tropical storm of at most 1010 mb at 16.1N, 65.9W at 12Z. HURDAT lists a 50 kt tropical storm at 16.4N, 66.1W at 12Z. Microfilm shows a closed low pressure of at most 1011 mb at 16.6N, 66.3W at 12Z. Ship highlights: 40 kt ESE and 1010 mb at 16.7N, 64.7W at 03Z (micro). 35 kt SE and 1010 mb at 15.9N, 65.8W at 18Z (COADS). 35 kt SSE and 1010 mb at 16.7N, 66.2W at 21Z (micro/MWL). Aircraft highlights: Penetration center fix measured a central pressure of 1003 mb and flight level winds of 50 kt at 16.1N, 64.4W at 0050Z (WALLET). Penetration center fix measured a central pressure of 1011 mb and estimated surface winds of 50 kt at 16.2N, 65.7W at 1140Z (WALLET). Penetration center fix measured a central pressure of 1010 mb and estimated surface winds of 50 kt at 16.2N, 67.6W at 1845Z (WALLET).

October 3:

HWM analyzes a tropical storm of at most 1010 mb at 19.5N, 69.5W at 12Z. HURDAT lists a 50 kt tropical storm at 19.2N, 69.1W at 12Z. Microfilm shows a closed low pressure of at most 1011 mb at 19.5N, 69.3W at 12Z. Ship highlights: 35 kt SE and 1010 mb at 17.1N, 66.8W at 00Z (COADS). 40 kt SE and 1010 mb at 18.3N, 67.7W at 06Z (COADS). 40 kt SE and 1008 mb at 19.0N, 68.3W at 09Z (micro/MWL). 40 kt SE and 1010 mb at 19.9N, 68.3W at 12Z (COADS). 45 kt SSE and 1008 mb at 21.6N, 69.7W at 21Z (micro). Aircraft highlights: Radar center fix at 16.7N, 69.5W at 03Z (WALLET). Radar center fix at 18.7N, 68.7W at 06Z (WALLET). Radar center fix at 19.4N, 69.3W at 13Z (WALLET). Penetration center fix measured a central pressure of 1006 mb and estimated surface winds of 50 kt at 21.3N, 70.0W at 2150Z (WALLET).

October 4:

HWM analyzes a hurricane of at most 1000 mb at 23.7N, 71.5W at 12Z. HURDAT lists a 65 kt hurricane at 24.3N, 71.3W at 12Z. Microfilm shows a closed low pressure of at most 1005 mb at 24.2N, 71.2W at 12Z. Ship highlights: 35 kt ESE and 1013 mb at 22.8N, 68.0W at 03Z (micro). 35 kt SE and 1012 mb at 22.3N, 67.9W at 06Z (micro). 40

kt ESE and 1011 mb at 26.1N, 70.4W at 12Z (COADS). 35 kt SE and 1012 mb at 27.6N, 69.8W at 21Z (micro). Aircraft highlights: Penetration center fix measured a central pressure of 1005 mb at 22.3N, 70.0W at 01Z (WALLET). Radar center fix at 23.6N, 70.8W at 07Z (WALLET). Penetration center fix measured a central pressure of 999 mb and estimated surface winds of 100 kt at 24.2N, 71.2W at 12Z (WALLET/ATSR). Penetration center fix estimated surface winds of 70 kt at 25.0N, 71.6W at 1615Z (WALLET). Penetration center fix measured a central pressure of 994 mb and estimated surface winds of 60 kt at 26.0N, 71.5W at 2145Z (WALLET).

ATSR: “Steadily intensifying as she moved north-northwestward, Frances reached hurricane force on the 4th.”

October 5:

HWM analyzes a hurricane of at most 1000 mb at 27.8N, 70.8W at 12Z. HURDAT lists an 85 kt hurricane at 28.7N, 70.7W at 12Z. Microfilm shows a closed low pressure of at most 1014 mb at 28.5N, 70.5W at 12Z. Ship highlights: 35 kt SE and 1011 mb at 27.2N, 70.3W at 00Z (COADS). 45 kt S and 1007 mb at 26.6N, 70.8W at 03Z (micro). 40 kt SW and 1009 mb at 26.5N, 71.0W at 06Z (COADS). 35 kt NNE and 1016 mb at 29.4N, 75.6W at 15Z (MWL). 55 kt W and 963 mb at 29.5N, 70.0W at 21Z (micro). Aircraft highlights: Penetration center fix measured a central pressure of 997 mb and an eye diameter of 12 nm at 26.7N, 71.9W at 01Z (WALLET). Penetration center fix measured a central pressure of 991 mb and an eye diameter of 11-13 nm at 27.5N, 71.1W at 07Z (WALLET). Penetration center fix measured a central pressure of 973 mb at 28.6N, 70.6W at 1410Z (ATSR/micro). Penetration center fix measured a central pressure of 963 mb at 29.3N, 70.2W at 1840Z (ATSR/advisories). Penetration center fix at 29.7N, 69.7W at 2140Z (ATSR).

October 6:

HWM analyzes a hurricane of at most 995 mb at 31.0N, 68.2W at 12Z. HURDAT lists a 105 kt hurricane at 31.2N, 68.2W at 12Z. Microfilm shows a closed low pressure of at most 1002 mb at 31.5N, 67.6W with a frontal boundary to the northwest at 12Z. Ship highlights: 45 kt WSW and 984 mb at 29.0N, 69.5W at 00Z (micro). 35 kt SE and 1013 mb at 29.9N, 64.3W at 12Z (micro). 35 kt NE and 1011 mb at 31.5N, 69.5W at 18Z (COADS). 35 kt NNE and 1011 mb at 34.0N, 67.3W at 21Z (micro). Aircraft highlights: Penetration center fix measured a central pressure of 965 mb at 31.1N, 69.1W at 1115Z (ATSR/micro). Penetration center fix measured a central pressure of 954 mb at 32.6N, 67.2W at 19Z (ATSR/advisories). Penetration center fix measured a central pressure of 948 mb, estimated surface winds of 125 kt and an eye diameter of 20 nm at 32.7N, 66.6W at 22Z (WALLET).

MWR: “Frances moved just to the west of Bermuda on October 6. The lowest sea level pressure reported was 948 mb (27.99 inches) which is in good agreement with the maximum winds estimated at 110 kt (127 mph). The maximum intensity occurred when the hurricane was west and northwest of Bermuda and gales were reported throughout the islands at this time. As it turned out, flooding along the south coastal plain of Puerto Rico caused more damage than at any place along the entire path, mainly to roads and bridges. There has been no loss of life reported in connection with Frances.” ATSR: “After turning northeastward in advance of an approaching cold front and buffeting Bermuda with gale force winds on the 6th, Frances pointed for the coast of Maine.”

October 7:

HWM analyzes a hurricane of at most 995 mb at 35.1N, 64.5W with a stationary boundary to the northeast at 12Z. HURDAT lists a 110 kt hurricane at 35.5N, 64.5W at 12Z. Microfilm shows a closed low pressure of at most 1011 mb at 35.0N, 65.0W at 12Z. Ship highlights: 35 kt NE and 1015 mb at 28.4N, 69.0W at 06Z (COADS). 35 kt ENE and 1014 mb at 37.7N, 65.9W at 12Z (micro). 35 kt ENE and 1017 mb at 39.3N, 61.6W at 18Z (COADS). Land highlights: 35 kt SSE and 1008 mb at Bermuda at 00Z (micro). Aircraft highlights: Penetration center fix at 35.8N, 64.5W at 1330Z (ATSR). Penetration center fix at 36.7N, 64.0W at 19Z (ATSR).

October 8:

HWM analyzes a hurricane of at most 1000 mb at 39.7N, 65.5W at 12Z. HURDAT lists a 95 kt hurricane at 40.1N, 65.2W at 12Z. Microfilm shows a closed low pressure of at most 1002 mb at 40.0N, 65.0W at 12Z. Ship highlights: 35 kt E and 1018 mb at 40.2N, 60.3W at 00Z (COADS). 40 kt N and 1017 mb at 39.5N, 67.7W at 06Z (COADS). 55 kt NE and 1002 mb at 40.7N, 65.1W at 12Z (COADS). 60 kt ESE and 1006 mb at 41.0N, 62.8W at 16Z (MWL). 40 kt SE and 1006 mb at 41.2N, 65.3W at 18Z (COADS). 40 kt SE and 1006 mb at 41.2N, 65.3W at 18Z (COADS). 60 kt W and 1006 mb at 40.9N, 66.8W at 21Z (MWL). Aircraft highlights: Penetration center fix at 40.3N, 65.2W at 14Z (ATSR). Penetration center fix at 41.7N, 66.5W at 19Z (ATSR).

MWR: “…then threatened Maine on October 8th. It later made an abrupt turn to the right and dissipated over Nova Scotia.”

October 9:

HWM analyzes a tropical storm of at most 1010 mb at 43.1N, 67.8W with a stationary front to the north at 12Z. HURDAT lists a 40 kt extratropical cyclone at 43.5N, 67.8W at 12Z. Microfilm shows a closed low pressure of at most 1011 mb at 43.5N, 67.8W with a frontal boundary to the north at 12Z. Ship highlights: 45 kt W and 1008 mb at 41.8N,

67.9W at 00Z (micro). 40 kt W and 1008 mb at 42.0N, 68.1W at 06Z (COADS). 45 kt WSW and 1011 mb at 41.9N, 68.0W at 12Z (COADS).

ATSR: “Coming to within 50 miles of the mainland on the 9th, the decaying storm was caught in a westerly current, sharply turned to the northeast and dissipated over Nova Scotia. Only minor damage, mostly due to flooding in Puerto Rico, was attributed to Frances. No loss of life was reported.”

October 10:

HWM analyzes a tropical storm of at most 1010 mb at 44.0N, 56.5W with an extratropical cyclone to the north at 12Z. HURDAT lists a 35 kt extratropical cyclone at 46.0N, 59.2W at 06Z (last position). Microfilm shows an extratropical cyclone of at most 1008 mb at 50.0N, 62.0W at 12Z. Ship highlights: No gales or low pressures.

A tropical wave left the African coast late in September and traveled westward showing little signs of development. Data over the eastern and central Atlantic is sparse and the first signs that the disturbance was becoming better organized occurred on September 28th when it was located about 500 nm east of the Lesser Antilles. Ship observations on the 28th and 29th show that a sharp trough was present but the disturbance lacked a closed low-level circulation. Genesis is analyzed at 06Z on September 30th as a 35 kt tropical storm based on data later in the day, up from 30 kt originally in HURDAT, a minor intensity change. Time of genesis is the same as originally shown in HURDAT. Very minor track alterations are introduced during the lifetime of this tropical cyclone. Frances moved westward and steadily intensified. The first reconnaissance aircraft reached the storm at 17Z on the 30th measuring a central pressure of 1007 mb and estimating surface winds of 70 kt. At 19Z on the 30th, another penetration fix measured a central pressure of 1005 mb, estimated surface winds of 70 kt and an eye diameter of 8 nm. A central pressure of 1005 mb suggests maximum sustained winds of 37 kt south of 25N from the Brown et al. pressure-wind relationship. An eye diameter of 8 nm suggests an RMW of 6 nm and the climatological value is 14 nm. Due to the small size of the circulation, forward speed of about 8 kt and using a blend between the pressure-wind value and the visual surface estimate, an intensity of 55 kt is analyzed at 18Z on the 30th, up from 45 kt originally in HURDAT, a minor intensity change. (Central pressures values for almost every 6 hour period were present in the original HURDAT between September 30th at 12Z and October 7th at 00Z. Some of these were obviously analyses that were added in, not based upon actual observations. Thus, based on actual observations, some were retained, others removed and new central pressure values added. Detailed information on these changes can be found in the table at the end.)

Frances continued westward on October 1st as it crossed into the eastern Caribbean Sea. A ship at 04Z on the 1st reported 60 kt SE and 1012 mb in a heavy squall. Observations from nearby ships and island stations seem to indicate that this measurement had a high bias but it cannot be disregarded due to the small size of the tropical cyclone and earlier visual estimates from the reconnaissance aircraft. The tropical storm made landfall in Guadeloupe around 08Z with an intensity of 50 kt. Frances weakened over the eastern Caribbean Sea during the 1st based on observations from reconnaissance aircrafts and synoptic data. Penetration center fixes at 1455Z and 1558Z on the 1st measured central pressures of 1012 mb and 1011 mb, respectively, and the surface wind estimates were only 35 kt. Observations from nearby ships and island stations show that these pressure values likely do not represent the central pressure as the synoptic data indicates slightly lower pressure values, thus they were not added to HURDAT as central pressures. Nonetheless, it shows that the tropical cyclone was less organized on the 1st than 24 hours earlier. On the 2nd, the weakened tropical storm passed south of Puerto Rico. Ships observations and reconnaissance aircraft indicate that the low-level circulation of Frances became much disorganized on the 2nd and the tropical cyclone may have weakened to a strong tropical wave. Late on the 2nd, reconnaissance aircraft data indicate that they were following two centers, one moving westward into the central Caribbean and the other moving northwestward toward Hispaniola. The system is retained as a tropical storm on the 2nd and early on the 3rd due to the small size of the circulation, which may have persisted but was difficult to locate, and because ship observations indicate that it was producing gale-force winds.

Ships, coastal and reconnaissance aircraft observations indicate that the northwestward-bound center of Frances became the dominant center. Landfall in southeast Dominican Republic is analyzed at 05Z on the 3rd as a 45 kt tropical storm. Observations over the northeastern coast of the Dominican Republic late on the 3rd indicate that a closed low-level circulation was present. The tropical cyclone began to intensify later on the 3rd as it passed about 60 nm east of the Turks and Caicos. A reconnaissance aircraft measured a central pressure of 1005 mb at 01Z on October 4th. A central pressure of 1005 mb suggests maximum sustained winds of 37 kt from the south of 25N pressure-wind relationship. Due to the small circulation of Frances, forward speed of about 13 kt and a ship report of 45 kt at 21Z on the 3rd, an intensity of 55 kt is analyzed at 0Z on the 4th, same as originally shown in HURDAT. The next reconnaissance aircraft measured a central pressure of 999 mb and estimated surface winds of 100 kt at 12Z on the 4th. A central pressure of 999 mb suggests maximum sustained winds of 49 kt from the south of 25N pressure-wind relationship. Based on a forward speed of 14 kt, small size of the circulation and weighting in the visual estimate, an intensity of 65 kt is analyzed at 12Z on the 4th, same as originally shown in HURDAT. Intensification to a hurricane is analyzed at 12Z on the 4th, same as originally shown in HURDAT. Late on the 4th, the

track of Frances turned to the north while located east of the northwestern Bahamas. On October 5th, the small hurricane continued to gain strength while turning to the northeast ahead of an approaching frontal boundary. A reconnaissance aircraft measured a central pressure of 997 mb and estimated an eye diameter of 12 nm. A central pressure of 997 mb suggests maximum sustained winds of 49 kt from the north of 25N pressure-wind relationship. An eye diameter of 12 nm suggests an RMW of 9 nm and the climatological value is 20 nm. Due to a forward speed of 11 kt and an RMW smaller than the climatological value, an intensity of 65 kt is analyzed at 00Z on the 5th, down from 75 kt originally in HURDAT, a minor intensity change. The next penetration center fix occurred at 07Z on the 5th measuring a central pressure of 991 mb and an eye diameter of 11-13 nm. A central pressure of 991 mb suggests maximum sustained winds of 60 kt from the north of 25N intensifying pressure-wind relationship. An eye diameter of 11-13 nm suggests an RMW of about 9 nm and the climatological value is 22 nm. Due to a forward speed of 10 kt and an RMW smaller than the climatological value, an intensity of 75 kt is analyzed at 06Z on the 5th, down from 80 kt originally in HURDAT, a minor intensity change. Another penetration center fix occurred at 1410Z on the 5th measuring a central pressure of 973 mb. A central pressure of 973 mb suggests maximum sustained winds of 85 kt from the intensifying north of 25N pressure-wind relationship. Due to a forward speed of 9 kt and the small size of the circulation, an intensity of 90 kt is analyzed at 12Z on the 5th, up from 85 kt originally in HURDAT, a minor intensity change. Advisory #22 of Hurricane Frances issued on the 5th at 22Z shows that a central pressure of 963 mb was measured by the reconnaissance aircraft. The Navy book indicates that penetration center fixes occurred at 1840Z and 1950Z on the 5th corresponding to the advisory data. For the purpose of this reanalysis, the central pressure measurement has been assigned to the 1840Z penetration center fix, which is closer to the 18Z time slot on the 5th. A central pressure of 963 mb suggests maximum sustained winds of 96 kt from the intensifying north of 25N pressure-wind relationship. Due to the small size of the circulation and forward speed of 9 kt, an intensity of 100 kt is analyzed at 18Z on the 5th, up from 90 kt originally in HURDAT. Intensification to a major hurricane is analyzed twelve hours earlier than originally shown in HURDAT. At 21Z on the 5th, a ship passed near the center of Frances and reported 55 kt W and 963 mb.

On October 6th, Frances continued to the northeast and kept intensifying. A central pressure of 960 mb was in HURDAT at 00Z on the 6th and was retained as it appears to be reasonable. A central pressure of 960 mb suggests maximum sustained winds of 95 kt north of 25N and 100 kt intensifying from the pressure-wind relationship. Due to the small size of circulation and forward speed of about 11 kt, an intensity of 105 kt is analyzed at 00Z on the 6th, up from 95 kt originally in HURDAT, a minor intensity change. Microfilm shows a central pressure of 965 mb measured by a dropsonde at 11Z on the 6th. It appears that the dropsonde missed the small center of Frances based on data

later in the day. A central pressure of 954 mb was in HURDAT at 18Z on the 6th and has been retained. A penetration center fix occurred at 19Z, which may have measured that central pressure, and advisory #26 at 22Z on the 6th also mentions a central pressure of 954 mb. A central pressure of 991 mb suggests maximum sustained winds of 106 kt from the north of 25N intensifying pressure-wind relationship. Based on the small size of the circulation and a forward speed of 14 kt, an intensity of 110 kt is analyzed at 18Z on the 6th, up from 105 kt originally shown in HURDAT. A reconnaissance aircraft measured a central pressure of 948 mb, estimated surface winds of 125 kt and an eye diameter of 20 nm at 22Z on the 6th. A central pressure of 948 mb suggests maximum sustained winds of 112 kt north of 25N intensifying from the pressure-wind relationship. An eye diameter of 20 nm suggests an RMW of 15 nm and the climatological value is 22 nm. Due to a forward speed of 14 kt and an RMW smaller than climatology, an intensity of 115 kt is analyzed at 00Z on the 7th, up from 110 originally shown in HURDAT. 115 kt is also the peak intensity of this tropical cyclone, up from 110 kt originally shown in HURDAT, a minor intensity change. Early on the 7th, Frances passed about 120 nm northwest of Bermuda where it produced gale-force winds. Late on the 7th, the hurricane turned to the north. Penetration center fixes occurred late on the 7th but no central pressures were reported. On October 8th, Frances turned to the northwest posing a threat to the Northeast of the United States. Cooler sea-surface temperatures caused the hurricane to rapidly weaken on the 8th and weakening below major hurricane intensity is analyzed at 06Z on the 8th, six hours earlier than originally shown in HURDAT. As the hurricane crossed 40N, cold, dry air started to enter the circulation and the system began to acquire extratropical characteristics. Transition to an extratropical cyclone is analyzed at 18Z on the 8th, eighteen hours earlier than originally shown in HURDAT. The small cyclone likely transitioned to a post-tropical cyclone as no frontal features are discernable in the ship observations. However, such a stage is uncertain without satellite and will not be formally shown here. An approaching frontal boundary caused the extratropical cyclone to stop its westward advancement and turn to the northeast toward Nova Scotia on October 9th. Weakening below hurricane intensity is analyzed at 00Z on the 9th, six hours earlier than originally shown in HURDAT. The small extratropical cyclone continued to weaken on the 9th and 10th, and it finally merged with another extratropical cyclone to the north around 12Z on the 10th. The last position is analyzed at 06Z on the 10th, same as originally shown in HURDAT.

Date	Original HURDAT Central Pressure	Evidence	Changes
Sep 30 12Z	1007 mb	Penetration center fix occurred at 17Z, closer to the 18Z time slot	Removed

Sep 30 18Z	1006 mb	Penetration center fix: 1005 mb at 19Z on Sep 30th	1005 mb
Oct 1 12Z	1004 mb	Ship reported 45 kt SSE and 1002 mb, and penetration center fixes reported 1012 mb at 1455Z and 1011 mb at 1558Z on Oct 1st	Removed
Oct 2 00Z	1010 mb	Penetration center fix: 1010 mb at 2130Z on Oct 1st	Retained
Oct 2 12Z	1011 mb	Penetration center fix: 1011 mb at 1140Z on Oct 2nd	
Oct 2 18Z	1010 mb	Penetration center fix: 1010 mb at 1845Z on Oct 2nd	
Oct 3 12Z	1010 mb	Synoptic data indicate a central pressure lower than 1010 mb	Removed
Oct 4 00Z	1005 mb	Penetration center fix: 1005 mb at 01Z on Oct 4th	Retained
Oct 4 12Z	999 mb	Penetration center fix: 999 mb at 12Z on Oct 4th	
Oct 5 00Z	997 mb	Penetration center fix: 997 mb at 00Z on Oct 5th	
Oct 5 06Z	991 mb	Penetration center fix: 991 mb at 12Z on Oct 5th	
Oct 5 12Z	974 mb	Penetration center fix: 973 mb at 1410Z on Oct 5th	973 mb
Oct 5 18Z		Penetration center fix: 963 mb at 1840Z on Oct 5th	963 mb
Oct 6 00Z	960 mb	No ship or aircraft observation and appears reasonable	Retained
Oct 6 12Z	968 mb	No ship or aircraft observation and does not appear reasonable with other available data	Removed
Oct 6 18Z	954 mb	Penetration center fix: 954 mb at 19Z on Oct 6th	Retained
Oct 7 00Z	948 mb	Penetration center fix: 948 mb at 22Z on Oct 6th	

Tropical Storm Gerda [October 16-22, 1961]

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42220 10/16/1961 M= 7  8 SNBR= 915 GERDA       XING=0 SSS=0

42225 10/16*175 770  30    0*183 775  30    0*189 778  30 1005*194 779  30    0*
42225 10/16*170 778  25    0*180 778  25    0*188 778  25 1005*193 779  25    0*
           *** ***  **      *** ***  **      ***      **      ***      **

42230 10/17*199 779  30    0*204 780  30    0*210 780  30    0*215 780  30    0*
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42230 10/17*197 779  30 1003*201 780  30    0*205 780  30    0*210 780  30 1002*
            ***         **** ***            ***            ***         ****

42235 10/18*220 780  30 1003*228 778  30    0*237 777  30 1004*247 768  30    0*
42235 10/18*216 780  30 1003*225 779  30    0*235 777  30 1004*245 772  35 1003*
            ***              *** ***         ***            *** ***  ** ****

42240 10/19*257 758  30 1003*268 744  30    0*288 730  30 1001*315 715  55  996*
42240 10/19*256 763  40 1003*268 750  50 1001*284 735  55 1001*303 718  55  996*
            *** ***  **           ***  ** **** *** ***  **       *** ***

42245 10/20*340 700  55    0*372 686  55    0*395 684  55  987*413 668  60    0*
42245 10/20*335 702  55    0*370 688  55  988*393 682  55  987E407 675  60    0*
            *** ***           *** ***     *** *** ***         **** ***

42250 10/21E420 650  60  993E429 630  50    0E434 616  40  994E440 587  30    0*
42250 10/21E415 660  65    0E424 645  60    0E432 627  50  994E440 612  45    0*
            *** ***  **    * *** ***  **      *** ***  **          ***  **

42255 10/22E440 565  30    0E440 527  30    0E440 490  30    0E440 450  30    0*
42255 10/22E442 585  35    0E444 540  35    0E446 493  35    0*  0   0   0    0*
            *** ***  **      *** ***  **      *** ***  **        *   *   *

42260 TS
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Major changes to the track (only during the extratropical phase) and intensity shown in McAdie et al. (2009). Evidence for these alterations comes from the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Monthly Weather Review, Navy reconnaissance book, Mariners Weather Log, Surface Weather Observations, State Climatological Data, Perez et al. (2000) and NHC Storm Wallets.

October 14:

HWM does not analyze an organized system at 12Z. HURDAT does not list an organized system on this date. Microfilm shows a closed low pressure of at most 1008 mb at 15.5N, 80.5W at 12Z. Ship highlights: No gales or low pressures.

October 15:

HWM analyzes a spot low pressure at 15.2N, 78.1W with a cold front far to the northwest at 12Z. HURDAT does not list an organized system on this date. Microfilm shows a tropical wave or trough over the central Bahamas and eastern Cuba, with a frontal boundary to the northwest at 12Z. Ship highlights: No gales or low pressures.

ATSR: “On the 15th of October, conditions began to appear very unsettled in the Central Caribbean.”

October 16:

HWM analyzes a closed low pressure at 18.0N, 78.0W at 12Z. HURDAT lists a 30 kt tropical depression at 18.9N, 77.8W at 12Z. Microfilm shows a closed low pressure of at

most 1008 mb at 18.0N, 79.0W at 12Z. Ship highlights: No gales or low pressures. Land highlights: 20 kt SE and 1004 mb at Cabo Cruz, Cuba at 18Z (micro).

MWR: “Several days before tropical storm Gerda developed, a Navy reconnaissance aircraft investigated an easterly wave in the eastern Caribbean, finding widespread shower activity and some evidence of a weak circulation. However, winds were not strong, generally less than 25 mph. The wave continued slowly westward and began to show evidence of intensification the night of the 15th with pressures dropping in the central Caribbean and heavy rain beginning over Jamaica and eastern Cuba. By the morning of the 16th, pressure at Kingston had dropped to 1005 mb with winds both at the surface and aloft indicating a circulation with the center a short distance north of Jamaica.” ATSR: “By the 15th of October, widespread shower activity and evidence of a circulation appeared, although wind velocities in general were light. The lowest pressure observed at this time was 1005.9 mb at Jamaica. The circulation remained weak and poorly organized as it began moving northward across Cuba.”

October 17:

HWM analyzes a closed low pressure of at most 1005 mb at 20.0N, 78.0W at 12Z. HURDAT lists a 30 kt tropical depression at 21.0N, 78.0W at 12Z. Microfilm shows an elongated area of low pressure of at most 1004 mb with two centers located at 18.5N, 82.0W and 20.8N, 77.5W with a frontal boundary to the north at 12Z. Ship highlights: 15 kt and 1005 mb at 18.8N, 77.6W at 00Z (COADS). Land highlights: 40 kt S and 1005 mb at Santiago de Cuba, Cuba at 00Z (micro). 10 kt NE and 1004 mb at Cabo Cruz, Cuba at 00Z (micro). 1004 mb at Cabo Cruz, Cuba at 12Z (micro). 15 kt SW and 1004 mb at Cabo Cruz, Cuba at 18Z (micro).

October 18:

HWM analyzes a closed low pressure of at most 1005 mb at 23.0N, 78.0W with a warm front far to the north at 12Z. HURDAT lists a 30 kt tropical depression at 23.7N, 77.7W at 12Z. Microfilm shows a closed low pressure of at most 1005 mb at 23.5N, 77.3W with a frontal boundary to the north at 12Z. Ship highlights: 25 kt NNE and 1005 mb at 23.2N, 80.2W at 06Z (COADS). Land highlights: 30 kt S and 1005 mb at Santiago de Cuba, Cuba at 00Z (micro). 10 kt SW and 1004 mb at Cabo Cruz, Cuba at 00Z (micro). 15 kt NE and 1005 mb at Andros Island, Bahamas at 12Z (micro). 10 kt NNE and 1004 mb at Andros Island, Bahamas at 18Z (micro).

MWR: “The poorly organized disturbance moved slowly northward across central Cuba, thence northeastward through the western Bahamas on the 18th with slow deepening but winds still only 25 to 40 mph in scattered squalls.” ATSR: “Reconnaissance was hampered by air space restrictions, but on the 18th two separate Navy flights investigated

areas north and south of Cuba, with one flight finding a low pressure area of 1005 mb just east of Andros Island in the Bahamas. No sign of development was encountered."

October 19:

HWM analyzes a closed low pressure of at most 1000 mb at 28.0N, 73.5W with a warm front to the north at 12Z. HURDAT lists a 30 kt tropical depression at 28.8N, 73.0W at 12Z. Microfilm shows a closed low pressure of at most 1002 mb at 28.5N, 73.0W with a frontal boundary to the north at 12Z. Ship highlights: 40 kt SE and 1007 mb at 25.3N, 73.6W at 00Z (COADS). 50 kt SSE and 1007 mb at 24.9N, 73.0W at 03Z (micro/MWL). 45 kt SE and 1007 mb at 24.5N, 72.4W at 06Z (COADS). 20 kt SW and 1003 mb at 26.6N, 74.8W at 06Z (COADS). 35 kt S and 1004 mb at 27.7N, 71.4W at 12Z (COADS). 55 kt SW (47 kt in MWL) and 1003 mb at 27.8N, 72.0W at 14Z (micro/MWL). 55 kt S and 1000 mb at 29.2N, 70.9W at 18Z (COADS). 40 kt SE and 993 mb at 34.0N, 67.1W at 21Z (micro).

MWR: "North of the Bahamas, reconnaissance aircraft found winds up to 60 mph on the morning of the 19th, although the storm still remained poorly organized with a large center and no evidence of a wall cloud." ATSR: "However, on the 19th, ship reports indicated deepening had occurred overnight since 45-knot winds were reported in the eastern quadrant of the low. The first warning on Gerda was issued at 192200Z."

October 20:

HWM analyzes a closed low pressure of at most 990 mb at 39.5N, 67.8W with weakening frontal boundaries to the north at 12Z. HURDAT lists a 55 kt tropical storm at 39.5N, 68.4W at 12Z. Microfilm shows a closed low pressure of at most 990 mb at 40.0N, 68.0W with a frontal boundary to the north at 12Z. Ship highlights: 50 kt SSW and 993 mb at 33.4N, 67.5W at 00Z (micro). 55 kt SW and 995 mb at 33.9N, 68.5W at 03Z (micro). 40 kt S and 994 mb at 36.2N, 67.1W at 06Z (COADS). 25 kt SSE and 991 mb at 37.2N, 68.6W at 06Z (COADS). 50 kt SSW and 1004 mb at 39.7N, 63.6W at 12Z (COADS). 55 kt S and 999 mb at 39.9N, 61.8W at 18Z (COADS). 63 kt S and 1000 mb at 39.7N, 61.0W at 21Z (MWL). Land highlights: 45 kt NE (gusts to 57 kt) and 999 mb at Nantucket Shoals, MA at 0855Z (SWO). 68 kt NE (gusts to 74 kt) and 993 mb at Georges Shoals, MA at 1455Z (SWO). 42 kt N (peak winds, gusts to 54 kt) at Nantucket, MA at 1630Z (SWO). 65 kt NE (gusts to 78 kt) and 989 mb at Georges Shoals, MA at 2055Z (SWO). 68 kt NNE (peak winds, gusts to 80 kt) at Georges Shoals, MA at 2255Z (SWO).

MWR: "Gerda moved north-northeastward to a position just off Nantucket on the 20th reaching its maximum intensity at that time. Texas Towers off the Massachusetts coast reported whole gale winds, occasionally of hurricane force for short periods." ATSR:

“Under the influence of a long wave positioned over the eastern seaboard of the United States, Gerda moved in a north-northeasterly direction to a point approximately 120 miles east of Nantucket on the 20th where reports showed it reached its maximum intensity. Texas towers Bravo and Charlie received wind gusts of hurricane force for a short period at this time. The storm then turned east-northeastward, accelerated.”

October 21:

HWM analyzes a closed low pressure of at most 1000 mb at 43.0N, 60.0W with a frontal boundary going through the center at 12Z. HURDAT lists a 40 kt extratropical cyclone at 43.4N, 61.6W at 12Z. Microfilm shows an extratropical cyclone of at most 996 mb at 43.2N, 61.5W at 12Z. Ship highlights: 63 kt S and 1000 mb at 39.8N, 61.4W at 00Z (MWL). 35 kt S and 984 mb at 41.0N, 65.6W at 00Z (COADS). 25 kt NW and 991 mb at 41.6N, 65.2W at 06Z (COADS). 60 kt N and 1000 mb at 41.6N, 67.9W at 06Z (micro). 50 kt SW and 999 mb at 42.0N, 62.0W at 12Z (COADS). 15 kt SSW and 996 mb at 43.5N, 62.2W at 12Z (COADS). 45 kt ENE and 1008 mb at 46.5N, 57.0W at 18Z (COADS). 15 kt SW and 999 mb at 43.4N, 61.1W at 18Z (COADS). Land highlights: Estimated 50 kt N (gusts to 60 kt) at Georges Shoals, MA at 0055Z (SWO). Estimated 60 kt N (gusts to 75 kt) at Georges Shoals, MA at 0458Z (SWO). 42 kt NNW (gusts to 49 kt) and 1006 mb at Georges Shoals, MA at 1158Z (SWO). 34 kt NE (gusts to 42 kt) and 1009 mb at Georges Shoals, MA at 1456Z (SWO).

MWR: “From this position Gerda turned to an east-northeastward course gradually accelerating and becoming extratropical on the 21st. Although Gerda had most of the characteristics of a tropical storm at low levels, conditions in the upper troposphere were not favorable for strong deepening.” ATSR: “...became extratropical on the 21st.”

October 22:

HWM analyzes a spot low pressure at 43.2N, 49.5W with a frontal boundary close to the north at 12Z. HURDAT lists a 30 kt extratropical depression at 44.0N, 49.0W at 12Z. Microfilm shows an extratropical cyclone of at most 1008 mb at 44.0N, 48.0W at 12Z. Ship highlights: 35 kt NE and 1009 mb at 46.5N, 55.6W at 00Z (COADS). 35 kt SW and 1012 mb at 41.1N, 48.0W at 06Z (COADS). 35 kt WSW and 1019 mb at 40.6N, 46.3W at 18Z (COADS).

October 23:

HWM analyzes an extratropical cyclone of at most 995 mb at 49.0N, 27.0W at 12Z. HURDAT does not list an organized system on this date. Microfilm shows an extratropical cyclone at 49.5N, 25.8W at 12Z. Ship highlights: 40 kt SW and 998 mb at 46.4N, 26.6W at 12Z (COADS).

MWR: “Reconnaissance aircraft did not report any indication of wall cloud formation or spiral bands at any time of the strong winds at the course of the storm. Even at the time of the strong winds at the Texas towers, an Air Force reconnaissance aircraft very near their location reported winds of only 10 kt at 700 mb. A low-level injection of polar air into Gerda was occurring at this time and the circulation apparently was quite shallow. Damage from Gerda was not heavy although according to press reports information was received from eastern Cuba of extensive flooding resulting in seven deaths. Five deaths were reported from Jamaica due to drowning. Heavy rains occurred for several days over Jamaica and extreme eastern Cuba. Orographic effects probably caused excessive amounts with flash flooding quite common over the more mountainous sections of these areas. Damage through the New England area was about the same as that from a typical wintertime northeaster. The strong winds reported by the Texas Towers did not occur on the coast where 30 to 50 mph were the strongest winds reported.” ATSR: “Except for its nascent stage, Gerda seemed to exhibit both tropical and extratropical characteristics. There was never any reports signifying the existence of either a wall cloud or spiral bands throughout the life of the storm. At the same time that the Texas towers were being buffeted with hurricane force gusts, an Air Force reconnaissance plane at 700 mn, near the same location, found only light winds, indicating a shallow system. Throughout Gerda's cycle a cold low was located over the eastern United States in the upper levels and her existence appeared to begin and end in the warm tongue to the east of the cold low. Gerda left only moderate damage in her path. Extensive flooding resulting from heavy rains was reported by the press to have caused a total of 12 deaths in eastern Cuba and Jamaica. The New England area received only moderate gale winds along the coastal sections.”

A broad disturbance developed in the central Caribbean Sea around October 14th. Under weak steering currents, the disturbance slowly drifted northward becoming better organized. Genesis is analyzed at 00Z on October 16th as a 25 kt tropical depression, down from 30 kt originally shown in HURDAT. Minor track alterations are introduced during the lifetime of this system as a tropical cyclone. Major track alterations are introduced on October 21st at 18Z and October 22nd at 00Z when it was an extratropical cyclone based on synoptic data. The tropical depression remained embedded in a large area of low pressure and was elongated southwest-northeast. A central pressure of 1005 mb was present in HURDAT at 12Z on the 16th and has been retained as it appears reasonable (but could not be verified, which occurred several times during the lifetime of this system). Late on the 16th, the center of the depression was located between eastern Cuba and Jamaica and a frontal boundary stretched across the Florida Straits. Cabo Cruz, Cuba reported 10 kt NE and 1004 mb at 00Z on October 17th, suggesting a central pressure of 1003 mb, which has been added to HURDAT. Santiago de Cuba reported 40 kt S at 00Z on the 17th but it was determined that this station

continuously reported winds higher than nearby observations, which is suspect. Thus the tropical cyclone was retained at tropical depression intensity. On the 17th, surface observations indicate that the center of the tropical depression was ill-defined and the system resembled a trough of low pressure extended from eastern Cuba to the eastern coast of Nicaragua. The ill-defined center of the tropical depression made landfall in Cuba around 15Z on the 17th. Perez et al. (2000) does not show this system as a tropical storm impacting Cuba, same as our reanalysis. Camaguey, Cuba reported 5 kt NE and 1004 mb at 18Z on the 17th, suggesting a central pressure of 1003 mb, which has been added to HURDAT. Central pressures of 1003 mb and 1004 mb were present in HURDAT at 00Z and 12Z, respectively, on October 18th and both have been retained as they seem reasonable with the available data. On the 18th, the low-level circulation became better organized as the tropical depression moved into the western Bahamas. A strong pressure gradient to the northwest of the cyclone caused gale-force winds, about 300 nm from the center. These winds were not considered to be part of the circulation. Andros Island reported 10 kt NNE and 1004 mb at 18Z on the 18th, suggesting a central pressure of 1003 mb, which has been added to HURDAT. Intensification to a tropical storm is analyzed at 18Z on the 18th based on data early on the 19th. This transition is eighteen hours earlier than originally shown in HURDAT.

Gerda intensified on the 19th as it moved away from the Bahamas. Central pressures of 1003 mb, 1001 mb and 996 mb were present in HURDAT at 00Z, 12Z and 18Z, respectively, on October 19th and all three have been retained as they seem reasonable with the available data. A ship reported 20 kt SW and 1003 mb at 06Z on the 19th, suggesting a central pressure of 1001 mb, which has been added to HURDAT. Based on surface observations of 50 kt at 03Z and 55 kt at 14Z, an intensity of 50 kt is analyzed at 06Z and 55 kt at 12Z on the 19th, up from 30 kt originally in HURDAT at both times, major intensity changes. 55 kt is also the peak intensity of this system as a tropical cyclone, down from 60 kt originally in HURDAT, a minor intensity change. Gerda increased in forward speed on October 20th traveling between Bermuda and East Coast of the United States. A ship reported 25 kt SSE and 991 mb at 06Z on the 20th, suggesting a central pressure of 988 mb, which has been added to HURDAT. A central pressure of 987 mb was present in HURDAT at 12Z on October 20th and has been retained as it seems reasonable with the available data. Synoptic observations indicate that Gerda began to transition into an extratropical cyclone around midday on the 20th with a distinct temperature gradient across the circulation and the beginning of frontogenesis. Transition to an extratropical cyclone is analyzed at 18Z on the 20th, six hours earlier than originally shown in HURDAT. Gerda remained a powerful extratropical cyclone and the offshore platforms off Massachusetts recorded hurricane-force winds. Georges Shoals, MA reported 68 kt at 1455Z and 2255Z. At an elevation of 200 feet, this suggests sustained winds of about 60 kt at the surface. A ship reported 63 kt

at 21Z on the 20th and 00Z on the 21st. An intensity of 65 kt is analyzed at 00Z on the 21st, up from 60 kt originally in HURDAT, a minor intensity change. A central pressure of 993 mb was present in HURDAT at 00Z on the 21st and has been removed due to a ship close to the center that reported 35 kt SSW and 984 mb. On the 21st, the extratropical cyclone turned to the northeast and moved away from the United States while gradually losing strength. Weakening below hurricane intensity is analyzed at 06Z on the 21st. A central pressure of 994 mb is analyzed at 12Z on the 21st and has been retained as it seems reasonable with the available data. HURDAT originally showed the extratropical cyclone weakening below gale-force at 18Z on the 21st but ship observations suggest that it retained minimal gale-force winds until dissipation. On October 22nd, the extratropical cyclone continued to weaken and degenerated into trough of low pressure over the north Atlantic after 12Z on the 22nd. The last position is analyzed at 12Z on the 22nd, six hours earlier than originally shown in HURDAT. While in the Caribbean Sea, Gerda resembled Tropical Storm Nicole in 2010 by not having a well-defined low level circulation.

Hurricane Hattie [October 27 – November 1, 1961]

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42265 10/27/1961 M= 6  9 SNBR= 916 HATTIE      XING=0 SSS=0

42270 10/27*  0   0   0    0*  0   0   0    0*116 815  45    0*120 816  55    0*
42270 10/27*110 810  35    0*113 815  40    0*116 818  50    0*120 818  60    0*
            *** ***  **      *** ***  **          ***  **          ***  **

42275 10/28*128 817  65  991*129 817 100    0*135 816 105  991*141 815 110  969*
42275 10/28*124 817  70    0*129 817  80    0*135 816  90  969*142 815 105  956*
            ***      **    *          **                **  *** ***     ***  ***

42280 10/29*150 814 110  952*161 812 110    0*169 813 110  963*177 819 110    0*
42280 10/29*150 814 110  952*160 812  95  966*169 813  95  963*177 818 100  956*
                         ***       **  ***          **                ***  ***

42285 10/30*182 824 115  956*185 838 120  942*184 841 130  937*182 852 140    0*
42285 10/30*181 825 100  958*185 836 115  942*184 844 120  937*182 852 135  923*
            *** *** ***  ***     *** ***          *** ***               ***  ***

42290 10/31*179 861 140  920*176 871 140    0*172 881 120  930*169 889  60    0*
42290 10/31*180 861 135  920*176 871 125  930*172 881 135  924*168 891  75    0*
            ***     ***               ***  ***         ***  *** *** ***  **

42295 11/01*166 896  55    0*157 901  45    0*  0   0   0    0*  0   0   0    0*
42295 11/01*164 901  45    0*160 911  30    0*  0   0   0    0*  0   0   0    0*
            *** ***  **      *** ***  **

42300 HR
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(Simone – in the NE Pacific – to be removed)

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03845 11/01/1961 M= 3  9 SNBR= 118 SIMONE      XING=1 SSS=0
03850 11/01*  0   0   0    0*140 920  25    0*139 934  25    0*143 944  45    0*
03855 11/02*150 950  45    0*158 958  25    0*166 957  25    0*172 959  25    0*
03860 11/03*176 954  25    0*180 952  25    0*186 946  25    0*  0   0   0    0*
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03865 TS

Hurricane Landfall

10/31 13Z 17.1N 88.3W 135 kt Belize

Minor changes to the track and major changes to the intensity shown in McAdie et al. (2009). Evidence for these alterations comes from the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Monthly Weather Review, Navy reconnaissance book, Mariners Weather Log, Mexican synoptic maps and NHC Storm Wallets.

October 25:

HWM and HURDAT do not analyze an organized system on this date. Microfilm shows a closed low pressure of at most 1008 mb at 11.0N, 79.2W at 12Z. Ship highlights: No gales or low pressures.

October 26:

HWM analyzes a spot low pressure at 10.2N, 82.0W at 12Z. HURDAT does not list an organized system on this date. Microfilm shows a closed low pressure of at most 1008 mb at 10.0N, 80.2W at 12Z. Ship highlights: 35 kt E and 1009 mb at 13.5N, 77.6W at 12Z (COADS).

ATSR: “Not since Hurricane Charlie of 1951 and Hurricane Janet of 1955 has a tropical storm in the western Caribbean taken a great toll of human life as the “killer” storm of the 1961 season, Hurricane Hattie, which claimed at least 300 victims with many more missing and presumed dead. Considerable rainfall, widespread altostratus, and slighly higher than normal winds were observed in the extreme southwestern Caribbean early on the 26th of October.”

October 27:

HWM analyzes a tropical storm of at most 1005 mb at 11.2N, 81.5W at 12Z. HURDAT lists a 45 kt tropical storm at 11.6N, 81.5W at 12Z (first position). Microfilm shows a closed low pressure of at most 1008 mb at 11.8N, 81.4W at 12Z. Ship highlights: 30 kt S and 1007 mb at 10.9N, 80.1W at 00Z (COADS). 20 kt NE and 1004 mb at 11.4N, 82.0W at 06Z (COADS). Land highlights: 40 kt ESE and 1004 mb at San Andres, Colombia at 18Z (micro).

MWR: “Hurricane Hattie was the killer storm of the 1961 hurricane season, although property damage mas much greater in Carla. Approximately 275 people perished in Hattie. Not since hurricane Janet, 1955, has a storm inflicted so much damage in the

Yucatan Peninsula region. The first indication of a tropical storm came from a ship, located about 120 rides south-southeast of San Andres Island at 1900 EST, October 26, reporting the 40-kt southerly wind. By 1000 EST, October 27, the airport at San Andres Island reported that it was closed because of 40- to 50-kt. easterly winds and, based on this report, the first tropical storm advisory for Hattie was issued by the Miami Weather Bureau at 1700 EST." ATSR: "A ship about 120 miles south-southeast of San Andres Island reported a southerly wind of 30 knots at 270000Z with 8-foot seas from the south. At 271500Z the airport at San Andres radioed that it was closed due to 30 to 40 knot easterly winds and foul weather. The first warning for Hattie was issued at 272200Z. After passing over San Andres Island on the afternoon of the 27th, the storm moved northward and intensified."

October 28:

HWM analyzes a hurricane of at most 1000 mb at 13.3N, 81.6W at 12Z. HURDAT lists a 105 kt hurricane at 13.5N, 81.6W at 12Z. Microfilm shows a closed low pressure of at most 1002 mb at 13.9N, 81.6W at 12Z. Ship highlights: 25 kt ENE and 1005 mb at 13.5N, 81.5W at 00Z (COADS). 30 kt NW and 1005 mb at 12.8N, 83.0W at 18Z (COADS). Land highlights: 70 kt (gusts to 90 kt) at San Andres, Colombia (time not given, likely early on the 28th) (MWR). 50 kt ESE and 993 mb at San Andres, Colombia at 00Z (micro). 991 mb at San Andres, Colombia at 01Z (MWR). 15 kt SW and 1004 mb at San Andres, Colombia at 12Z (micro). 35 kt W and 1005 mb at San Andres, Colombia at 18Z (micro). 15 kt NW and 1001 mb at Puerto Cabezas, Nicaragua at 21Z (micro). Aircraft highlights: Radar center fix at 12.4N, 81.5W at 0322Z (ATSR). Penetration center fix measured a central pressure of 998 mb and an eye diameter of 20 nm at 13.0N, 81.7W at 07Z (ATSR). Penetration center fix measured a central pressure of 969 mb, estimated surface winds of 110 kt and an eye diameter of 20 nm at 13.6N, 81.6W at 1247Z (ATSR). Penetration center fix measured a central pressure of 963 mb at 13.8N, 81.6W at 15Z (ATSR). Penetration center fix measured a central pressure of 964 mb, estimated surface winds of 110 kt and an eye diameter of 10 nm at 14.4N, 81.6W at 1935Z (ATSR). Penetration center fix measured a central pressure of 956 mb and estimated surface winds of 100 kt at 14.3N, 81.6W at 20Z (ATSR).

MWR: "Hattie passed over or just to the west of San Andres in the late afternoon of the 27th. A minimum pressure of 991 mb was observed at 2100 EST, October 27, and highest steady winds were 70 kt with 90-kt gusts. One person was killed on the island and 15 were injured, with property damage estimated at $300,000." ATSR: "A Navy reconnaissance plane obtained a nighttime fix on Hattie early on the 28th and reported a poorly defined eye and a surface pressure by dropsonde of 998 mb.

October 29:

HWM analyzes a hurricane of at most 990 mb at 16.5N, 81.2W at 12Z. HURDAT lists a 110 kt hurricane at 16.9N, 81.3W at 12Z. Microfilm shows a closed low pressure of at most 1002 mb at 16.5N, 81.2W at 12Z. Ship highlights: Ship highlights: 30 kt NW and 1004 mb at 14.4N, 83.1W at 00Z (COADS). 35 kt E and 1009 mb at 19.5N, 79.0W at 06Z (micro). 35 kt SSW and 1004 mb at 15.2N, 80.7W at 09Z (micro). 35 kt ESE and 1010 mb at 19.9N, 79.9W at 12Z (COADS). 35 kt SSW and 1007 mb at 15.7N, 81.0W at 15Z (micro). 40 kt NE and 1006 mb at 19.2N, 83.3W at 18Z (COADS). 50 kt NE at 19.5N, 84.0W at 21Z (micro). Land highlights: 10 kt N and 1003 mb at Cabo Gracias a Dios, Honduras at 00Z (micro). 15 kt NE and 1005 mb at Swan Islands, Honduras at 09Z (micro). 25 kt NE and 1004 mb at Grand Cayman at 18Z (micro). 30 kt E and 1002 mb at Grand Cayman at 21Z (micro). Aircraft highlights: Penetration center fix measured a central pressure of 952 mb at 15.1N, 81.4W at 0030Z (WALLET). Penetration center fix measured a central pressure of 966 mb and estimated an eye diameter of 12 nm at 16.3N, 81.2W at 07Z (ATSR). Penetration center fix measured a central pressure of 963 mb, estimated surface winds of 110 kt and an eye diameter of 40 nm at 17.0N, 81.4W at 13Z (ATSR). Penetration center fix measured a central pressure of 956 mb, estimated surface winds of 110 kt and an eye diameter of 40 nm at 18.0N, 82.2W at 1915Z (ATSR).

ATSR: “Twenty-four hours later another Navy aircraft reported a 963 mb surface pressure, showing rapidly development had occurred. Hattie continued her northerly course until approximately 291000Z, then began a wide cyclonic curve before eventually ending up on a west-southwest course. This turn is probably accounted for by marked height rises to the north and north-west of the storm in conjection with a cut-off low over the southwestern United States in the upper levels. Hattie's continuing increase in intensity, coinciding with the 500 mb height rises, supports the thumb rule that one can expect intensification when height rises occur north of the storm.”

October 30:

HWM analyzes a hurricane of at most 990 mb at 18.0N, 84.3W at 12Z. HURDAT lists a 130 kt hurricane at 18.4N, 84.1W at 12Z. Microfilm shows a closed low pressure of at most 993 mb at 18.5N, 84.5W at 12Z. Ship highlights: 40 kt N at 18.2N, 83.6W at 00Z (COADS). 35 kt SW and 1005 mb at 16.3N, 82.5W at 06Z (COADS). 50 kt N and 1004 mb at 18.0N, 85.3W at 12Z (COADS). 45 kt NW and 999 mb at 17.4N, 85.2W at 15Z (micro). 70 kt W and 1000 mb at 17.4N, 85.2W at 18Z (micro). 75 kt SSW and 991 mb at 17.1N, 85.0W at 21Z (micro). Land highlights: 15 kt NNW and 1002 mb at Swan Islands, Honduras at 00Z (micro). 20 kt W and 1000 mb at Swan Islands, Honduras at 06Z (micro). 30 kt WSW and 997 mb at Swan Islands, Honduras at 09Z (micro). 35 kt SW and 996 mb at Swan Islands, Honduras at 12Z (micro). 50 kt SW and 999 mb at Swan Islands, Honduras at 15Z (micro). 45 kt SSW and 1002 mb at Swan Islands, Honduras at

18Z (micro). 40 kt S and 1002 mb at Swan Islands, Honduras at 21Z (micro). Aircraft highlights: Penetration center fix measured a central pressure of 958 mb and estimated an eye diameter of 30 nm at 18.1N, 82.6W at 01Z (ATSR). Penetration center fix measured a central pressure of 942 mb and estimated an eye diameter of 28 nm at 18.5N, 83.9W at 07Z (ATSR). Penetration center fix measured a central pressure of 937 mb, estimated surface winds of 115 kt and an eye diameter of 25 nm at 18.5N, 84.2W at 10Z (ATSR). Penetration center fix measured a central pressure of 924 mb, estimated surface winds of 130 kt and an eye diameter of 20 nm at 18.4N, 84.5W at 15Z (ATSR). Penetration center fix measured a central pressure of 923 mb and estimated an eye diameter of 20 nm at 18.3N, 85.0W at 17Z (ATSR). Penetration center fix measured a central pressure of 920 mb and estimated an eye diameter of 22 nm at 18.0N, 86.0W at 22Z (ATSR).

MWR: “From this point Hattie continued on a generally northerly course for the next 36 hours and intensified with the central pressure reaching 952 mb near 15ºN. By 1900 EST, October 29, a change to a more westerly course became clearly evident. The storm continued on a cyclonic turn passing between Swan and Cayman Islands with maximum winds on these two islands remaining under hurricane force. Hattie finally settled on a west-southwestward course and intensified markedly during the morning of October 30 when the central pressure probably reached its lowest value, 924 mb at 0800 EST. A lower pressure of 920 mb was computed at 1700 EST; however, this was based upon the 700 mb height and not determined by dropsonde.” ATSR: “On the 30th a central pressure of 923 mb was reported by dropsonde.”

October 31:

HWM analyzes a hurricane of at most 985 mb at 17.1N, 88.0W at 12Z. HURDAT lists a 120 kt hurricane at 17.2N, 88.1W at 12Z. Microfilm shows a closed low pressure of at most 1002 mb at 17.2N, 88.2W at 12Z. Ship highlights: 65 kt SW and 980 mb at 17.3N, 85.0W at 00Z (micro). 40 kt SE and 1009 mb at 19.8N, 84.7W at 03Z (micro). 60 kt SE and 996 mb at 17.8N, 85.4W at 06Z (COADS). 30 kt E and 1003 mb at 18.1N, 85.5W at 12Z (COADS). 35 kt NW and 1005 mb at 13.4N, 94.0W at 18Z (micro). Land highlights: 25 kt SE and 1005 mb at Swan Islands, Honduras at 00Z (micro). 25 kt NW and 999 mb at Belize City, Belize at 06Z (micro). 966 mb at Belize City, Belize at 11Z (WALLET). 924 mb at 11Z (ship located between Belize City and Stann Creek) (WALLET). 40 kt W and 1001 mb at San Pedro Sula, Honduras at 12Z (micro). 10 kt S and 999 mb at Santa Barbara, Honduras at 18Z (micro). Aircraft highlights: Radar center fix at 18.1N, 86.1W at 00Z (ATSR). Penetration center fix measured a central pressure of 930 mb and estimated an eye diameter of 22 nm at 17.5N, 87.3W at 07Z (ATSR). Penetration center fix measured a central pressure of 933 mb at 17.5N, 87.3W at 08Z (ATSR). Radar center fix estimated an eye diameter of 25 nm at 17.2N, 88.1W at 1130Z (ATSR).

MWR: “Hattie moved inland on the British Honduras coast about sunrise on October 31. The center of the radar eye, which measured approximately 25 miles in diameter, passed 20 miles southeast of Belize. The lowest pressure on the barograph at Stanley Field, Belize, was 972 mb indicating a gradient of some 45 to 50 mb in the 20 miles between that point and the center of the eye. A trained observer estimated winds from 150 to 160 mph at Belize with unofficial estimates to 200 mph or more. A copy of the Dines anemometer record is shown in figure 14. The pen remained at the top of the graph for a while. Storm tides of 10 to 11 feet along the Belize waterfront were general and waves deposited mud on the third floor of some buildings. Other locations near Belize reported storm tides up to 14 feet. Seventy-five percent of Belize, the capital of British Honduras, was either destroyed or severely damaged. Some communities such as Stann Creek were almost completely erased. Damage was so great in Belize that plans are under consideration for its relocation farther inland. Latest fatality figures show 262 dead in British Honduras. The ready-to-harvest citrus crop scheduled for export and worth $2,000,000 was destroyed and unknown million were lost in timber, cocoa, and bananas. Damage is estimated near $60 million. Guatemala reported 11 deaths and Honduras 1, most of these apparently occurring in flash flooding. The Governor of British Honduras stated that hurricane Hattie was much worse than the 1931 hurricane in which 2,000 persons died and the fact that the death toll was not higher at this time was due to the excellent warnings. A large percentage of the people in Belize either evacuated or moved to supposedly safer buildings. In Stan Creek, 3,500 of the 4,500 residents were evacuated. Hattie continued west-southwestward and southwestward through British Honduras and Guatemala, dissipating in the mountains of Guatemala. Tropical Storm Simone was already in existence in the Pacific Ocean as Hattie passed near Belize, and the remnants of Hattie developed into neither Simone nor Inga. There are a number of interesting points connected with hurricane Hattie which are worthy of mention. This is the fourth hurricane of record to affect San Andres Island, and its most unusual to have one form south of the island. Residents could recall only one other hurricane with passed over the island since the turn of the century; this one occurred in October 1908. This development of hurricane Hattie appears to have been triggered by events near the outflow level. Riehl pointed out the importance of this level suggesting that superposition of high-level divergence over a low-level disturbance could lead to intensification. More recently, Alaka proposed that anomalous winds in the upper troposphere may be the dynamic mechanism for triggering hurricane formation.” ATSR: “The storm entered the coast of British Honduras about 20 miles south of Belize at approximately 311300Z and wreaked such destruction that this capitol city has since been relocated further inland. Hattie then dissipated in the mountains of Guatemala. The final warning was issued at 311600Z.”

November 1:

HWM analyzes a tropical storm of at most 995 mb at 14.0N, 91.5W and a spot low pressure at 13.5N, 93.5W at 12Z. HURDAT lists a 45 kt tropical storm at 15.7N, 90.1W at 06Z (last position). Microfilm shows a closed low pressure of at most 1002 mb at 14.0N, 93.5W at 12Z. Ship highlights: 25 kt NNW and 1004 mb at 12.7N, 92.3W at 00Z (micro). 35 kt W and 1000 mb at 13.5N, 93.1W at 12Z (COADS). 40 kt W and 1002 mb at 14.0N, 94.4W at 18Z (COADS).

November 2:

HWM analyzes a closed low pressure of at most 1000 mb at 16.5N, 97.8W at 12Z. HURDAT does not list an organized system in the Atlantic Ocean on this date. Microfilm shows a closed low pressure of at most 1002 mb at 16.0N, 97.7W at 12Z. Ship highlights: 20 kt W and 1001 mb at 15.8N, 98.9W at 00Z (micro). 30 kt SW and 1005 mb at 14.8N, 96.0W at 12Z (micro).

November 3:

HWM analyzes a closed low pressure of at most 1000 mb at 19.2N, 94.2W with a weakening cold front to the north at 12Z. HURDAT does not list an organized system in the Atlantic Ocean on this date. Microfilm shows a closed low pressure of at most 1002 mb at 21.5N, 95.3W with a frontal boundary to the north at 12Z. Ship highlights: No gales or low pressures.

Synoptic observations over the southern Caribbean Sea indicate that a tropical disturbance developed north of Panama around October 25th, likely associated with the Eastern Pacific monsoon trough extending into the Caribbean. Ship data shows that the system steadily became better organized and the first position is analyzed as a 35 kt tropical storm at 00Z on October 27th, twelve hours earlier than originally shown in HURDAT. Genesis may have occurred late on October 26th but observations over the extreme southern Caribbean Sea, especially over Panama, are sparse. Minor track alterations were introduced during the lifetime of this tropical cyclone. Intensification to a tropical storm is analyzed 12 hours earlier than originally shown in HURDAT. Hattie slowly moved northward in the general direction of the Colombian island of San Andres. Late on the 27th, San Andres began to report gale-force winds and winds reached hurricane-force very late on the 27th and early on October 28th. Thus, intensification to a hurricane is analyzed at 00Z on the 28th, same as originally shown in HURDAT. A central pressure of 991 mb was present in HURDAT at 00Z on the 28th and has been removed since MWR does not indicate that this was a central pressure (MWR says

minimum pressure) and at 00Z on the 28th San Andres was reporting 50 kt ESE and 993 mb, indicating a central pressure lower than 991 mb. At 07Z on the 28th, the first reconnaissance aircraft reported a central pressure of 998 mb and an eye diameter of 20 nm. Based on the observations from San Andres and also because this was a nighttime fix, it was determined that the dropsonde did not fall at the center of Hattie. Thus, 998 mb is not a central pressure and was not used to determine the intensity of Hattie, nor added to HURDAT. Hurricane Hattie steadily intensified on the 28th as it moved away from San Andres. The next reconnaissance aircraft measured a central pressure of 969 mb, estimated surface winds of 110 kt and an eye diameter of 20 nm at 1247Z on the 28th. A central pressure of 969 mb suggests maximum sustained winds of 92 kt south of 25N intensifying from the south of 25N Brown et al. pressure-wind relationship. An eye diameter of 20 nm suggests an RMW of 15 nm and the climatological value is 12 nm. An intensity of 90 kt is selected at 12Z on the 28th, down from 105 kt originally shown in HURDAT, a minor intensity change. A central pressure of 991 mb was present in HURDAT at 12Z on the 28th and has been replaced with 969 mb. Another reconnaissance aircraft measured a central pressure of 956 mb and estimated surface winds of 100 kt at 20Z on the 28th. An eye diameter of 10 nm was estimated at 1935Z. A central pressure of 956 mb suggests maximum sustained winds of 107 kt south of 25N intensifying from the south of 25N pressure-wind relationship. An eye diameter of 10 nm suggests an RMW of about 8 nm and the climatological value is 12 nm. Due to an RMW close or slightly smaller than climatology and a forward speed of 8 kt, an intensity of 105 kt is selected at 18Z on the 28th, down from 110 kt originally shown in HURDAT, a minor intensity change. A central pressure of 969 mb was present in HURDAT at 18Z on the 28th and has been replaced with 956 mb. Intensification to a major hurricane is analyzed at 18Z on the 28th, 36 hours later than originally shown in HURDAT. Hattie likely produced gale-force winds over northeastern Nicaragua and Honduras late on the 28th and early the next day.

Early on October 29th, the tropical cyclone moved northward fluctuating in intensity. Late on the 29th, Hattie turned to the northwest. The first reconnaissance aircraft on the 29th arrived at 0030Z measuring a central pressure of 952 mb. A central pressure of 952 mb suggests maximum sustained winds of 111 kt south of 25N intensifying from the pressure-wind relationship. An intensity of 110 kt is selected at 00Z on the 29th, same as originally shown in HURDAT. A central pressure of 952 mb was present in HURDAT at 00Z on the 29th and has been retained. It is apparent that Hattie began a concentric eyewall replacement cycle early on the 29th based on reconnaissance aircraft data and radar images available in the 1961 Navy book (pg. 229 and 233). At 07Z on the 29th, a penetration center fix measured a central pressure of 966 mb and an eye diameter (of the inner eye) of 12 nm. A central pressure of 966 mb suggests maximum sustained winds of 92 kt south of 25N weakening from the pressure-wind relationship. An eye diameter of

12 nm suggests an RMW of about 9 nm and the climatological value is 13 nm. An intensity of 95 kt is selected at 06Z on the 29th, down from 110 kt originally in HURDAT, a minor intensity change. A central pressure of 966 mb has been added to HURDAT at 06Z on the 29th. The next reconnaissance aircraft measured a central pressure of 963 mb and estimated surface winds of 110 kt and an eye diameter of 40 nm at 13Z on the 29th. A central pressure of 963 mb suggests maximum sustained winds of 98 kt south of 25N from the pressure-wind relationship. An eye diameter of 40 nm suggests an RMW of about 30 nm and the climatological value is 13 nm. Due to an RMW larger than the climatological value and forward speed of 8 kt, an intensity of 95 kt is selected at 12Z on the 29th, down from 110 kt originally shown in HURDAT, a minor intensity change. A central pressure of 963 mb was present in HURDAT at 12Z and has been retained. Another reconnaissance aircraft measured a central pressure of 956 mb and estimated surface winds of 110 kt and an eye diameter of 40 nm at 1915Z on the 29th. A central pressure of 956 mb suggests maximum sustained winds of 105 kt south of 25N intensifying from the pressure-wind relationship. An eye diameter of 40 nm suggests an RMW of about 30 nm and the climatological value is 12 nm. Due to an RMW larger than the climatological value and forward speed of 6 kt, an intensity of 100 kt is selected at 18Z on the 29th, down from 100 kt originally shown in HURDAT, a minor intensity change. A central pressure of 956 mb was added to HURDAT at 12Z on the 29th.

On October 30th, Hattie experienced a period of rapid intensification as the system turned to the west and west-southwest. Early on the 30th, the hurricane passed between Swan Island and the Cayman Islands, producing gale-force winds. The first reconnaissance aircraft on the 30th measured a central pressure of 958 mb and an eye diameter of 30 nm at 01Z. A central pressure of 958 mb suggests maximum sustained winds of 103 kt south of 25N from the pressure-wind relationship. An eye diameter of 30 nm suggests an RMW of about 23 nm and the climatological value is 12 nm. Due to the large circulation and forward speed of about 10 kt, an intensity of 100 kt is selected at 00Z on the 30th, down from 115 kt originally shown in HURDAT, a minor intensity change. A central pressure of 956 mb was present in HURDAT at 00Z on the 30th and has been replaced with 958 mb. The next reconnaissance aircraft measured a central pressure of 942 mb and estimated an eye diameter of 28 nm at 07Z on the 30th. A central pressure of 942 mb suggests maximum sustained winds of 121 kt south of 25N intensifying from the pressure-wind relationship. An eye diameter of 28 nm suggests an RMW of about 21 nm and the climatological value is 11 nm. Based on an RMW larger than climatology and forward speed of about 11 kt, an intensity of 115 kt is selected at 06Z on the 30th, down from 120 kt originally shown in HURDAT, a minor intensity change. A central pressure of 942 mb was present in HURDAT at 06Z on the 30th and has been retained. At 10Z on the 30th, a penetration center fix measured a central pressure of 937 mb, estimated surface winds of 115 kt and an eye diameter of 25 nm. A central pressure of 937 mb

suggests maximum sustained winds of 126 kt south of 25N intensifying from the pressure-wind relationship. An eye diameter of 25 nm suggests an RMW of about 19 nm and the climatological value is 11 nm. Based on an RMW larger than climatology and forward speed of about 6 kt, an intensity of 120 kt is selected at 12Z on the 30th, down from 130 kt originally shown in HURDAT, a minor intensity change. A central pressure of 937 mb was present in HURDAT at 12Z on the 30th and has been retained. Another penetration center fix measured a central pressure of 923 mb and an eye diameter of 20 nm at 17Z on the 30th. A central pressure of 923 mb suggests maximum sustained winds of 139 kt south of 25N intensifying from the pressure-wind relationship. An eye diameter of 20 nm suggests an RMW of about 15 nm and the climatological value is 10 nm. Based on an RMW larger than climatology and forward speed of about 10 kt, an intensity of 135 kt is selected at 18Z on the 30th, down from 140 kt originally shown in HURDAT, a minor intensity change. 135 kt is also the peak intensity of this tropical cyclone, down from 140 kt originally in HURDAT, a minor intensity change. A central pressure of 923 mb was added to HURDAT at 18Z on the 30th. Late on the 30th, ships near the tropical cyclone reported hurricane-force winds.

On October 31st, powerful hurricane Hattie moved southwestward toward central Belize. At 22Z on the 30th, a reconnaissance aircraft measured a central pressure of 920 mb and estimated an eye diameter of 22 nm. A central pressure of 920 mb suggests maximum sustained winds of 141 kt south of 25N intensifying from the pressure-wind relationship. An eye diameter of 22 nm suggests an RMW of about 17 nm and the climatological value is 10 nm. Based on an RMW larger than climatology and forward speed of 9 kt, an intensity of 135 kt is selected at 00Z on the 31th, down from 140 kt originally shown in HURDAT, a minor intensity change. A central pressure of 920 mb was present in HURDAT at 00Z on the 31st and has been retained. The next penetration center fix measured a central pressure of 930 mb and estimated an eye diameter of 22 nm at 07Z on the 31st. A central pressure of 930 mb suggests maximum sustained winds of 124 kt south of 25N weakening from the pressure-wind relationship. An eye diameter of 22 nm suggests an RMW of about 17 nm and the climatological value is 11 nm. Due to the large RMW and forward speed of 10 kt, an intensity of 125 kt is selected at 06Z on the 31th, down from 140 kt originally shown in HURDAT, a minor intensity change. A central pressure of 930 mb was added to HURDAT at 06Z on the 31st. Thus, it is analyzed that Hattie did not reach category 5 in the Saffir-Simpson scale as originally shown in HURDAT. It is interesting to note that the highest winds estimated by the reconnaissance aircrafts were 130 kt and the advisories of Hattie also show a peak intensity of 130 kt. As the hurricane approached the coastline of Belize, a British ship named “M.V. Tactician” was caught between Belize City and Stann Creek. The captain of the ship wrote a detailed account about the experience and the letter reached the US Weather Bureau on June 1st, 1962, about three months after the 1961 Hurricane Season summary had been published

in the Monthly Weather Review. A comparison between the reported central pressures by the ship and Belize City indicates that the barometer was well calibrated. According to the captain, a central pressure of 924 mb was recorded at 11Z on the 31st. The captain also recounts a lull that lasted about 45 minutes, providing enough time to reposition the ship ahead of the second half of the hurricane. Hence, a central pressure of 924 mb was added to HURDAT at 12Z. In this time slot HURDAT originally had 930 mb. A central pressure of 924 mb suggests maximum sustained winds of 135 kt south of 25N and 138 kt intensifying from the pressure-wind relationship. At 1135Z, a reconnaissance aircraft made a radar center fix and estimated an eye diameter of 25 nm. An eye diameter of 25 nm suggests an RMW of about 19 nm and the climatological value is 9. Based on an RMW larger than the climatological value and a forward speed of about 11 kt, an intensity of 135 kt is selected at 12Z on the 31st, up from 120 kt originally in HURDAT, a minor intensity change. Landfall in analyzed at 13Z on the 31st near 17.1N and 88.3W, or about 24 nm south of Belize City, Belize. The impact of the northern eyewall of Hattie on Belize City was devastating, causing the rebuilding of the city to take place farther inland. After landfall, the large hurricane continued inland on a southwest course and rapidly weakened. The Kaplan and DeMaria model was run for 18Z on the 31st, and 00Z, and 06Z on November 1st yielding 87 kt, 60 kt and 43 kt, respectively. Data over western Central America and southeastern Mexico was sparse and no winds of tropical storm intensity were reported on land during those three time periods. An intensity of 75 kt is selected for 18Z on the 31st, 45 kt at 00Z and 30 kt at 06Z on the 1st (up from 60 kt at 18Z on the 31st, down from 55 kt and 45 kt at 00Z and 06Z, respectively, on the 1st, originally in HURDAT), minor intensity changes. The analyzed intensity is below that suggested by Kaplan-DeMaria due to the mountainous terrain in Central America. Weakening to a tropical storm is analyzed at 00Z on the 1st, six hours later than originally shown in HURDAT. The last position of Hattie is analyzed at 06Z on the 1st, same as originally shown in HURDAT. Over the Eastern Pacific, synoptic data indicates that the circulation of Hattie remained the dominant feature as the hurricane made landfall in Belize and moved southwestward toward that ocean basin. There is no evidence to support the statement in the Monthly Weather Review that Tropical Storm Simone was already in existence as Hattie made landfall in Belize. Furthermore, the first advisory issued on Simone clearly indicates the opinion at the time was that this tropical cyclone was the former Atlantic hurricane. Nonetheless, data over the Eastern Pacific shows that the location in which Simone was supposedly located was in a large area of low environmental pressures with strong westerly flow associated with the monsoon trough. Based on the ship and coastal observations, it appears that Simone never had a closed low-level circulation and therefore, was not been a tropical cyclone. Thus, in addition to alterations for Hattie, it is recommended that Simone be removed from the Northeast Pacific HURDAT.

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42305 11/01/1961 M= 9 10 SNBR= 917 JENNY       XING=0 SSS=0
42305 11/02/1961 M=10 10 SNBR= 917 JENNY       XING=0 SSS=0
         **        **

42310 11/01*  0   0   0    0*  0   0   0    0*170 620  30    0*193 610  30 1006*
42310 11/01*  0   0   0    0*  0   0   0    0*  0   0   0    0*  0   0   0    0*
                                              *   *   *        *   *   *    *

42315 11/02*210 600  30    0*223 590  30    0*238 580  30    0*248 572  30    0*
42315 11/02*  0   0   0    0*235 580  30    0*245 573  30    0*254 567  30    0*
              *   *   *      *** ***          *** ***          *** ***

42320 11/03*260 568  30    0*267 556  30    0*269 545  30    0*270 529  30    0*
42320 11/03*262 563  30    0*267 556  30    0*269 545  30    0*270 529  30    0*
            *** ***

42325 11/04*270 513  30    0*270 489  30    0*270 470  30 1002*260 460  30    0*
42325 11/04*270 510  30    0*270 489  30    0*267 470  30 1002*262 460  30 1001*
            *** ***                          ***              ***          ****

42330 11/05*257 450  30    0*259 438  30    0*265 432  30    0*276 435  30  991*
42330 11/05*259 450  30    0*259 440  30    0*265 435  35    0*274 440  40    0*
            ***              ***              ***  **       *** ***  **    *

42335 11/06*288 470  45  976*284 491  55    0*280 510  65    0*283 523  70  974*
42335 11/06*280 465  45    0*283 491  55    0*284 510  65    0*285 522  70  974*
            *** ***          * ***            ***              *** ***

42340 11/07*285 524  70    0*287 525  65    0*288 528  60  988*297 519  60    0*
42340 11/07*287 528  70    0*290 532  65    0*293 529  60    0*297 523  60  985*
            *** ***            *** ***          *** ***        *     ***      ***

42345 11/08*304 517  55  985*311 509  50    0*318 504  50    0E324 493  45    0*
42345 11/08*304 517  55    0*311 510  50    0*318 502  50    0*324 492  45    0*
                           *     ***              ***          *    ***

42350 11/09E327 486  40  987E332 475  40    0E338 465  35    0E345 458  35    0*
42350 11/09*330 484  40    0*336 475  40    0*342 465  35    0*352 457  40    0*
            ***  ***         *****            ****             **** ***  **

(November 10th and 11th are new to HURDAT)
42351 11/10*365 450  45    0*382 443  50    0*400 435  55    0*430 430  55    0*
42353 11/11E465 415  55    0E490 390  45    0*  0   0   0    0*  0   0   0    0*
42355 HR
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Minor changes to the track and intensity shown in McAdie et al. (2009). Major alterations are also introduced to show that the tropical cyclone did not become extratropical until two days after that originally shown in HURDAT and to add 36 hours to its lifetime. Evidence for these alterations comes from the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Monthly Weather Review, Navy reconnaissance book, Mariners Weather Log, and NHC Storm Wallets.

October 31:

HWM does not analyze an organized system at 12Z. HURDAT does not list an organized system on this date. Microfilm shows a tropical wave or trough over the eastern Caribbean at 12Z. Ship highlights: No gales or low pressures. Land highlights: 10 kt S and 1005 mb at Dominique at 18Z (micro).

November 1:

HWM does not analyze an organized system at 12Z. HURDAT lists a 30 kt tropical depression at 17.0N, 62.0W at 12Z. Microfilm shows a tropical wave or trough over the eastern Caribbean at 12Z. Ship highlights: 15 kt S and 1005 mb at 16.4N, 62.0W at 18Z (COADS).

MWR: “Jenny, the tenth and last cyclone for which advisories were issued in the 1961 hurricane season, was only quasi-tropical, resembling the Kona Low of the Pacific or what has been called the “subtropical” storm in the Atlantic. These develop in connection with cold-core cyclones and are more likely to occur outside the usual hurricane season. Some other examples were hurricane Greta of 1956 and the unusual May hurricane in 1951. The disturbance which eventually became Jenny was first noted in the vicinity of the Windward Islands on November 1, at which time it was only a broad area of unsettled weather with lowest pressure around 1005 mb. The formation of the disturbance coincided with the development of a cut-off Low in the middle and upper troposphere just to the north of Puerto Rico. The depression moved northeastward during the next two days then turned abruptly eastward in advance of a deepening upper-level trough in the westerlies.” ATSR: “The disturbance which became the tenth and last tropical storm of the season originated near Antigua in the Windward Islands on 1 November. Navy reconnaissance aircraft investigating the area on the 1st reported what appeared to be “the joining of the Intertropical Convergence Zone and a polar trough east of Puerto Rico.” The low began to move rapidly to the northeast while filling slightly.”

November 2:

HWM analyzes a closed low pressure of at most 1010 mb at 23.0N, 59.0W at 12Z. HURDAT lists a 30 kt tropical depression at 23.8N, 58.0W at 12Z. Microfilm shows a closed low pressure of at most 1008 mb at 22.5N, 57.5W at 12Z. Ship highlights: No gales or low pressures.

November 3:

HWM analyzes a closed low pressure of at most 1005 mb at 26.0N, 54.5W with a weakening cold front to the north at 12Z. HURDAT lists a 30 kt tropical depression at

26.9N, 54.5W at 12Z. Microfilm shows a closed low pressure of at most 1014 mb at 29.0N, 52.5W at 12Z. Ship highlights: 35 kt NE and 1018 mb at 31.0N, 53.8W at 23Z (COADS).

ATSR: “It continued on this course until the third when reports from Ocean Station Echo indicated considerable deepening of an upper level trough to the northwest of the surface disturbance. The low on the surface appeared to react by turning eastward abruptly.”

November 4:

HWM analyzes a closed low pressure of at most 1005 mb at 26.5N, 48.0W with a warm front to the north at 12Z. HURDAT lists a 30 kt tropical depression at 27.0N, 47.0W at 12Z. Microfilm shows a closed low pressure of at most 1008 mb at 26.0N, 45.0W with a frontal boundary to the north at 12Z. Ship highlights: 35 kt NE and 1007 mb at 31.7N, 52.2W at 06Z (COADS). 25 kt NW and 1003 mb at 24.7N, 46.3W at 18Z (micro).

November 5:

HWM analyzes a closed low pressure of at most 1000 mb at 26.0N, 44.0W with warm front to the north at 12Z. HURDAT lists a 30 kt tropical depression at 26.5N, 43.2W at 12Z. Microfilm shows a closed low pressure of at most 996 mb at 25.7N, 43.0W with a frontal boundary to the north at 12Z. Ship highlights: 40 kt (50 kt in micro) NE and 1010 mb at 30.3N, 47.2W at 00Z (COADS). 15 kt NE and 1002 mb at 25.8N, 47.7W at 06Z (micro). 20 kt NE and 999 mb at 27.5N, 43.7W at 12Z (COADS). 35 kt SE and 991 mb at 27.9N, 43.1W at 18Z (COADS).

MWR: “On November 5, the 500 mb charts showed that the trough had sheared, cutting off an intense cold Low some 300 miles northwest of the position of the surface disturbance. ATSR: “On the 5th the upper level trough sheared, cutting off a cold upper low approximately 300 miles to the north of the surface system. This cold low moved southwestward as a warm high pressure cell moved eastward across its northern boundary. The surface system came under the upper low and radically altered its course to the west while deepening rapidly to hurricane intensity.”

November 6:

HWM analyzes a hurricane of at most 985 mb at 28.0N, 51.1W with warm front to the north at 12Z. HURDAT lists a 65 kt hurricane at 28.0N, 51.0W at 12Z. Microfilm shows a closed low pressure of at most 987 mb at 28.5N, 51.5W at 12Z. Ship highlights: 40 kt SE and 1008 mb at 32.5N, 44.0W at 00Z (COADS). 55 kt SE and 1007 mb at 32.1N, 45.3W at 06Z (COADS). 60 kt NW and 992 mb at 28.1N, 52.6W at 12Z (COADS). 65 kt E and 989 mb at 29.7N, 51.9W at 18Z (micro). 70 kt SE and 986 mb at 28.8N, 51.7W at

21Z (MWL). Aircraft highlights: Penetration center fix measured a central pressure of 974 mb and estimated surface winds of 70 kt at 28.4N, 52.4W at 1910Z (WALLET).

MWR: “This Low moved southwestward during the next 24 hours and the surface Low, apparently steered by the upper system, reversed its course and moved rapidly westward. As the surface Low began to move under the upper cyclone, it deepened rapidly and the central pressure on November 6 was 974 mb. Maximum winds were barely of hurricane force near the center but gales extended outward as much as 600 miles to the north and 300 miles to the south. This was evidently due to reflection in the surface pressure gradients of the upper Low and not to a true tropical development. However, the latitude of the storm and the concentration of winds of hurricane force about the center made it advisable to treat the storm as tropical for purposes of marine advisories. It has been observed in “subtropical” storms that a warm core may exist within the circulation of the larger cold Low. The possibility that this was true in the case of Jenny cannot be ruled out but it could have been for only a matter of hours and was not observed by the reconnaissance flight on November 6, which reported “no eye, no temperature rise, no spiral bands.” It was never a threat to land and the only known damage was to the ship Venore, an 8000-ton ore carrier, which required assistance after becoming disabled in the storm on the afternoon of November 6.” ATSR: “Warning number one went out on hurricane Jenny at 062200Z.”

November 7:

HWM analyzes a hurricane of at most 985 mb at 28.4N, 52.3W with a weakening stationary front to the north at 12Z. HURDAT lists a 40 kt tropical storm at 28.8N, 52.8W at 12Z. Microfilm shows a closed low pressure of at most 990 mb at 29.2N, 52.5W at 12Z. Ship highlights: 50 kt ENE and 983 mb at 29.3N, 52.7W at 00Z (micro). 30 kt NNW and 985 mb at 28.7N, 53.4W at 03Z (micro). 60 kt NNW and 990 mb at 29.0N, 53.7W at 06Z (COADS). 45 kt NNW and 990 mb at 28.8N, 53.8W at 09Z (micro). 50 kt N and 994 mb at 28.0N, 54.5W at 12Z (COADS). 40 kt SSE and 994 mb at 30.3N, 50.8W at 18Z (micro). Aircraft highlights: Penetration center fix at 29.0N, 52.6W at 1155Z (ATSR). Penetration center fix measured a central pressure of 988 mb at 28.8N, 52.5W at 1554Z (WALLET). Penetration center fix estimated surface winds of 55 kt at 29.5N, 52.0W at 1610Z (WALLET). Penetration center fix measured a central pressure of 985 mb and estimated surface winds of 60 kt at 29.8N, 51.8W at 19Z (WALLET).

MWR: “Jenny became essentially stationary on November 7, then began to move to the northeast and weaken, becoming clearly extratropical during the next two days.” ATSR: “By the 7th, the upper level pressure rises had moved northeast of the storm, enabling it to turn once again to a northeastward course.”

November 8:

HWM analyzes a tropical storm of at most 995 mb at 31.4N, 50.4W with a frontal boundary close to the north at 12Z. HURDAT lists a 50 kt tropical storm at 31.8N, 50.4W at 12Z. Microfilm shows a closed low pressure of at most 993 mb at 31.7N, 49.0W at 12Z. Ship highlights: 40 kt SW and 1004 mb at 26.2N, 51.2W at 00Z (COADS). 35 kt SSE and 1007 mb at 32.3N, 45.1W at 06Z (COADS). 40 kt S and 994 mb at 29.8N, 48.1W at 09Z (micro). 40 kt WSW and 999 mb at 30.0N, 50.2W at 12Z (COADS). 35 kt S and 998 mb at 31.3N, 46.6W at 18Z (COADS).

ATSR: “The final warning was issued at 081600Z.”

November 9:

HWM analyzes a closed low pressure of at most 995 mb at 33.2N, 47.0W with an extratropical cyclone to the west at 12Z. HURDAT lists a 35 kt extratropical cyclone at 33.8N, 46.5W at 12Z. Microfilm shows a closed low pressure of at most 993 mb at 34.0N, 46.0W at 12Z. Ship highlights: 40 kt SSW and 997 mb at 30.8N, 47.3W at 00Z (COADS). 35 kt WSW and 999 mb at 31.0N, 47.3W at 06Z (COADS). 30 kt NE and 993 mb at 34.5N, 46.7W at 12Z (micro). 30 kt ESE and 1001 mb at 36.9N, 44.5W at 18Z (micro).

ATSR: “Jenny was clearly extratropical by the 9th.”

November 10:

HWM analyzes a closed low pressure of at most 990 mb at 40.0N, 43.0W with a cold front to the west at 12Z. HURDAT does not list an organized system on this date. Microfilm shows a closed low pressure of at most 996 mb at 39.2N, 43.0W at 12Z. Ship highlights: 35 kt E and 997 mb at 37.5N, 45.0W at 00Z (COADS). 35 kt S and 999 mb at 38.3N, 43.6W at 06Z (COADS). 35 kt SE and 988 mb at 40.2N, 42.7W at 12Z (COADS). 56 kt SSE and 1001 mb at 39.8N, 42.8W at 12Z (MWL). 30 kt WNW and 999 mb at 42.7N, 44.0W at 18Z (COADS).

November 11:

HWM analyzes a spot low pressure at 50.2N, 35.0W with a frontal boundary close to the west at 12Z. HURDAT does not list an organized system on this date. Microfilm is not available on this date. Ship highlights: 45 kt SW and 1009 mb at 47.4N, 34.1W at 06Z (COADS).

ATSR: “From her inception, Jenny appeared to be only quasitropical in nature. Although scarce data in the area of the storm precluded accurate temperature and pressure analyses,

all available reports from Ocean Station Echo and reconnaissance aircraft indicated that the upper level structure around the storm was extratropical. The deepening of Jenny, which coincided with its movement underneath an upper level low, indicated that jenny had extratropical characteristics. After the central pressure dropped to 974 mb, maximum winds did not exceed an average of 65 knots, although some gusts to as 600 miles, and, as depicted on surface charts at the time that Jenny was most intense, she resembled a wintertime "Nor'easter." It is conjectured that a small warm core could have existed within the circulation of the larger low."

A tropical wave entered the eastern Caribbean Sea late in October generating an area of disturbed weather. In an environment of weak steering currents, the disturbance slowly moved northeastward and became better organized. On November 1st, the sharp trough stretched from the southeast Caribbean Sea, across the Leeward Islands, and into the Atlantic Ocean. HURDAT originally indicated that genesis occurred at 12Z on November 1st but synoptic observations show that the disturbance did not have a closed low-level circulation at this time. Genesis is analyzed at 06Z on November 2nd as a 30 kt tropical depression, 18 hours later than originally shown in HURDAT. Very minor track alterations were introduced during the lifetime of this tropical cyclone. The broad tropical depression moved northeastward during the 2nd and turned to the east on November 3rd. During this time, the synoptic-scale pressure gradient increased to the northwest of the cyclone and gale-force winds began to be reported about 300 nm from the center. During most of the lifetime of the tropical cyclone (with the exception of the 6th and 7th), the system exhibited characteristics of a subtropical cyclone. The Monthly Weather Review mentions the similarities of this cyclone with previous cyclones that have exhibited subtropical characteristics like Hurricane Greta in 1956. Furthermore, they mention the term "subtropical" to describe this tropical cyclone, a milestone. Previously the term used to describe these cyclones was quasi-tropical.

On November 4th, the tropical depression moved east-southeast maintaining a large circulation with gale-force winds about 300 nm and further from the center, but these were not judged to have been directly associated with this system. A central pressure of 1002 mb is present in HURDAT at 12Z on November 4th and although there is no evidence to suggest that it was an actual measurement, it appears reasonable and has been retained. A central pressure of 1002 mb suggests maximum sustained winds of 40 kt north of 25N and 43 kt south of 25N from the Brown et al. pressure-wind relationship. While the tropical cyclone had a forward speed of 19 kt, the analyzed intensity is 30 kt due to its large circulation and ship observations near the center showing winds below gale-force, same as originally shown in HURDAT. A ship reported 20 kt NE and 1003 mb at 18Z on the 4th, suggesting a central pressure of 1001 mb, which has been added to HURDAT. On November 5th, synoptic observations indicate that the tropical cyclone

became better organized and the gale-force winds were being reported closer to the center. Intensification to a tropical storm is analyzed at 12Z on the 5th, twelve hours earlier than originally shown in HURDAT. A central pressure of 991 mb was present in HURDAT at 18Z on the 5th but it has been removed since it was likely originally added due to a ship that reported 35 kt SE and 991 mb. A peripheral pressure of 991 mb suggests maximum sustained winds greater than 58 kt from the north of 25N pressure-wind relationship. Due to the large size of the circulation, an intensity of 40 kt is analyzed at 18Z on the 5th, up from 30 kt originally in HURDAT, a minor intensity change. A central pressure of 976 mb was present in HURDAT at 00Z on November 6th and it has been removed since there is no evidence that it was an actual observation, nor does it appear reasonable. A reconnaissance aircraft reached Jenny at 1910Z on the 6th measuring a central pressure of 974 mb and estimated surface winds of 70 kt. A central pressure of 974 mb suggests maximum sustained winds of 80 kt and 83 kt intensifying from the north of 25N pressure-wind relationship. Due to the very large size of the circulation and forward speed of about 12 kt, an intensity of 70 kt is analyzed at 18Z on the 6th, same as originally shown in HURDAT. 70 kt is also the peak intensity of this hurricane, same as originally shown in HURDAT. Intensification to a hurricane is analyzed at 12Z on the 6th, same as originally shown in HURDAT. A central pressure of 974 mb was present in HURDAT at 18Z on the 6th and has been retained. Late on the 6th, ships observations near the center indicated that Jenny had developed a strong, tighter core. A couple of ships reported hurricane-force winds, up to 70 kt.

On November 7th, Jenny turned to the northeast ahead of a frontal boundary. The period of intensification observed on the 5th and 6th came to a stop early on the 7th and Jenny began to weaken. The next reconnaissance aircraft measured a central pressure of 988 mb at 1554Z and 985 mb at 19Z. A central pressure of 988 mb was present in HURDAT at 12Z on the 7th and has been removed since the observation was closer to the 18Z time slot. A central pressure of 985 mb was present at 00Z on November 8th and has been moved to 18Z on the 7th. A central pressure of 985 mb suggests maximum sustained winds of 66 kt from the north of 25N pressure-wind relationship. Due to the very large size of the circulation, forward speed of about 10 kt and visual estimate from the aircraft of 60 kt, an intensity of 60 kt is analyzed at 18Z on the 7th, same as originally shown in HURDAT. Weakening below hurricane intensity is analyzed at 12Z on the 7th, same as originally shown in HURDAT. Jenny increased in forward speed to the northeast on the 8th and continued to lose strength. HURDAT shows transition to an extratropical cyclone at 18Z on the 8th but synoptic observations indicate that Jenny remained a tropical storm in the warm sector of an approaching frontal boundary. The circulation remained symmetric and the data shows no signs of frontal boundaries associated with Jenny on that date. As the frontal boundary got closer to Jenny, the storm continued to gain in forward speed and began to re-intensify over the North Atlantic. A ship reported 55 kt SE

at 12Z on the 10th near the center of Jenny. Transition to an extratropical cyclone is analyzed at 00Z on the 11th, 54 hours later than originally shown in HURDAT. The last position in HURDAT was at 18Z on the 9th but surface observations show that Jenny retained a well-defined center into November 10th and early on the 11th. Ship observations at 12Z on the 11th indicate that Jenny had been absorbed by a larger extratropical cyclone, thus the last position is analyzed at 06Z on the 11th, 36 hours later than originally shown in HURDAT. Furthermore, it is probable that Jenny was a post-tropical cyclone on the 9th and 10th but without satellite images it is not possible to use this classification.

Tropical Storm Inga [November 4-8, 1961]

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42360 11/05/1961 M= 4 11 SNBR= 918 INGA        XING=0 SSS=0                    L
42360 11/04/1961 M= 5 11 SNBR= 918 INGA        XING=0 SSS=0
         **          *                                                       *

(November 4th is new in HURDAT)
42363 11/04*197 943  40    0*199 944  50    0*201 945  60    0*204 946  60    0*
           *** ***  **      *** ***  **      *** ***  **      *** ***  **

42365 11/05*208 947  40    0*215 955  45    0*221 959  45  997*225 960  50    0*
42365 11/05*209 949  60  997*214 954  60    0*220 959  60  997*223 960  60    0*
           *** ***  **  *** *** ***  **      ***      **      ***      **

42370 11/06*225 959  50  992*219 958  55    0*212 955  55  998*202 947  60    0*
42370 11/06*223 959  60  992*221 958  60    0*217 957  60    0*202 947  60 1000*
           ***      **      ***      **      *** ***  **    *             ****

42375 11/07*195 940  60 1004*195 939  60    0*195 938  60    0*195 938  60    0*
42375 11/07*197 940  60 1004*196 939  60    0*195 938  60 1004*193 937  60 1006*
           ***              ***                        **** *** ***     ****

42380 11/08*195 938  60    0*195 938  55    0*194 937  50    0*  0   0   0    0*
42380 11/08*193 933  55    0*193 927  55    0*194 919  55    0*  0   0   0    0*
           *** ***  **      *** ***              ***  **

(Special position at 15Z on November 6th)
42370 11/06*209 952  60  998*

42385 TS
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Minor changes to the track and major changes to the intensity shown in McAdie et al. (2009). Another major change is to indicate genesis 24 hours earlier than originally in HURDAT. Evidence for these alterations comes from the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Monthly Weather Review, Navy reconnaissance book, Mariners Weather Log, and NHC Storm Wallets.

November 3:

HWM analyzes a closed low pressure of at most 1000 mb at 19.2N, 94.2W with a weakening cold front to the north at 12Z. HURDAT lists a 25 kt tropical depression at 18.6N, 94.6W at 12Z (last position of Eastern Pacific's Simone). Microfilm shows a closed low pressure of at most 1002 mb at 21.5N, 95.3W with a frontal boundary to the north at 12Z. Ship highlights: No gales or low pressures.

November 4:

HWM analyzes a closed low pressure of at most 1000 mb at 19.9N, 94.8W with a weakening cold front to the north at 12Z. HURDAT does not list an organized system on this date. Microfilm shows a closed low pressure of at most 999 mb at 20.5N, 95.4W with a frontal boundary to the north at 12Z. Ship highlights: 40 kt NW and 1006 mb at 19.5N, 94.5W at 00Z (COADS). 70 kt NNW and 1001 mb at 20.0N, 95.0W at 11Z (micro). 40 kt NW and 1008 mb at 19.9N, 95.5W at 18Z (COADS). Land highlights: 40 kt NW and 1007 mb at Veracruz, Mexico at 00Z (micro). Aircraft highlights: Penetration center fix measured a central pressure of 997 mb, estimated an eye diameter of 15 nm and surface winds of 40 kt at 20.6N, 94.6W at 2215Z (ATSR).

MWR: "Inga, a very late-season tropical cyclone in the Gulf of Mexico, moved and behaved quite erratically. It was of true tropical nature during only part of its life, and the first of record to form in November in the Gulf. Early on November 4, the SS Navigator reported northwesterly winds estimated at 70 to 80 kt with pressure dropping rapidly to 1001 mb at a position about 100 miles northeast of Vera Cruz, Mexico. That afternoon the Navy reconnaissance plane located the center of the storm circulation about 150 miles northeast of Vera Cruz with a central pressure of 998 mb and the highest winds 50 kt." ATSR: "Early on the 4th of November, reports from Vera Cruz, Mexico, and the SS MAASLLOYD indicated an area of gale force winds in the extreme southwestern Gulf of Campeche. This phenomenon was thought at the time to be associated with a cold front which had moved into the area. At 041200Z the SS NAVIGATOR, at a position about 90 miles northeast of Vera Cruz reported northwesterly winds of 70 to 80 knots and a pressure of 1001 mb falling rapidly. A short time later Navy reconnaissance verified the existence of a short circulation about 100 miles north-northeast of Vera Cruz. This flight reported a central pressure of 997 mb and a maximum wind of only 40 knot. Direction of movement appeared to be northwest."

November 5:

HWM analyzes a closed low pressure of at most 1000 mb at 22.0N, 95.7W with a cold front far to the north at 12Z. HURDAT lists a 45 kt tropical storm at 22.1N, 95.9W at 12Z. Microfilm shows a closed low pressure of at most 1002 mb at 22.1N, 95.9W with a

frontal boundary far to the north at 12Z. Ship highlights: 35 kt NW and 1004 mb at 20.3N, 95.6W at 00Z (COADS). 35 kt W and 1005 mb at 20.5N, 95.7W at 06Z (COADS). 30 kt W and 1003 mb at 21.3N, 95.0W at 12Z (COADS). 35 kt E and 1003 mb at 23.6N, 93.6W at 22Z (micro). Aircraft highlights: Penetration center fix measured a central pressure of 997 mb, estimated an eye diameter of 5 nm and surface winds of 50 kt at 22.1N, 95.9W at 1223Z (ATSR). Penetration center fix estimated surface winds of 50 kt at 22.2N, 95.9W at 16Z (ATSR). Penetration center fix measured a central pressure of 992 mb, estimated an eye diameter of 25 nm and surface winds of 50 kt at 22.3N, 95.7W at 2155Z (ATSR).

ATSR: “Warning number one on tropical storm Inga was issued at 050000Z. By noon of the 5th, a cold front had pushed southward off the Texas coast in advance of a strong surface high pressure ridge.”

November 6:

HWM analyzes a closed low pressure of at most 1005 mb at 21.3N, 95.8W with a cold front close to the northwest at 12Z. HURDAT lists a 55 kt tropical storm at 21.2N, 95.5W at 12Z. Microfilm shows a closed low pressure of at most 1002 mb at 21.5N, 95.4W with a frontal boundary to the northwest at 12Z. Ship highlights: 35 kt NNW at 20.9N, 96.7W at (micro). 45 kt NW and 1009 mb at 21.2N, 96.8W at 12Z (COADS). 60 kt WNW and 1003 mb at 19.5N, 94.9W at 18Z (COADS). Aircraft highlights: Penetration center fix measured a central pressure of 998 mb at 22.3N, 95.7W at 00Z (ATSR). Penetration center fix measured a central pressure of 998 mb, estimated an eye diameter of 3 nm and surface winds of 60 kt at 20.6N, 95.0W at 1425Z (ATSR). Penetration center fix measured a central pressure of 1000 mb, estimated an eye diameter of 3 nm and surface winds of 60 kt at 20.0N, 94.5W at 19Z (ATSR). Penetration center fix measured a central pressure of 1004 mb and estimated surface winds of 40 kt at 19.6N, 93.8W at 2326Z (ATSR).

MWR: “The storm moved north-northwest to a position about 100 miles east of Tampico by the night of the 5th. A strong pressure rise and cold front pushed southward out of Texas into the northwestern Gulf and southward along the Mexican coast during the night of the 5th. The strong pressure rises to the northwest of the storm caused it to turn southward, and at 0800 EST on the 6th a Navy plane located the center about 100 miles east-northeast of Tuxpan. The plane flew on southward and located a second eye at 0900 EST about 80 miles southeast of the first eye. The cold air apparently moved into the first eye and it dissipated rapidly, leaving the southern eye as the main center. This center moved slowly southeastward and became stationary in the Gulf of Campeche about 160 miles east-northeast of Vera Cruz on the afternoon of the 6th. It continued essentially stationary in this area and gradually became extratropical as the cold air moved into it.”

ATSR: “The combination of high pressure and cold air seemed to have a marked effect on the storm for it made a sharp turn early on the 6th and, almost retracing its previous track, moved slowly toward the southeast. An oddity occurred later on the 6th. A Navy reconnaissance plane staging out of Corpus Christi located the storm as it was moving on its southeasterly heading; then, about 80 miles further to the southeast, the plane found a separate eye. Subsequent reports led forecasters to believe that the first eye filled and the second eye became the storm circulation.”

November 7:

HWM analyzes a closed low pressure of at most 1005 mb at 19.4N, 93.5W with a cold front close to the northwest at 12Z. HURDAT lists a 60 kt tropical storm at 19.5N, 93.8W at 12Z. Microfilm does not show a closed low pressure but a tropical cyclone symbol at 19.6N, 93.5W with a frontal boundary to the north at 12Z. Ship highlights: 55 kt NW and 1007 mb at 19.0N, 94.6W at 00Z (COADS). 50 kt NW and 1011 mb at 19.4N, 95.3W at 06Z (COADS). 65 kt NW and 1010 mb at 19.4N, 95.4W at 12Z (COADS). 45 kt NW and 1013 mb at 19.6N, 96.1W at 18Z (micro). 45 kt NW and 1008 mb at 19.8N, 94.8W at 21Z (micro). Land highlights: 40 kt NNW at Veracruz, Mexico at 00Z (micro). Aircraft highlights: Penetration center fix measured a central pressure of 1004 mb, estimated an eye diameter of 20 nm and surface winds of 60 kt at 19.5N, 93.8W at 13Z (ATSR). Penetration center fix measured a central pressure of 1003 mb and estimated surface winds of 60 kt at 19.3N, 93.9W at 16Z (ATSR/WALLET). Penetration center fix measured a central pressure of 1006 mb and estimated surface winds of 65 kt at 19.3N, 93.7W at 19Z (ATSR).

ATSR: “Inga became stationary by the 7th in the south central Gulf of Campeche.”

November 8:

HWM analyzes a stationary front over the southern Gulf of Mexico at 12Z. HURDAT lists a 50kt tropical storm at 19.4N, 93.7W at 12Z (last position). Microfilm shows a frontal boundary over the southern Gulf of Mexico at 12Z. Ship highlights: 55 kt NW and 1011 mb at 19.7N, 95.2W at 00Z (COADS). 45 kt NW and 1014 mb at 19.7N, 95.2W at 06Z (COADS). 40 kt NW and 1016 mb at 20.3N, 95.1W at 12Z (COADS). 55 kt NW and 1017 mb at 19.5N, 95.4W at 18Z (micro). Aircraft highlights: Penetration center fix found no closed circulation, lowest pressure was 1012 mb and estimated surface winds of 45 kt at 19.4N, 91.7W at 13Z (ATSR).

MWR: “On the morning of the 8th, the flight into the area encountered no closed circulation but ships a short distance northeast of Vera Cruz continued to report winds of gale force until that night.” ATSR: “Navy reconnaissance on the 8th found no wind circulation and a low pressure of 1012 mb. The final warning on Inga was issued at

081600Z. It is interesting to note that the same flight on the 8th which could find no evidence of a circulation did find an area of 45-knot northwesterly winds near Inga's original birthplace. This couples with the even more interesting fact that no ship ever reported strong winds in the eastern quadrant of the storm, yet a number of ships reported gale to hurricane force northwesterly winds between the circulation center and the Mexican coast, a distance of approximately 180 miles. It is believed that the Sierra Madre Orion mountain range, which juts outward to the coast near Vera Cruz, had some effect on Inga's abnormal windfield, or conceivably, triggered the disturbance initially."

November 9:

HWM analyzes a stationary front over the southern Gulf of Mexico at 12Z. HURDAT does not list an organized system on this date. Microfilm shows a closed low pressure of at most 1012 mb at 19.4N, 92.8W at 12Z. Ship highlights: 40 kt NW and 1016 mb at 19.4N, 95.6W at 00Z (COADS). 40 kt NW and 1016 mb at 19.5N, 95.5W at 06Z (COADS).

November 10:

HWM and microfilm do not show an organized system at 12Z. HURDAT does not list an organized system on this date. Ship highlights: No gales or low pressures.

MWR: "The storm was apparently a shallow system, because its movement was determined mainly by the forces at low levels. On the 6th, the strong pressure rises moving southward along the Mexican coast ahead of the cold front apparently caused the new eye or center to develop in the same area where the original circulation was found. This first circulation developed as a strong pressure rise pushed southward along the Mexican coast ahead of a weak cold front of the night of the 3rd. This area of development is about 100 miles east of the position where a high mountain range in Mexico protrudes eastward to near the coast in the vicinity of Nautla. The New Orleans hurricane center hypothesized that the funneling effect set up by these mountains may be a factor in the development of the circulations in that particular area. The lowest pressure reported by dropsondes from reconnaissance was 997 mb (992 mb from the low-level extrapolation), and the highest wind was 65 kt in the cold air to the west and south of the circulation on the afternoon of the 7th, after the storm had been stationary for about 24 hours in the Gulf of Campeche and was becoming extratropical. During the period when the storm was predominantly tropical in nature, the highest winds were about 50 kt."

Tropical Storm Inga had a unique time and place of formation. The remnants of Tropical Storm Simone in the Eastern Pacific reached the Gulf of Mexico early on the

November 3rd and interacted with an approaching cold front. Genesis likely occurred in the Bay of Campeche late on the 3rd but the first position is analyzed at 00Z on November 4th, 24 hours earlier than originally shown in HURDAT, based on synoptic data. The initial intensity is assessed at 40 kt based on a ship near the center that reported 40 kt NW and 1006 mb at 00Z on the 4th. Minor track alterations are introduced during the lifetime of this tropical cyclone. The tropical storm steadily intensified and reached a peak intensity of 60 kt at 12Z on the 4th. 60 kt is also the original peak intensity in HURDAT. At this time, a ship named “SS Navigator” near the center reported 70 kt and 1001 mb. A significant pressure gradient had developed over the western and northwestern quadrants as a strong ridge moved into the central United States behind the frontal boundary just northwest of the tropical cyclone. At 2215Z on the 4th, the first reconnaissance aircraft reached Inga measuring a central pressure of 997 mb, estimating surface winds of 40 kt and an eye diameter of 15 nm. A central pressure of 997 mb suggests maximum sustained winds of 53 kt south of 25N from the Brown et al. pressure-wind relationship. An eye diameter of 15 nm suggests an RMW of about 11 nm and the climatological value is 17 nm. Due to an RMW smaller than the climatological value, forward speed of 6 kt and strong pressure gradient, an intensity of 60 kt is analyzed at 00Z on November 5th, up from 40 kt originally in HURDAT, a major intensity change. A central pressure of 997 mb was added to HURDAT at 00Z on the 5th. Even though the first reconnaissance aircraft visually estimated weaker winds than those reported by the SS Navigator, it is possible that the ship's measurement was high biased slightly and/or was a transient event. When the aircraft reached the storm, it was diurnal minimum and the strong convection could have weakened. The ESRL Daily Mean Wind Shear for the 4th indicates that Inga was being affected by moderate southwest vertical wind shear. It is possible that Inga may have reached hurricane intensity for a brief period early on the 4th. An analog is Tropical Storm Alberto in 2006, which while in the northern Gulf of Mexico under strong vertical wind shear, a significant convective burst caused the winds to increase to 60 kt. On the 5th, Inga moved northwestward before stalling late in the day as another frontal boundary moved into the Gulf of Mexico. At 1223Z on the 5th, a reconnaissance aircraft reported a central pressure of 997 mb, estimated surface winds of 50 kt and an eye diameter of 5 nm. A central pressure of 997 mb suggests maximum sustained winds of 53 kt south of 25N from the pressure-wind relationship. An eye diameter of 5 nm suggests an RMW of about 4 nm and the climatological value is 17 nm. Due to an RMW much smaller than the climatological value but a forward speed of only 3 kt, an intensity of 60 kt is analyzed at 12Z on the 5th, up from 45 kt originally in HURDAT, a minor intensity change. A central pressure of 997 mb was present in HURDAT at 12Z on the 5th and has been retained. At 2155Z on the 5th, another penetration fix measured a central pressure of 992 mb, estimated surface winds of 50 kt and an eye diameter of 25 nm. A central pressure of 992 mb suggests maximum sustained

winds of 61 kt south of 25N from the pressure-wind relationship. An eye diameter of 25 nm suggests an RMW of about 19 nm and the climatological value is 17 nm. Due to an RMW close to the climatological value and being almost stationary, an intensity of 60 kt is analyzed at 00Z on November 6th, up from 50 kt originally in HURDAT, a minor intensity change. A central pressure of 992 mb was present in HURDAT and has been retained.

After a period when the movement of the storm was almost stationary, Inga started to move to the southeast later on the 6th. Observations from the reconnaissance aircraft investigating the tropical cyclone around midday on the 6th indicate that the original low-level center dissipated after 13Z and another low-level center was fixed about an hour later about 80 nm to the southeast. An analog of a system in the Gulf that had a center dissipate and a new one form elsewhere is Tropical Storm Arlene in 1993. At 1425Z on the 6th, a penetration fix measured a central pressure of 998 mb, estimated surface winds of 60 kt and an eye diameter of 3 nm. A central pressure of 998 mb suggests maximum sustained winds of 51 kt south of 25N from the pressure-wind relationship. An eye diameter of 3 nm suggests an RMW of about 2 nm and the climatological value is 16 nm. Based on a tiny RMW and ship data later on the day, an intensity of 60 kt is analyzed at 12Z on the 6th, up from 55 kt originally in HURDAT, a minor intensity change. A central pressure of 998 mb was present in HURDAT at 12Z on the 6th and has been moved to a special 15Z best track position due to the reformation of the center farther to the southeast as it did not represent the central pressure of the old center at 12Z. At 19Z, another penetration center fix measured a central pressure of 1000 mb, estimated surface winds of 60 kt and an eye diameter of 3 nm. A central pressure of 1000 mb suggests maximum sustained winds of 47 kt south of 25N weakening from the pressure-wind relationship. An eye diameter of 3 nm suggests an RMW of about 2 nm and the climatological value is 16 nm. Based on a tiny RMW, forward speed of about 5 kt and a ship at 16Z that measured 60 kt, an intensity of 60 kt is analyzed at 18Z on the 6th, same as originally shown in HURDAT. A central pressure of 1000 mb has been added to HURDAT at 18Z on the 6th. A final penetration fix on the 6th occurred at 2326Z and measured a central pressure of 1004 mb and estimated surface winds of 40 kt. A central pressure of 1004 mb suggests maximum sustained winds of 41 kt south of 25N weakening from the pressure-wind relationship. Based on ship data early on November 7th, an intensity of 60 kt is analyzed at 00Z on the 7th, same as originally shown in HURDAT. On the 7th, Inga stalled again in the Bay of Campeche. Ships observations indicate that the strong pressure gradient continued over the western quadrant of Inga, generating winds up to hurricane force. These winds were in part caused by Inga but it is difficult to determine if they were part of the circulation and what portion of the winds were due to funneling induced by interaction of the cold front with the orography, thus the intensity is retained at 60 kt, as originally shown in HURDAT, just below hurricane

intensity. Dry, cold air behind the cold front was present as far south as Tampico but ship observations near the center of Inga show that the tropical storm retained its tropical characteristics. Penetration center fixes occurred at 13Z and 19Z on the 7th measuring central pressures of 1004 mb and 1006 mb, respectively, which have been added to HURDAT. Early on November 8th, Inga began to move to the east and slightly weakened before dissipating and being absorbed by the cold front after 12Z. The last position is analyzed at 12Z on the 8th, same as originally shown in HURDAT. Inga is the only tropical cyclone since 1851 to have formed in the Bay of Campeche in the month of November.

New Tropical Storm [November 17-21, 1961]

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37265 11/17/1961 M= 5 12 SNBR= 820 UNNAMED       XING=0 SSS=0

37265 11/17*  0   0   0    0*  0   0   0    0*  0   0   0    0*225 550  25    0*
37265 11/18*240 543  25    0*254 536  25 1004*266 530  30    0*273 523  30    0*
37265 11/19*278 510  30    0*283 495  35    0*295 475  40    0*314 460  40    0*
37265 11/20*330 445  40    0*345 425  40    0*354 410  45    0*362 395  50    0*
37265 11/21E370 382  50    0E384 370  50    0*  0   0   0    0*  0   0   0    0*
37275 TS
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A new tropical storm has been added to HURDAT, not previously shown in McAdie et al. (2009). Evidence for its existence comes from the Historical Weather Map series, Microfilm, COADS ship database, Mariners Weather Log and Jack Beven's and David Roth’s suspect list.

November 16:

HWM analyzes a closed low pressure of at most 1010 mb at 19.0N, 51.0W at 12Z. Microfilm shows a closed low pressure of at most 1011 mb over the northeastern Caribbean Sea near 17.0N, 64.0W at 12Z. Ship highlights: No gale force winds or equivalent low pressures.

November 17:

HWM analyzes an elongated area of low pressure with a center at 21.2N, 60.0W and another center at 22.2N, 48.2W and a stationary front to the north at 12Z. Microfilm shows a closed low pressure of at most 1008 mb at 21.0N, 60.0W at 12Z. Ship highlights: No gale force winds or equivalent low pressures.

November 18:

HWM analyzes a closed low pressure of at most 1000 mb at 27.2N, 53.2W with a frontal boundary going through the center at 12Z. Microfilm shows a closed low pressure of at

most 1008 mb at 25.0N, 53.5W at 12Z. Ship highlights: 10 kt WNW and 1005 mb at 23.9N, 53.9W at 06Z (COADS). 25 kt S and 1001 mb at 26.9N, 52.8W at 12Z (COADS). 30 kt WSW and 1001 mb at 25.2N, 52.6W at 18Z (COADS).

November 19:

HWM analyzes a closed low pressure of at most 1005 mb at 29.0N, 48.0W with a cold front to the east and a cold front to the south at 12Z. Microfilm shows a closed low pressure of at most 999 mb at 30.5N, 47.0W with a frontal boundary going through the center at 12Z. Ship highlights: 20 kt SE and 1002 mb at 28.1N, 51.0W at 00Z (COADS). 15 kt WNW and 1000 mb at 27.2N, 50.0W at 06Z (COADS). 40 kt SW and 1005 mb at 28.6N, 46.7W at 12Z (COADS). 35 kt S and 1006 mb at 28.6N, 45.7W at 12Z (COADS). 40 kt SW and 1005 mb at 29.0N, 45.2W at 18Z (COADS). 25 kt S and 1000 mb at 31.5N, 45.8W at 18Z (COADS).

November 20:

HWM analyzes a closed low pressure of at most 1010 mb at 35.0N, 41.0W with a warm front to the northeast and weakening cold front to the south and an approaching weakening front to the west at 12Z. Microfilm shows a closed low pressure of at most 1005 mb at 33.0N, 46.5W with a frontal boundary to the west at 12Z. Ship highlights: 30 kt NE and 1002 mb at 33.5N, 46.0W at 00Z (COADS). 40 kt SE and 1014 mb at 34.3N, 39.6W at 00Z (COADS). 30 kt NE and 998 mb at 33.6N, 45.1W at 06Z (COADS). 35 kt S and 995 mb at 35.3N, 40.1W at 12Z (COADS). 40 kt SE and 1013 mb at 34.5N, 36.1W at 12Z (COADS). 30 kt W and 992 mb at 35.6N, 40.8W at 18Z (COADS). 40 kt W and 1003 mb at 32.6N, 40.8W at 18Z (COADS).

November 21:

HWM analyzes a closed low pressure of at most 990 mb at 40.0N, 33.5W with a warm front to the southeast and cold front to the south at 12Z. Microfilm is not available on this date, storm has moved off the map. Ship highlights: 35 kt SW and 998 mb at 34.3N, 36.6W at 00Z (COADS). 40 kt SE and 1007 mb at 34.7N, 32.0W at 00Z (COADS). 15 kt SW and 987 mb at 38.0N, 36.8W at 06Z (COADS). 40 kt E and 997 mb at 40.7N, 37.4W at 06Z (COADS). 45 kt W and 991 mb at 37.7N, 38.2W at 12Z (COADS). 55 kt NNE and 987 mb at 41.1N, 41.7W at 18Z (COADS).

The origin of this unnamed tropical storm is uncertain but the Historical Weather Maps indicate that a trough of low pressure led to the development of a surface circulation around mid-November over the central Atlantic. The broad and elongated low pressure moved northward and slowly became better organized on the 16th and 17th. A 25-kt tropical depression is analyzed to have developed on November 17th at 18Z. A ship

reported 10 kt WNW and 1005 mb at 06Z on November 18th, which suggests a central pressure of 1004 mb, which has been added to this time slot. A central pressure of 1004 mb suggests maximum sustained winds of 39 kt from the south of 25N Brown et al. and 36 kt from the north of 35N from the Landsea et al. pressure-wind relationships. Due to the large circulation of the tropical cyclone and synoptic observations, an intensity of 25 kt is selected at 06Z on the 18th. At 12Z on the 18th, a ship reported 25 kt S and 1001 mb, indicating that the tropical cyclone was intensifying. The intensity is increased to 30 kt at 12Z on the 18th. The HWM at 12Z on the 18th shows frontal features associated with this system. This depiction appears erroneous as there is no temperature gradient across the circulation. At the same time, microfilm shows a low pressure without frontal features. Ship observations late on the 18th showed that the circulation was more symmetrical, but it retained its large size. It is probable that the system had some subtropical characteristics. Intensification to a tropical storm is analyzed at 06Z on November 19th. The first gales were recorded at 12Z on November 19th. Two ships in the southern quadrant reported 40 kt SW and 35 kt S, about 60-90 nm from the center. HWM and microfilm depict the system with frontal features at 12Z on the 19th, but surface observations indicate that the environment was warm and moist around the center and no temperature gradient was present across the circulation. Two more ships reported gale-force winds at 18Z on the 19th.

On November 20th, a frontal boundary began to approach the tropical cyclone. A ship at 12Z on the 20th reported 35 kt S and 995 mb. A peripheral pressure of 995 mb suggests maximum surface winds greater than 52 kt from the north of 25N Brown et al. and 56 kt from the north of 35N Landsea et al. pressure-wind relationships. Due to the large size of the circulation, an intensity of 45 kt is selected at 12Z on the 20th. At 18Z on the 20th, a ship reported 30 kt W and 992 mb. A peripheral pressure of 992 mb suggests maximum surface winds greater than 60 kt from the north of 35N pressure-wind relationship. An intensity of 50 kt is selected at 18Z on the 20th. 50 kt is the peak intensity of this tropical storm. Synoptic data late on the 20th indicate that the tropical cyclone was beginning to acquire extratropical characteristics as it interacted with the approaching frontal boundary. Transition to an extratropical cyclone is analyzed at 00Z on November 21st. Ship observations at 12Z on the 21st indicate that the system had merged with an extratropical cyclone associated with the frontal boundary. The last position is analyzed at 06Z on the 21st.

1961 - Additional Notes

1) May 16-20: Historical Weather Maps show a trough of low pressure over the eastern Bahamas on May 16th. The disturbance moved northward ahead of a frontal boundary and surface observations indicate that a tropical depression may have developed by May 18th. COADS indicate that the peak winds associated with this system stayed below gale-force. The disturbance began to interact with the frontal boundary on May 19th and became absorbed the next day. Therefore, because the system did not produce winds of tropical storm intensity, it is not added to HURDAT. This disturbance was in Jack Beven's and David Roth's List of Suspects.

Day	Latitude	Longitude	Status
May 16	22N	72W	Trough
May 17	26N	71W	Trough
May 18	29N	68W	Tropical Depression?
May 19	32N	68W	Tropical Depression?
May 20			Absorbed

2) June 8-14: Historical Weather Maps and Microfilm indicate that a tropical wave reached the western Caribbean Sea on June 8th. The disturbance slowly became better organized as it moved toward the southeastern Gulf of Mexico and a closed surface circulation developed early on the 10th as it moved across South Florida toward the Atlantic Ocean. The disturbance moved generally northeastward along the east coast of the United States producing winds up to 30 kt based on synoptic observations. At 15Z on the 12th, one ship reported 35 kt, the only definite piece of evidence to indicate that this disturbance may have been a small tropical storm. An approaching frontal boundary caused the small system to accelerate northeastward and on the 13th it appears that it weakened to a trough of low pressure east of New England. By the 14th, it was absorbed by an extratropical cyclone over eastern Canada. Therefore, because there is not enough evidence to support upgrading this system to a tropical storm, it is not added to HURDAT. This disturbance was in Jack Beven, David Roth and Ryan Truchelut's List of Suspects.

Day	Latitude	Longitude	Status
June 8	11N-26N	81W	Tropical Wave
June 9	15N-30	83W	Tropical Wave
June 10	28N	80W	Tropical Depression
June 11	31N	78W	Tropical Depression

June 12	36N	74W	Tropical Storm?
June 13	41N	63W	Trough
June 14			Absorbed

3) July 28-31: Historical Weather Maps show a low pressure over the eastern Atlantic during the last few days of July. Synoptic data over the eastern Atlantic is sparse and no winds of gale-force were observed. Therefore, because the disturbance did not produce tropical storm force winds and that it may not have been a closed low, it is not added to HURDAT. This disturbance was in Ryan Truchelut's List of Suspects.

Day	Latitude	Longitude	Status
July 28	14N	21W	Tropical Wave?
July 29	14N	23W	Tropical Depression?
July 30	14N	26W	Tropical Depression?
July 31			Dissipated

4) August 2-5: Historical Weather Maps indicate that a tropical wave left the African coast early on August. Synoptic data over the eastern Atlantic show that the disturbance steadily moved westward. COADS indicate that winds stayed below tropical storm force. Therefore, because the disturbance did not produce tropical storm force winds and that it may not have been a closed low, it is not added to HURDAT. This disturbance was in Ryan Truchelut's List of Suspects.

Day	Latitude	Longitude	Status
August 2	13N	22W	Tropical Depression?
August 3	13N	25W	Tropical Depression?
August 4	13N	28W	Tropical Wave?
August 5			Dissipated

5) October 10-15: Historical Weather Maps show a trough over the northwest Bahamas on October 10th. The disturbance moved initially northward and slowly became better organized. On the 12th, the system turned to the northeast and intensified to a tropical depression while on a high-pressure environment. Over the next two days, the circulation of the system became much better organized and synoptic data show a discernible decrease in pressure. Yet, COADS indicate that winds remained below gale-force and lowest pressure was only 1009 mb. On the 15th, the system merged with an approaching

frontal boundary. Therefore, because the disturbance did not produce tropical storm force winds, it is not added to HURDAT. This disturbance was in Jack Beven and David Roth's List of Suspects.

Day	Latitude	Longitude	Status
October 10	28N	74W	Trough
October 11	29N	76W	Trough
October 12	34N	71W	Tropical Depression
October 13	36N	66W	Tropical Depression
October 14	37N	61W	Tropical Depression
October 15			Merged

6) October 20-30: Historical Weather Maps indicate that a weakening frontal boundary entered the Atlantic Ocean from the United States on October 20th. A low pressure system quickly developed in the tail-end of front and moved to the northeast. The extratropical cyclone occluded on the 22nd but became entangled with another frontal boundary on the 23rd. Over the next couple of days, the disturbance moved northeastward into the North Atlantic and was absorbed on the 30th. COADS indicate that the system was producing gale-force winds on the 22nd, when it was occluded, but it also shows that it maintained a cold core. Therefore, because the system remained non-tropical, it is not added to HURDAT. This disturbance was in Jack Beven's List of Suspects.

Day	Latitude	Longitude	Status
October 20	East Coast		Weakening cold front
October 21	33N	74W	Extratropical
October 22	37N	72W	Occluded
October 23	37N	67W	Extratropical
October 24	40N	65W	Extratropical
October 25	42N	60W	Extratropical
October 26	46N	60W	Extratropical
October 27	50N	50W	Extratropical
October 28	50N	36W	Extratropical
October 29	50N	35W	Extratropical
October 30			Absorbed

7) November 19-27: Historical Weather Maps show a frontal boundary entering the Atlantic Ocean from the United States on November 18th. An extratropical low pressure

developed on November 20th off the southeast coast of the United States and initially traveled northeastward. Beginning on the 21st, the extratropical cyclone began to move southeastward and occluded. The disturbance reached its southernmost latitude on the 24th and 25th. Surface analyses indicate that the frontal boundaries had dissipated and the environment around the system was warmer and the temperature gradient had decreased across the circulation, but at this time it was large low pressure producing winds below gale force. On the 26th, an approaching cold front caused the disturbance to move northward and gales were registered about 300 nm northeast of the center due to the strong pressure-gradient. On the 27th, it had been absorbed by a stronger extratropical cyclone over the north Atlantic. Therefore, because observations indicate that the system did not acquire tropical characteristics, it is not added to HURDAT. This disturbance was in Jack Beven and David Roth's List of Suspects.

Day	Latitude	Longitude	Status
November 19	30N	78W	Cold front
November 20	36N	73W	Extratropical
November 21	41N	67W	Extratropical
November 22	40N	63W	Extratropical
November 23	37N	57W	Occluded
November 24	33N	54W	Occluded
November 25	33N	50W	Occluded
November 26	38N	49W	Occluded
November 27			Absorbed

1962 hurricane season

New Tropical Storm [June 29 – July 6, 1962]

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42125 06/29/1962 M= 8  1 SNBR= 913 NOT NAMED   XING=0 SSS=0

42130 06/29E322 777  40    0E324 770  40    0E327 762  40    0E332 756  45    0*
42135 06/30E338 754  50    0E344 757  50 1000E350 761  55 1000*354 760  55  998*
42140 07/01*350 757  55    0*348 751  55    0*350 741  50    0*352 730  45    0*
42145 07/02*354 710  45    0*356 685  40    0*359 660  40    0E362 630  40    0*
42150 07/03E368 610  45    0E380 585  45    0E400 545  45    0E437 523  45    0*
42155 07/04E475 550  40    0E485 590  35    0E477 625  35    0E470 640  35    0*
42160 07/05E450 650  30    0E432 650  25    0E425 644  25    0E430 637  25    0*
42165 07/06E435 630  25    0E442 625  25    0*  0   0   0    0E  0   0   0    0*
42170 TS
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U.S. Tropical Storm Landfall

06/30 21Z 35.2N 75.8W 55 kt NC

A new tropical storm has been added to HURDAT, not previously shown in McAdie et al. (2009). Evidence for these alterations comes from the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Mariners Weather Log, Surface Weather Observations, and Local Climatological Data. This disturbance was in Jack Beven's List of Suspects

June 28:
HWM and microfilm analyze a stationary front over the western Atlantic at 12Z. Ship highlights: No gales or low pressures.
June 29:
HWM analyzes an extratropical cyclone of at most 1015 mb at 32.0N, 77.0W at 12Z. Microfilm shows an extratropical cyclone of at most 1014 mb at 33.3N, 75.0W at 12Z. Ship highlights: 40 kt NE and 1023 mb at 33.5N, 77.6W at 00Z (micro). 35 kt E and 1015 mb at 35.0N, 75.1W at 12Z (COADS). 40 kt ENE and 1021 mb at 33.6N, 77.5W at 18Z (micro). 35 kt E and 1016 mb at 35.4N, 74.1W at 23Z (COADS).
CLIMO: "On June 29 an offshore storm caused torrential rains over the central section of the coast, with very heavy rains extending inland fifty to sixty miles. Cedar Island reported 17 inches in about 18 hours, the second greatest one-day rain in North Carolina weather history. Several stations in that section of the State had their greatest 24-hour rainfall of record and their greatest June total of record. Agricultural losses from the storm rainfall were very high."
June 30:
HWM analyzes an extratropical cyclone of at most 1005 mb at 35.0N, 75.0W at 12Z. Microfilm shows an extratropical cyclone of at most 1002 mb at 35.5N, 76.2W at 12Z.

Ship highlights: 50 kt NW and 1003 mb at 33.7N, 76.7W at 00Z (COADS). 10 kt NW and 1001 mb at 34.3N, 75.9W at 06Z (COADS). 55 kt W and 1008 mb at 34.0N, 76.5W at 12Z (COADS). 40 kt W and 1009 mb at 33.9N, 74.9W at 18Z (COADS). 35 kt SSW and 1006 mb at 35.8N, 74.0W at 23Z (MWL). Land highlights: 21 kt NNW and 1003 mb at Cherry Point, NC at 1058Z (SWO). 20 kt SE and 1002 mb at Cape Hatteras, NC at 12Z (micro). 20 kt W and 1000 mb at Cape Hatteras, NC at 1558Z (SWO).

July 1:

HWM analyzes an extratropical cyclone of at most 1010 mb at 36.0N, 71.0W at 12Z. Microfilm shows a closed low pressure of at most 1002 mb at 36.0N, 73.5W at 12Z. Ship highlights: 50 kt SW and 1006 mb at 34.5N, 74.3W at 00Z (COADS). 35 kt W and 1010 mb at 33.0N, 75.5W at 06Z (COADS). 35 kt NE and 1013 mb at 40.5N, 68.9W at 12Z (micro). 35 kt WSW at 34.7N, 73.0W at 18Z (COADS). Land highlights: 50 kt NE and 1001 mb at Diamond Shoals, NC at 06Z (micro).

July 2:

HWM analyzes an extratropical cyclone of at most 1010 mb at 39.0N, 67.0W at 12Z. Microfilm shows a closed low pressure of at most 1005 mb at 36.7N, 64.3W with a frontal boundary just to the northwest at 12Z. Ship highlights: 35 kt SW and 1008 mb at 34.0N, 66.3W at 12Z (COADS). 35 kt SW and 1009 mb at 34.6N, 62.8W at 18Z (COADS).

July 3:

HWM analyzes an extratropical cyclone of at most 995 mb at 41.0N, 54.0W at 12Z. Microfilm shows an extratropical cyclone of at most 999 mb at 40.0N, 54.0W at 12Z. Ship highlights: 45 kt NNE and 999 mb at 36.6N, 66.5W at 00Z (COADS). 55 kt (or 25 kt) SE and 1002 mb at 37.5N, 58.5W at 06Z (micro). 45 kt SSE and 996 mb at 40.1N, 53.5W at 12Z (COADS/micro). 35 kt NW and 1003 mb at 42.0N, 53.0W at 18Z (COADS).

July 4:

HWM analyzes an occluded extratropical cyclone of at most 1000 mb at 48.0N, 63.0W at 12Z. Microfilm shows a closed low pressure of at most 1005 mb at 47.0N, 63.5W at 12Z. Ship highlights: 40 kt SW and 1005 mb at 46.0N, 51.5W at 00Z (COADS). 40 kt E and 1009 mb at 50.4N, 52.0W at 03Z (COADS). Land highlights: 35 kt NE and 1013 mb at Anticosti Island, Canada at 18Z (micro).

July 5:

HWM does not analyze an organized system at 12Z. Microfilm shows a closed low pressure of at most 1008 mb at 47.0N, 64.5W at 12Z. Ship highlights: No gales or low pressures.

July 6:

HWM analyzes an extratropical cyclone of at most 1005 mb at 40.5N, 61.5W (original cyclone appears to have been absorbed) at 12Z. Microfilm shows a closed low pressure

of at most 1008 mb at 43.0N, 62.0W at 12Z. Land highlights: 40 kt ESE and 1015 mb at Fatima, Canada at 06Z (micro).

A weakening frontal boundary over the western Atlantic led to the formation of an extratropical cyclone early on June 29th off the southeast of the United States. The first position is analyzed at 00Z on June 29th as a 40 kt extratropical cyclone based on synoptic data. The extratropical cyclone moved northeastward, turning to the north and northwest on June 30th. The system gradually intensified and a couple of ships reported winds of 40 kt on the 29th, 50 kt at 00Z on the 30th and 55 kt at 06Z on the 30th. A ship reported 10 kt NW and 1001 mb at 06Z on the 30th, suggesting a central pressure of 1000 mb, which has been added to the corresponding time slot. Cape Hatteras, NC, reported 20 kt SE and 1002 mb at 12Z on the 30th, suggesting a central pressure of 1000 mb, which was also added to the appropriate time slot. Transition to a tropical storm was gradual and based on the synoptic data, is analyzed to have occurred at 18Z on the 30th. At this time, there was no temperature gradient across the circulation and the strongest winds were about 60 nm from the center. The system may have been a subtropical storm but at the moment, without the availability of satellite images, it is going to be analyzed as a tropical storm. 55 kt is analyzed as the peak intensity. Cape Hatteras, NC, measured 20 kt W and 1000 mb at 1558Z on the 30th suggesting a central pressure of 998 mb, which has been added at 18Z on this day. A central pressure of 998 mb suggests maximum surface winds of 47 kt north of 25N from the Brown et al. and 52 kt north of 35N from the Landsea et al. pressure-wind relationships. The analyzed intensity at 18Z on the 30th is 55 kt based on the pressure-wind relationship and synoptic data. The tropical storm moved to the southeast late on the 30th making landfall in the Outer Banks of North Carolina. An approaching frontal boundary caused the tropical cyclone to move eastward increasing in forward speed on July 1st. Gales were also reported on the 1st, up to 50 kt. At 06Z on the 1st, Diamond Shoals reported 50 kt NE and 1001 mb. The reporting station located at an elevation of 65 feet, suggesting surface winds of about 48 kt. The tropical storm weakened on July 1st and 2nd as it moved away from the United States. Late on the 2nd, the tropical cyclone interacted with the approaching frontal boundary and transition back to an extratropical cyclone is analyzed at 18Z on the 2nd. A ship at 06Z on July 3rd appears in microfilm suggesting 55 kt SE and 1002 mb. It is possible that the reading was 25 kt since the triangle is unfilled and 55 kt appears substantially too high compared to the surrounding ships. The reported pressure also appears inconsistent with the surrounding synoptic data. Because of all the inconsistencies, it is not used in this reanalysis. The extratropical cyclone moved across Newfoundland on July 4th and across New Brunswick and Nova Scotia on July 5th while performing a large counter-clockwise loop. Weakening below gale-force is analyzed at 00Z on the 5th. A rapidly developing extratropical cyclone approached the weakening system early on July 6th and synoptic

data suggests that both merged after 06Z on this day. The last position is analyzed at 06Z on the 6th.

Hurricane Alma [August 26 – September 2, 1962]

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42390 08/26/1962 M= 8  1 SNBR= 919 ALMA        XING=1 SSS=0
42390 08/26/1962 M= 8  2 SNBR= 919 ALMA        XING=1 SSS=0
                       *

42395 08/26*  0   0   0    0*  0   0   0    0*253 797  25    0*264 801  25    0*
42395 08/26*  0   0   0    0*  0   0   0    0*261 797  25    0*270 801  30    0*
                                             ***             ***       **

42400 08/27*277 803  25    0*292 802  30 1007*306 797  40    0*318 788  45    0*
42400 08/27*279 803  30    0*292 802  35    0*304 797  40    0*315 788  45 1002*
           ***       **                 **    * ***             ***          ****

42405 08/28*329 777  45 1002*341 766  50    0*352 753  65  986*369 735  75  991*
42405 08/28*326 777  45 1002*338 766  55 1000*352 753  65    0*369 735  75  990*
           ***              ***       ** ****               *              ***

42410 08/29*387 717  80  988*401 704  85    0*410 694  80  990*415 687  75    0*
42410 08/29*387 717  75  988*401 702  75    0*410 694  70  990*415 687  70  984*
                    **           ***  **                 **               **  ***

42415 08/30*415 679  60  994*413 670  55    0*410 665  45    0E408 651  40    0*
42415 08/30*415 678  60    0E413 669  55    0E410 660  45    0E408 651  40    0*
                  ***        **    ***         *    ***

42420 08/31E405 643  40    0E399 635  40    0E391 633  40    0E386 638  35    0*
42420 08/31E404 643  40    0E399 640  40    0E391 638  40    0E386 641  35    0*
           ***                    ***             ***         ***  ***

42425 09/01E383 644  35    0E384 651  35    0E388 656  35    0E393 652  35    0*
42425 09/01E383 645  35    0E384 650  35    0E386 655  35    0E390 654  35    0*
                 ***              ***         *** ***         ***  ***

42430 09/02E397 650  35    0E409 636  25 1002E422 610  15    0E453 555  15    0*
42430 09/02E395 650  35    0E404 636  35    0*  0   0   0    0*  0   0   0    0*
           ***              ***             *

42435 HR
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U.S. Tropical Storm Impact

08/28 11Z 35.0N 75.1W 40 kt North Carolina

Minor changes to the track and intensity shown in McAdie et al. (2009). Evidence for these alterations comes from the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Monthly Weather Review, Navy reconnaissance book, Mariners Weather Log, State Climatological Data, Atlas of Cloud Vortex Patterns, and NHC Storm Wallets.

August 13:

HWM and microfilm do not show an organized system at 12Z. HURDAT does not list an organized storm on this date. Ship highlights: No gales or low pressures.

August 14:

HWM does not analyze an organized system at 12Z. HURDAT does not list an organized storm on this date. Microfilm shows a tropical wave near longitude 40W at 12Z. Ship highlights: No gales or low pressures.

MWR: “A possible weak circulation center was first noted in the eastern Atlantic by TIROS V on August 14.” MICRO: “Special TIROS Bulletin. TIROS V Photographs at 14/1606Z show a well defined circulation in 14 degrees north 38 degrees west with the main band spiraling from the center to 15 degrees north 40 degrees west to 15 degrees north 35 degrees west then south east. A second band is evident from 15 degrees west to 15 degrees north 32 degrees west. Major cloudiness is in the east and north east quadrants with little cloudiness south west thru north west.”

August 15:

HWM does not analyze an organized system at 12Z. HURDAT does not list an organized storm on this date. Microfilm shows a closed low pressure of at most 1014 mb at 18.5N, 42.2W at 12Z. Ship highlights: No gales or low pressures.

MICRO: “Flight summary. No significant radar weather encountered entire track area invof 1510N 4418W overcast with cs. Max obsd sfc wnd 15 kts min obsd slp 1012 mb by drop min 700 mb hgt.”

August 16:

HWM analyzes a spot low pressure at 12.2N, 41.6W at 12Z. HURDAT does not list an organized storm on this date. Microfilm shows a tropical wave near longitude 42W at 12Z. Ship highlights: No gales or low pressures.

August 17:

HWM analyzes a spot low pressure at 12.2N, 46.9W at 12Z. HURDAT does not list an organized storm on this date. Microfilm shows a tropical wave near longitude 45W at 12Z. Ship highlights: No gales or low pressures.

August 18:

HWM analyzes a spot low pressure at 12.3N, 51.7W at 12Z. HURDAT does not list an organized storm on this date. Microfilm shows a tropical wave near longitude 50W at 12Z. Ship highlights: No gales or low pressures.

MWR: “Subsequent westward movement at about 10 kt. brought the perturbation to the vicinity of 12.5N, 51W on August 18 where Weather Bureau research aircraft, on a routine flight to the Cape Verdes, located a weak center.”

August 19:

HWM analyzes a spot low pressure at 11.1N, 56.1W at 12Z. HURDAT does not list an organized storm on this date. Microfilm does not show an organized system at 12Z. Ship highlights: No gales or low pressures.

August 20:

HWM and microfilm do not show an organized system at 12Z. HURDAT does not list an organized storm on this date. Ship highlights: No gales or low pressures.

MWR: “Crossing the Windward Islands during August 20, the circulation moved west northwestward at 10 kt …”

August 21:

HWM does not analyze an organized system at 12Z. HURDAT does not list an organized storm on this date. Microfilm shows a tropical wave near longitude 65W at 12Z. Ship highlights: No gales or low pressures.

August 22:

HWM does not analyze an organized system at 12Z. HURDAT does not list an organized storm on this date. Microfilm shows a tropical wave near longitude 67W at 12Z. Ship highlights: No gales or low pressures.

MWR: “and was again located by Weather Bureau reconnaissance aircraft near 21N, 69W on August 22.”

August 23:

HWM analyzes a tropical wave along longitude 76W at 12Z. HURDAT does not list an organized storm on this date. Microfilm shows a tropical wave near longitude 72W at 12Z. Ship highlights: No gales or low pressures.

August 24:

HWM analyzes a broad low pressure of at most 1010 mb at 19.0N, 81.0W at 12Z. HURDAT does not list an organized system on this date. Microfilm shows a tropical wave over the Windward Passage at 12Z. Ship highlights: No gales or low pressures.

MWR: “Gradually recurving, the Low moved across eastern Cuba on August 24 remaining weak and unorganized.” ATSR: “The first significant tropical disturbance of the 1962 Hurricane Season appeared in the form of an easterly wave moving across the Caribbean during the period of 24 to 26 August attended by considerable shower activity, below normal pressures and gusty winds.”

August 25:

HWM analyzes a low pressure of at most 1010 mb at 22.3N, 79.8W at 12Z. HURDAT does not list an organized system on this date. Microfilm shows a tropical wave over central Cuba and western Bahamas at 12Z. Ship highlights: 35 kt SE and 1013 mb at 22.0N, 74.4W at 00Z (COADS).

August 26:

HWM analyzes a low pressure of at most 1010 mb at 25.5N, 79.6W at 12Z. HURDAT lists a 25 kt tropical depression at 25.3N, 79.7W at 12Z (first position). Microfilm shows a closed low pressure of at most 1011 mb at 26.0N, 79.5W at 12Z. Ship highlights: No gales or low pressures.

MWR: “On the morning of August 26, slow development began between the Florida east coast and the western Bahamas, with the depression moving on a course which kept it a short distance off the United States east coast until August 29.” ATSR: “Imposing an immediate threat to the U.S. Coastline, a weak vortex formed off ships reporting winds of 30 knots.”

August 27:

HWM analyzes a tropical storm of at most 1010 mb at 30.2N, 80.1W at 12Z. HURDAT lists a 40 kt tropical storm at 30.6N, 79.7W at 12Z. Microfilm shows a closed low pressure of at most 1011 mb at 29.5N, 79.0W at 12Z. Ship highlights: 35 kt SSW and 1011 mb at 28.9N, 77.7W at 12Z (COADS). 45 kt SSE and 1005 mb at 30.8N, 78.2W at 15Z (COADS). 40 kt SE and 1011 mb at 31.8N, 77.1W at 18Z (COADS). 20 kt S and 1004 mb at 31.6N, 77.9W at 18Z (COADS). 45 kt S and 1005 mb at 32.3N, 78.0W at 21Z (micro).

MWR: “As deepening continued, the first advisory was issued on August 27 when Alma was about 150 mi. east of the Georgia coast.” ATSR: “While moving northward in the circulation pattern of the Bermuda High, slow intensification occurred and a Tropical Disturbance Warning was issued at 271500Z followed by the first numbered warning on Tropical Storm Alma at 271830Z.”

August 28:

HWM analyzes a closed low pressure of at most 995 mb at 35.5N, 74.6W with a warm front to the north at 12Z. HURDAT lists a 65 kt hurricane at 35.2N, 75.3W at 12Z. Microfilm shows a closed low pressure of at most 1005 mb at 34.5N, 75.5W at 12Z. Ship highlights: 45 kt S and 1006 mb at 32.8N, 77.2W at 00Z (COADS). 20 kt NE and 1002 mb at 33.0N, 78.2W at 03Z (micro). 50 kt S and 1007 mb at 34.0N, 76.0W at 06Z (COADS). 55 kt SSE and 1006 mb at 34.4N, 74.2W at 10Z (COADS). 55 kt S and 1005 mb at 34.3N, 74.2W at 12Z (COADS). 60 kt SSW and 1006 mb at 35.0N, 74.2W at 15Z (micro). 50 kt W and 990 mb at 36.7N, 73.8W at 18Z (COADS). 50 kt NNW and 1002 mb at 36.6N, 73.7W at 21Z (micro). Land highlights: 10 kt and 1001 mb at Frying Pan Shoals, NC at 05Z (SWO). 997 mb (min pressure) at Cape Hatteras WB, NC at 1105Z (WALLET). 35 kt NNE (peak winds, gusts to 42 kt) at Cape Hatteras WB, NC at 1110Z (CLIMO/WALLET). Aircraft highlights: Penetration center fix measured a central pressure of 990 mb and estimated surface winds of 80 kt at 37.9N, 72.7W at 2054Z (ATSR). Penetration center fix at 38.0N, 72.2W at 2215Z (ATSR).

MWR: “Hurricane Alma reached maximum intensity August 28 north of the Virginia Capes but was classified as a hurricane for only 12 hours. No well defined eye with wall cloud development was ever observed and radar tracking was difficult. On the North Carolina Capes, Nags Head reported gusts to 53 mph and Hatteras 48 mph. Tides in general were about 2 ft. above normal in the Hatteras-Norfolk area but up to 3 ft. at Nags Head. Beach erosion was slight. Over 8 in. of rain fell at Cape Hatteras on August 27-28. After moving northeastward from the Capes, the storm increased in intensity and during the afternoon of the 28th) aircraft reconnaissance reported a sustained wind speed of 92 mph.” ATSR: “By 281200Z, while moving northeastward from a point about 120 miles off the Virginia coast, ALMA began rapid intensification under the influence of a strong, divergent, high level flow immediately in advance of a 200 MB trough approaching from the west. Hurricane force winds were reported by 281800Z.”

August 29:

HWM analyzes a closed low pressure of at most 990 mb at 41.2N, 69.0W with a weakening warm front to the northeast at 12Z. HURDAT lists an 80 kt hurricane at 41.0N, 69.4W at 12Z. Microfilm shows a closed low pressure of at most 993 mb at 40.9N, 69.4W with a frontal boundary to the northeast at 12Z. Ship highlights: 55 kt SE and 992 mb at 38.8N, 71.0W at 00Z (COADS). 45 kt NE and 1002 mb at 40.7N, 69.5W at 03Z (micro). 45 kt NE and 1002 mb at 40.5N, 69.4W at 06Z (micro). 25 kt ESE and 992 mb at 41.0N, 69.0W at 09Z (micro). 35 kt ENE and 992 mb at 41.5N, 68.9W at 12Z (COADS). 50 kt NE and 990 mb at 41.8N, 68.8W at 15Z (micro). 45 kt ENE and 992 mb at 42.0N, 68.8W at 18Z (COADS). 45 kt NE and 1002 mb at 43.3N, 68.5W at 21Z

(COADS). Land highlights: 28 kt N (gusts to 42 kt) and 994 mb at Nantucket, MA at 0957Z (SWO). 19 kt and 990 mb at Nantucket Light, MA at 11Z (SWO). 35 kt and 993 mb at Pollock Rip Lightship, MA at 12Z (SWO). 36 kt and 994 mb at Pollock Rip Lightship, MA at 18Z (SWO). Aircraft highlights: Penetration center fix measured a central pressure of 992 mb at 41.5N, 68.9W at 1447Z (WALLET). Penetration center fix measured a central pressure of 984 mb at 41.8N, 68.6W at 1850Z (WALLET).

MWR: “Alma began to weaken to tropical storm strength at about the time the center passed some 60 mi to the east of Nantucket. Coastal areas of Massachusetts and Rhode Island were buffeted by northerly gales gusting to 60 mph.”

August 30:

HWM analyzes a closed low pressure of at most 1000 mb at 41.2N, 65.8W with a weakening warm front to the north at 12Z. HURDAT lists a 45 kt tropical storm at 41.0N, 66.5W at 12Z. Microfilm shows a closed low pressure of at most 1005 mb at 40.5N, 65.5W at 12Z. Ship highlights: 40 kt SW and 994 mb at 40.8N, 68.0W at 00Z (COADS). 50 kt NE and 1010 mb at 40.5N, 71.0W at 06Z (COADS). 25 kt NW and 1001 mb at 40.2N, 67.7W at 12Z (COADS). 25 kt NE and 1002 mb at 41.5N, 66.7W at 18Z (micro). 35 kt E and 1013 mb at 42.1N, 67.1W at 23Z (COADS).

MWR: “Blocking over eastern Canada prevented complete recurvature into the westerlies. During the period August 30 through September 1, Alma drifted on a clockwise loop 200-300 mi. east-southeast of Cape Cod and slowly filled.” ATSR: “After coming under the influence of a cold low at the 500 MB level, ALMA dissipated and her course was radically defected to the eastward. The last advisory was transmitted at 301000Z, making a total of twelve. Storm damage was widespread, but minor, along the eastern seaboard, mostly confined to small craft and moorings with some erosion along the mid-eastern states. Rainfall in excess of 10 inches was reported in some areas north of Cape Hatteras.”

August 31:

HWM analyzes a closed low pressure of at most 1005 mb at 39.1N, 63.8W with a warm front to the north at 12Z. HURDAT lists a 40 kt extratropical storm at 39.1N, 63.3W at 12Z. Microfilm shows a closed low pressure of at most 1008 mb at 38.5N, 63.3W at 12Z. Ship highlights: 35 kt NE and 1013 mb at 43.3N, 64.5W at 00Z (COADS). 15 kt WSW and 1004 mb at 40.0N, 64.3W at 00Z (COADS). 40 kt NE and 1014 mb at 43.5N, 64.0W at 06Z (COADS). 35 kt SSW and 1015 mb at 41.6N, 58.2W at 12Z (COADS).

September 1:

HWM analyzes a closed low pressure of at most 1010 mb at 38.5N, 65.9W with a warm front to the north at 12Z. HURDAT lists a 35 kt extratropical storm at 38.8N, 65.6W at 12Z. Microfilm shows a closed low pressure of at most 1011 mb at 38.0N, 65.0W at 12Z. Ship highlights: 35 kt N and 1013 mb at 38.4N, 68.1W at 00Z (COADS). 35 kt N and 1010 mb at 38.7N, 66.3W at 06Z (COADS).

September 2:

HWM analyzes an extratropical cyclone of at most 995 mb at 54.0N, 63.0W (Alma appears to have been absorbed) at 12Z. HURDAT lists a 25 kt extratropical depression at 42.2N, 61.0W at 12Z. Microfilm shows an extratropical cyclone of at most 995 mb at 54.0N, 62.0W (Alma appears to have been absorbed) at 12Z. Ship highlights: 35 kt SW and 1013 mb at 39.9N, 63.0W at 06Z (COADS).

MWR: “On September 2 Alma accelerated northeastward and was absorbed by an active trough in the westerlies.”

September 3:

HWM analyzes an extratropical cyclone of at most 995 mb at 54.0N, 50.0W (Alma appears to have been absorbed) at 12Z. HURDAT does not list an organized storm on this date. Microfilm shows an extratropical cyclone of at most 1002 mb at 48.0N, 62.0W (Alma appears to have been absorbed) at 12Z. Ship highlights: No gales or low pressures.

MWR: “Damage along the east coast was comparatively minor with no fatalities and only one injury. Tides were generally less than 2 ft. above normal and there was little flooding of low-lands and shore roads. However, huge waves pounded exposed coastal installations inflicting widespread but mostly minor damage. Damage also resulted from wind and wave action. More than 100 small pleasure craft were sunk along the Massachusetts coast. Total damage was estimated at less than $1,000,000 along the New England coast and $35,000 to crops and property in North Carolina. Benefits to agriculture and water supplies in the drought areas of New England more than offset property damage inflicted by the storm.”

Hurricane Alma developed from a strong tropical wave that left the African coast around August 11th. The tropical wave traveled westward becoming better organized. The TIROS V satellite captured an image of the disturbance on August 14th at 1606Z located near 14N, 38W depicted in the microfilm nephanalysis at 18Z on the 14th showing an area of convection over the center with banding features over the northern and eastern quadrant. The surface data over the eastern Atlantic is sparse and it is not possible to

determine if a closed, low-level circulation was present. The system continued westward and was investigated by a reconnaissance aircraft on August 15th, which did not find a closed circulation and the lowest sea level pressure measured by a drop was 1012 mb. Late on August 20th and early on the 21st, the disturbance crossed the Windward Islands and surface observations suggest that a closed surface circulation may have been present, but the circulation was likely transient based on subsequent synoptic data late on the 21st. The sharp tropical wave continued across the Caribbean Sea, turning to the north on August 24th. While approaching the Florida peninsula, the disturbance became better organized and intensified into a 25 kt tropical depression at 12Z on August 26th, same as originally shown in HURDAT, just off Miami. Minor track alterations are introduced during the lifetime of this tropical cyclone.

The tropical depression moved northward on the 26th paralleling the east coast of Florida and turned to the northeast on August 27th. Intensification to a tropical storm is analyzed at 06Z on the 27th, six hours earlier than originally shown in HURDAT based upon gales observed later in the day. A central pressure of 1007 mb was present in HURDAT at 06Z on the 27th and has been removed based on surface observations indicating lower pressure values. The first gales were reported at 12Z on the 27th on the eastern quadrant of the tropical cyclone. At 15Z and 21Z on the 27th, two ships reported 45 kt near the center of Alma. A ship reported 20 kt SE and 1004 mb at 18Z on the 27th, suggesting a central pressure of 1002 mb, which has been added to HURDAT. A central pressure of 1002 mb suggests maximum sustained winds of 40 kt north of 25N from the Brown et al. pressure-wind relationship. Based on a forward speed of about 15 kt and synoptic data, an intensity of 45 kt is selected at 18Z on the 27th, same as originally shown in HURDAT.

A central pressure of 1002 mb was present in HURDAT at 00Z on August 28th and although there was no central pressure measured by a reconnaissance aircraft or ship, it appears reasonable and it is retained. At 03Z on the 28th, a ship reported 20 kt NE and 1002 mb near the center and Frying Pan Shoals, NC, had 10 kt with 1001 mb at 05Z, both suggesting a central pressure of 1000 mb, which has been added to HURDAT at 06Z on the 28th. At 06Z on the 28th, two ships reported 50 kt on the eastern quadrant. A central pressure of 1000 mb suggests maximum surface winds of 47 kt from the north of 25N pressure-wind relationship. Based on a forward speed of about 17 kt and synoptic data, an intensity of 55 kt is selected at 06Z on the 28th, same as originally shown in HURDAT. Alma made its closest approach to the Outer Banks of North Carolina, passing about 10 nm east of Hatteras Island, around 11Z on the 28th. At 1110Z on the 28th, WB Cape Hatteras, NC reported sustained winds of 35 kt and gusts to 42 kt, and five minutes earlier, the station reported its minimum pressure for the day of 997 mb. The Schwerdt et al. parametric hurricane wind model suggests that the highest sustained winds that impacted North Carolina reached 40 kt. Therefore, Alma is analyzed as a tropical storm

impact for North Carolina. Intensification to a hurricane is analyzed at 12Z on the 28th, same as originally shown in HURDAT. A central pressure of 986 mb was present in HURDAT at 12Z on the 28th and has been removed since there was no central pressure measured by a ship or reconnaissance aircraft around 12Z on the 28th. Observations from Cape Hatteras, NC, and subsequent reconnaissance data indicate that the central pressure was likely higher than 986 mb at 12Z on the 28th. At 15Z on the 28th, a ship reported 60 kt SW and 1006 mb. The reconnaissance aircraft to investigating Alma on the 28th at 2054Z measured a central pressure of 990 mb and estimated surface winds of 80 kt. A central pressure of 990 mb suggests maximum surface winds of 63 kt north of 35N from the pressure-wind relationship. Based on a forward speed of about 25 kt, an intensity of 75 kt is analyzed at 18Z on the 28th, same as originally shown in HURDAT. 75 kt is also the peak intensity of this tropical cyclone, down from 85 kt originally in HURDAT, a minor intensity change. A central pressure of 988 mb was present in HURDAT at 00Z on August 29th and although there was no central pressure measured by a reconnaissance aircraft or ship, it appears reasonable and has been retained. The existing central pressure of 990 mb in HURDAT at 12Z on the 29th has been retained based on surface observations near the center. A reconnaissance aircraft investigated the hurricane at 1850Z on the 29th measuring a central pressure of 984 mb. A central pressure of 984 mb suggests maximum surface winds of 69 kt north of 35N from the pressure-wind relationship. Based on a forward speed of about 8 kt and an increase in the size of the circulation of the hurricane, an intensity of 70 kt is selected at 18Z on the 29th, down from 75 kt originally in HURDAT, a minor intensity change.

Early on August 30th, Alma turned to the southeast and continued to lose strength. Weakening to a tropical storm is analyzed at 00Z on the 30th, same as originally shown in HURDAT. A central pressure of 994 mb was present in HURDAT at 00Z on the 30th and has been removed based on surface observations indicating a lower central pressure. Synoptic data late on the 29th and early on the 30th indicates that Alma began to acquire extratropical characteristics over the cool waters south of Nova Scotia, Canada. Transition to an extratropical cyclone is analyzed at 06Z on the 30th, twelve hours earlier than originally shown in HURDAT. This is based on the development of frontal features and a temperature-gradient between the eastern and western quadrant. The extratropical cyclone continued to weaken on August 31st and September 1st while performing a small clock-wise loop south of Nova Scotia. An approaching frontal boundary caused the weak cyclone to turn to the northeast late on the 1st and surface observations indicate that it was absorbed after 06Z on the 2nd. Thus, the last position is analyzed at 06Z on the 2nd, twelve hours earlier than originally shown in HURDAT. A central pressure of 1002 mb was present in HURDAT at 06Z on the 2nd and has been removed based on surface observations indicating a higher central pressure.

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42440 08/27/1962 M= 6  2 SNBR= 920 BECKY       XING=0 SSS=0
42440 08/27/1962 M= 6  3 SNBR= 920 BECKY       XING=0 SSS=0
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42445 08/27*  0   0   0    0*160 188  15    0*160 198  15    0*161 207  15    0*
42445 08/27*  0   0   0    0*160 180  40    0*161 190  40    0*163 199  40    0*
                              ***  **      ***  ***  **      ***  ***  **

42450 08/28*164 217  15    0*171 223  25    0*182 233  30    0*195 233  35    0*
42450 08/28*167 207  40    0*176 215  40    0*187 220  40    0*201 225  40    0*
           ***  ***  **      ***  ***  **      ***  ***  **      ***  ***  **

42455 08/29*211 235  35    0*229 239  35    0*246 248  35    0*260 260  35    0*
42455 08/29*219 230  40    0*239 235  45    0*255 242  50    0*269 254  50    0*
           ***  ***  **      ***  ***  **      ***  ***  **      ***  ***  **

42460 08/30*274 271  35    0*290 282  35    0*307 288  35    0*326 279  35    0*
42460 08/30*281 270  50    0*293 282  50    0*307 288  50    0*322 281  50    0*
           ***  ***  **      ***       **                **      ***  ***  **

42465 08/31*343 268  35    0E360 252  30    0E374 236  25    0E390 219  25    0*
42465 08/31*338 270  50    0*354 254  45    0*370 238  40    0E388 221  35    0*
           ***  ***  **     ****  ***  **     ****  ***  **      ***  ***  **

42470 09/01E407 195  25    0E421 170  20    0E433 154  15    0E449 140  15    0*
42470 09/01E407 195  25    0*  0   0   0    0*  0   0   0    0*  0   0   0    0*
                            *  *   *   *     *  *   *   *     *  *   *   *

42475 TS
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Minor changes to the track and major changes to the intensity shown in McAdie et al. (2009). Evidence for these alterations comes from the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Monthly Weather Review, Navy reconnaissance book, Mariners Weather Log, Atlas of Cloud Vortex Patterns, and NHC Storm Wallets.

August 25:

HWM and microfilm do not analyze an organized system at 12Z. HURDAT does not list an organized system on this date. Ship highlights: No gales or low pressures.

August 26:

HWM analyzes a spot low pressure at 15.8N, 19.9W at 12Z. HURDAT does not list an organized system on this date. Microfilm does not show an organized system on this date. Ship highlights: No gales or low pressures.

August 27:

HWM analyzes a closed low pressure of at most 1010 mb at 15.5N, 20.0W at 12Z. HURDAT lists a 15 kt tropical depression at 16.0N, 19.8W at 12Z. Microfilm does not show an organized system at 12Z. Ship highlights: 40 kt SSW and 1005 mb at 14.8N, 17.7W at 06Z (COADS). 25 kt S and 1005 mb at 16.7N, 17.7W at 18Z (COADS).

MWR: “The first indication of Becky in the eastern Atlantic Ocean was an increase in cloudiness and showers in the Cape Verde Islands beginning at 1200 GMT, August 27. The bad weather lasted about 30 hr and was accompanied by a surface pressure drop to about 1008 mb.” ATSR: “The first indication of a tropical disturbance in the eastern Atlantic ocean was an increase in cloudiness and showers in the vicinity of the Cape Verdes Islands on 27 August.”

August 28:

HWM analyzes a closed low pressure of at most 1010 mb at 18.0N, 23.0W at 12Z. HURDAT lists a 30 kt tropical depression at 18.2N, 23.3W at 12Z. Microfilm does not show an organized system at 12Z. Ship highlights: No gales or low pressures.

MWR: “The wind backed gradually from east and northeast to west and southwest by 1800 GMT, August 28, which suggested that a Low had moved northward east of the Islands.”

August 29:

HWM analyzes a tropical storm of at most 1005 mb at 24.5N, 25.1W at 12Z. HURDAT lists a 35 kt tropical storm at 24.6N, 24.8W at 12Z. Microfilm does not show an organized system at 12Z. Ship highlights: No gales or low pressures.

MWR: “Cloud pictures from the TIROS satellite on August 29, 1106 GMT, confirmed an area of weather with a possible vortex near 25N, 25W. Even though it is difficult to infer flow patterns from the TIROS data in the early stages of tropical cyclone development, once a well developed tropical cyclone appears, past experience suggests cloud patterns take on definite characteristics. The TIROS picture on the 29th had all the characteristics of a tropical storm.” ATSR: “Two days later, at 291106Z, the TIROS satellite revealed a cloud area with a possible vortex near 25ºN – 25ºW.”

August 30:

HWM analyzes a tropical storm of at most 1005 mb at 30.5N, 28.8W at 12Z. HURDAT lists a 35 kt tropical storm at 30.7N, 28.8W at 12Z. Microfilm shows a closed low

pressure of at most 1005 mb at 30.0N, 27.5W at 12Z. Ship highlights: 50 kt NE and 1006 mb at 30.7N, 29.2W at 1130Z (micro/MWR/WALLET).

MWR: “Further verification was received 24 hr later from a ship reporting NE winds force 9 (45 kt.) and rough seas near 30.7N, 29.2W. On the basis of this information, the US Fleet Weather Central at Port Lyautey issued an advisory at 1730 GMT. The Weather Bureau does not normally issue advisories for Atlantic storms east of longitude 35W, but arrangements have been made with military forecasting offices having responsibility in this area to use names from the official list of tropical cyclone names.” ATSR: “Twenty-four hours later a ship reported 45 knots winds and rough seas near 31ºN – 29ºW. On the basis of this information, the U.S. Fleet Weather Central, Port Lyautey issued the first of nine warnings on Tropical Storm Becky at 291730Z.”

August 31:

HWM analyzes a closed low pressure of at most 1010 mb at 37.8N, 23.2W with a cold front just to the west at 12Z. HURDAT lists a 25 kt extratropical depression at 37.4N, 23.6W at 12Z. Microfilm shows a closed low pressure of at most 1011 mb at 38.2N, 21.8W at 12Z. Ship highlights: 40 kt SE at 38.6N, 20.4W at 12Z (micro). Aircraft highlights: Penetration center fix at 39.1N, 22.0W at 1845Z (WALLET).

MWR: “The first of two reconnaissance flights was made on the 31st when an eye fix at 1845 GMT located the storm at 39.1N, 21.8W. At this time there was no evidence of a warm center since the 500-mb temperature was -10ºC. The normal increase in temperature within the eye also was not indicated and the pilot added the remark that the storm showed no tropical characteristics. There is little doubt that the storm was extratropical at this time.” ATSR: “On the 31st of September the first of two Air Force reconnaissance flights fixed the storm’s eye position approximately 175 miles soth of the Azores. Shortly thereafter, as BECKY moved over colder waters, she became extratropical while continuing on a northeasterly track toward the British Isles.”

September 1:

HWM analyzes a spot low at 43.3N, 15.9W with a cold front just to the west at 12Z. HURDAT lists a 15 kt extratropical depression at 43.3N, 15.4W at 12Z. Microfilm shows a closed low pressure of at most 1011 mb at 44.0N, 16.0W at 12Z. Ship highlights: No gales or low pressures.

MWR: “A second flight on the next day did not even find a circulation at 500 mb.”

September 2:

HWM analyzes an extratropical cyclone of at most 990 mb at 57.0N, 28.0W (Becky appears to have been absorbed) at 12Z. HURDAT does not analyze an organized storm on this date. Microfilm does not show an organized storm at 12Z. Ship highlights: No gales or low pressures.

Tropical Storm Becky developed from a strong tropical wave that left the African coast late on August 26th based on surface observations from ships and coastal stations. The first position is analyzed at 06Z on August 27th off the African coast, same as originally shown in HURDAT. The initial intensity is analyzed at 40 kt based on a ship report of 40 kt SW and 1005 mb at 06Z on the 27th, up from 15 kt originally shown in HURDAT, a major intensity change. Intensification to a tropical storm is analyzed at 06Z on the 27th, 36 hours earlier than originally shown in HURDAT. Minor track alterations are introduced during the lifetime of this tropical cyclone with the most significant changes made to the east-northeast on the 28th based on ship observations. Becky moved to the northwest passing about 90 nm northeast of the Cape Verde Islands early on August 28th. Surface observations over the far eastern Atlantic are generally sparse due to the low tripping traffic. On August 29th, the TIROS V satellite captured an image of the tropical storm at 1106Z, showing a large circulation with organized convection and banding features. The satellite image also indicates that wind shear from the south was affecting Becky and the center of circulation was tucked in the southern portion of the area of convection. The next day, a ship reported 50 kt NE in the northwest quadrant at 1130Z. Based on the satellite image and ship observation, an intensity of 50 kt is selected between 12Z on the 29th and 12Z on the 30th, up from 35 kt originally in HURDAT, a minor intensity change. 50 kt is also the peak intensity of this tropical cyclone, up from 35 kt originally in HURDAT, a minor intensity change. The peak intensity of Becky is uncertain due to the lack of data and it is possible the system may have been significantly stronger than shown. An approaching frontal boundary caused Becky to turn to the northeast on the 30th and the system began to weaken. Due to the potential threat the tropical storm posed to the Azores, a reconnaissance aircraft from the Air Force investigated Becky late on August 31st and found that it had lost its tropical characteristics. Transition to an extratropical cyclone is analyzed at 18Z on the 31st, twelve hours later than originally shown in HURDAT. Surface observation after 00Z on September 1st indicate that Becky had been absorbed by the frontal boundary, thus the last position is analyzed at 00Z on the 1st, eighteen hours earlier than originally shown in HURDAT.

Tropical Storm Celia [September 12-21, 1962]

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2480 09/12/1962 M=10  3 SNBR= 921 CELIA       XING=0 SSS=0
2480 09/12/1962 M=10  4 SNBR= 921 CELIA       XING=0 SSS=0
                      *

42485 09/12*159 459  25    0*160 467  25    0*162 475  30    0*164 487  35    0*
42485 09/12*154 459  35    0*155 468  40    0*157 477  45    0*160 487  55    0*
           ***       **      ***  ***  **      ***  ***  **      ***       **

42490 09/13*166 498  40    0*170 512  50    0*175 526  60  995*179 539  50    0*
42490 09/13*165 499  60    0*170 512  60    0*175 526  60  995*180 539  55    0*
           ***  ***  **                 **                      ***       **

42495 09/14*184 551  45    0*188 562  45 1005*193 573  45 1007*197 580  45    0*
42495 09/14*184 551  50    0*188 562  45 1005*193 572  45 1005*197 580  45    0*
                     **                       ***     ****

42500 09/15*201 586  40    0*208 594  35    0*216 601  30 1010*231 605  30    0*
42500 09/15*202 588  40    0*208 596  35    0*218 601  35 1010*231 605  30    0*
           ***  ***              ***          ***       **

42505 09/16*246 605  25    0*260 605  25    0*275 603  25    0*287 597  25    0*
42505 09/16*246 609  25    0*260 610  25    0*274 608  25    0*287 605  25    0*
           ***  ***              ***          ***  ***          ***  ***

42510 09/17*297 589  25 1010*301 576  25    0*298 563  25    0*300 550  25    0*
42510 09/17*300 595  25 1010*305 580  25    0*305 565  30    0*304 550  30    0*
           ***  ***           ***  ***          ***  ***  **      ***       **

42515 09/18*303 536  25    0*305 525  25    0*300 516  30    0*296 518  30    0*
42515 09/18*303 537  30    0*302 527  30    0*300 521  30    0*297 518  35    0*
                ***  **      ***  ***  **          ***          ***       **

42520 09/19*291 522  30    0*292 525  35    0*292 528  40    0*293 536  40 1005*
42520 09/19*294 520  40    0*292 523  45    0*292 528  45    0*293 536  45 1005*
           ***  ***  **          ***  **                **                **

42525 09/20*296 544  40    0*307 552  30    0*319 555  25 1009*327 552  25    0*
42525 09/20*296 544  40    0*305 551  40    0*315 555  40 1007*326 552  40    0*
                         ***  ***  **      ***       ** ****  ***       **

42530 09/21*336 548  25    0*358 537  25    0E380 526  25    0E407 521  25    0*
42530 09/21*338 545  40    0*358 535  40    0*380 520  35    0*  0   0   0    0*
           ***  ***  **          ***  **     *    ***  **     *  *   *   *

42535 TS
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Minor changes to the track and major changes to the intensity shown in McAdie et al. (2009). Evidence for these alterations comes from the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Monthly Weather Review, Navy reconnaissance book, Mariners Weather Log, Atlas of Cloud Vortex Patterns, and NHC Storm Wallets.

September 9:

HWM analyzes a spot low pressure at 8.5N, 34.8W at 12Z. HURDAT does not list an organized system on this date. Microfilm does not show an organized system on this date. Ship highlights: No gales or low pressures.

September 10:

HWM analyzes a closed low pressure of at most 1010 mb at 10.5N, 38.7W at 12Z. HURDAT does not list an organized system on this date. Microfilm does not show an organized system on this date. Ship highlights: No gales or low pressures.

September 11:

HWM analyzes a closed low pressure of at most 1010 mb at 13.3N, 45.0W at 12Z. HURDAT does not list an organized system on this date. Microfilm does not show an organized system at 12Z. Ship highlights: No gales or low pressures.

MWR: “A photograph from the weather satellite TIROS V showed an unorganized cloud mass near 12N, 40W at 0000 GMT, September 11, which was probably the storm in an early depression stage.”

September 12:

HWM analyzes a closed low pressure of at most 1010 mb at 16.2N, 47.7W at 12Z. HURDAT lists a 30 kt tropical depression at 16.2N, 47.5W at 12Z. Microfilm shows a tropical wave along longitude 49W at 12Z. Ship highlights: 35 kt E and 1015 mb at 18.4N, 50.7W at 12Z (COADS). 40 kt E and 1008 mb at 17.1N, 49.6W at 18Z (micro). 60 kt E and 1008 mb at 17.0N, 49.6W at 21Z (micro). TIROS highlights: Center fix at 16.8N, 47.7W around 12Z (ATSR). Aircraft highlights: Penetration center fix measured a central pressure of 1011 mb and estimated surface winds of 35 kt at 16.9N, 48.0W at 2237Z (ATSR).

MWR: “Tropical storm Celia formed in an easterly wave in the tropical atlantic on September 12, 1962. The first indication of development was an observation from the ship Mormacbay at 18.4N, 50.7W which reported an east wind of 35 kt, pressure 1014.9 mb and an easterly swell of 13 ft. at 1200 GMT, September 12. As the Mormacbay continued southeastward, its pressure fell rapidly and at 2100 GMT on the 12th it reported a pressure of 1007.8 mb with an east wind of 60 kt. A TIROS V photograph on September 12 showed a definite circulatory pattern with spiral bands centered near 17.0N, 47.5W. Navy reconnaissance aircraft reached the storm area the evening of September 12, but did not obtain a good eye fix due to darkness and because radar coverage was not feasible.” ATSR: “On the morning of 12 September, a ship in the vicinity of 16N 47W reported winds to 35 knots with increasing seas. The unsetted area appeared to be associated with a moderate easterly wave which had been under observation during the previous 24 to 36 hours. A Navy reconnaissance aircraft was immediately dispatched from Puerto Rico. Shortly thereafter, a TIROS V satellite photograph indicated a possible vortex at 16.8N and 47.7W. The circulation indicated by

TIROS V was partially verified by reconnaissance at 122137Z when the aircraft reported an apparent eye with a wide area of considerable shower and thunderstorm activity and maximum winds of 35 knots. Coincidently, at 2100Z, the same ship which had initially been affected by the disturbance reported winds reaching 50 knots approximately 60 miles to the east-northeast of the area."

September 13:

HWM analyzes a tropical storm of at most 1005 mb at 17.2N, 51.9W at 12Z. HURDAT lists a 60 kt tropical storm at 17.5N, 52.6W at 12Z. Microfilm shows a closed low pressure of at most 1005 mb at 17.5N, 52.9W at 12Z. Ship highlights: 35 kt ENE and 1011 mb at 17.9N, 50.5W at 00Z (micro). 60 kt E and 1011 mb at 17.1N, 49.1W at 03Z (micro). 35 kt ESE and 1014 mb at 19.0N, 50.9W at 12Z (micro). 35 kt SE and 1013 mb at 18.7N, 50.9W at 15Z (micro). 35 kt SE and 1012 mb at 18.2N, 50.9W at 18Z (micro). Aircraft highlights: Penetration center fix measured a central pressure of 995 mb and an eye diameter of 16 nm at 17.8N, 53.4W at 1340Z (ATSR/WALLET). Penetration center fix measured a central pressure of 1007 mb, estimated surface winds of 45 kt and an eye diameter of 6 nm at 18.5N, 54.6W at 1922Z (ATSR).

MWR: "The first advisory on Tropical Storm Celia, issued by the San Juan Weather Bureau Office at 0000 Gm, September 13, located the storm near 16.4N, 48.6W. with winds near the center estimated to be 55 to 60 mph. A hurricane watch was issued for the northern Leeward Islands at 1600 GMT September 13. Navy reconnaissance located the eye of Celia at 1000 GMT, September 13, near 17.4N, 52.5W. The eye was poorly defined, maximum winds were 45 kt, and minimum sea level pressure was 995 mb by dropsonde. This was the lowest pressure ever measured during the life cycle of Celia." ATSR: "The first warning on Tropical Storm CELIA was issued at 130000Z. As CELIA moved toward the northwest, a cyclonic circulation was observed northeast of the Leeward Islands at the 200 MB level. CELIA reached an intensity slightly under 1000 MBS with winds to 60 knots during a brief period on 13 September."

September 14:

HWM analyzes a tropical storm of at most 1005 mb at 19.3N, 57.1W at 12Z. HURDAT lists a 45 kt tropical storm at 19.3N, 57.3W at 12Z. Microfilm shows a closed low pressure of at most 1005 mb at 19.2N, 57.5W at 12Z. Ship highlights: No gales or low pressures. Aircraft highlights: Penetration center fix measured a central pressure of 1012 mb and estimated an eye diameter of 20 nm at 18.2N, 54.2W at 0053Z (ATSR). Penetration center fix measured a central pressure of 1005 mb at 18.8N, 56.6W at 0940Z (ATSR). Penetration center fix measured a central pressure of 1005 mb and estimated surface winds of 55 kt at 19.3N, 57.6W at 1245Z (ATSR).

MWR: “On the 14th the storm began to take a more northwestward course and appeared to be very poorly organized. In fact, Navy reconnaissance late on the 14th reported that the associated weather no longer resembled a tropical cyclone. The hurricane watch for the northern Leewards was discontinued at 1600 GMT, September 14.”

September 15:

HWM analyzes a closed low pressure of at most 1010 mb at 21.2N, 60.8W with a weakening stationary front far to the north at 12Z. HURDAT lists a 30 kt tropical depression at 21.6N, 60.1W at 12Z. Microfilm shows a trough northeast of the Leeward Islands at 12Z. Ship highlights: 35 kt SE and 1013 mb at 22.6N, 58.0W at 12Z (COADS). Aircraft highlights: Penetration center fix measured a central pressure of 1014 mb at 22.5N, 57.2W at 01Z (ATSR).

MWR: “Reconnaissance early on the 15th confirmed that the storm was no longer in evidence and the last advisory on Celia was issued by the Miami Weather Bureau Office at 1600 GMT, September 15. The storm had moved underneath the eastern side of a trough in the westerlies at middle and upper tropospheric levels. At the surface there was a marked absence of any significant easterly gradient winds over a large area to the north and northwest of the storm. These factors no doubt contributed to the degeneration of Celia in an area climatologically favorable for development.” ATSR: “As CELIA approached the trough, she veered to the north and by the 15th had lost tropical storm intensity. The final warning was issued at 151600Z.”

September 16:

HWM analyzes a closed low pressure of at most 1015 mb at 27.2N, 60.8W with a frontal boundary far to the northwest at 12Z. HURDAT lists a 25 kt tropical depression at 27.5N, 60.3W at 12Z. Microfilm shows a spot low pressure at 28.3N, 57.8W at 12Z. Ship highlights: No gales or low pressures. TIROS highlights: Center fix near 29.5N, 59.0W at 1813Z (micro).

ATSR: “In a weakened stage, the cyclone continued north-northeast and on the 16th TIROS photographed the circulation near 30N 58W.”

September 17:

HWM analyzes a closed low pressure of at most 1015 mb at 29.5N, 57.0W with a stationary front to the north at 12Z. HURDAT lists a 25 kt tropical depression at 29.8N, 56.3W at 12Z. Microfilm shows a closed low pressure of at most 1014 mb at 32.5N, 54.0W with a frontal boundary just to the northwest at 12Z. Ship highlights: No gales or low pressures.

MWR: “Celia was not in evidence from data on surface weather charts from the time of the last advisory until late on September 17 when it became apparent that there was a weak surface circulation well to the southeast of Bermuda. This no doubt was the remains of Celia and it apparently was reintensifying slightly.” ATSR: “…completed a small clockwise loop near 30N 55W during the period 17 thru the 20th.”

September 18:

HWM analyzes a closed low pressure of at most 1015 mb at 30.0N, 52.0W with a warm front to the north at 12Z. HURDAT lists a 30 kt tropical depression at 30.0N, 51.6W at 12Z. Microfilm shows a closed low pressure of at most 1017 mb at 30.0N, 51.0W with a frontal boundary just to the north at 12Z. Ship highlights: No gales or low pressures.

September 19:

HWM analyzes a tropical storm of at most 1010 mb at 29.2N, 52.9W at 12Z. HURDAT lists a 40 kt tropical storm at 29.2N, 52.8W at 12Z. Microfilm shows a closed low pressure of at most 1008 mb at 29.2N, 52.8W at 12Z. Ship highlights: 45 kt SSW and 1009 mb at 29.1N, 50.9W at 06Z (COADS). 35 kt SSE and 1009 mb at 29.5N, 52.0W at 12Z (COADS). 35 kt SE and 1016 mb at 30.7N, 50.7W at 18Z (COADS).

MWR: “Surface ship reports in the area indicate that Celia probably regained tropical storm intensity for about 24 hr around September 19 before turning northward and becoming extratropical. During this period of regeneration it apparently made a loop in the area some 600 mi. east-southeast of Bermuda.”

September 20:

HWM analyzes a closed low pressure of at most 1015 mb at 31.7N, 55.8W with a weakening stationary front to the northwest at 12Z. HURDAT lists a 25 kt tropical depression at 31.9N, 55.5W at 12Z. Microfilm shows a closed low pressure of at most 1011 mb at 32.3N, 55.5W at 12Z. Ship highlights: No gales or low pressures.

MWR: “A reconnaissance flight from Bermuda investigated the area early on the 20th and reported lowest pressure 1009.0 mb with maximum winds 28 kt.” ATSR: “After completing the loop the cyclone resumed its northward movement and appeared to regenerate as reconnaissance aircraft reported a wind eye together with a dispersed area of squally weather at 201300Z at a position 500 miles east-southeast of Bermuda.”

September 21:

HWM analyzes a closed low pressure of at most 1010 mb at 38.0N, 53.0W with a cold front just to the west at 12Z. HURDAT lists a 25 kt extratropical depression at 38.0N,

52.6W at 12Z. Microfilm shows a closed low pressure of at most 1011 mb at 38.0N, 51.5W with an extratropical cyclone just to the northwest at 12Z. Ship highlights: 35 kt SE and 1018 mb at 31.7N, 53.2W at 00Z (micro). 40 kt SE and 1012 mb at 36.0N, 52.4W at 06Z (COADS). 35 kt SW and 1014 mb at 36.1N, 52.5W at 12Z (COADS).

ATSR: “On the 21st the circulation again decreased in intensity and finally merged with a developing extratropical low off the Grand Banks of Newfoundland.”

September 22:

HWM analyzes an extratropical cyclone of at most 985 mb at 55.5N, 40.0W (Celia appears to have been absorbed) at 12Z. HURDAT does not list an organized storm on this date. Microfilm shows an extratropical cyclone of at most 996 mb at 54.5N, 38.0W (Celia appears to have been absorbed) at 12Z. Ship highlights: No gales or low pressures.

Tropical Storm Celia developed from a tropical wave that left the African coast around September 6th. The tropical wave moved westward and the first indications that it was becoming better organized came from a satellite image from the TIROS V on September 11th mentioned in the hurricane season summary of the Monthly Weather Review describing an unorganized cloud mass near 12N, 40W at 00Z. Ship data over the eastern and central Atlantic, especially between Africa and the Lesser Antilles, is sparse and it is difficult to assess the time of genesis. The disturbance continued westward and the first position, not genesis, is analyzed at 00Z on September 12th, same as HURDAT, as a 35 kt tropical storm, up from 25 kt originally shown in HURDAT. Minor track alterations are analyzed during the lifetime of this tropical cyclone. Intensification to a tropical storm is analyzed 18 hours earlier than originally shown in HURDAT. The first gale was reported at 12Z on the 12th, a ship northwest of the center reported 45 kt E and 1015 mb. It is this report that is the basis for indicating 35 kt at the initial point at 00Z on the 12th. Later at 21Z on the 12th, a ship reported 60 kt E and 1008 mb. Based on the ship reports and reconnaissance aircraft data later on September 13th, the intensity is analyzed at 55 kt on the 12th and 60 kt at 00Z on the 13th, up from 35 kt and 40 kt, respectively, major intensity changes to the original HURDAT. 60 kt is also the peak intensity of this tropical cyclone, same as originally analyzed in HURDAT. The TIROS V satellite captured an image of Celia at 1850Z on the 12th showing a large, organized area of convection centered near 16N, 48W with banding features over the northern and eastern quadrant. The center appears to be displaced, just under the convection in the southwest corner. The first reconnaissance aircraft reached the tropical cyclone late on the 12th estimating surface winds of 35 kt and measuring a central pressure of 1011 mb. Based on synoptic data, it is likely that the dropsonde missed the center of the tropical cyclone, thus it is not added to HURDAT. Another ship reported 60 kt E at 03Z on the 13th. The next reconnaissance aircraft investigated Celia at 10Z on the 13th measuring a central pressure

of 995 mb, estimating surface winds of 45 kt and an eye diameter of 16 nm. A central pressure of 995 mb suggests maximum surface winds of 56 kt south of 25N from the Brown et al. pressure-wind relationship. An eye diameter of 16 nm suggests an RMW of about 12 nm and the climatological value is 14. Based on a forward speed of about 15 kt, an RMW close to climatology and surface observations, an intensity of 60 kt is selected at 12Z on the 13th, same as originally shown in HURDAT.

As the tropical storm moved closer to the Lesser Antilles, it likely encountered a less favorable environment and began to gradually weaken. A reconnaissance aircraft reached Celia at 1922Z on the 13th estimating surface winds of 45 kt and a central pressure of 1007 mb. It appears likely that the dropsonde missed the center of the tropical cyclone due to the irregularities observed in the measurements on the 13th and 14th, possibly due to the poor organization of the tropical cyclone, thus the value measured was not a central pressure and it is not added to HURDAT. The next penetration fix occurred at 0053Z on September 14th measuring a central pressure of 1012 mb, which also missed the center. Another penetration fix occurred at 0940Z on the 14th measuring a central pressure of 1005 mb. A central pressure of 1005 mb was present in HURDAT at 06Z and has been retained. A central pressure of 1005 mb suggests maximum surface winds of 39 kt weakening from the south of 25N pressure-wind relationship. Based on a forward speed of about 13 kt, an intensity of 45 kt is analyzed at 06Z on the 14th, same as originally shown in HURDAT. Ship data indicates that no gales or low pressures were reported on the 14th. A reconnaissance aircraft investigated Celia at 1245Z on the 14th measuring a central pressure of 1005 mb and estimating surface winds of 55 kt. A central pressure of 1007 mb was present in HURDAT at 12Z on the 14th and has been replaced with 1005 mb. An intensity of 45 kt is analyzed at 12Z on the 14th, same as originally shown in HURDAT.

On September 15th, Celia turned to the north, passing about 225 nm to the northeast of the Leeward Islands early on the day. A reconnaissance aircraft investigated the tropical cyclone at 01Z on the 15th reporting a central pressure of 1014 mb and a center fix about 200 nm east of the analyzed position, an indication of the poorly organized state of the system. The aircraft likely missed the center, thus the central pressure value is not added to HURDAT. A central pressure of 1010 mb is present in HURDAT at 12Z on the 15th and although it was not measured by the reconnaissance aircraft or ship, it appears reasonable and has been retained. A ship reported 35 kt SE and 1013 mb at 12Z on the 15th. Weakening to a tropical depression is analyzed at 18Z on the 15th, six hours later than originally shown in HURDAT. Synoptic observations late on the 15th and on September 16th indicate that Celia was very poorly organized and may have weakened to a tropical wave. The data is inconclusive, thus Celia is retained as a tropical depression during that time. At 1821Z on the 16th, the TIROS V satellite captured another image of

Celia, showing a sheared system with a poorly organized center and all the convection over the northeast quadrant. Late on the 16th, an approaching frontal boundary caused the tropical cyclone to turn to the northeast and to the east on September 17th. A central pressure of 1010 mb is present in HURDAT at 00Z on the 17th and although it was not measured by the reconnaissance aircraft or ship, it appears reasonable and has been retained. On September 18th, the forward motion of Celia slowed down and on September 19th, the tropical cyclone turned to the west while performing a clock-wise loop. In the meantime, Celia became better organized and it is analyzed to have regained tropical storm status at 18Z on the 18th based upon susbsequent ship data, twelve hours earlier than originally shown in HURDAT. At 06Z on the 19th, a ship reported 45 kt SSW and 1009 mb. An intensity of 45 kt is analyzed at 06Z on the 19th, up from 35 kt originally in HURDAT. A central pressure of 1005 mb is present in HURDAT at 18Z on the 19th and appears reasonable based on a ship report of 30 kt S and 1008 mb near the center, thus it is retained. A central pressure of 1005 mb suggests maximum surface winds of 34 kt north of 25N from the pressure-wind relationship. Based on synoptic data, an intensity of 45 kt is analyzed at 18Z on the 19th, up from 40 kt originally in HURDAT, a minor intensity change. On September 20th, Celia turned to the northeast ahead of a frontal boundary. A central pressure of 1009 mb at 12Z on the 20th is present in HURDAT and has been replaced with 1007 mb based on a reconnaissance aircraft investigation which reported 1009 mb and 15 kt SW at 1230Z on the 20th. HURDAT originally had Celia weakening to a tropical depression at 06Z on September 21st but ship observations indicate that the tropical cyclone continued to produce gale-force winds until it was absorbed. HURDAT also originally indicated that Celia became extratropical at 12Z on the 21st but synoptic data show that the system retained its tropical characteristics until becoming absorbed after 12Z on the 21st. The last position is analyzed at 12Z on the 21st, six hours earlier than originally shown in HURDAT.

New Tropical Storm [September 20–24, 1962]

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42125 09/20/1962 M= 8  5 SNBR= 913 NOT NAMED   XING=0 SSS=0

42130 09/20*  0   0   0    0*  0   0   0    0*  0   0   0    0E400 125  40    0*
42135 09/21E395 143  40    0E390 160  40    0E384 174  40    0*377 182  40    0*
42140 09/22*370 189  40    0*364 195  40    0*359 201  40    0*356 208  40 1002*
42145 09/23*355 217  40    0*355 225  40 1003*354 229  35    0*352 228  35    0*
42150 09/24*348 218  35    0*344 200  30    0*339 175  25    0*  0   0   0    0*
42155 TS
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A new tropical storm has been added to HURDAT, not previously shown in McAdie et al. (2009). Evidence for these alterations comes from the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, and Mariners Weather Log. This disturbance was in Jack Beven’s List of Suspects.

September 19:

HWM and microfilm analyze a stationary front over the western Atlantic at 12Z. Ship highlights: No gales or low pressures.

September 20:

HWM analyzes an extratropical cyclone of at most 1010 mb at 40.0N, 12.0W at 12Z. Microfilm shows a closed low pressure of at most 1011 mb at 41.0N, 13.5W at 12Z. Ship highlights: 40 kt E and 1021 mb at 47.0N, 10.5W at 18Z (COADS). 40 kt ENE and 1016 mb at 45.1N, 16.3W at 21Z (COADS).

September 21:

HWM analyzes an extratropical cyclone of at most 1005 mb at 35.5N, 18.0W at 12Z. Microfilm shows a closed low pressure of at most 1005 mb at 35.5N, 16.5W at 12Z. Ship highlights: 35 kt ENE and 1018 mb at 45.1N, 16.3W at 00Z (COADS). 40 kt N and 1014 mb at 40.2N, 23.5W at 06Z (COADS). 40 kt N and 1010 mb at 39.3N, 20.9W at 12Z (COADS). 40 kt ENE and 1008 mb at 39.2N, 18.6W at 18Z (COADS). 30 kt N and 1002 mb at 37.5N, 19.1W at 18Z (COADS/micro).

September 22:

HWM analyzes a closed low pressure of at most 1005 mb at 36.0N, 20.0W at 12Z. Microfilm shows a closed low pressure of at most 1005 mb at 36.0N, 20.0W at 12Z. Ship highlights: 40 kt NE and 1006 mb at 38.6N, 18.6W at 00Z (COADS). 35 kt SE and 1010 mb at 39.2N, 14.5W at 06Z (COADS). 35 kt NNW and 1017 mb at 34.2N, 27.6W at 12Z (COADS). 35 kt NE and 1017 mb at 39.1N, 26.9W at 18Z (COADS). 25 kt W and 1005 mb at 34.4N, 20.6W at 18Z (COADS).

September 23:

HWM analyzes a closed low pressure of at most 1010 mb at 35.5N, 23.2W with a cold front to the northwest at 12Z. Microfilm shows a closed low pressure of at most 1008 mb at 37.0N, 22.0W at 12Z. Ship highlights: 35 kt SW and 1014 mb at 33.9N, 20.1W at 06Z (COADS). 15 kt W and 1014 mb at 34.6N, 23.3W at 06Z (COADS).

September 24:

HWM analyzes a closed low pressure of at most 1015 mb at 34.0N, 18.8W with a cold front to the northwest at 12Z. Microfilm shows a closed low pressure of at most 1011 mb at 35.0N, 19.0W with a frontal boundary to the northwest at 12Z. Ship highlights: No gales or low pressures.

September 25:

HWM analyzes a cold front over the northeast Atlantic, just off Western Europe at 12Z. Microfilm shows a closed low pressure of at most 1008 mb at 47.0N, 5.0W (original system appears to have dissipated) at 12Z. Ship highlights: No gales or low pressures.

A frontal boundary extended from the northeast Atlantic into the Iberian Peninsula on September 19th. Synoptic data indicate that an extratropical low pressure gradually organized on September 20th off the Portugal coast and moved southwestward. Surface observations show that a closed low-level circulation had developed by 18Z on the 20th and the first position is analyzed at this time as a 40 kt extratropical cyclone. Gales were reported on the 20th about 300 nm north of the center. The system gradually acquired tropical characteristics and ship observations indicate that it transitioned to a tropical storm at 18Z on September 21st. At this time, ships near the center show that the temperature gradient is uniform and the strongest winds are about 100 nm north of the center. Based on its origin and size of the circulation, it is possible that this system may have been a subtropical cyclone. A ship reported 40 kt ENE and 1008 mb at 18Z on the 21st. 40 kt is the peak intensity of this tropical cyclone. On September 22nd, the tropical cyclone continued on a southwest course maintaining its intensity. At 1318Z on the 22nd, a TIROS V captured an image of the system showing an area of convection around the center. On September 23rd, the westward movement of the tropical cyclone came to a halt as a frontal boundary approached from the west. Gales and low pressures were also reported on the 23rd by ships near the center. On September 24th, the small tropical storm turned to the southeast and is analyzed to have weakened to a tropical depression at 06Z. At 12Z on the 24th, TIROS VI captured another image of the tropical cyclone showing a sheared circulation with most of the convection northeast of the center. Surface observations at 18Z on the 24th indicate that the tropical cyclone had weakened into a trough over the northeast Atlantic. The last position is analyzed at 12Z on the 24th. Analogs to this tropical cyclone include Hurricane Vince, 2005, and Tropical Storm Grace, 2009.

Hurricane Daisy [September 29 – October 9, 1962]

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2540 09/29/1962 M=11  4 SNBR= 922 DAISY       XING=0 SSS=0
2540 09/29/1962 M=11  5 SNBR= 922 DAISY       XING=0 SSS=0
                      *

42545 09/29*  0   0   0    0*145 489  25    0*148 505  25    0*150 523  30    0*

42550 09/30*152 540  30    0*155 556  30    0*158 572  30    0*163 588  30    0*
42550 09/30*152 540  30    0*155 557  35    0*158 574  40 1005*163 590  40 1006*
                           ***  **          ***  ** ****     ***  ** ****

42555 10/01*169 599  30    0*174 607  30    0*178 612  30    0*190 620  30    0*
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42555 10/01*168 601  35    0*174 608  35    0*180 614  35 1004*190 619  35    0*
           *** ***  **          ***  **      *** ***  ** ****     ***  **

42560 10/02*203 626  30    0*213 628  30 1003*218 632  40    0*225 638  45    0*
42560 10/02*201 623  35    0*211 626  35    0*220 630  35 1005*225 638  40    0*
           *** ***  **      *** ***  **    * *** ***  ** ****          **

42565 10/03*228 644  50    0*231 651  55    0*233 656  60    0*236 663  65    0*
42565 10/03*228 645  45 1003*231 651  50    0*233 656  50 1000*236 662  55  995*
                ***  ** ****          **                ** ****     ***  **  ***

42570 10/04*239 670  65  994*241 673  65    0*243 681  65    0*248 689  70  986*
42570 10/04*239 668  55  994*241 674  60    0*243 681  65  992*247 688  70  986*
                ***  **          ***  **                    *** *** ***

42575 10/05*255 694  80    0*264 698  85    0*272 698  85    0*280 696  95  969*
42575 10/05*252 693  70  985*260 696  70  984*270 696  80  973*280 696  85  969*
           *** ***  **  *** *** ***  **  *** *** ***  **  ***          **

42580 10/06*292 696  90    0*310 686  80    0*328 681  85  965*345 675  95  968*
42580 10/06*292 693  90  967*308 686  90    0*326 679  90  965*348 672  85  968*
                ***      *** ***      **      *** ***  **      *** ***  **

42585 10/07*371 663  95    0*391 654  70  975*422 666  65    0*427 669  65    0*
42585 10/07*375 665  85    0E400 660  80    0E417 665  80  960E427 669  75    0*
           *** ***  **     **** ***  **    ***** ***  **  ****         **

42590 10/08*435 665  65    0*441 648  65    0E447 628  55    0E451 603  50    0*
42590 10/08E435 665  70    0E441 648  65    0E447 633  55    0E453 615  50    0*
          *        **     *                      ***         *** ***

42595 10/09E455 577  50    0E460 549  50    0*  0   0   0    0*  0   0   0    0*
42595 10/09E455 595  50    0E460 549  50    0*  0   0   0    0*  0   0   0    0*
                ***

42600 HR
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Minor changes to the track and intensity shown in McAdie et al. (2009). A major alteration is to show extratropical transition 30 hours earlier than originally shown in HURDAT. Evidence for these alterations comes from the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Monthly Weather Review, Navy reconnaissance book, Mariners Weather Log, Surface Weather Observations, Environment Canada and NHC Storm Wallets.

September 24:

HWM analyzes a closed low pressure of at most 1015 mb at 8.6N, 26.8W at 12Z. HURDAT does not list an organized system on this date. Microfilm does not show an organized system on this date. Ship highlights: No gales or low pressures.

September 25:

HWM analyzes a spot low pressure at 10.3N, 31.3W at 12Z. HURDAT does not list an organized system on this date. Microfilm does not show an organized system on this date. Ship highlights: No gales or low pressures.

September 26:

HWM analyzes a spot low pressure at 11.6N, 36.3W at 12Z. HURDAT does not list an organized system on this date. Microfilm shows a tropical wave along longitude 45W at 12Z. Ship highlights: No gales or low pressures.

ATSR: “The origin of the fourth tropical cyclone can be synoptically traced to 26 September when the TIROS satellite nephanalysis revealed a cloud mass at 12ºN and 36ºW. In approximately the same area, surface analysis indicated a moderate easterly wave.”

September 27:

HWM analyzes a spot low pressure at 13.0N, 41.5W at 12Z. HURDAT does not list an organized system on this date. Microfilm shows a tropical wave along longitude 47W at 12Z. Ship highlights: No gales or low pressures.

September 28:

HWM analyzes a spot low pressure at 14.5N, 46.2W at 12Z. HURDAT does not list an organized system on this date. Microfilm shows a closed low pressure of at most 1005 mb at 17.5N, 52.9W at 12Z. Ship highlights: No gales or low pressures. TIROS: Satellite center fix at 13.5N, 47W at 1303Z (micro).

MWR: “It was nearly a week after the discovery of a weak circulation that Daisy reached hurricane intensity. On September 28 ship reports and a TIROS satellite picture indicated a circulation well to the east of the Antilles.” ATSR: “On the 28th, analysis and extrapolation placed the wave at a position where TIROS again photographed a possible vortex near 28.5ºN and 47ºW.”

September 29:

HWM analyzes a spot low pressure at 14.5N, 51.0W at 12Z. HURDAT lists a 25 kt tropical depression at 14.8N, 50.5W at 12Z. Microfilm shows a closed low pressure of at most 1011 mb at 14.0N, 52.0W at 12Z. Ship highlights: No gales or low pressures. Aircraft highlights: Radar center fix near 15.0N, 52.0W at 1710Z (micro).

MWR: “The next day [29] reconnaissance aircraft located a tropical depression near 15N, 52W. The core of this circulation was cold and remained so for several days.” ATSR: “Subsequently, three NAVY reconnaissance flights were dispatched into the area on 29 and 30 September.”

September 30:

HWM analyzes a closed low pressure of at most 1010 mb at 15.5N, 57.5W at 12Z. HURDAT lists a 30 kt tropical depression at 15.8N, 57.2W at 12Z. Microfilm shows a closed low pressure of at most 1011 mb at 15.5N, 56.5W at 12Z. Ship highlights: No gales or low pressures. Aircraft highlights: Penetration center fix measured a central pressure of 1005 mb at 14.8N, 57.6W at 13Z (ATSR). Penetration center fix measured a central pressure of 1006 mb and estimated surface winds of 35 kt at 16.3N, 58.8W at 1726Z (ATSR). TIROS: Center fix at 15.0N, 56.3W at 1356Z (micro).

ATSR: “The last flight prompted the first of 31 advisories on DAISY at 301930Z.”

October 1:

HWM analyzes a closed low pressure of at most 1010 mb at 18.0N, 61.0W at 12Z. HURDAT lists a 30 kt tropical depression at 17.8N, 61.2W at 12Z. Microfilm shows a closed low pressure of at most 1008 mb at 18.0N, 61.0W at 12Z. Ship highlights: No gales or low pressures. Aircraft highlights: Penetration center fix measured a central pressure of 1006 mb and estimated surface winds of 28 kt at 17.8N, 60.9W at 1137Z (ATSR). Penetration center fix measured a central pressure of 1009 mb and estimated surface winds of 30 kt at 18.6N, 62.1W at 1615Z (ATSR).

MWR: “The depression moved toward the west-northwest, turned northward on October 1.”

October 2:

HWM analyzes a tropical storm of at most 1005 mb at 22.1N, 63.5W at 12Z. HURDAT lists a 40 kt tropical storm at 21.8N, 63.2W at 12Z. Microfilm shows a closed low pressure of at most 1008 mb at 22.0N, 63.0W at 12Z. Ship highlights: 35 kt E and 1011 mb at 23.0N, 60.9W at 06Z (COADS). 35 kt E at 24.2N, 62.5W at 12Z (micro). 35 kt ESE and 1012 mb at 24.8N, 61.1W at 17Z (micro). Aircraft highlights: Penetration center fix measured a central pressure of 1005 mb, estimated surface winds of 35 kt and an eye diameter of 4 nm at 22.2N, 63.0W at 1140Z (ATSR). Penetration center fix measured a central pressure of 1003 mb and estimated surface winds of 40 kt at 22.5N, 64.4W at 23Z (WALLET).

MWR: “…reached storm intensity on the 2nd.” ATSR: “The track of DAISY shows several marked changes in direction of movement following a northwesterly course to a position north of the Leeward Islands, then a dogleg to the west followed by a northerly track for approximately 60 hours.”

October 3:

HWM analyzes a tropical storm of at most 1005 mb at 23.1N, 65.5W with a warm front far to the north at 12Z. HURDAT lists a 40 kt tropical storm at 23.3N, 65.6W at 12Z. Microfilm shows a closed low pressure of at most 1008 mb at 22.2N, 65.8W with a frontal boundary far to the north at 12Z. Ship highlights: 50 kt SSE (gusts to 58 kt) and 1003 mb at 22.8N, 64.4W at 09Z (micro). 45 kt SSW and 1011 mb at 20.9N, 64.2W at 15Z (micro). 45 kt SW and 1008 mb at 22.0N, 65.0W at 18Z (COADS). 15 kt and 999 mb at 22.8N, 66.2W at 21Z (micro). Aircraft highlights: Penetration center fix measured a central pressure of 1000 mb and estimated surface winds of 40 kt at 23.5N, 64.8W at 1051Z (WALLET). Penetration center fix measured a central pressure of 995 mb and estimated surface winds of 57 kt at 23.6N, 66.5W at 1830Z (WALLET). Penetration center fix measured a central pressure of 994 mb and estimated surface winds of 55 kt at 23.7N, 66.5W at 2152Z (WALLET).

MWR: "…and hurricane force on the 3rd. The main intensification occurred from October 3 to October 5."

October 4:

HWM analyzes a hurricane of at most 995 mb at 24.3N, 68.8W with a stationary front to the north at 12Z. HURDAT lists a 65 kt hurricane at 24.3N, 68.1W at 12Z. Microfilm shows a closed low pressure of at most 1002 mb at 24.5N, 68.5W with a frontal boundary to the north at 12Z. Ship highlights: 15 kt SSE and 998 mb at 23.6N, 66.1W at 00Z (micro). 35 kt S and 1001 mb at 23.3N, 66.2W at 06Z (micro). 40 kt SE and 1003 mb at 24.3N, 66.4W at 09Z (COADS). 40 kt SE and 1007 mb at 24.9N, 66.4W at 12Z (COADS). 35 kt SW and 1006 mb at 22.7N, 68.2W at 15Z (micro). 45 kt ESE and 1005 mb at 26.1N, 67.2W at 18Z (micro). 45 kt SE and 1007 mb at 25.7N, 66.5W at 21Z (micro). Aircraft highlights: Ship radar fix at 24.2N, 67.3W at 02Z (WALLET). Penetration center fix at 24.5N, 67.4W at 0630Z (WALLET). Penetration center fix measured a central pressure of 992 mb, estimated surface winds of 50 kt and an eye diameter of 10 nm at 24.2N, 68.1W at 1105Z (WALLET/ATSR). Penetration center fix measured a central pressure of 986 mb, estimated surface winds of 65 kt and an eye diameter of 12 nm at 24.8N, 68.9W at 19Z (ATSR). Penetration center fix measured a central pressure of 985 mb at 25.1N, 69.1W at 2135Z (ATSR).

October 5:

HWM analyzes a hurricane of at most 995 mb at 26.6N, 69.8W with a weakening stationary front to the northeast and a cold front to the northwest at 12Z. HURDAT lists an 85 kt hurricane at 27.2N, 69.8W at 12Z. Microfilm shows a closed low pressure of at most 993 mb at 26.8N, 69.5W with a frontal boundary to the northwest at 12Z. Ship highlights: 45 kt SE and 1008 mb at 25.1N, 66.6W at 00Z (micro). 45 kt SE and 1008 mb

at 24.0N, 66.5W at 03Z (micro). 50 kt SSE and 1008 mb at 24.0N, 66.4W at 06Z (micro). 40 kt SSW and 1003 mb at 25.0N, 68.5W at 09Z (micro). 45 kt SE and 1010 mb at 26.6N, 67.2W at 12Z (micro). 50 kt E and 1010 mb at 28.2N, 69.0W at 15Z (micro). 60 kt SE and 1006 mb at 29.0N, 67.0W at 18Z (micro). 60 kt NW and 1000 mb at 27.0N, 68.0W at 21Z (micro). Aircraft highlights: Penetration center fix measured a central pressure of 984 mb at 25.5N, 69.1W at 0345Z (WALLET). Penetration center fix measured a central pressure of 973 mb at 26.6N, 69.7W at 1025Z (WALLET). Penetration center fix at 27.1N, 69.4W at 13Z (WALLET). Penetration center fix measured a central pressure of 969 mb, estimated surface winds of 85 kt and an eye diameter of 35 nm at 27.8N, 69.7W at 1801Z (ATSR).

October 6:

HWM analyzes a hurricane of at most 995 mb at 32.5N, 68.5W with a weakening front to the northwest and a warm front to the northeast at 12Z. HURDAT lists an 85 kt hurricane at 32.8N, 68.1W at 12Z. Microfilm shows a closed low pressure of at most 1005 mb at 32.6N, 68.5W with an extratropical cyclone to the northwest at 12Z. Ship highlights: 55 kt N and 1002 mb at 29.9N, 70.6W at 00Z (micro). 45 kt SE and 1011 mb at 30.0N, 65.5W at 03Z (micro). 35 kt SSE and 1011 mb at 27.2N, 65.4W at 06Z (micro). 35 kt ESE and 1009 mb at 35.1N, 67.1W at 09Z (COADS). 45 kt WNW and 1011 mb at 30.7N, 69.3W at 12Z (micro). 35 kt NNE and 1001 mb at 36.2N, 69.2W at 18Z (COADS). Land highlights: 35 kt SSE (gusts to 43 kt) and 1004 mb at Bermuda at 12Z (micro). 30 kt SSW (gusts to 46 kt) and 1003 mb at Bermuda at 18Z (micro). Aircraft highlights: Radar center fix estimated an eye diameter of 45 nm at 29.4N, 69.2W at 0130Z (ATSR). Penetration center fix measured a central pressure of 967 mb at 29.3N, 69.2W at 02Z (ATSR). Penetration center fix measured a central pressure of 965 mb and estimated surface winds of 90 kt at 32.3N, 68.3W at 1010Z (WALLET). Penetration center fix measured a central pressure of 968 mb, estimated surface winds of 100 kt and an eye diameter of 50 nm at 35.1N, 66.8W at 1924Z (ATSR).

MWR: “The hurricane passed well west of Bermuda on the 6th and the lowest central pressure, 965 mb, was reported at that time with winds of about 100 mph. The combined impact in New England of a "northeaster" on the 5th and 6th and tropical storm Daisy on the 6th and 7th produced widespread and heavy damage. Casualties included two fatalities and five injuries. Heaviest rainfall yields were produced by the coastal storm while Daisy's contribution intensified and prolonged the floods. Rain fell almost continuously for 65 hours. Areas that received more than 4 in. with flood damage included the eastern half of southern New England, eastern Vermont, New Hampshire except for the extreme northern parts, and southwestern Maine. Within the limits of these areas, amounts gradually increased to a record or near fall of 10 to 12 inches in

Middlesex and Essex Counties, Mass. Highest winds were experienced over the coastal areas of Maine, especially the central sections where speeds of 60 to more than 70 mph. were reported. Coastal installations were hammered by giant waves. Lobster fishermen suffered heavy losses and hundreds of small boats were ripped from their moorings and sunk or damaged. Acre-size Mt. Desert Rock, 22 mi offshore from Southwest Harbor, Maine, was pounded and washed by mountainous waves, some of which reportedly reached elevations 50 ft. above sea level. Damage was said to be the heaviest in the 115-yr history of the Coast Guard Base there. Estimates indicate damage from the combined storms (coastal storm immediately preceding Daisy and Daisy) may have reached $10,000,000. Estimates of damage attributed directly to Daisy were $600,000 from surf and waves, mostly in Maine, and about $500,000 from wind for all of New England. Damage was also considerable in Nova Scotia." ATSR: "DAISY passed 200 miles to the west of Bermuda early on the 6th."

October 7:

HWM analyzes a hurricane of at most 975 mb at 42.0N, 66.9W with a cold front to the southeast and a warm front to the northeast at 12Z. HURDAT lists a 65 kt hurricane at 42.2N, 66.6W at 12Z. Microfilm shows an extratropical cyclone of at most 990 mb at 42.0N, 67.0W at 12Z. Ship highlights: 65 kt NNW and 995 mb at 38.1N, 68.4W at 00Z (COADS). 70 kt ENE at 39.9N, 68.0W at 03Z (micro). 50 kt W and 992 mb at 38.0N, 68.0W at 06Z (COADS). 60 kt N and 963 mb at 42.0N, 68.0W at 12Z (COADS). 5 kt SW (70 kt in micro) and 990 mb at 39.7N, 65.3W at 12Z (COADS). 70 kt WSW and 996 mb at 40.0N, 64.4W at 15Z (COADS). 60 kt SW and 997 mb at 40.3N, 63.0W at 18Z (COADS). Land highlights: 18 kt N and 997 mb at Nantucket, MA at 0555Z (SWO). 18 kt NW and 992 mb at Nantucket, MA at 1158Z (SWO). 50 kt ESE and 975 mb at Yarmouth, Canada at 15Z (micro). 40 kt ENE and 983 mb at Eastport, ME at 18Z (micro). Aircraft highlights: Penetration center fix measured a central pressure of 975 mb and estimated an eye diameter of 8 nm at 40.7N, 64.9W at 0733Z (ATSR). Penetration center fix measured a central pressure of 960 mb at 42.0N, 66.7W at 13Z (WALLET).

MWR: "Cold air began feeding into the circulation October 7. It reached land near Yarmouth, Nova Scotia, late that day and turned sharply eastward. Yarmouth reported 977 mb as the weakening center passed there." ATSR: "On 7 October the circulation associated with a mid-tropospheric low approaching from the west briefly turned the storm to the northwest so that it skirted the New England coast with high winds and excessive precipitation. Late on the 7th the storm's circulation merged with the upper level circulation and thereafter, DAISY rapidly lost tropical characteristics. The last warning was issued at 072200Z calling for the storm to become extratropical during the forecast period."

October 8:

HWM analyzes a hurricane of at most 985 mb at 44.5N, 63.1W with a cold front to the north at 12Z. HURDAT lists a 55 kt extratropical storm at 44.7N, 62.8W at 12Z. Microfilm shows a closed low pressure of at most 981 mb at 45.0N, 63.0W at 12Z. Ship highlights: 60 kt SW and 1001 mb at 40.7N, 61.5W at 00Z (COADS). 45 kt SW and 996 mb at 40.1N, 62.8W at 06Z (micro). 40 kt SW and 989 mb at 42.3N, 62.8W at 12Z (COADS). 45 kt WSW and 996 mb at 41.6N, 61.2W at 18Z (COADS). 15 kt NE and 984 mb at 46.0N, 62.0W at 18Z (micro). Land highlights: 20 kt SE and 978 mb at Yarmouth, Canada at 00Z (micro). 20 kt SE and 985 mb at Halifax, Canada at 06Z (micro). 15 kt N and 982 mb at Halifax, Canada at 12Z (micro).

October 9:

HWM analyzes a closed low pressure of at most 995 mb at 45.0N, 50.0W with a cold front going through the center at 12Z. HURDAT lists a 50 kt extratropical storm at 46.0N, 54.9W at 06Z (last position). Microfilm shows a closed low pressure of at most 990 mb at 48.5N, 47.0W at 12Z. Ship highlights: 50 kt NW and 1000 mb at 41.5N, 63.1W at 00Z (COADS). 40 kt NE and 1005 mb at 48.2N, 61.2W at 06Z (COADS). 40 kt S and 1003 mb at 46.2N, 40.5W at 12Z (COADS).

October 10:

HWM analyzes an extratropical cyclone of at most 985 mb at 57.0N, 40.0W at 12Z. HURDAT does not list an organized storm on this date. Microfilm shows a closed low pressure of at most 990 mb at 48.5N, 47.0W at 12Z. Ship highlights: No gales or low pressures.

Hurricane Daisy developed from a tropical wave that left the African coast late in September. The system moved westward and slowly became better organized. Data over the eastern and central Atlantic is sparse, thus the time of genesis is uncertain. The first indication that the tropical wave was developing was a TIROS VI satellite image on September 28th at 1303Z showing a large area of convection with some banding features on the northern quadrant, as depicted in the nephanalysis at 12Z on the 28th. The first position is analyzed at 06Z on September 29th as a 25 kt tropical depression, same as originally shown in HURDAT. The tropical cyclone moved westward at a rapid forward speed of about 17 kt on the 29th and 30th. A reconnaissance aircraft reached the tropical depression at 13Z on September 30th measuring a central pressure of 1005 mb. A central pressure of 1005 mb suggests maximum surface winds of 37 kt south of 25N from the Brown et al. pressure-wind relationship. Based on a forward speed of about 17 kt, an intensity of 40 kt is selected at 12Z on the 30th, up from 30 kt originally in HURDAT, a minor intensity change. (Central pressures values for almost every 6 hour period were

present in the original HURDAT between October 2nd at 06Z and October 7th at 06Z. Some of these were obviously analyses that were added in, not based upon actual observations. Thus, based on actual observations, some were retained, others removed and new central pressure values added. Detailed information on these changes can be found in the table at the end.) Intensification to a tropical storm is analyzed at 06Z on the 30th, 54 hours earlier than originally shown in HURDAT. Minor track changes are analyzed during the lifetime of this tropical cyclone. On October 1st, Daisy turned to the northwest and decreased in forward speed, passing about 30 nm northeast of Barbuda, closest approach to the Leeward Islands. Surface observations and data from the reconnaissance aircrafts on October 1st and 2nd indicate that the system remained a weak tropical storm with only minor fluctuations in intensity. The first gale-force wind was reported on the 2nd at 06Z by a ship in the northeast quadrant of Daisy.

The tropical cyclone began to deepen on October 3rd while located north of Puerto Rico. A reconnaissance aircraft at 23Z on the 2nd reported a central pressure of 1003 mb and estimated surface winds of 40 kt. A central pressure of 1003 mb suggests maximum surface winds of 41 kt south of 25N from the pressure-wind relationship. Based on a forward speed of about 7 kt and synoptic observations, an intensity of 45 kt is analyzed at 00Z on the 3rd, down from 50 kt originally in HURDAT, a minor intensity change. A ship at 09Z on the 3rd reported 50 kt SSE and 1003 mb. Another penetration fix occurred at 1051Z on the 3rd measuring a central pressure of 1000 mb and estimated surface winds of 40 kt. A central pressure of 1000 mb suggests maximum surface winds of 47 kt south of 25N from the pressure-wind relationship. Based on a forward speed of about 9 kt and ship data, an intensity of 50 kt is analyzed at 12Z on the 3rd, down from 60 kt originally in HURDAT, a minor intensity change. A penetration fix occurred at 1830Z on the 3rd measuring a central pressure of 995 mb and estimated surface winds of 57 kt. A central pressure of 995 mb suggests maximum surface winds of 56 kt south of 25N from the pressure-wind relationship. Based on a forward speed of about 8 kt, an intensity of 55 kt is analyzed at 18Z on the 3rd, down from 65 kt originally in HURDAT, a minor intensity change. At 2152Z on the 3rd, another reconnaissance aircraft investigated Daisy measuring a central pressure of 994 mb and estimating surface winds of 55 kt. A central pressure of 994 was already present in HURDAT at 00Z on October 4th and it is retained. An intensity of 55 kt is selected at 00Z on the 4th, down from 65 kt originally in HURDAT, a minor intensity change. The next reconnaissance aircraft measured a central pressure of 992 mb, estimated surface winds of 50 kt and an eye diameter of 10 nm. A central pressure of 992 mb suggests maximum surface winds of 61 kt south of 25N and 56 kt north of 25N from the pressure-wind relationship. An eye diameter of 10 nm suggests an RMW of about 8 nm and the climatological value is 20. Based on an RMW smaller than the climatological value and a forward speed of about 8 kt, an intensity of 65 kt is selected at 12Z on the 4th, same as originally shown in HURDAT. Intensification to

a hurricane is analyzed at 12Z on the 4th, 18 hours later than originally shown in HURDAT. The TIROS V satellite captured an image of Daisy at 1312Z on the 4th showing a well-organized tropical cyclone with a central dense overcast and an eye. A penetration center fix measured a central pressure of 986 mb, estimated surface winds of 65 kt and an eye diameter of 12 nm at 19Z on the 4th. A central pressure of 986 mb suggests maximum surface winds of 70 kt south of 25N, 65 kt north of 25N, and 68 kt intensifying from the pressure-wind relationship. An eye diameter of 12 nm suggests an RMW of about 9 nm and the climatological value is 20. Based on an RMW smaller than the climatological value and a forward speed of about 8 kt, an intensity of 70 kt is selected at 18Z on the 4th, same as originally shown in HURDAT. Another center fix measured a central pressure of 985 mb at 2135Z on the 4th. An intensity of 70 kt is analyzed at 00Z on the 5th, down from 80 kt originally shown in HURDAT.

On October 5th, Daisy turned to the north gradually intensifying. At 0345Z on the 5th, the reconnaissance aircraft measured a central pressure of 984 mb. A central pressure of 984 mb suggests maximum surface winds of 68 kt north of 25N from the pressure-wind relationship. Based on a forward speed of about 10 kt, an intensity of 70 kt is selected at 06Z on the 5th, down from 85 kt originally shown in HURDAT. Another penetration fix measured a central pressure of 973 mb at 1025Z on the 5th. A central pressure of 973 mb suggests maximum surface winds of 81 kt north of 25N from the pressure-wind relationship. Based on a forward speed of about 10 kt, an intensity of 80 kt is selected at 12Z on the 5th, down from 85 kt originally shown in HURDAT. The TIROS V satellite captured an image of 1245Z on the 5th showing a well-organized tropical cyclone. The next reconnaissance aircraft measured a central pressure of 969 mb, estimated surface winds of 85 kt and an eye diameter of 35 nm at 1801Z on the 5th. A central pressure of 969 mb suggests maximum surface winds of 86 kt north of 25N from the pressure-wind relationship. An eye diameter of 35 nm suggests an RMW of about 26 nm and the climatological value is 22. Based on an RMW close or slightly larger than climatology and a forward speed of about 10 kt, an intensity of 85 kt is selected at 18Z on the 5th, down from 95 kt originally shown in HURDAT. On October 6th, Daisy turned to the northeast and passed about 150 nm west of Bermuda. The first reconnaissance aircraft on the 6th reached the hurricane at 02Z measuring a central pressure of 967 mb. A central pressure of 967 mb suggests maximum surface winds of 88 kt north of 25N from the pressure-wind relationship. Based on a forward speed of about 17 kt, an intensity of 90 kt is selected at 00Z on the 6th, same as originally shown in HURDAT. 90 kt is also the peak intensity of this tropical cyclone, down from 95 kt originally in HURDAT. A penetration center fix at 1010Z on the 6th measured a central pressure of 965 mb and estimated surface winds of 90 kt. A central pressure of 965 mb suggests maximum surface winds of 90 kt north of 25 north from the pressure-wind relationship. Based on a forward speed of 23 kt and large circulation, an intensity of 90 kt is analyzed at 12Z on

the 6th, down from the 85 kt originally shown in HURDAT, a minor intensity change. Another penetration center fix at 1924Z on the 6th measured a central pressure of 968 mb, estimated surface winds of 100 kt and an eye diameter of 50 nm. A central pressure of 968 mb suggests maximum surface winds of 87 kt north of 25N from the Brown et al. and 84 kt north of 35N from the Landsea et al. pressure-wind relationships. An eye diameter of 50 nm suggests an RMW of about 38 nm and the climatological value is 28. Based on a forward speed of 28 kt and large circulation, an intensity of 85 kt is analyzed at 18Z on the 6th, down from the 95 kt originally shown in HURDAT, a minor intensity change. Late on the 6th and early on October 7th, Daisy began to acquire extratropical characteristics. Synoptic observations indicate that it became an extratropical cyclone at 06Z on the 7th while located south of Nova Scotia. Transition to an extratropical cyclone is analyzed 30 hours earlier than originally shown in HURDAT. On October 7th, Daisy turned to the northwest and slowed its forward speed. The windfield expanded producing strong winds across the coastal areas of the Northeast of the United States and the southeastern Canada. The strong winds produced large waves that battered the coastline and heavy rains led to flooding. The last reconnaissance aircraft to investigate Ella measured a central pressure of 960 mb at 13Z on the 7th. On October 8th, the extratropical cyclone turned to the east-northeast increasing in forward speed while crossing Nova Scotia. Weakening below hurricane intensity is analyzed at 12Z on the 8th, same as originally shown in HURDAT. Ella continued to weaken on the 9th and synoptic observations indicate that it was absorbed by a larger extratropical cyclone after 06Z. The last position is analyzed at 06Z on the 9th, same as originally shown in HURDAT.

Date	Original HURDAT Central Pressure	Evidence	Changes
Sep 30 12Z		Penetration center fix: 1005 mb at 13Z on Sep 30th	1005 mb
Sep 30 18Z		Penetration center fix: 1006 mb at 1726Z on Sep 30th	1006 mb
Oct 01 12Z		Dropsonde measured 1006 mb and 20 kt SSW at 1045Z on Oct 01th	1004 mb
Oct 02 06Z	1003 mb	No central pressure report around this time from reconnaissance aircraft or ships	Removed
Oct 02 12Z		Penetration center fix: 1005 mb at 1140Z on Oct 02nd	1005 mb
Oct 03 00Z		Penetration center fix: 1003 mb at 23Z on Oct 02nd	1003 mb

Oct 03 12Z		Penetration center fix: 1000 mb at 1051Z on Oct 03rd	1000 mb
Oct 03 18Z		Penetration center fix: 995 mb at 1830Z on Oct 03rd	995 mb
Oct 04 00Z	994 mb	Penetration center fix: 994 mb at 2152Z on Oct 03rd	Retained
Oct 04 12Z		Penetration center fix: 992 mb at 1105Z on Oct 04th	992 mb
Oct 04 18Z	986 mb	Penetration center fix: 986 mb at 19Z on Oct 04th	Retained
Oct 05 00Z		Penetration center fix: 985 mb at 2135Z on Oct 04th	985 mb
Oct 05 06Z		Penetration center fix: 984 mb at 0345Z on Oct 05th	984 mb
Oct 05 12Z		Penetration center fix: 973 mb at 1025Z on Oct 05th	973 mb
Oct 05 18Z	969 mb	Penetration center fix: 969 mb at 1801Z on Oct 05th	Retained
Oct 06 00Z		Penetration center fix: 967 mb at 02Z on Oct 06th	967 mb
Oct 06 12Z	965 mb	Penetration center fix: 965 mb at 1010Z on Oct 06th	Retained
Oct 06 18Z	968 mb	Penetration center fix: 968 mb at 1924Z on Oct 06th	
Oct 07 06Z	975 mb	Ship observations suggests that the central pressure was lower	Removed
Oct 07 12Z		Penetration center fix: 960 mb at 13Z on Oct 07th	960 mb

Hurricane Ella [October 14-23, 1962]

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42605 10/14/1962 M=10  5 SNBR= 923 ELLA        XING=0 SSS=0                    L
42605 10/14/1962 M=10  6 SNBR= 923 ELLA        XING=0 SSS=0
                       *                                                       *

42610 10/14*  0   0   0    0*  0   0   0    0*  0   0   0    0*221 714  25    0*
42610 10/14*  0   0   0    0*225 730  30    0*230 728  30    0*234 725  30    0*
                           *** ***  **      *** ***  **      *** ***  **

42615 10/15*238 721  25 1002*247 721  30    0*250 721  35    0*252 721  40 1002*
42615 10/15*238 723  30 1002*242 722  30    0*247 721  35    0*252 721  40 1002*
              ***  **      *** ***          ***

42620 10/16*258 722  40 1002*261 726  50    0*263 732  55    0*264 740  60 1002*
42620 10/16*257 722  40 1002*261 726  40    0*263 732  45    0*264 740  45 1002*
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42625 10/17*267 748  60  994*270 751  60  997*274 752  60  992*281 754  70  987*
42625 10/17*266 748  50  994*270 751  50  997*275 752  55  992*282 754  60  989*
           ***      **               **      ***      **      ***      **  ***

42630 10/18*287 756  75    0*292 757  70  981*297 758  70  978*302 758  70  976*
42630 10/18*290 755  65    0*295 756  65  981*298 758  70  978*302 760  75  973*
           *** ***  **      *** ***  **      ***                  ***  **  ***

42635 10/19*307 758  75    0*307 751  80  973*307 746  90  969*313 736 100  962*
42635 10/19*306 760  75    0*307 756  75  973*307 746  80  969*311 736  90  962*
           *** ***              ***  **                  **      ***      **

42640 10/20*319 728 100    0*330 718  85  960*339 708  85  960*346 696  85  964*
42640 10/20*319 727  90  960*330 718  90  963*339 708  90  960*345 697  85  964*
               ***  **  ***          **  ***          **          ***

42645 10/21*352 681  80    0*360 663  75    0*367 646  70  972*375 626  65  950*
42645 10/21*352 681  85    0*360 663  80    0*367 645  80  961*375 626  80  958*
                **               **          ***  **  ***          **  ***

42650 10/22*395 597  65    0E429 563  60    0E467 534  60    0E490 500  60    0*
42650 10/22*395 599  75    0E429 572  65    0E460 540  60    0E480 490  60    0*
               ***  **          ***  **      *** ***          *** ***

42655 10/23E520 451  60    0E541 414  60    0E562 370  60    0*  0   0   0    0*
42655 10/23E510 451  60    0E541 421  60    0E555 390  60    0E560 350  55    0*
           ***              ***          ***  ***          **** ***  **

(October 24th and 25th are new to HURDAT)
42657 10/24E570 310  50    0E580 270  50    0E590 230  50    0E600 175  50    0*
42659 10/25E605 105  50    0E610 055  50    0*  0   0   0    0*  0   0   0    0*

42660 HR
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Minor changes to the track and major changes to the intensity shown in McAdie et al. (2009). Evidence for these alterations comes from the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Monthly Weather Review, Navy reconnaissance book, Mariners Weather Log, Local Climatological Data, National Hurricane Research Project and NHC Storm Wallets.

October 11:

HWM does not analyze an organized system at 12Z. HURDAT does not list an organized system on this date. Microfilm shows a tropical wave near the Lesser Antilles along longitude 59W. Ship highlights: No gales or low pressures.

October 12:

HWM does not analyze an organized system at 12Z. HURDAT does not list an organized system on this date. Microfilm shows a tropical wave over the Lesser Antilles. Ship highlights: No gales or low pressures. Aircraft highlights: Flight level winds of 35 kt and a pressure of 1010 mb at 14.8N, 63.8W at 1130Z (micro).

October 13:

HWM analyzes a closed low pressure of at most 1010 mb at 16.8N, 75.8W at 12Z. HURDAT does not list an organized system on this date. Microfilm shows a tropical wave over Hispaniola and attached is a closed low pressure of at most 1011 mb at 17.7N, 72.7W at 12Z. Ship highlights: No gales or low pressures.

MWR: “The only prior indication of a disturbance was an area of increasing cloudiness and shower activity centered about 200 mi northeast of Turks Island on the 13th. This area coincided with the northern portion of a weak 500-mb Low which had become cut off at the base of a polar trough and was drifting slowly west-northwestward. The surface charts on the 13th showed a rather weak gradient with general easterly flow and a minor inverted trough with cyclonic curvature and shear in the vicinity of the unsettled weather.” ATSR: “First evidence of a surface disturbance was a weak inverted trough located north of Hispaniola coast on 13 October. This was attended by squally weather and stratus type clouds while peripheral ships to the north of the center were reporting winds of 20-25 knots.”

October 14:

HWM analyzes a closed low pressure of at most 1010 mb at 23.0N, 72.0W at 12Z. HURDAT lists a 25 kt tropical depression at 22.1N, 71.4W at 18Z (first position). Microfilm shows a closed low pressure of at most 1011 mb at 23.0N, 72.0W at 12Z. Ship highlights: 35 kt ENE and 1011 mb at 24.3N, 72.2W at 00Z (COADS). Aircraft highlights: Penetration center fix measured a central pressure of 1012 mb, estimated surface winds of 18 kt and an eye diameter of 20 nm at 23.8N, 73.0W at 20Z (ATSR).

MWR: “The depression which was to grow into hurricane Ella developed in the southeastern Bahamas on October 14. Ships and islands near and to the north of the circulation center reported winds of 20 to 30 knots on that date.” ATSR: “The unsettled area drifted north and then west-northwest so that the 14th it was located in the extreme southeastern Bahamas area. Early on the 14th aircraft reconnaissance reported that a depression had formed and this prompted the first of four tropical depression warnings issued at 141805Z. The depression remained to the east of the Bahamas while gradually intensifying.”

October 15:

HWM analyzes a closed low pressure of at most 1010 mb at 24.2N, 72.9W with a weakening cold front to the north at 12Z. HURDAT lists a 35 kt tropical storm at 25.0N, 72.1W at 12Z. Microfilm shows a closed low pressure of at most 1008 mb at 24.8N, 71.2W with a frontal boundary to the north at 12Z. Ship highlights: 35 kt NE and 1011

mb at 26.2N, 74.1W at 15Z (micro). 40 kt NE and 1011 mb at 28.5N, 69.6W at 18Z (COADS). 35 kt ENE and 1012 mb at 28.1N, 71.7W at 21Z (micro). Aircraft highlights: Penetration center fix measured a central pressure of 1002 mb, estimated surface winds of 40 kt and an eye diameter of 20 nm at 25.5N, 72.4W at 1850Z (WALLET). Penetration center fix measured a central pressure of 1003 mb and estimated surface winds of 40 kt at 25.3N, 71.8W at 2125Z (WALLET).

MWR: “The depression drifted toward the north, then west-northwestward, and gradually intensified. It attained tropical storm force on the 15th, but remained poorly organized.” ATSR: “Tropical storm force was reached by late afternoon on the 15th. The first numbered advisory on Tropical Storm ELLA was issued at 152200Z.”

October 16:

HWM analyzes a tropical storm of at most 1005 mb at 26.4N, 73.3W with a warm front to the northeast at 12Z. HURDAT lists a 55 kt tropical storm at 26.3N, 73.2W at 12Z. Microfilm shows a closed low pressure of at most 1008 mb at 25.5N, 74.0W at 12Z. Ship highlights: 40 kt NE and 1014 mb at 29.8N, 70.3W at 00Z (COADS). 45 kt NE and 1011 mb at 29.0N, 74.0W at 03Z (micro). 35 kt ENE and 1009 mb at 27.6N, 74.0W at 06Z (COADS). 35 kt NE and 1012 mb at 28.7N, 74.0W at 12Z (COADS). 40 kt NE and 1012 mb at 30.0N, 73.9W at 18Z (COADS). Land highlights: 35 kt N and 1009 mb at North Eleuthera, Bahamas at 12Z (micro). Aircraft highlights: Penetration center fix measured a central pressure of 1006 mb (1002 mb from 700 mb), estimated surface winds of 70 kt in the northeast quadrant and an eye diameter of 20 nm at 26.4N, 73.7W at 1353Z (WALLET/ATSR). Penetration center fix measured a central pressure of 1002 mb and estimated surface winds of 70 kt at 26.4N, 73.8W at 16Z (WALLET). Penetration center fix measured a central pressure of 994 mb, estimated flight level winds of 60 kt and an eye diameter of 25 nm at 26.6N, 74.9W at 2242Z (WALLET).

October 17:

HWM analyzes a tropical storm of at most 1000 mb at 27.5N, 75.4W with a warm front to the northeast at 12Z. HURDAT lists a 60 kt tropical storm at 27.4N, 75.2W at 12Z. Microfilm shows a closed low pressure of at most 993 mb at 28.1N, 75.2W at 12Z. Ship highlights: 35 kt E and 1010 mb at 29.2N, 71.6W at 00Z (COADS). 35 kt NE and 1010 mb at 30.6N, 74.9W at 06Z (COADS). 25 kt WSW and 999 mb at 26.1N, 74.2W at 09Z (micro). 35 kt SW and 1000 mb at 26.9N, 73.9W at 12Z (COADS). 45 kt SE and 1000 mb at 29.4N, 73.5W at 15Z (micro). 60 kt NE and 994 mb at 28.9N, 76.6W at 18Z (micro). 40 kt SSE and 997 mb at 28.6N, 73.7W at 21Z (micro). Land highlights: 20 kt W and 1005 mb at San Salvador, Bahamas at 00Z (micro). 30 kt NW and 1005 mb at Central Abaco, Bahamas at 12Z (micro). 30 kt NW and 1004 mb at Central Abaco,

Bahamas at 18Z (micro). Aircraft highlights: Penetration center fix measured a central pressure of 997 mb at 27.1N, 75.0W at 04Z (WALLET). Penetration center fix measured a central pressure of 992 mb and estimated surface winds of 60 kt at 27.5N, 75.1W at 1215Z (WALLET). Penetration center fix measured a central pressure of 989 mb, estimated surface winds of 75 kt and an eye diameter of 80 nm at 28.5N, 75.4W at 1735Z (WALLET).

MWR: “A turn to the north-northwest occurred on the 17th and Ella reached hurricane intensity about noon on that date. Intermittent gales and heavy seas affected the central and northern Bahamas but the hurricane-force winds were well to the north of the islands.” ATSR: “After attaining hurricane force, aircraft reconnaissance reported eyes from 60 to 100 miles in diameter as she progressed in a northeasterly direction off the Atlantic coastline.”

October 18:

HWM analyzes a tropical storm of at most 990 mb at 29.7N, 75.7W with a cold front to the northwest at 12Z. HURDAT lists a 70 kt hurricane at 29.7N, 75.8W at 12Z. Microfilm shows a closed low pressure of at most 986 mb at 30.1N, 75.5W with a frontal boundary to the northwest at 12Z. Ship highlights: 35 kt S and 1000 mb at 28.3N, 73.4W at 00Z (COADS). 50 kt NE and 1009 mb at 32.2N, 78.6W at 00Z (COADS). 40 kt NE and 1016 mb at 33.7N, 74.3W at 06Z (COADS). 40 kt SSE and 999 mb at 30.7N, 73.0W at 09Z (micro). 35 kt S and 999 mb at 28.3N, 73.6W at 12Z (micro). 90 kt SSE (gusts to 100 kt) and 987 mb at 30.6N, 74.5W at 15Z (micro). 85 kt SSE and 983 mb at 30.6N, 74.6W at 18Z (micro). 60 kt S and 995 mb at 30.9N, 73.9W at 21Z (micro). Land highlights: 35 kt NE and 1008 mb at Diamond Shoals, NC at 15Z (micro). Aircraft highlights: Aircraft highlights: Penetration center fix measured a central pressure of 981 mb at 29.5N, 75.4W at 0726Z (WALLET). Penetration center fix measured a central pressure of 978 mb and estimated surface winds of 60 kt at 29.8N, 76.0W at 1247Z (WALLET). Penetration center fix measured a central pressure of 973 mb, estimated surface winds of 75 kt and an eye diameter of 61-84 nm at 30.5N, 76.3W at 1910Z (ATSR).

MWR: “On October 18, Ella continued toward the north-northwest with gradual deepening. Central pressure dropped to 976 mb and maximum winds were reported as 80 kt. A ship 90 mi southeast of the center reported heavy confused seas ranging up to 40 to 45 ft.”

October 19:

HWM analyzes a hurricane of at most 985 mb at 30.7N, 74.7W with a weakening stationary front just to the northwest at 12Z. HURDAT lists a 90 kt hurricane at 30.7N,

74.6W at 12Z. Microfilm shows a closed low pressure of at most 1005 mb at 30.5N, 74.5W at 12Z. Ship highlights: 50 kt N and 1006 mb at 32.2N, 79.0W at 00Z (COADS). 40 kt S and 992 mb at 29.7N, 73.7W at 06Z (COADS). 55 kt WNW and 1004 mb at 27.9N, 76.5W at 12Z (COADS). 105 kt SW and 999 mb at 30.3N, 74.4W at 15Z (micro). 80 kt W and 982 mb at 30.2N, 74.3W at 18Z (micro). 75 kt W and 993 mb at 29.5N, 73.8W at 21Z (MWL). Aircraft highlights: Penetration center fix at 30.6N, 75.9W at 01Z (WALLET). Penetration center fix measured a central pressure of 976 mb and an eye diameter of 40-60 nm at 30.7N, 75.9W at 04Z (WALLET). Penetration center fix measured a central pressure of 973 mb and estimated surface winds of 95 kt at 30.3N, 75.5W at 07Z (WALLET). Penetration center fix measured a central pressure of 969 mb, estimated surface winds of 90 kt and an eye diameter of 55 nm at 30.7N, 74.5W at 1205Z (WALLET). Penetration center fix measured a central pressure of 962 mb, estimated flight level winds of 105 kt and an eye diameter of 50 nm at 31.2N, 73.6W at 19Z (WALLET).

MWR: “The hurricane came under the influence of a short-wave trough passing to the north on the 19th and changed course first to the east, then to the northeast, accelerating from about 5 kt to 12 to 15 kt.” ATSR: “The passage of a short wave late on the 19th veered ELLA to the east then northeast.”

October 20:

HWM analyzes a hurricane of at most 985 mb at 33.6N, 70.9W with a weakening stationary front just to the south and a warm front to the north at 12Z. HURDAT lists an 85 kt hurricane at 33.9N, 70.8W at 12Z. Microfilm shows a closed low pressure of at most 1005 mb at 33.5N, 70.5W at 12Z. Ship highlights: 80 kt S and 968 mb at 32.0N, 72.3W at 00Z (COADS). 85 kt E and 969 mb at 32.7N, 72.3W at 03Z (COADS). 55 kt SSE and 972 mb at 33.6N, 70.5W at 06Z (micro). 50 kt SW and 979 mb at 32.4N, 70.5W at 12Z (COADS). 45 kt SW and 988 mb at 32.5N, 75.5W at 15Z (micro). 50 kt SW and 994 mb at 31.8N, 69.4W at 18Z (COADS). Aircraft highlights: Penetration center fix measured a central pressure of 960 mb, estimated flight level winds of 78 kt and an eye diameter of 50 nm at 32.2N, 72.7W at 0204Z (WALLET/ATSR). Penetration center fix measured a central pressure of 963 mb at 33.3N, 71.7W at 0705Z (WALLET/ATSR). Penetration center fix measured a central pressure of 960 mb, estimated surface winds of 85 kt and an eye diameter of 100 nm at 33.9N, 70.4W at 13Z (WALLET). Penetration center fix measured a central pressure of 964 mb, estimated surface winds of 85 kt and an eye diameter of 100 nm at 34.5N, 69.7W at 19Z (WALLET).

MWR: “Some further intensification occurred with a minimum pressure of 960 mb and maximum winds of about 90 kt on the 20th.”

October 21:

HWM analyzes a hurricane of at most 975 mb at 36.3N, 64.9W with a weakening warm front to the north at 12Z. HURDAT lists a 70 kt hurricane at 36.7N, 64.6W at 12Z. Microfilm shows a closed low pressure of at most 990 mb at 36.7N, 64.6W with a frontal boundary to the north at 12Z. Ship highlights: 60 kt SE and 1011 mb at 32.1N, 65.9W at 00Z (COADS). 40 kt WNW and 977 mb at 35.8N, 62.5W (longitude likely 5 degrees off to the east) at 06Z (COADS). 65 kt SW and 992 mb at 34.3N, 64.8W at 12Z (COADS). 50 kt W and 1001 mb at 34.1N, 64.9W at 18Z (COADS). 55 kt S and 997 mb at 37.3N, 57.3W at 21Z (MWL). Aircraft highlights: Penetration center fix measured a central pressure of 961 mb, estimated surface winds of 60 kt and an eye diameter of 100 nm at 36.8N, 64.2W at 13Z (WALLET). Penetration center fix measured a central pressure of 958 mb, estimated surface winds of 70 kt and an eye diameter of 100 nm at 37.9N, 62.3W at 19Z (WALLET).

MWR: “A gradual rise in central pressure followed, accompanied by a slow decrease in maximum winds and a spread of the gale area as Ella moved northeastward more rapidly on the 21st and 22nd of October. An interesting feature of Ella was an unusually large eye. The diameter was reported as 25 mi. on the 16th, 40 to 60 mi on the l9th, and 100 mi on the 21st.” ATSR: “This course was maintained until the hurricane merged with a frontal system south of Newfoundland and became extratropical on the 21st.”

October 22:

HWM analyzes a closed low pressure of at most 975 mb at 44.5N, 51.5W with a warm front to the east at 12Z. HURDAT lists a 60 kt extratropical storm at 46.7N, 53.4W at 12Z. Microfilm shows an extratropical cyclone of at most 984 mb at 47.3N, 54.7W at 12Z. Ship highlights: 75 kt SE and 994 mb at 37.2N, 57.5W at 00Z (COADS/MWL). 65 kt SE and 999 mb at 39.1N, 52.9W at 06Z (COADS). 55 kt S and 1002 mb at 41.2N, 48.4W at 12Z (COADS). 50 kt SW and 994 mb at 44.2N, 46.8W at 18Z (micro).

MWR: “However, by the evening of the 21st, her broad circulation pattern had begun to merge with that of a developing frontal wave moving through Nova Scotia with a resultant gradual loss of tropical characteristics.” ATSR: “However advisories were continued with the final warning being issued at 221600Z.”

October 23:

HWM analyzes an extratropical cyclone of at most 970 mb at 56.0N, 38.0W at 12Z. HURDAT lists a 60 kt extratropical storm at 56.2N, 37.0W at 12Z (last position). Microfilm shows an extratropical cyclone of at most 1002 mb at 54.7N, 42.7W at 12Z. Ship highlights: 50 kt W and 1007 mb at 43.5N, 49.0W at 00Z (COADS). 50 kt SW and

994 mb at 50.7N, 37.6W at 06Z (COADS). 50 kt SSW and 987 mb at 53.0N, 36.2W at 12Z (COADS). 50 kt SW and 993 mb at 52.8N, 35.5W at 15Z (COADS). 30 kt SW and 973 mb at 56.1N, 34.1W at 18Z (micro).

October 24:

HWM analyzes an extratropical cyclone of at most 985 mb at 61.0N, 19.0W at 12Z. HURDAT does not list an organized storm on this date. Microfilm shows a closed low pressure of at most 999 mb at 58.5N, 20.0W at 12Z. Ship highlights: 45 kt NE and 998 mb at 62.1N, 32.7W at 00Z (COADS). 50 kt N and 997 mb at 58.6N, 35.0W at 06Z (COADS). 45 kt SW and 990 mb at 55.0N, 21.8W at 12Z (COADS). 45 kt NE and 993 mb at 62.2N, 18.3W at 18Z (COADS).

October 25:

HWM analyzes an extratropical cyclone of at most 985 mb at 72.0N, 11.0E at 12Z. HURDAT does not list an organized storm on this date. Microfilm is not available on this date (cyclone outside the map). Ship highlights: 35 kt N and 997 mb at 58.9N, 19.1W at 00Z (COADS). 50 kt NE and 999 mb at 61.3N, 10.7W at 06Z (COADS). 45 kt N and 1001 mb at 58.8N, 9.2W at 12Z (COADS).

MWR: “Property damage associated with Ella was minor, consisting mostly of beach erosion along the middle Atlantic coast. Two fishermen apparently lost their lives in the fringes of the hurricane during its closest approach to the coast. The men set out from near Charleston, S.C., on October 18 in a 14-ft outboard motor boat. They were never found despite an intensive air and sea search.”

Hurricane Ella developed from a tropical wave that was first dtected as it approached the Lesser Antilles on October 11th. The disturbance moved northwestward across the Greater Antilles and reached the southeastern Bahamas on October 13th. Surface observations early on October 14th indicate that a closed, low-level circulation was forming and intensification to a 30 kt tropical depression is analyzed at 06Z on the 14th, twelve hours earlier than originally shown in HURDAT. Minor track alterations are introduced during the lifetime of this tropical cyclone. In an area of weak steering currents, the tropical depression slowly moved northward while becoming better organized. The first reconnaissance aircraft to investigate the tropical cyclone arrived at 20Z on the 14th measuring a central pressure of 1012 mb. Synoptic observations indicate that the dropsonde missed the center, thus the value reported is not a central pressure and was not added to HURDAT. A ship reported 40 kt E at 00Z on October 15th and appears to have a high bias compared to ships nearby. Intensification to a tropical storm is analyzed at 12Z on the 15th, same as originally shown in HURDAT. The first gale-force winds were reported at 18Z on the 15th. This tropical cyclone presented a large

circulation and the gale-force winds were reported about 200 nm north of the center but within the envelope of the outermost closed isobar. It is possible that Ella had some subtropical characteristics. (Central pressures values for almost every 6 hour period were present in the original HURDAT between October 15th at 00Z and October 21st at 18Z. Some of these were obviously analyses that were added in, not based upon actual observations. Thus, based on actual observations, some were retained and new central pressure values added. Detailed information on these changes can be found in the table at the end.) The next reconnaissance aircraft reached Ella at 1850Z measuring a central pressure of 1002 mb, estimating surface winds of 40 kt and an eye diameter of 20 nm. A central pressure of 1002 mb suggests maximum surface winds of 43 kt south of 25N from the Brown et al. pressure-wind relationship. Due to the large circulation of the tropical cyclone and forward speed of about 4 kt, an intensity of 40 kt is selected at 18Z on the 15th, same as originally shown in HURDAT. Another reconnaissance aircraft investigated the tropical storm late on the 15th suggesting that the system was generally stationary between 1745Z and 2315Z, measuring a central pressure of 1002 mb and estimating surface winds of 40 kt.

On October 16th, Ella turned to the northwest and began to deepen later in the day. The first reconnaissance aircraft on the 16th reached the tropical cyclone at 16Z measuring a central pressure of 1002 mb and estimating surface winds of 70 kt. An intensity of 45 kt is selected at 18Z on the 16th based on a blend between the reconnaissance aircraft data and synoptic observations, down from 60 kt originally in HURDAT, a minor intensity change. Another penetration fix at 2242Z on the 16th measured a central pressure of 994 mb, estimated flight level winds of 60 kt and an eye diameter of 25 nm. A central pressure of 994 mb suggests maximum surface winds of 53 kt north of 25N and 56 kt intensifying from the pressure-wind relationship. An eye diameter of 25 nm suggests an RMW of about 19 nm and the climatological value is 20 nm. Based on a forward speed of about 8 kt, an RMW close to climatology and the large circulation of the tropical cyclone, an intensity of 50 kt is selected at 00Z on the 17th, down from 60 kt originally in HURDAT, a minor intensity change. At 04Z on the 17th, another penetration fix measured a central pressure of 997 mb. An intensity of 50 kt is analyzed at 06Z on the 17th, down from 60 kt originally in HURDAT, a minor intensity change. The next penetration fix measured a central pressure of 992 mb and estimated surface winds of 60 kt. A central pressure of 992 mb suggests maximum surface winds of 56 kt north of 25N from the pressure-wind relationship. An intensity of 55 kt is analyzed at 12Z on the 17th, down from 60 kt originally shown in HURDAT, a minor intensity change. Numerous ships reported gale-force winds on the 17th, not just in the periphery like in the previous days, but also close to the center. The highest wind reported on the 17th was 60 kt NE and 994 mb at 18Z. A reconnaissance aircraft measured a central pressure of 989 mb, estimated surface winds of 75 kt and an eye diameter of 80 nm at 1735Z on the 17th. A

central pressure of 989 mb suggests maximum surface winds of 61 kt north of 25N from the pressure-wind relationship. An eye diameter of 80 nm suggests an RMW of about 60 nm and the climatological value is 23 nm. Based on the forward speed of about 6 kt, large circulation and synoptic data, an intensity of 60 kt is selected at 18Z on the 17th, down from 70 kt originally in HURDAT, a minor intensity change. A central pressure of 987 mb was present in HURDAT at 18Z on the 17th and has been replaced by 989 mb.

On October 18th, Ella moved very slowly to the north-northwest while intensifying. A reconnaissance aircraft measured a central pressure of 981 mb at 0726Z on the 18th. A central pressure of 981 mb suggests maximum surface winds of 71 kt north of 25N from the pressure-wind relationship. Due to the large circulation of Ella and forward speed of about 6 kt, an intensity of 65 kt is analyzed at 06Z on the 18th, down from 70 kt originally in HURDAT, a minor intensity change. Intensification to a hurricane is analyzed at 00Z on October 18th, six hours later than originally shown in HURDAT. The next penetration fix measured a central pressure of 978 mb and estimated surface winds of 60 kt at 1247Z on the 18th. A central pressure of 978 mb suggests maximum surface winds of 75 kt north of 25N from the pressure-wind relationship. Due to the large circulation of Ella and forward speed of about 6 kt, an intensity of 70 kt is analyzed at 12Z on the 18th, down from 70 kt originally in HURDAT, a minor intensity change. The final penetration fix on the 18th occurred at 1910Z measuring a central pressure of 973 mb, estimating surface winds of 75 kt and an eye diameter of 61-84 nm. A central pressure of 973 mb suggests maximum surface winds of 81 kt north of 25N from the pressure-wind relationship. An eye diameter of 61-84 nm suggests an RMW of about 46-63 nm and the climatological value is 23 nm. Due to the large circulation of Ella and forward speed of about 5 kt, an intensity of 75 kt is analyzed at 18Z on the 18th, up from 70 kt originally in HURDAT, a minor intensity change. Many ships reported gale-force winds on the 18th. The ship “CHRV” appears to have a high bias reporting 90 kt at 15Z and 95 kt at 18Z. It is interesting to note that Monthly Weather Review mentions the waves reported by the ship “CHRV” but does not mention the winds, possibly an indication that Gordon Dunn did not have confidence in the measurements. On October 19th, Ella turned to the east and later northeast, as it continued to strengthen. A reconnaissance aircraft reached the hurricane at 1205Z on the 19th measuring a central pressure of 969 mb, estimated surface winds of 90 kt and an eye diameter of 55 nm. A central pressure of 969 mb suggests maximum surface winds of 86 kt north of 25N from the pressure-wind relationship. An eye diameter of 55 nm suggests an RMW of about 41 nm and the climatological value is 23 nm. Due to the large circulation of Ella and a forward speed of about 10 kt, an intensity of 80 kt is selected at 12Z on the 19th, down from 90 kt originally shown in HURDAT, a minor intensity change. The next reconnaissance aircraft investigated the hurricane at 19Z on the 19th measuring a central pressure of 962 mb, estimated flight level winds of 105 kt and an eye diameter of 50 nm.

A central pressure of 962 mb suggests maximum surface winds of 93 kt north of 25N and 97 kt intensifying from the pressure-wind relationship. An eye diameter of 50 nm suggests an RMW of about 38 nm and the climatological value is 22 nm. Due to the large circulation of Ella and a forward speed of about 10 kt, an intensity of 90 kt is selected at 18Z on the 19th, down from 100 kt originally shown in HURDAT, a minor intensity change. 90 kt is also the peak intensity of this tropical cyclone, down from 100 kt originally shown in HURDAT, a minor intensity change. Thus, it is analyzed that Ella did not reach major hurricane intensity.

On October 20th, hurricane Ella began to move to the northeast, away from the United States while holding its strength. A penetration center fix at 0204Z on the 20th measured a central pressure of 960 mb, estimating flight level winds of 78 kt and an eye diameter of 50 nm. A central pressure of 960 mb suggests maximum surface winds of 95 kt north of 25N from the pressure-wind relationship. An eye diameter of 50 nm suggests an RMW of about 38 nm and the climatological value is 24 nm. Due to the large circulation of Ella and a forward speed of about 12 kt, an intensity of 90 kt is selected at 00Z on the 20th, down from 100 kt originally shown in HURDAT, a minor intensity change. Another penetration center fix occurred at 13Z on the 20th and measured a central pressure of 960 mb, estimated surface winds of 85 kt and an eye diameter of 100 nm. A central pressure of 960 mb suggests maximum surface winds of 95 kt north of 25N from the Brown et al. pressure-wind relationship and 90 kt north of 35N from the Landsea et al. pressure-wind relationship. An eye diameter of 100 nm suggests an RMW of about 75 nm and the climatological value is 26 nm. Due to the large circulation of Ella and a forward speed of about 11 kt, an intensity of 90 kt is selected at 12Z on the 20th, up from 85 kt originally shown in HURDAT, a minor intensity change. The final penetration center fix on the 20th occurred at 19Z and measured a central pressure of 964 mb and an eye diameter of 100 nm. A central pressure of 964 mb suggests maximum surface winds of 91 kt north of 25N and 87 kt north of 35N from the pressure-wind relationships. An eye diameter of 100 nm suggests an RMW of about 75 nm and the climatological value is 26 nm. Due to the large circulation of Ella and a forward speed of about 17 kt, an intensity of 85 kt is selected at 18Z on the 20th, same as originally shown in HURDAT. Numerous ships experienced gale-force winds on the 20th, including a few up to hurricane intensity. On October 21st, Ella continued moving to the northeast while gradually acquiring extratropical characteristics. A central pressure of 972 mb appears in HURDAT at 12Z on the 21st, likely a dropsonde measurement. The list of aircraft reconnaissance fixes available in the Storm Wallets of Ella indicates that the central pressure adjusted to the surface from 700 mb is 961 mb. This appears more reasonable and has been used to replace the existing 972 mb at 12Z on the 21st. Similarly, at 18Z on the 21st, HURDAT has a central pressure of 950 mb and the list of aircraft reconnaissance fixes indicates that the central pressure adjusted from 700 mb is 958 mb. This also appears more reasonable

and has been used to replace the existing 950 mb at 18Z on the 21st. Transition to an extratropical cyclone is analyzed at 06Z on October 22nd, same as originally shown in HURDAT. Synoptic observations at 06Z on the 22nd indicate that a temperature-gradient had developed across the tropical cyclone, along with frontal features. Weakening below hurricane intensity is analyzed at 12Z on the 22nd, six hours later than originally shown in HURDAT. Numerous ships reported gale-force winds on the 22nd and hurricane-force winds were registered at 00Z and 06Z on this date. Over the next couple of days, the extratropical cyclone moved northeastward across the North Atlantic passing south of Greenland on October 23rd and between Iceland and the United Kingdom on October 24th and 25th. The system gradually weakened and began to interact with a larger extratropical cyclone on the 24th. Synoptic data early on the 25th indicate that Ella was absorbed after 06Z. Thus, the last position is analyzed at 06Z on the 25th, 42 hours later than originally shown in HURDAT.

Date	Original HURDAT Central Pressure	Evidence	Changes
Oct 15 00Z	1002 mb	No central pressure report but appears reasonable based on synoptic observations	Retained
Oct 15 18Z	1002 mb	Penetration center fix: 1002 mb at 1850Z on Oct 15th	
Oct 16 00Z	1002 mb	Penetration center fix: 1002 mb at 1745Z-2315Z on Oct 01th	
Oct 16 18Z	1002 mb	Penetration center fix: 1002 mb at 16Z on Oct 15th	
Oct 17 00Z	994 mb	Penetration center fix: 994 mb at 2242Z on Oct 15th	
Oct 17 06Z	997 mb	Penetration center fix: 997 mb at 04Z on Oct 17th	
Oct 17 12Z	992 mb	Penetration center fix: 992 mb at 1215Z on Oct 17th	
Oct 17 18Z	987 mb	Penetration center fix: 989 mb at 1735Z on Oct 17th	989 mb
Oct 18 06Z	981 mb	Penetration center fix: 981 mb at 0726Z on Oct 18th	Retained
Oct 18 12Z	978 mb	Penetration center fix: 978 mb at 1247Z on Oct 18th	
Oct 18 18Z	976 mb	Penetration center fix: 973 mb at 1910Z on Oct 18th	973 mb
Oct 19 06Z	973 mb	Penetration center fix: 973 mb at 07Z on Oct 19th	Retained

Oct 19 12Z	969 mb	Penetration center fix: 969 mb at 1205Z on Oct 19th	
Oct 19 18Z	962 mb	Penetration center fix: 962 mb at 19Z on Oct 19th	
Oct 20 00Z		Penetration center fix: 960 mb at 0204Z on Oct 20th	960 mb
Oct 20 06Z	960 mb	Penetration center fix: 963 mb at 0705Z on Oct 20th	963 mb
Oct 20 12Z	960 mb	Penetration center fix: 960 mb at 13Z on Oct 20th	Retained
Oct 20 18Z	964 mb	Penetration center fix: 964 mb at 19Z on Oct 20th	
Oct 21 12Z	972 mb	Penetration center fix: 961 mb at 13Z on Oct 21th	961 mb
Oct 21 18Z	950 mb	Penetration center fix: 958 mb at 19Z on Oct 21th	958 mb

New Hurricane [November 26 – December 6, 1962]

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42125 11/26/1962 M=11  7 SNBR= 913 NOT NAMED   XING=0 SSS=0                    L

42130 11/26*  0   0   0    0*  0   0   0    0E330 730  70    0E330 745  70    0*
42135 11/27E327 757  70    0E320 764  70    0E313 766  65    0E302 762  65    0*
42140 11/28*291 756  65    0*288 745  65    0*288 732  60    0*295 722  60    0*
42145 11/29*303 716  55    0*308 714  55    0*310 717  50    0*310 722  50    0*
42150 11/30*308 728  50    0*305 736  55    0*305 742  55    0*310 744  60    0*
42155 12/01*317 744  65    0*324 740  70    0*330 737  75    0*337 743  80    0*
42160 12/02*343 749  80    0*341 753  75    0*337 755  70    0*331 758  65    0*
42165 12/03*326 760  60    0*321 755  55    0*320 749  50    0*325 744  50    0*
42170 12/04*330 742  50    0*333 740  50    0*338 737  50    0*346 730  55    0*
42175 12/05E356 720  60    0E364 710  65    0E370 699  70    0E376 687  70    0*
42175 12/06E380 670  60    0E385 652  50    0*  0   0   0    0*  0   0   0    0*
42180 TS
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U.S. Tropical Storm Impact

12/01 18Z 33.7N 74.3W 40 kt North Carolina

A new hurricane has been added to HURDAT, not previously shown in McAdie et al. (2009). Evidence for these alterations comes from the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Surface Weather Observations, Local and State Climatological Data, Atlas of Cloud Vortex Patterns, Weather Bureau Bulletins and Mariners Weather Log. This disturbance was in Jack Beven and David Roth's List of Suspects.

= synoptic observations outside of OCI

November 25:

HWM analyzes a stationary front over the western Atlantic at 12Z. Microfilm shows a frontal boundary over the western Atlantic at 12Z. Ship highlights: No gales or low pressures.

November 26:

HWM analyzes an extratropical cyclone of at most 1005 mb at 33.5N, 73.0W at 12Z. Microfilm shows a closed low pressure of at most 1008 mb at 33.0N, 72.5W at 12Z. Ship highlights: 40 kt NE and 1023 mb at 37.2N, 74.0W at 06Z (COADS). 70 kt NE and 1009 mb at 35.0N, 74.0W at 12Z (COADS). 70 kt NE and 1006 mb at 34.8N, 74.2W at 15Z (COADS). 70 kt NE and 1003 mb at 34.6N, 74.4W at 18Z (COADS). 60 kt ENE and 1005 mb at 34.5N, 74.6W at 21Z (COADS). Land highlights: 40 kt NNE (peak winds) at WB Cape Hatteras, NC (time unknown) (CLIMO). 35 kt NNE and 1021 mb at Flying Pan, NC at 11Z (SWO). 50 kt NNE and 1017 mb at Flying Pan, NC at 17Z (SWO). 43 kt H (peak winds) at Cape Henry WB, VA at 2151Z (MWL). Gusts to 77 kt NNE at Oak Island, NC at 22Z (MWL). 64 kt NNE (peak winds) and 1011 mb at Flying Pan, NC at 23Z (SWO). 51 kt N (peak winds) (gusts to 57 kt N) at Wilmington, NC at 2311Z (MWL).

BULLETIN: “The pressure center of this storm is located about 200 miles east-southeast of Cape Hatteras, North Carolina with very little movement expected during the next 12 to 24 hours. Highest winds along the coast have been 56 mph in gusts at Cape Hatteras but winds over 60 mph have been reported by vessels.”

November 27:

HWM analyzes an occluded extratropical cyclone of at most 1000 mb at 29.5N, 75.5W at 12Z. Microfilm shows a closed low pressure of at most 1005 mb at 31.5N, 76.5W at 12Z. Ship highlights: 70 kt ENE and 1000 mb at 33.9N, 75.9W at 00Z (COADS). 60 kt NE and 1020 mb at 37.2N, 74.5W at 06Z (COADS). 50 kt NNE and 1011 mb at 32.3N, 78.2W at 12Z (COADS). 65# kt NE and 1014 mb at 35.1N, 74.8W at 18Z (COADS). 50 kt SW and 1002 mb at 27.8N, 74.7W at 18Z (COADS). Land highlights: 38 kt NNE (peak winds) at WB Cape Hatteras, NC (time unknown) (CLIMO). 61 kt NNE and 1011 mb at Flying Pan, NC at 05Z (SWO). 55 kt NNE and 1013 mb at Flying Pan, NC at 11Z (SWO). 36 kt NNE and 1016 mb at Flying Pan, NC at 17Z (SWO). 36 kt NNE and 1016 mb at Flying Pan, NC at 23Z (SWO).

BULLETIN: “The severe winter type storm has drifted a few miles southward and is now centered about 300 miles east of Jacksonville, Florida. It is expected to remain essentially stationary for the next 24 hours. No reports have been received from the immediate

vicinity of the storm center but winds of as much as 60 to 70 mph are being reported by ships some 300 miles north of the center."

November 28:

HWM analyzes an occluded extratropical cyclone of at most 1005 mb at 29.0N, 74.0W at 12Z. Microfilm shows a closed low pressure of at most 999 mb at 28.8N, 73.0W at 12Z. Ship highlights: 60# kt ENE and 101 mb at 34.9N, 73.9W at 00Z (COADS). 40 kt E and 1008 mb at 30.8N, 74.5W at 00Z (COADS). 60 kt E and 1005 mb at 29.9N, 74.0W at 06Z (COADS). 50 kt ENE and 1013 mb at 31.4N, 68.5W at 12Z (COADS). 60# kt E and 1019 mb at 36.0N, 71.5W at 18Z (COADS). 45 kt NE and 1013 mb at 33.1N, 71.8W at 18Z (COADS). Land highlights: 35 kt NE and 1017 mb at Flying Pan, NC at 05Z (SWO). 36 kt NE and 1017 mb at Flying Pan, NC at 11Z (SWO). 35 kt SE and 1015 mb at Bermuda at 18Z (micro).

BULLETIN: "At 5 pm EST the large intense Atlantic storm was located some 600 miles east of Daytona Beach moving eastward 15 mph. Continued eastward movement of 15 mph is forecast for the next 24 hours. Gales from 35 to 55 knots extend outward some 300 miles from the center except to near 600 miles in the northeast quadrant. No worsening of the flooding and erosion problem along the southeast coast is expected, however, it will be late Thursday before any important decrease in the seas take place. Seas of near 30 feet have been reported some 100 miles east of St. Augustine, Florida while winds of 59 knots were recorded at Bermuda."

November 29:

HWM analyzes an occluded extratropical cyclone of at most 1000 mb at 30.0N, 73.0W at 12Z. Microfilm shows a closed low pressure of at most 1008 mb at 31.0N, 72.0W at 12Z. Ship highlights: 50# kt E and 1020 mb at 36.7N, 71.3W at 00Z (COADS). 45 kt ENE and 1008 mb at 32.2N, 71.4W at 00Z (COADS). 50 kt E and 1017 mb at 34.5N, 75.1W at 06Z (COADS). 50# kt ENE and 1022 mb at 37.2N, 68.6W at 12Z (COADS). 40 kt SW and 1003 mb at 30.0N, 71.3W at 12Z (COADS). 50 kt ENE and 1015 mb at 33.2N, 76.5W at 18Z (COADS). Land highlights: 35 kt NE and 1017 mb at Flying Pan, NC at 17Z (SWO). 38 kt NE and 1016 mb at Flying Pan, NC at 23Z (SWO).

BULLETIN: "The large and intense Atlantic storm remains stationary some 600 miles east of Jacksonville, Florida. Gales with very rough seas are occurring over most of the area from off the middle Atlantic coast to the north and east to the north and east of Bermuda and southward in the area east of the northern Bahamas."

November 30:

HWM analyzes a closed low pressure of at most 1005 mb at 31.0N, 73.0W with a warm front to the north at 12Z. Microfilm shows a closed low pressure of at most 996 mb at 30.5N, 74.5W at 12Z. Ship highlights: 55 kt NE and 1015 mb at 33.8N, 75.8W at 00Z (COADS). 55 kt NE and 1013 mb at 32.6N, 77.6W at 06Z (COADS). 55 kt NE and 1006 mb at 32.9N, 73.9W at 12Z (COADS). 55 kt NE and 1014 mb at 33.5N, 77.0W at 18Z (COADS). Land highlights: 34 kt NE and 1016 mb at Frying Pan, NC at 05Z (SWO). 40 kt NE and 1015 mb at Flying Pan, NC at 11Z (SWO). 42 kt NE and 1016 mb at Flying Pan, NC at 17Z (SWO). 38 kt NE and 1014 mb at Flying Pan, NC at 23Z (SWO).

BULLETIN: “The intense Atlantic storm was located about 550 statute miles east of Jacksonville at noon and has moved southward between 5 and 10 mph during the past 12 hours. Gales with very rough seas cover an area approximately 400 miles wide from the middle Atlantic coast to Bermuda. Ships near the storm center have reported 45 to 60 mph winds and 25 foot seas. A ship about 100 miles southeast of Wilmington, North Carolina is currently reporting 65 mph.”

December 1:

HWM analyzes a closed low pressure of at most 1005 mb at 32.5N, 75.0W with a warm front to the north at 12Z. Microfilm shows a closed low pressure of at most 1002 mb at 33.0N, 74.0W at 12Z. Ship highlights: 45 kt NNE and 1014 mb at 34.3N, 76.1W at 00Z (COADS). 45 kt N and 1002 mb at 32.7N, 75.4W at 06Z (COADS). 50 kt N and 1003 mb at 34.3N, 75.6W at 12Z (COADS). 75 kt NE and 1004 mb at 35.2N, 75.0W at 18Z (COADS/MWL). 55 kt NNE and 988 mb at 34.1N, 75.0W at 20Z (MWL). Land highlights: 35 kt NE and 1013 mb at Frying Pan, NC at 05Z (SWO). 39 kt NNE (peak winds) at WB Cape Hatteras, NC (time unknown) (CLIMO). 33 kt NNE (gusts to 48 kt) and 1006 mb at Cape Hatteras, NC at 1949Z (SWO).

BULLETIN: “At 5 pm EST the severe Atlantic storm was moving northward abreast of the North Carolina coast some 100 miles offshore. Gale winds extend over an area 250 statute miles north and west of the center and 150 miles to the east and south. Ships have reported winds up to 50 to 60 mph in heavier squalls near the center and during the afternoon winds gusts up to 50 mph where recorded in the vicinity of Hatteras, North Carolina.”

December 2:

HWM analyzes an extratropical cyclone of at most 1005 mb at 34.0N, 74.0W at 12Z. Microfilm shows a closed low pressure of at most 999 mb at 33.5N, 75.0W at 12Z. Ship

highlights: 55 kt N and 1002 mb at 35.0N, 75.3W at 00Z (COADS). 50 kt N and 1006 mb at 34.0N, 76.4W at 06Z (COADS). 60 kt E and 1004 mb at 34.6N, 74.5W at 12Z (COADS). 50 kt N and 1000 mb at 33.3N, 76.5W at 18Z (COADS). Land highlights: 38 kt NNE and 1011 mb at Frying Pan, NC at 17Z (SWO). 40 kt NNE and 1010 mb at Frying Pan, NC at 23Z (SWO).

BULLETIN: At 5 pm today the center of the Atlantic storm was located about 125 miles south of Cape Hatteras. The movement of the storm continued to be erratic and since early this morning it has moved slowly toward the southwest. During the next 12 hours it is expected to drift slowly southward with a tendency to move toward the east thereafter.

December 3:

HWM analyzes a closed low pressure of at most 1005 mb at 33.0N, 75.0W with a stationary front to the north at 12Z. Microfilm shows a closed low pressure of at most 1008 mb at 32.0N, 75.0W at 12Z. Ship highlights: 45 kt NNE and 1009 mb at 33.1N, 77.1W at 00Z (COADS). 35 kt N and 1006 mb at 33.3N, 76.9W at 06Z (COADS). 45 kt N and 1010 mb at 33.1N, 77.1W at 12Z (COADS). 35 kt E and 1010 mb at 34.3N, 75.0W at 18Z (micro). Land highlights: 36 kt NNE and 1011 mb at Frying Pan, NC at 05Z (SWO).

BULLETIN: “The storm is forecast to remain nearly stationary during the day with little change in size or intensity. Gale winds up to 65 mph in the heavier squalls are occurring near the center while winds from 25 to 45 mph extend outward some 300 miles from the center. The storm is seven days old and during this time has moved in every possible direction with the center remaining within an area which could roughly be called a circle with radius of less than 250 miles. The circulation of the storm has been cutoff from the general circulation of the atmosphere from its position. While cutoff lows are not new certainly one as strong as this is indeed unusual for this area and since it has remained so long in such a relatively small area.”

December 4:

HWM analyzes a closed low pressure of at most 995 mb at 34.5N, 73.0W with a stationary front to the north at 12Z. Microfilm shows a closed low pressure of at most 993 mb at 34.0N, 73.5W at 12Z. Ship highlights: 35 kt WSW and 1002 mb at 32.6N, 74.2W at 00Z (COADS). 35 kt NE and 997 mb at 33.4N, 74.5W at 06Z (COADS). 45 kt NE and 994 mb at 34.7N, 73.6W at 12Z (COADS). 50 kt NW and 998 mb at 34.8N, 74.8W at 18Z (COADS).

BULLETIN: “The Atlantic storm continues to move slowly toward the north-northeast and at 5 pm was centered about 150 miles east of Cape Hatteras. Highest winds are

estimated 55 mph near the center and winds of 30 mph or higher extend out 200 miles from the center with rough seas and squalls. Seas as high as 30 feet have been reported near the center today."

December 5:

HWM analyzes a closed low pressure of at most 995 mb at 36.2N, 71.2W with a stationary front to the northeast at 12Z. Microfilm shows a closed low pressure of at most 990 mb at 34.0N, 73.5W at 12Z. Ship highlights: 45 kt NE and 992 mb at 36.9N, 72.5W at 00Z (COADS). 70 kt SW and 987 mb at 34.9N, 71.1W at 00Z (COADS). 45 kt N and 1010 mb at 33.1N, 77.1W at 12Z (COADS). 80 kt SW and 990 mb at 34.9N, 71.2W at 12Z (COADS). 70 kt WNW and 1000 mb at 34.7N, 71.9W at 18Z (COADS). 50 kt WSW and 978 mb at 36.5N, 68.7W at 18Z (COADS).

BULLETIN: "At 5 pm EST the Atlantic storm was centered about 240 miles south-southeast of Cape Cod moving north-northeast about 15 mph. This storm is forecast to continue moving north-northeast at about 15 mph tonight and pass close to the east of Cape Cod after midnight. Strongest winds are 45 to 65 mph near the storm center and winds 25 to 45 mph extend about 300 miles to the north and 200 miles in other quadrants. The storm is expected to maintain about the same intensity and spread out over a larger area during the next 24 hours."

December 6:

HWM analyzes an extratropical cyclone over the Mid-Atlantic (system appears to be dissipated) at 12Z. Microfilm shows a closed low pressure of at most 993 mb at 39.0N, 65.0W with a frontal boundary to the east at 12Z. Ship highlights: 40 kt SW and 1005 mb at 33.8N, 64.2W at 00Z (COADS). 35 kt SSE and 979 mb at 38.8N, 64.7W at 06Z (micro). 40 kt E and 1000 mb at 40.6N, 68.8W at 12Z (COADS). 45 kt E and 1014 mb at 44.5N, 62.5W at 18Z (COADS).

December 7:

HWM and microfilm analyze an extratropical cyclone over the Great Lakes (system appears to be dissipated) at 12Z. Ship highlights: No gales or low pressures.

CLIMO: "An unusually persistent low pressure storm whose center remained off the North Carolina coast from the night of November 25th until December 5th caused very heavy beach erosion and widespread minor wind damage. Sections of protective sand dunes several hundred feet in length were washed flat and beaches were cut back as much as 50 feet in width in some areas. Several buildings were destroyed and many damaged when undermined by the pounding seas; sand thus carried away was deposited in other

areas, burying streets and highways in several feet of sand. Small boats tied up in port were badly battered by the long siege of onshore winds and waves, and one ship sank."

MWL (Volume 7, Number 2, March 1963, Page 50): "A well-developed low pressure system of extratropical origin lay off the coast of the southeastern states from November26toDecember5, its center meandering between latitudes 28°N and 35°N and between longitudes 70°W and 75°W during the entire period. The intensity of the storm varied considerably from day to day, but at weakest it was an active closed low pressure circulation and at strongest it was the equal of a minor hurricane. The center of the storm remained offshore at all times, but the prolonged pounding of the coast with winds between north and east and high seas and tides caused severe erosion along the coast from Virginia southward to central Florida. Rainfall amounts were generally light except for locally heavy amounts along the immediate coast of North Carolina and Georgia. Whole gale winds off Hampton Roads blew the Chesapeake Lightship off station early in the storm, and a huge dredge used on the Chesapeake Bridge-Tunnel Project broke loose and was driven aground off Little Creek. Farther south along the Virginia coast much of the sand which had been replaced at great expense in resort areas since the March 1962 storm was washed away again. Very extensive erosion also occurred along the Outer Banks of North Carolina. The 700-ft. wide inlet cut through Hatteras Island north of Buxton by the March storm was widened by an additional estimated 1,000 ft. , and the bridge which had been built across it was destroyed. A state-owned ferry sank in Pamlico Sound, a loaded tanker was severely damaged, and small boats along the coast were battered. Some minor shallow flooding occurred at high tides. At Carolina Beach south of Wilmington about a 1,000-ft. length of beach was cut back as much as 50 ft. in width, and sections of dunes 500 ft. or more in length were reported washed flat in a number of areas. Numerous beach cottages were undermined, and several of them fell into the ocean and were washed up as debris. Shoreline erosion of a less severe nature extended southward along the South Carolina and Georgia coast. A fishing trawler based at Charleston was lost during the storm but the crew was subsequently rescued. A schooner valued at $35,000 was also lost off the South Carolina coast. Sections along the Florida coast also experienced severe erosion mostly from Cape Canaveral northward with many seawalls, docks, and piers sustaining damage. No lives were reported lost and damage estimates are rather incomplete though probably not exceeding $10,000,000."

MWL (Volume 7, Number 2, March 1963, Page 63): "An unusual storm developed southeast of Cape Hatteras on the 26th. A warm HIGH had rapidly been developing over New England and a dynamically sympathetic LOW formed about 200 mi. southeast of Cape Hatteras at about the same time. This LOW at first moved southwestward to about 250 mi. east of the central Florida coast on the 28th accompanied by whole gale winds. The storm then drifted northward describing a couple of minor loops to the southeast of

Hatteras before moving northeastward out of the area on December 3. This storm, though considered an extratropical LOW cut off from the westerlies aloft, exhibited many characteristics of a tropical cyclone while meandering over the warm Gulf Stream south of Hatteras. Even when finally moving northward off the coast on December 4 and 5 it was imbedded in a mid-tropospheric ridge with no associated fronts and with core temperatures being quite warm. Extensive beach erosion and minor flooding at high tides were experienced mainly from the central Florida coast northward to Hampton Roads. Highest winds along the coast were recorded at cooperative hurricane reporting stations along the North Carolina coast south of Cape Lookout on the 26th. Oak Island reported a gust from the north-northeast of 77 kt. and Sneads Ferry 70 kt. Precipitation generally was not excessive over land and confined to the immediate coast. Fog and haze, associated with the persistent high pressure cell centered over New England during the end of November and into the first week of December, was bothersome to shipping in the Great Lakes and in the ports along the upper Atlantic coast. The 6,471-ton freighter SARAH BOWATER and the 10,730-ton tanker CHEMICAL TRANSPORTER collided in fog in New York harbor on December 4. No injuries were reported, and damage to both vessels was about 12 ft."

A frontal boundary is observed in the Historical Weather Maps over the southeast of the United States and extended into the western Atlantic on November 25th. Synoptic observations late on the 25th and early on November 26th indicate that an extratropical cyclone gradually organized and is analyzed to have developed around 12Z on the 26th. A strong ridge over the northeast of the United States and the intensifying cyclone combined to produce a strong pressure gradient and gale-force winds quickly developed. At 12Z on the 26th, two ships reported hurricane-force winds about 200 nm north of the center and the intensity at the first position is analyzed at 70 kt. Gale-force winds affected the coastal areas of Virginia and North Carolina late on the 26th with recorded gusts up to 77 kt. The intense extratropical cyclone initially moved westward but turned to the south and southeast on November 27th. On the 27th, the pressure gradient remained strong and gale-force winds were being reported over 300 nm northeast of the center. Late on the 27th, synoptic data indicates that the system became more symmetric with a decrease in the temperature gradient. Transition to a tropical cyclone is analyzed at 00Z on November 28th with an intensity of 65 kt based upon a ship report near the center at 06Z on the 28th of 60 kt E and 1005 mb. Synoptic data on the 28th shows that even though gale-force winds were being measured near the center of the hurricane, the strong pressure gradient continued to produce gale-force winds over 500 nm northeast of center. The winds outside of the outermost closed isobar are not considered part of the circulation of the hurricane. The tropical cyclone is analyzed to have weakened to a tropical storm at 12Z on the 28th based on ship data. TIROS VI captured an image of the tropical storm at 1951Z on the 28th showing a sheared cyclone with most of the

convection over the north and eastern quadrants. After moving eastward early on the 28th, the tropical storm moved northeast late on this date and early on November 29th. Synoptic observations on the 29th continued to show gale-force winds near the center of the tropical storm, up to 45 kt. Late on the 29th, the tropical cyclone moved to the southwest and turned to the west on November 30th. Late on the 30th, the erratic tropical storm turned to the north and began to intensify. Winds near the center reported by ships reached up to 55 kt on the 30th. Another TIROS VI image of the tropical storm was captured at 1933Z on the 30th showing a large area of convection, especially in the northeast quadrant, and an eye-like feature.

On December 1st, the strong ridge over the Northeast of the United States weakened and the gale-force winds decreased to about 150 nm away from the center. Synoptic observations late on the 1st show that the tropical cyclone had strengthened and it is analyzed to have regained hurricane intensity at 00Z on the 1st. Two ships reported hurricane intensity at 18Z on the 1st, 75 kt NE and 95 kt N. The ship report of 95 kt appears to have a high bias compared to the neighboring observations, thus a blend of the two observations have been used to come up with an intensity of 80 kt at 18Z on the 1st. 80 kt is also the peak intensity of this hurricane. Climatological Data indicates that 45 mph (fastest mile) was measured on the 1st in Cape Hatteras, NC, time unknown. This measurement likely occurred late on the 1st or early on the 2nd (zulu time). Thus, North Carolina is added as a tropical storm impact. The hurricane turned to the southwest on December 2nd and gradually weakened. Gale-force winds up to 60 kt were reported by ships near the center. TIROS VI captured an image of the hurricane at 1919Z on the 2nd showing a large area of convection all-around the center and no signs of strong wind shear. On December 3rd, the tropical cyclone turned to the east and later to the northeast. Synoptic observations indicate that the hurricane weakened to a tropical storm at 00Z on the 3rd. At 1817Z on the 3rd, TIROS VI captured another image of the tropical cyclone showing a sheared system with most of the convection over the northern and eastern quadrants. An approaching frontal boundary on December 4th caused the tropical storm to increase in forward speed to the northeast as it began to lose its tropical characteristics late in the day. Ship data at 18Z on the 4th showed an increase in the temperature gradient between the eastern and western quadrants as the system moved away from the Gulf Stream and into cooler waters of the northwest Atlantic. Transition to an extratropical cyclone is analyzed at 00Z on December 5th based upon synoptic observations showing a strong temperature gradient. A ship at 06Z on the 5th showed 70 kt SW, 80 kt SW at 12Z, and 70 kt WNW at 18Z, and based upon nearby ship observations is analyzed that this ship has a high wind bias. Thus, the extratropical cyclone is analyzed to have regained hurricane intensity at 06Z on the 5th, reaching a tertiary peak in intensity at 12Z on this day of 70 kt. TIROS V captured an image of the extratropical cyclone at 1832Z on the 5th showing a large system over the northwest

Atlantic. The extratropical cyclone weakened on December 6th. Synoptic observations indicate that it became elongated and weakened into a trough before being absorbed by a larger extratropical cyclone over the Northeast of the United States. The last position is analyzed at 06Z on the 6th. There is no proper analog to compare to this system, but the Yankee Hurricane of 1935 had a similar development and unusual southward track that enabled it to attain tropical cyclone status.

1962 - Additional Notes

1) February 24 – March 3: Historical Weather Maps show an extratropical cyclone exiting the United States on February 24th. The disturbance moved eastward and became occluded on February 27th producing gales. After meandering over the north Atlantic for a couple of days, an approaching frontal boundary absorbed the non-tropical cyclone on March 4th. Therefore, because the system did not acquire tropical characteristics, it is not added to HURDAT. This disturbance was in Jack Beven's List of Suspects.

Day	Latitude	Longitude	Status
February 24	40N	75W	Extratropical
February 25	41N	51W	Extratropical
February 26	46N	44W	Extratropical
February 27	40N	47W	Occluded
February 28	38N	39W	Occluded
March 1	41N	42W	Occluded
March 2	43N	48W	Occluded
March 3	42N	41W	Occluded
March 4			Absorbed

2) April 28 – May 3: Historical Weather Maps and Microfilm indicate that a trough of low pressure developed north of Puerto Rico late on the April 28th or early on the 29th. The disturbance moved northward developing a closed low-level circulation on April 30th. The system turned to the northeast on May 1st becoming better defined at the surface. A gale of 35 kt was reported at 12Z and 18Z on the 1st in the southwest quadrant, about 200 nm from the center, but both likely have a high bias compared to the surrounding ship data. On May 2nd, the disturbance continued moving eastward and weakened due to an approaching frontal system, becoming absorbed the next day. Therefore, because there is not enough evidence to support upgrading this system to a

tropical storm, it is not added to HURDAT. This disturbance was in Jack Beven and David Roth's List of Suspects.

Day	Latitude	Longitude	Status
April 28	15N-25N	68W	Trough
April 29	15N-25N	65W	Trough
April 30	25N	65W	Tropical Depression
May 1	29N	65W	Tropical Storm?
May 2	29N	61W	Tropical Storm?
May 3			Absorbed

3) May 11-22: Historical Weather Maps shows an extratropical cyclone exiting the United States on May 11th and moving to the southeast. On May 15th, the disturbance became an occluded cyclone while producing gale-force winds over 300 nm away from the center. The system moved little over the next couple of days while filling as a non-tropical cyclone. On May 19th, the disturbance began to move eastward and synoptic observations indicate that it dissipated around May 22nd. Therefore, because the system did not acquire tropical characteristics, it is not added to HURDAT. This disturbance was in Jack Beven and David Roth's List of Suspects.

Day	Latitude	Longitude	Status
May 11	37N	82W	Extratropical
May 12	34N	70W	Extratropical
May 13	33N	60W	Extratropical
May 14	36N	56W	Extratropical
May 15	36N	57W	Occluded
May 16	32N	62W	Occluded
May 17	32N	60W	Occluded
May 18	33N	63W	Occluded
May 19	34N	59W	Occluded
May 20	35N	53W	Occluded
May 21	34N	47W	Occluded
May 22	37N	44W	Dissipated

4) June 5-7: Historical Weather Maps indicate that a small, non-frontal low pressure system developed between the Bahamas and Bermuda on June 5th. The disturbance moved northeastward and dissipated on June 7th. No gale-force winds were associated

with this disturbance based on the synoptic data in Microfilm, COADS and MWL. Therefore, because the system did not produce tropical storm force winds, it is not added to HURDAT. This disturbance was in Jack Beven's List of Suspects.

Day	Latitude	Longitude	Status
June 5	29N	71W	Tropical Depression?
June 6	31N	68W	Tropical Depression?
June 7			Dissipated

5) July 14-20: Microfilm shows a tropical wave east of the Lesser Antilles on July 14th moving westward. Synoptic observations indicate that the disturbance became better organized as it crossed the Windward Islands but no gales were reported. The disturbance continued westward entering the Gulf of Mexico on July 19th and dissipated two days later. Therefore, because the system did not produce tropical storm force winds and did not have a closed circulation, it is not added to HURDAT. This disturbance was in Jack Beven's List of Suspects.

Day	Latitude	Longitude	Status
July 14	8N-15N	47W	Tropical Wave
July 15	9N-17N	54W	Tropical Wave
July 16	12N-20N	62W	Tropical Wave
July 17	12N-20N	71W	Tropical Wave
July 18	15N-25N	80W	Tropical Wave
July 19	16N-25N	87W	Tropical Wave
July 20	20N-30N	95W	Tropical Wave
July 21			Dissipated

6) August 23-25: Microfilm indicates that a trough of low pressure developed northeast of the Leeward Island around August 23rd. A non-frontal, low pressure formed on August 24th and a ship reported 40 kt in the southeast quadrant, close to the center. An approaching frontal boundary caused the system to move to the northeast, absorbing it on August 25th. Therefore, because there is not enough evidence to support upgrading this system to a tropical storm, it is not added to HURDAT. This disturbance was in Jack Beven's List of Suspects.

Day	Latitude	Longitude	Status
August 23	23N-32N	56W	Trough

August 24	31N	56W	Tropical Storm?
August 25			Absorbed

7) August 25-30: Historical Weather Maps and Microfilm show that the southern portion of the tropical wave that produced Hurricane Alma continued westward into the Gulf of Mexico. The disturbance became better organized on the Bay of Campeche and a tropical depression likely formed on August 27th. The system moved northward and a ship reported 55 kt, but it appears to have a very high bias, so it's disregarded. Late on the 28th and on the 29th, an oil rig over the northwestern Gulf of Mexico reported 35 kt, but this is an elevated site, thus the winds at the surface are likely below gale-force. TIROS V captured an image of the system at 16Z on the 29th. In the picture, the system is inland over eastern Texas and looks very well-organized with a large area of convection. At the same time, surface observations show a weak reflection with winds below tropical storm force. The depression produced severe weather across eastern Texas and western Louisiana, including very heavy rains and tornadoes. However, no land based station reported tropical storm force winds. The system dissipated on the 30th. Therefore, because there is not enough evidence to support upgrading this system to a tropical storm, it is not added to HURDAT. This disturbance was in Jack Beven's List of Suspects.

Day	Latitude	Longitude	Status
August 25	20N-27N	89W-92W	Tropical Wave
August 26	20N-28N	89W-95W	Tropical Wave
August 27	22N	94W	Tropical Depression
August 28	26N	95W	Tropical Depression
August 29	30N	95W	Tropical Depression - Inland
August 30			Dissipated

8) September 19-24: Historical Weather Maps and Microfilm indicates that a tropical wave and frontal boundary interacted in the eastern Gulf of Mexico. A trough of low pressure developed on September 19th and intensified into a tropical depression on the 20th. The system continued to interact with the stationary frontal boundary to the north producing very heavy rains over the Florida peninsula. The depression moved erratically over the next couple of days before dissipating on the 24th over the water. No gales or low pressures were associated with this system based on the ship data in the Microfilm, COADS and MWL. Therefore, because the system did not produce tropical storm force

winds, it is not added to HURDAT. This disturbance was in Ryan Truchelut's List of Suspects.

Day	Latitude	Longitude	Status
September 19	20N-27N	85W-90W	Trough
September 20	27N	86W	Tropical Depression
September 21	25N	85W	Tropical Depression
September 22	28N	85W	Tropical Depression
September 23	28N	85W	Tropical Depression
September 24			Dissipated

9) September 28 - October 5: Historical Weather Maps and Microfilm show that a tropical wave entered the Caribbean Sea on September 28th. The disturbance moved westward and became better organized over the central Caribbean. TIROS V captured an image of the disturbance on October 1st at 12Z showing a large area of convection with some signs of organization. Another satellite image was captured at 1410Z on October 2nd, showing some banding in the northern quadrant of the circulation. The system moved westward, making landfall over northern Nicaragua on October 3rd. Another satellite image captured at 1348Z on the 4th indicates that although the system was interacting with land, it remained organized with a large area of convection. The system moved into southern Mexico on October 5th and weakened into a tropical wave. No gales or low pressures were associated with this system based on the synoptic data in Microfilm, COADS and MWL. Therefore, because the system did not produce tropical storm force winds, it is not added to HURDAT.

Day	Latitude	Longitude	Status
September 28	13N-16N	58W-66W	Tropical Wave
September 29	12N-17N	67-69W	Tropical Wave
September 30	12N-17N	72W	Tropical Wave
October 1	14N	75W	Tropical Depression?
October 2	14N	80W	Tropical Depression?
October 3	15N	84W	Tropical Depression?
October 4	16N	89W	Tropical Depression?
October 5	16N	94W	Tropical Wave

10) October 14-15: Microfilm indicates that a tropical wave was located southwest of the Cape Verde Islands on October 14th. Bulletins were issued on this system as a tropical

depression, mistakenly available in the Storm Wallets of 1963 as TD8. The system moved westward, and gradually weakening and later dissipating over the central Atlantic. No gales or low pressures were associated with this system according to Microfilm, COADS and MWL. Therefore, because the system did not produce tropical storm force winds, it is not added to HURDAT. This disturbance was in Jack Beven's List of Suspects.

Day	Latitude	Longitude	Status
October 14	13N	29W	Tropical Depression?
October 15	13N	34W	Tropical Depression?
October 16			Absorbed

11) November 12-15: Historical Weather Maps shows that an extratropical cyclone developed along the tail-end of a frontal boundary on November 12th. The disturbance moved slowly northward becoming an occluded cyclone on the 13th while producing gales far north of the center. On the 14th, TIROS VI captured an image at 1308Z showing a large non-tropical cyclone. The disturbance was absorbed a day later. Therefore, because the system did not acquire tropical characteristics, it is not added to HURDAT.

Day	Latitude	Longitude	Status
November 12	30N	40W	Extratropical
November 13	33N	40W	Occluded
November 14	34N	37W	Occluded
November 15			Absorbed

12) November 25-30: Historical Weather Maps indicates that an extratropical cyclone developed on November 25th. The disturbance moved westward becoming an occluded cyclone the next day and gale-force winds were reported on the 27th about 200 nm north of the center. The disturbance was absorbed by a larger extratropical cyclone on the 30th. Therefore, because the system did not acquire tropical characteristics, it is not added to HURDAT. This disturbance was in Jack Beven's List of Suspects.

Day	Latitude	Longitude	Status
November 25	40N	15W	Extratropical
November 26	38N	15W	Occluded
November 27	38N	20W	Occluded
November 28	40N	22W	Occluded

November 29	40N	25W	Occluded
November 30			Absorbed

13) December 9-14: Historical Weather Maps shows an extratropical cyclone developing on December 9th along the tail-end of a frontal boundary. The disturbance moved southwestward becoming an occluded cyclone the next day with gales reported over 200 nm north of the elongated center. The system became better organized on December 11th with gales and a prominent decrease in the pressure near the center. Nevertheless, the ship coverage south of 30N is sparse over the eastern Atlantic and it cannot be established if the disturbance had a closed low-level circulation. The system continued to the southwest over the next couple of days gradually losing strength and dissipating on December 14th. Therefore, because it cannot be shown that a closed low-level circulation was present, it is not added to HURDAT. This disturbance was in David Roth's List of Suspects.

Day	Latitude	Longitude	Status
December 9	33N	28W	Extratropical
December 10	31N	36W	Occluded
December 11	30N	40W	Tropical Storm?
December 12	24N	45W	Tropical Storm?
December 13	18N	50W	Tropical Depression?
December 14			Dissipated

1963 hurricane season

Unnamed Tropical Storm [June 2–4, 1963]

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42125 06/02/1963 M= 3  1 SNBR= 913 NOT NAMED   XING=0 SSS=0
42130 06/02*  0   0   0    0*  0   0   0    0*298 752  40    0*311 752  40    0*
42135 06/03*325 754  45 1008*344 756  50 1002*364 760  50 1002*382 765  40 1002*
42140 06/04*392 770  30 1006*400 777  25 1010*404 787  25 1012*  0   0   0    0*
42145 TS
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U.S. Tropical Storm Landfall

06/03 08Z 35.2N 75.8W 50 kt NC (40 kt peak winds along the coast)

A new tropical storm has been added to HURDAT, not previously shown in McAdie et al. (2009). Evidence for these alterations comes from the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Mariners Weather Log, Surface Weather Observations, and State Climatological Data. This disturbance was in Jack Beven and David Roth's List of Suspects.

May 29:

HWM analyzes a closed low pressure of 1010 mb at 11.5N, 76.5W at 12Z. Microfilm does not show an organized system at 12Z. Ship highlights: No gales or low pressures.

MWL: "A tropical disturbance, which had been tracked north-northeastward from just north of Panama on May 29."

May 30:

HWM analyzes a closed low pressure of 1010 mb at 11.0N, 78.0W at 12Z. Microfilm shows a spot low pressure near 13N, 78W at 12Z. Ship highlights: No gales or low pressures.

May 31:

HWM analyzes a spot low pressure of 1010 mb at 16.8N, 79.8W at 12Z. Microfilm shows a closed low pressure at 18.0N, 79.5W at 12Z. Ship highlights: No gales or low pressures.

MWL: "Heavy rainfall was reported along the track of the disturbance with Santiago de Cuba receiving about 7.50 in. during a 2-day period in the incipient stage."

June 1:

HWM analyzes a closed low pressure of 1010 mb at 26.0N, 77.0W with a weakening frontal boundary to the north at 12Z. Microfilm shows a closed low pressure of at most 1008 mb at 26.0N, 78.0W at 12Z. Ship highlights: 35 kt SE and 1009 mb at 26.0N, 74.0W at 12Z (micro). 35 kt SE and 1012 mb at 27.2N, 74.7W at 15Z (micro).

MWL: “Developed a closed sea level circulation over the northwestern Bahamas during the afternoon hours of June 1.”

June 2:

HWM analyzes a closed low pressure of 1010 mb at 30.0N, 76.0W with a warm frontal boundary to the north at 12Z. Microfilm shows a closed low pressure of at most 1011 mb at 30.5N, 75.0W at 12Z. Ship highlights: 35 kt SE and 1011 mb at 28.2N, 74.5W at 00Z (COADS). 35 kt SE and 1010 mb at 30.7N, 73.3W at 12Z (COADS). 55 kt [likely high bias] ESE and 1015 mb at 31.3N, 72.7W at 12Z (COADS). 40 kt ESE and 1003 mb at 33.6B, 74.6W at 18Z (COADS). Aircraft highlights: Central pressure of 1008 mb near 32.5N, 75.5W at 2130Z (micro).

MWL: “The tropical depression continued toward Hatteras, reaching tropical storm Intensity late the following day when information received from a Navy reconnaissance aircraft and from ship reports near the center of the cyclone indicated winds in excess of 34 kt. This unnamed tropical storm was the first of the season in the North Atlantic region. The highest sustained wind measured in the storm was recorded aboard the ALCOA POLARIS at noon on the 2d near 31°N, 73°W when 55-kt east-southeasterly winds were encountered.”

June 3:

HWM analyzes a closed low pressure of 1005 mb at 36.5N, 76.2W with a warm frontal boundary extending to the northeast at 12Z. Microfilm shows a closed low pressure of at most 1005 mb at 36.5N, 76.0W at 12Z. Ship highlights: 40 kt SE and 1009 mb at 33.4N, 73.4W at 00Z (COADS). 40 kt S and 1001 mb at 33.4N, 74.2W at 03Z (MWL). 40 kt SSE and 1015 mb at 33.2N, 71.7W at 05Z (MWL). 40 kt S and 1016 mb at 36.8N, 72.5W at 12Z (COADS). Land highlights: 40 kt ESE and 1006 mb at Diamond Shoals, NC at 06Z (micro). 11 kt SE and 1003 mb at Cape Hatteras, NC at 0659Z (SWO). 20 kt ENE and 1004 mb at NAS Oceana, VA at 1058Z (SWO). 40 kt ENE and 1006 mb at Chesapeake Lightship, VA at 11Z (SWO). 35 kt SSE and 1011 mb at Ocean City, MD at 18Z (micro/SWO). 14 kt ENE and 1005 mb at NAS Patuxent River, MD at 19Z (SWO). 12 kt ENE and 1008 mb at Baltimore, MD at 2156Z (SWO). 34 kt NE at Norfolk, VA (no time given) (CLIMO).

MWL: “The cyclone crossed over the Carolina Outer Banks before noon on the 3d with a central pressure of 1004 mb and continued in a generally northwesterly direction up the Chesapeake Bay while losing intensity. At Norfolk, Virginia a new all time 24-hourly precipitation record was set with 6.87 in. collected after 0650 EST on the 2d. The fastest mile recorded at Norfolk during the storm was 39 mph registered on the 3d. Vessels encountering gale force winds off the southeastern United States coast in this tropical cyclone were mainly concentrated in the northeastern quadrant of the storm in the 5-degree square between latitudes 30° and 35°N., longitudes 70° and 75°W on the 2d and 3d. They include the ALCOA POLARIS, ASTID ONSTAD, CHARIS, COMAYAGUA, CROWN TRADER, KENDALL FISH, RIVIERA PRIMA, and WORLD CHARITY.” September Unnamed Storm MWR: “Each year several storms occur which are not entirely tropical in character. Tropical cyclones derive their energy from latent heat of condensation while extratropical cyclones depend upon proper positioning of cold and

warm air masses; i.e., cold air sinks and spreads under warm air causing air motion. At times "half-breed" cyclones develop over tropical oceans and tap both energy sources. In these cases it is difficult to decide whether a tropical cyclone name should be assigned to the Low. The Unnamed Storm in September was of this type, as was the late May-early June storm."

June 4:

HWM analyzes a closed low pressure of 1015 mb at 40.0N, 78.0W with a weakening warm frontal boundary extending to the northeast at 12Z. Microfilm shows a closed low pressure of at most 1014 mb at 40.0N, 78.5W at 12Z. Ship highlights: 9 kt ESE and 1012 mb at Harrisburg, PA at 0559Z (SWO). 10 kt ESE and 1014 mb at Philipsburg, PA at 1151Z (SWO).

MWL: "Late on the 4th it dissipated over eastern Ohio."

A tropical disturbance developed over the southern Caribbean Sea late ion May and slowly moved northward. The system began to become better organized just south of Cuba late on May 31st, crossing the island early on June 1st as a trough over into the western Bahamas. A few ships reported gales over the eastern and northeastern quadrants on the 1st in its periphery due to the strong synoptic scale pressure gradient. Synoptic observations indicate that a well-defined center developed around 12Z on the June 2nd. The first position is analyzed at 12Z on the 2nd as a 40 knot tropical storm based on a few ship reports of gale-force winds. COADS shows two ships at 12Z on the 2nd reporting 55 kt in the northeast quadrant but MWL and microfilm indicate that it was only one ship. Furthermore, comparison with nearby ship data at 12Z on the 2nd show that the 55 kt reported is likely to have a 10-15 kt high bias. At 2130Z on the 2nd, a reconnaissance aircraft investigated the tropical storm measuring a central pressure of 1008 mb, which has been added to the 00Z time slot of June 3rd. On the 3rd, the tropical storm continued northward and a couple of ships reported gale-force winds, mainly over the northern and eastern quadrant where the pressure-gradient was the strongest. The tropical storm made landfall around 08Z on the 3rd, just west of Cape Hatteras, NC. Cape Hatteras, NC, reported 11 kt SE and 1003 mb at 0659Z on the 3rd, suggesting a central pressure of 1002 mb, which has been added to the 06Z time slot. A central pressure of 1002 mb suggests maximum surface winds of 40 kt and 45 kt, from the north of 25N Brown et al. and north of 35N Landsea et al. pressure-wind relationships, respectively. Based on a forward speed of about 20 kt, an intensity of 50 kt is analyzed at 06Z on the 3rd and at landfall. 50 kt is also the peak intensity of this tropical cyclone. Diamond Shoals, NC, reported 40 kt E at 06Z on the 3rd. The fast-moving tropical storm reached the coast of North Carolina around 08Z on the 3rd as a 50 kt tropical storm. No gale-force winds were reported in the Outer Banks of North Carolina likely because the radius of maximum winds stayed offshore. However, some tropical storm force winds did occur farther north along the coast (see below) and it is analyzed that the strongest winds along the coast were about 40 kt. At 1058Z on the 3rd, Oceana, VA, a coastal station, reported 20 kt ENE and 1004 mb, suggesting a central pressure of 1002 mb, which has been added to the 12Z time slot. Late on the 3rd, the tropical storm moved farther inland

and began to weaken. Ocean City, MD, reported 35 kt SSE and 1011 mb at 18Z on the 3rd. Norfolk, VA, reported 34 kt NE but the time is unknown. At 19Z on the 3rd, Patuxent River, MD, an inland station, reported 14 kt ENE and 1005 mb, suggesting a central pressure of 1002 mb, which has been added to the 18Z time slot. At 2156Z on the 3rd, Baltimore, MD, reported 12 kt ENE and 1008 mb, suggesting a central pressure of 1006 mb, which has been added to the 00Z time slot on June 4th. On the 4th, the tropical cyclone turned to the northwest and west and gradually lost strength. Weakening to a tropical depression is analyzed at 00Z on the 4th. At 0559Z on the 4th, Harrisburg, PA, reported 9 kt ESE and 1012 mb, suggesting a central pressure of 1010 mb, which has been added to the 06Z time slot. At 1151Z on the 4th, Philipsburg, PA, reported 10 kt ESE and 1014 mb, suggesting a central pressure of 1012 mb, which has been added to the 12Z time slot. Synoptic observations over the Ohio Valley after 12Z on the 4th indicate that the tropical cyclone had weakened to a trough of low pressure. The last position is analyzed at 12Z on the 4th.

Hurricane Arlene [July 31 - August 12, 1963]

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42665 07/31/1963 M=12  1 SNBR= 924 ARLENE      XING=0 SSS=0
42665 07/31/1963 M=13  2 SNBR= 924 ARLENE      XING=0 SSS=0
                      **  *

42670 07/31*  0   0   0    0*  0   0   0    0*  0   0   0    0*110 394  25    0*
42675 08/01*110 409  25    0*111 422  25    0*112 435  25    0*113 448  30    0*
42675 08/01*110 409  25    0*111 422  30    0*112 435  35    0*114 448  45    0*
                                     **                **      ***       **

42680 08/02*115 460  40    0*124 474  50    0*133 487  70    0*143 499  90  987*
42680 08/02*118 461  55    0*124 474  65    0*133 487  75    0*143 499  75  987*
           *** ***  **                **                **                **

42685 08/03*149 508  80  996*152 523  65    0*155 539  65 1000*159 553  65  988*
42685 08/03*149 511  65  996*152 524  65    0*155 539  70    0*159 553  75  988*
                ***  **          ***                      **    *         **

42690 08/04*163 567  50    0*167 580  45    0*174 592  30 1007*182 603  30    0*
42690 08/04*163 567  65    0*170 580  50    0*179 594  35    0*190 607  30    0*
                     **      ***       **      *** ***  **    * *** ***

42695 08/05*191 614  30    0*200 625  25    0*210 636  25 1011*220 646  25    0*
42695 08/05*200 620  30    0*207 632  25    0*214 642  25    0*220 652  25    0*
           *** ***           *** ***           *** ***         *     ***

42700 08/06*228 656  25    0*235 667  25    0*240 680  25 1012*244 688  30    0*
42700 08/06W228 662  25    0W235 671  25    0W240 680  25 1012W245 688  30    0*
          *    ***          *    ***          *                ****

42705 08/07*250 695  30    0*254 701  30    0*260 703  30    0*265 704  30    0*
42705 08/07*250 695  30    0*257 701  30    0*264 703  30    0*270 704  35    0*
                             ***               ***               ***       **

42710 08/08*273 705  55    0*280 701  60    0*285 697  65  981*288 691  65  981*
42710 08/08*275 704  45    0*279 703  55    0*283 699  65  992*287 693  75  981*
           *** ***  **      *** ***  **      *** ***       *** *** ***  **

42715 08/09*293 685  65    0*300 676  70    0*313 662  75  979*328 640  90  974*
42715 08/09*293 685  75    0*300 676  80    0*313 662  90  979*328 640 100  970*
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                     **              **              **              ***  ***

42720 08/10*345 615  90  969*364 590  90    0*380 561  85  985*400 540  80    0*
42720 08/10*347 615 100  969*364 590  95    0*382 563  85  985*400 540  75    0*
           ***     ***                **      *** ***  **                **

42725 08/11E425 520  65    0E448 501  65    0*  0   0   0    0*  0   0   0    0*
42725 08/11*420 516  65    0E435      55    0E444 458  50    0E452 425  45    0*
           *    ***          *** ***  **      *** ***  **      *** ***  **

(August 12th is new to HURDAT)
42727 08/12E457 400  45    0E462 375  40    0E470 350  35    0*  0   0    0    0*
           *** ***  **      *** ***  **      *** ***  **
42730 HR
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Hurricane Landfall

08/09 1530Z 32.3N 64.8W 95 kt Bermuda – 975 mb

Minor changes to the track and intensity shown in McAdie et al. (2009). Major alterations are to show a tropical wave stage on August 6th and to add 30 hours to the track as an extratropical cyclone. Evidence for these alterations comes from the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Monthly Weather Review, Navy reconnaissance book, Mariners Weather Log, Tucker (1996), Allison & Thompson (1966) and NHC Storm Wallets.

July 30:

HWM and microfilm do not analyze an organized system at 12Z. HURDAT does not list an organized system on this date. Ship highlights: No gales or low pressures.

July 31:

HWM analyzes a spot low pressure at 10.8N, 38.8W at 12Z. HURDAT lists a 25 kt tropical depression at 11.0N, 39.4W at 18Z (first position). Microfilm does not show an organized system on this date. Ship highlights: No gales or low pressures.

MWR: “A cloud mass first detected in the mid-Atlantic by the TlROS VI satellite at 1505 GMT July 31, was undoubtedly Arlene in her embryonic tropical depression stage.” ATSR: “Hurricane ARLENE began formation in the tropical Atlantic near 11N 39W. An area of unusual cloudiness detected by TIROS VI at 1505Z on 31 July was beyond the range of reconnaissance aircraft.”

August 1:

HWM analyzes a closed low pressure of at most 1005 mb at 11.1N, 43.8W at 12Z. HURDAT lists a 25 kt tropical depression at 11.2N, 43.5W at 12Z. Microfilm shows a tropical wave at 45W at 12Z. Ship highlights: No gales or low pressures.

August 2:

HWM analyzes a hurricane of at most 1000 mb at 13.5N, 48.5W at 12Z. HURDAT lists a 70 kt hurricane at 13.3N, 48.7W at 12Z. Microfilm shows a closed low pressure of at most 1008 mb at 12.5N, 49.5W at 12Z. Ship highlights: No gales or low

pressures. Aircraft highlights: Penetration center fix measured a central pressure of 987 mb, estimated surface winds of 85 kt and an eye diameter of 18 nm at 14.2N, 49.8W at 1642Z (ATSR). Penetration center fix estimated flight level winds of 54 kt at 14.8N, 50.7W at 2338Z (ATSR).

MWR: “Too far away then for immediate air reconnaissance, the Navy as a fully developed hurricane at 1642 GMT located it August 2 at 14.2º N., 49.8º W. During the preceding night the *Mormactrader* passed very close to Arlene. Although a complete ship's log is not available, an examination of her excellent 6-hourly reports indicates that the cyclone had just reached tropical storm intensity. It is estimated that Arlene intensified from storm to Hurricane force within 12 hr., a rather rapid development.” ATSR: “It was determined that a normal westerly movement would bring the cloud mass within striking distance of the reconnaissance aircraft on 2 August. Departing Roosevelt Roads at first light, a Navy reconnaissance aircraft investigated the area and by 1642Z had located fully developed Hurricane ARLENE at 14.2N 49.8W. The first warning on Hurricane ARLENE was issued at 021800Z. Maximum winds were 85 knots.”

August 3:

HWM analyzes a hurricane of at most 1000 mb at 15.8N, 53.8W at 12Z. HURDAT lists a 65 kt hurricane at 15.5N, 53.9W at 12Z. Microfilm shows a closed low pressure of at most 1011 mb at 15.0N, 52.5W at 12Z. Ship highlights: No gales or low pressures. Aircraft highlights: Penetration center fix measured a central pressure of 996 mb, estimated flight level winds of 82 kt and an eye diameter of 12 nm at 14.9N, 50.9W at 01Z (ATSR). Penetration center fix measured a central pressure of 1000 mb and estimated surface winds of 55 kt at 15.6N, 54.7W at 14Z (WALLET). Penetration center fix measured a central pressure of 988 mb, estimated surface winds of 110 kt and an eye diameter of 25 nm at 16.1N, 55.4W at 1803Z (ATSR).

MWR: “Three different flights, which penetrated the cyclone during the next 26-hr period, reported hurricane-force winds. Based upon the surface pressures taken from the dropsondes, various pressure-wind graphs would support most of the Hurricane-force winds reported by the aircraft. There is no doubt it was a well-developed hurricane, and was so described by the plane's meteorologist, yet rapid deterioration of the eye structure as well as a reduction of winds took place during the night of August 3-4 in an area where this rarely occurs…” ATSR: “Subsequent reconnaissance flights throughout 2 and 3 august indicated that ARLENE was maintaining hurricane intensity and moving northwestward.”

August 4:

HWM analyzes a tropical storm of at most 1010 mb at 17.6N, 59.0W at 12Z. HURDAT lists a 30 kt tropical depression at 17.4N, 59.2W at 12Z. Microfilm shows a closed low pressure of at most 1005 mb at 18.6N, 60.4W at 12Z. Ship highlights: No gales or low pressures. Aircraft highlights: Radar center fix estimated an eye diameter of 23 nm at 15.6N, 55.8W at 0248Z (WALLET). Radar center fix measured a peripheral pressure of 1004 mb and estimated surface winds of 60 kt at 15.6N, 57.9W at 0630Z (WALLET).

MWR: “and by midday of the 4th Arlene was, at most, a tropical depression.” ATSR: “However, during the night of 3 August, ARLENE rapidly weakened and by 041600Z was a moderate tropical depression.”

August 5:

HWM analyzes a closed low pressure of at most 1010 mb at 20.8N, 63.7W at 12Z. HURDAT lists a 25 kt tropical depression at 21.0N, 63.6W at 12Z. Microfilm shows a closed low pressure of at most 1011 mb at 21.5N, 64.8W at 12Z. Ship highlights: 40 kt SW at 22.5N, 64.0W at 18Z (micro).

ATSR: “Further weakening occurred and by 050400Z ARLENE’s winds were less than 25 knots. The reason for this weakening was not fully understood at the time, but post-analyses indicate that troughing at 200 mbs in the storm area had a “damping” effect on the storm’s outflow. During the period 5-7 August, ARLENE remained a weak tropical depression, moving northwestward to a point approximately 550 miles east of the southern tip of Florida.”

August 6:

HWM analyzes a closed low pressure of at most 1015 mb at 23.8N, 68.8W at 12Z. HURDAT lists a 25 kt tropical depression at 24.0N, 68.0W at 12Z. Microfilm shows a closed low pressure of at most 1014 mb at 23.8N, 68.3W at 12Z. Ship highlights: No gales or low pressures.

August 7:

HWM analyzes a closed low pressure of at most 1015 mb at 26.5N, 70.0W with a warm front to the north at 12Z. HURDAT lists a 30 kt tropical depression at 26.0N, 70.3W at 12Z. Microfilm shows a closed low pressure of at most 1014 mb at 28.0N, 69.0W with a frontal boundary to the north at 12Z. Ship highlights: 15 kt SSE and 1005 mb at 28.9N, 69.4W at 12Z (COADS). 35 kt S and 1012 mb at 27.0N, 70.0W at 18Z (COADS).

MWR: “Tropical depression intensity was maintained through August 7, mainly, it is believed, as it reflection of a circulation aloft which seemed to persist throughout this degenerate stage, although at times the surface perturbation appeared to be nothing more than a disturbed area.”

August 8:

HWM analyzes a tropical storm of at most 1005 mb at 28.5N, 69.5W with a cold front far to the northwest and a warm front to the north at 12Z. HURDAT lists a 65 kt hurricane at 28.5N, 69.7W at 12Z. Microfilm shows a closed low pressure of at most 1011 mb at 28.5N, 69.7W at 12Z. Ship highlights: 45 kt SSW and 1009 mb at 27.4N, 70.0W at 00Z (COADS). 15 kt NW and 1002 mb at 27.5N, 72.8W at 06Z (COADS). 55 kt S and 1000 mb at 28.5N, 69.2W at 18Z (COADS). Aircraft highlights: Penetration center fix measured a central pressure of 992 mb and estimated an eye diameter of 20 nm at 28.6N, 69.6W at 1357Z (WALLET). Penetration center fix measured a central pressure of 981 mb, estimated surface winds of 65 kt and an eye diameter of 22 nm at 28.8N,

69.3W at 19Z (ATSR). Penetration center fix estimated surface winds of 65 kt at 29.1N, 68.8W at 2230Z (WALLET).

MWR: “Ship reports during the late evening of the 7th indicated that Arlene was once again a tropical storm and by 1357 GMT August 8, an Air Force plane penetrated the center. The eye was well defined and maximum surface winds were estimated at 75 mph. A rather unusual type of fix and a very excellent one was obtained by radar from the USS Lawrence just prior to the Air Force plane penetration. Except for an increase in forward speed, Arlene changed little during the night and early morning hours of August 8-9.” ATSR: “By 080400Z, however, ship reports indicated that ARLENE was reintensifying, and a tropical storm warning was issued at 080500Z. Reintensification continued and by 081600Z ARLENE was again a hurricane. By this time, she had commenced recurvature and the eye subsequently passed over Bermuda at 091600Z. Maximum winds recorded in Bermuda were gust to 84 knots.”

August 9:

HWM analyzes a hurricane of at most 1000 mb at 31.5N, 66.4W with a cold front just to the northwest at 12Z. HURDAT lists a 75 kt hurricane at 31.3N, 66.2W at 12Z. Microfilm shows a closed low pressure of at most 1008 mb at 31.3N, 66.1W with a frontal boundary to the north at 12Z. Ship highlights: 70 kt SW and 991 mb at 28.9N, 68.7W at 00Z (micro). 45 kt WSW and 1007 mb at 29.2N, 67.6W at 09Z (COADS). 35 kt SW and 1011 mb at 29.3N, 67.0W at 12Z (COADS). 35 kt S and 1011 mb at 31.4N, 62.7W at 18Z (COADS). 40 kt SW and 1006 mb at 32.6N, 61.9W at 21Z (micro). Land highlights: 975 mb at Kindley Air Force Base, Bermuda near 16Z (WALLET). 60 kt (gusts to 85 kt) at Kindley Air Force Base, Bermuda near 16Z (WALLET). Aircraft highlights: Radar center fix at 30.1N, 67.4W at 0611Z (WALLET). Penetration center fix measured a central pressure of 979 mb, estimated surface winds of 65 kt and an eye diameter of 20 nm at 30.9N, 66.8W at 1005Z (WALLET). Penetration center fix measured a central pressure of 982 mb, estimated surface winds of 65 kt and an eye diameter of 8 nm at 31.4N, 66.0W at 1220Z (WALLET). Penetration center fix measured a central pressure of 970 mb and estimated surface winds of 100 kt at 33.0N, 63.6W at 19Z (WALLET). Penetration center fix measured a central pressure of 969 mb, estimated surface winds of 115 kt and an eye diameter of 20-30 nm at 34.1N, 62.5W at 22Z (WALLET).

MWR: “The eye passed over Bermuda at 1600 GMT and observers there were able to obtain an eye sounding. Temperatures in the eye, at least in the lower and middle troposphere, were quite similar to those obtained in the eye of an October hurricane at Tampa in 1944. Temperatures at higher levels in the Bermuda sounding were considerably lower than in the Tampa sounding. As observed winds aloft indicate, the radiosonde did not remain within the eye throughout its flight. There were no lives lost at Bermuda although there was $300,000 property damage. The lowest pressure was 28.78 in. or 974.5 mb, while rainfall was 2.69 in. Highest winds at Bermuda were from the east-southeast, 69 mph, with gusts to 98 mph, and tides were estimated at 4 ft. above normal.”

August 10:

HWM analyzes a hurricane of at most 990 mb at 38.8N, 56.2W with a weakening cold front just to the west and a warm front to the north at 12Z. HURDAT lists an 85 kt hurricane at 38.0N, 56.1W at 12Z. Microfilm shows a closed low pressure of at most 1005 mb at 38.3N, 55.7W with an extratropical cyclone just to the northwest at 12Z. Ship highlights: 45 kt SSW and 1010 mb at 32.7N, 60.4W at 00Z (COADS). 40 kt S and 1015 mb at 38.0N, 49.2W at 18Z (COADS). 45 kt E and 1005 mb at 45.9N, 40.6W at 21Z (COADS/micro). Aircraft highlights: Penetration center fix at 34.8N, 61.3W at 01Z (WALLET). Penetration center fix measured a central pressure of 985 mb, estimated surface winds of 75 kt and an eye diameter of 15 nm at 38.6N, 55.3W at 1340Z (WALLET). Penetration center fix at 40.4N, 53.7W at 19Z (WALLET).

MWR: "After leaving Bermuda, Arlene moved on a northward course and probably increased slightly in intensity for a short while, only to weaken a bit on the 10th."

August 11:

HWM analyzes an extratropical cyclone of at most 1005 mb at 50.0N, 50.0W with frontal boundaries extending to the southeast and southwest at 12Z. HURDAT lists a 65 kt extratropical cyclone at 44.8N, 50.1W at 06Z (last position). Microfilm shows a closed low pressure of at most 1002 mb at 39.0N, 45.4W with an extratropical cyclone to the northwest at 12Z. Ship highlights: 40 kt SW and 1018 mb at 36.2N, 47.0W at 00Z (COADS). 5 kt SE and 1003 mb at 44.2N, 48.3W at 06Z (COADS). 35 kt SW and 1010 mb at 43.0N, 43.9W at 12Z (COADS). 35 kt WNW and 1008 mb at 44.5N, 45.0W at 15Z (COADS). 35 kt WNW and 1001 mb at 45.1N, 43.0W at 18Z (COADS).

MWR: "During the night of August 10-11, it quickly lost tropical characteristics and merged with a polar front some 200 mi. southeast of Cape Race, Newfoundland." ATSR: "After passing Bermuda, ARLENE continued on a northeasterly course and finally lost all tropical characteristics during the night of 10 August as the storm came under the influence of a cool air mass and low sea temperatures."

August 12:

HWM analyzes an extratropical cyclone of at most 1015 mb at 42.0N, 23.0W at 12Z. HURDAT does not list an organized storm on this date. Microfilm shows an extratropical cyclone of at most 1017 mb at 43.0N, 35.0W at 12Z. Ship highlights: 40 kt E and 1013 mb at 46.4N, 38.9W at 00Z (COADS). 35 kt W and 1017 mb at 41.7N, 38.2W at 12Z (COADS).

Hurricane Arlene developed from a tropical wave that left the African coast around July 27th. The disturbance moved westward across the far eastern Atlantic where the ship data is sparse. Time of genesis is uncertain and it is retained from the original HURDAT at 18Z on July 31st as a 25 kt tropical depression. Minor track alterations are shown during the lifetime of this tropical cyclone. At 18Z on the 31st, microfilm shows a nephanalysis of a TIROS satellite image that captured the system, indicating a large area of convection around the estimated position. The tropical depression continued moving westward on the August 1st and another satellite image appears as a nephanalysis at 18Z on this date but only captured the eastern half of the system. Intensification to a tropical storm is analyzed

at 12Z on the 1st, twelve hours earlier than originally shown in HURDAT, based on aircraft reconnaissance data on August 2nd. A ship moved across the tropical cyclone early on the 2nd, showing a distinctive shift in the winds, and it is the first confirmation that a closed low-level circulation was present. The first reconnaissance aircraft to investigate Arlene on the 2nd measured a central pressure of 987 mb, estimated surface winds of 85 kt and an eye diameter of 18 nm at 1642Z. A central pressure of 987 mb suggests maximum surface winds of 68 kt from the Brown et al. south of 25N pressure-wind relationship. An eye diameter of 18 nm suggests an RMW of about 14 nm and the climatological value is 13. Based on a blend of the pressure-wind relationship and the estimated surface wind, an intensity of 75 kt is selected at 18Z on the 2nd, down from 90 kt originally in HURDAT, a minor intensity change. Intensification to a hurricane is analyzed at 06Z on the 2nd, six hours earlier than originally shown in HURDAT, as HURDAT showed – without justification – a very rapid intensification which is now smoothed out. (Some central pressures values were present in the original HURDAT between August 2nd at 18Z and August 10th at 12Z. Some of these were in the wrong time slots or not accurate. Thus, based on actual observations, some were retained, others removed and new central pressure values added. Detailed information on these changes can be found in the table at the end.) The next penetration center fix measured a central pressure of 996 mb, estimated surface winds of 82 kt and an eye diameter of 12 nm at 01Z on August 3rd. A central pressure of 996 mb suggests maximum surface winds of 55 kt from the weakening subset south of 25N pressure-wind relationship. An eye diameter of 12 nm suggests an RMW of about 9 nm and the climatological value is 14. Based on a fast forward speed of about 15 kt and a blend of the other values, an intensity of 65 kt is selected at 00Z on the 3rd, down from 80 kt originally in HURDAT, a minor intensity change. The next reconnaissance aircraft reached Arlene late on the 3rd and the measurements obtained show some irregularities. At 14Z on the 3rd, a center penetration fix measured a central pressure of 1000 mb and estimated surface winds of 55 kt. Four hours later, at 1803Z on the 3rd, a center penetration fix measured a central pressure of 988 mb, estimated surface winds of 110 kt and an eye diameter of 25 nm. Based upon the data available, it is difficult to determine which measurement is incorrect, but based on the estimated surface winds, the measurement at 1803Z on the 3rd appears to be correct and has been retained. A central pressure of 988 mb suggests maximum surface winds of 67 kt from the south of 25N pressure-wind relationship. An eye diameter of 25 nm suggests an RMW of about 19 nm and the climatological value is 14. Based on a quick forward speed of about 14 kt and putting some weight on the estimated surface winds, an intensity of 75 kt is selected at 18Z on the 3rd, up from 65 kt originally in HURDAT, a minor intensity change.

On August 4th, Arlene likely entered an area of unfavorable environmental conditions and rapidly weakened. Weakening to a tropical storm is analyzed at 06Z on the 4th, six hours later than originally shown in HURDAT. Weakening to a tropical depression is analyzed at 18Z on the 4th, also six hours later than originally shown in HURDAT. A recent analog showing a similar rapid weakening due to strong vertical wind shear is Hurricane Carlos, 2009, in the eastern Pacific. Reconnaissance aircraft investigating Arlene on the 4th were not able to locate a center. Synoptic observations late on the 4th and on August 5th indicate that Arlene may have weakened to a sharp tropical wave. But a reconnaissance

mission around noon (12Z) on the 5th shows that Arlene still had a closed circulation, thus it is retained as a tropical depression late on the 4th through late on the 5th. A ship reported 40 kt SW at 18Z on the 5th but appears to have a high bias compared to the nearby ship observations. Ship data on August 6th at 00Z show that Arlene had weakened to a tropical wave as the wind flow was easterly in the southwest quadrant. The sharp tropical wave continued moving west-northwest and slowed its forward speed. At 00Z on August 7th, ship observations indicate that Arlene had regained a closed circulation, thus becoming a tropical depression once again. On the 7th, Arlene reached the westernmost extent of its track and began to slowly move to the north while becoming better organized. Intensification to a tropical storm is analyzed at 18Z on the 7th, six hours earlier than HURDAT, based on a ship report of 35 kt S in the eastern quadrant. HURDAT originally showed an unrealistic jump in intensity from 30 kt at 18Z on the 7th to 55 kt at 00Z on August 8th. A few ships reported gale-force winds and even storm-force winds, up to 55 kt on the 8th. A reconnaissance aircraft measured a central pressure of 992 mb and estimated an eye diameter of 20 nm at 1357Z on the 8th. A central pressure of 992 mb suggests maximum surface winds of 64 kt from the south of 25N pressure-wind relationship. An eye diameter of 20 nm suggests an RMW of about 15 nm and the climatological value is 20. Based on a forward speed of about 7 kt, an intensity of 65 kt is selected at 12Z on the 8th, same as originally shown in HURDAT. Regaining hurricane intensity is analyzed at 12Z on the 8th, same as originally shown in HURDAT. TIROS VII captured a partial satellite image of Arlene at 1749Z on the 8th showing a well-organized area of convection with banding features. The next penetration center fix measured a central pressure of 981 mb, estimated surface winds of 65 kt and an eye diameter of 22 nm at 19Z on the 8th. A central pressure of 981 mb suggests maximum surface winds of 71 kt and 74 kt from the north of 25N and intensifying subset of the pressure-wind relationship, respectively. An eye diameter of 22 nm suggests an RMW of about 17 nm and the climatological value is 22. Based on a slow forward speed of about 6 kt, but a small RMW, an intensity of 75 kt is selected at 18Z on the 8th, up from 65 kt originally in HURDAT, a minor intensity change. On August 9th, Arlene increased its forward speed to the northeast and impacted the island of Bermuda. A ship reported 70 kt SW and 991 mb at 00Z on the 9th in the southern quadrant of the hurricane. At 1005Z on the 9th, a penetration center fix measured a central pressure of 979 mb, estimated surface winds of 65 kt and an eye diameter of 20 nm. A central pressure of 979 mb suggests maximum surface winds of 74 kt from the north of 25N pressure-wind relationship. An eye diameter of 20 nm suggests an RMW of about 15 nm and the climatological value is 24. Based on a fast forward speed of about 22 kt and an RMW smaller than the climatological value, an intensity of 90 kt is selected at 12Z on the 9th, up from 75 kt originally shown in HURDAT, a minor intensity change. Arlene made landfall in Bermuda around 1530Z on the 9th as a small, rapidly-moving and intensifying hurricane. The Kindley Air Force Base, located in the northeastern part of the island, measured maximum sustained winds of 66 kt and with gusts to 85 kt around 16Z. A central pressure measured in Bermuda was 975 mb, which suggests maximum surface winds of 79 kt from the north of 25N pressure-wind relationship. Based on a forward speed of about 31 kt and small RMW, an intensity of 95 kt is selected at the time of landfall. After leaving Bermuda, a reconnaissance aircraft investigated Arlene measuring a central

pressure of 970 mb and estimated surface winds of 100 kt at 19Z on the 9th. A central pressure of 970 mb suggests maximum surface winds of 84 kt and 88 kt from the north of 25N and intensifying subset of the pressure-wind relationship, respectively. Based upon a forward speed of 31 kt and small RMW, an intensity of 100 kt is selected at 18Z on the 9th, up from 90 kt originally in HURDAT, a minor intensity change. An intensity of 100 kt is also the peak intensity of this tropical cyclone, up from 90 kt originally in HURDAT. This reanalysis indicates that Arlene was a major hurricane. At 22Z on the 9th, another penetration center fix measured a central pressure of 969 mb, estimated surface winds of 115 kt and an eye diameter of 20-30 nm. A central pressure of 969 mb suggests maximum surface winds of 86 kt from the north of 25N Brown et al. and 83 kt from the north of 35N Landsea et al. pressure-wind relationships. An eye diameter of 20-30 nm suggests an RMW of about 15-23 nm and the climatological value is 28. Based on a forward speed of 31 kt, small circulation and putting some weight on the estimated surface winds, an intensity of 100 kt is analyzed at 00Z on August 10th, up from the 90 kt originally shown in HURDAT, a minor intensity change.

On the 10th, Arlene was moving northeastward ahead of a frontal boundary. The hurricane was so small synoptically, that in the microfilm the ship observations available do not even suggest that a closed circulation was present. Later on the 10th, the hurricane began to weaken. The last reconnaissance aircraft to investigate Arlene reached the tropical cyclone at 1340Z on the 10th measuring a central pressure of 985 mb, estimating surface winds of 75 kt and an eye diameter of 15 nm. A central pressure of 985 mb suggests maximum surface winds of 68 kt from the Landsea et al. north of 35N pressure-wind relationship. An eye diameter of 15 nm suggests an RMW of about 11 nm and the climatological value is 34. Based on a forward speed of about 31 kt and small circulation, an intensity of 85 kt is analyzed at 12Z on the 10th, same as originally shown in HURDAT. Early on August 11th, Arlene passed a couple of hundred miles southeast of Newfoundland and turned to the east-northeast. Transition to an extratropical cyclone is analyzed in HURDAT at 00Z on the 11th but synoptic observations indicate that Arlene remained in the warm sector of an extratropical cyclone located to the northwest. Transition to an extratropical cyclone is analyzed at 06Z on the 11th, six hours later than originally shown in HURDAT. Weakening below hurricane intensity is analyzed at 06Z on the 11th, six hours earlier than originally shown in HURDAT. Arlene continued to weaken on the 11th and synoptic observations show that it weakened into a trough after 12Z on the 12th while located northwest of the Azores. The last position is analyzed at 12Z on the 12th, 30 hours later than originally shown in HURDAT.

Date	Original HURDAT Central Pressure	Evidence	Changes
Aug 02 18Z	987 mb	Penetration center fix: 987 mb at 1642Z on Aug 02nd	Retained

Aug 03 00Z	996 mb	Penetration center fix: 996 mb at 01Z on Aug 03rd	
Aug 03 12Z	1000 mb	Penetration center fix: 1000 mb at 14Z on Aug 03rd – Likely incorrect based on subsequent central pressure measurement	Removed
Aug 03 18Z	988 mb	Penetration center fix: 988 mb at 1803Z on Aug 03rd	Retained
Aug 04 12Z	1007 mb	Ship reported 1007 mb and 20 kt suggesting a central pressure of a lower value	Removed
Aug 05 12Z	1011 mb	Dropsonde measured 1011 mb and 15 kt SW at 1Z on Aug 05th	
Aug 06 12Z	1012 mb	Aircraft reconnaissance measured a minimum pressure of 1012 mb	Retained
Aug 08 12Z	981 mb	Penetration center fix: 992 mb at 1357Z on Aug 08th	992 mb
Aug 08 18Z	981 mb	Penetration center fix: 981 mb at 19Z on Aug 08th	Retained
Aug 09 12Z	979 mb	Penetration center fix: 979 mb at 1005Z on Aug 09th	
Aug 09 18Z	974 mb	Penetration center fix: 970 mb at 19Z on Aug 09th	970 mb
Aug 10 12Z	985 mb	Penetration center fix: 985 mb at 1340Z on Aug 10th	985 mb

Hurricane Beulah [August 20 – September 6, 1963]

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42735 08/20/1963 M= 9  2 SNBR= 925 BEULAH      XING=0 SSS=0
42735 08/20/1963 M=17  3 SNBR= 925 BEULAH      XING=0 SSS=0
                    **  *

42740 08/20*  0   0   0    0*  0   0   0    0*137 495  30    0*143 509  30 1006*
42740 08/20*112 474  25    0*121 485  25    0*130 496  30    0*139 507  30 1006*
           *** ***  **      *** ***  **      *** ***          *** ***

42745 08/21*150 517  30    0*155 528  35    0*160 535  35    0*165 546  45 1005*
42745 08/21*147 518  30    0*154 528  35    0*160 537  35    0*165 546  45 1005*
           *** ***          ***                ***

42750 08/22*168 554  45    0*173 560  55    0*179 569  70  994*187 578  75    0*
42750 08/22*169 554  50    0*173 560  55    0*179 569  60  994*187 578  70    0*
           ***       **                      **                **

42755 08/23*196 583  80    0*205 588  85    0*213 591  85    0*221 592  90  962*
42755 08/23*196 583  75    0*205 588  80  977*213 591  90    0*220 592  95  963*
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                     **              **  ***          **      ***      **  ***

42760 08/24*226 594  95    0*231 596 105  958*237 597 105    0*241 598 100  961*
42760 08/24*226 594  95  962*231 596 100  958*237 597 100  961*243 598  95  961*
                         ***         ***                 ***  *** ***      **

42765 08/25*248 600  85    0*256 602  80    0*266 603  75  985*278 604  80  976*
42765 08/25*248 600  90    0*256 602  80    0*266 603  65  985*278 604  75  976*
                     **                                  **                **

42770 08/26*290 602  80  978*304 592  85    0*316 583  85  983*329 570  85  979*
42770 08/26*290 601  75  978*304 593  70    0*316 583  70  983*329 570  75  979*
                 ***  **          ***  **                 **                **

42775 08/27*345 553  80    0*363 536  75    0*384 523  70    0*416 510  70    0*
42775 08/27*345 553  75    0*363 536  75    0*384 523  70    0E416 510  70    0*
                     **                                       *

42780 08/28*458 483  70    0E494 449  65    0E516 410  60    0E542 355  60    0*
42780 08/28E458 483  70    0E494 449  65    0E518 410  60    0E540 370  60    0*
          *                                   ***             *** ***
(August 29th through 31st, and September 1st through 6th are new to HURDAT)
42781 08/29E550 340  55    0E560 300  55    0E564 250  55    0E567 210  55    0*
42783 08/30E570 170  55    0E572 140  55    0E572 110  55    0E560 085  55    0*
42785 08/31E545 070  60    0E525 060  60    0E510 050  60    0E500 040  60    0*
42787 09/01E490 030  55    0E485 020  50    0E485 010  45    0E490 005  40    0*
42789 09/02E500 000  35    0E515 005  30    0E530 010  30    0E540 005  30    0*
42791 09/03E550 000  30    0E5553590  30    0E5603580  30    0E5653575  30    0*
42793 09/04E5703572  30    0E5803575  30    0E5953580  30    0E6103570  30    0*
42795 09/05E6353560  30    0E6503545  30    0E6653530  25    0E6803520  25    0*
42797 09/06E6903510  25    0E7003505  25    0E7103500  25    0E7203495  25    0*

42800 HR
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Minor changes to the track and intensity shown in McAdie et al. (2009). A major alteration is to add eight days to the lifetime of this tropical cyclone. Evidence for these alterations comes from the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Monthly Weather Review, Navy reconnaissance book, Mariners Weather Log, National Hurricane Research Project (NHRP), Allison & Thompson (1966) and NHC Storm Wallets.

August 16:

HWM analyzes a spot low pressure at 15.6N, 44.2W at 12Z. HURDAT does not list an organized system on this date. Microfilm does not show an organized system on this date. Ship highlights: No gales or low pressures.

August 17:

HWM analyzes a spot low pressure at 14.7N, 46.0W at 12Z. HURDAT does not list an organized system on this date. Microfilm shows a tropical wave at 49W at 12Z. Ship highlights: No gales or low pressures.

MIAMI WEATHER BUREAU BULLETIN: “Special statement from the Miami Weather Bureau. A Navy reconnaissance aircraft today investigated an area of suspicion photographed by TIROS satellite yesterday some 1000 miles east of the Lesser Antilles in the central Atlantic. The flight found no evidence of a tropical disturbance or a developing circulation and reported no unusual weather in the area.”

August 18:

HWM analyzes a spot low pressure at 14.0N, 47.5W at 12Z. HURDAT does not list an organized system on this date. Microfilm does not show an organized system on this date. Ship highlights: No gales or low pressures.

August 19:

HWM analyzes a spot low pressure at 14.4N, 48.5W at 12Z. HURDAT does not list an organized system on this date. Microfilm does not show an organized system on this date. Ship highlights: No gales or low pressures.

August 20:

HWM analyzes a closed low pressure of at most 1010 mb at 13.5N, 48.5W at 12Z. HURDAT lists a 30 kt tropical depression at 13.7N, 49.5W at 12Z (first position). Microfilm shows a closed low pressure of at most 1011 mb at 13.0N, 49.0W at 12Z. Ship highlights: No gales or low pressures.

MWR: "The circulation that developed into hurricane Beulah was located by aerial reconnaissance near 14ºN, 51ºW about midday on August 20. Maximum winds were 35 mph in squalls and the lowest observed surface pressure was 1006 mb or 29.71 in. Cloudiness and shower activity covered a large area. Surface ship reports during the preceding several days had indicated disturbed conditions over much of the area from the Cape Verdes westward to the longitude of the incipient storm. Data limitations preclude specification of the exact position of the Inter-tropical Convergence Zone during this period, but south and southwest winds of 23 to 30 m.p.h. were prevalent its much as 300 mi. to the north of the normal ITC position. Sparsity of data also makes the earlier history of the vortex obscure. Westward movement of about 11 mph would have brought a cloud mass photographed by TIROS VI near 13ºN, 25ºW on August 14 to the vicinity of the developing circulation. However, it is not possible to say whether this represented the nascent stages of Beulah." ATSR: "The circulation that developed into Hurricane BEULAH apparently formed on the Intertropical Convergence Zone during a period of abnormal northward displacement of this zone. Surface ship reports for several days had indicated disturbed weather conditions in an area east of the Antilles but no closed circulation could be found. Location of the first well-defined closed circulation was observed by reconnaissance aircraft on the 20th, about 660 miles east of the Lesser Antilles. Maximum winds were 30 knots in squalls and the lowest observed surface pressure was 1006 millibars."

August 21:

HWM analyzes a tropical storm of at most 1005 mb at 16.3N, 53.5W at 12Z. HURDAT lists a 35 kt tropical storm at 16.0N, 53.5W at 12Z. Microfilm shows a closed low pressure of at most 1011 mb at 16.5N, 54.0W at 12Z. Ship highlights: 35 kt SE and 1005 mb at 16.9N, 54.3W at 12Z (micro). 45 kt NW and 1011 mb at 16.5N, 51.0W (may

be 56.0W) at 18Z (micro). Aircraft highlights: Penetration center fix measured a central pressure of 1005 mb and estimated surface winds of 45 kt at 16.5N, 54.5W at 1645Z (WALLET).

MWR: "At 1200 GMT August 21, surface ships reported winds of 35 to 40 mph and when reconnaissance aircraft reached the area around noon, maximum winds were 52 mph with a minimum pressure of 1005 mb (29.68 in.) at the center near 16.5ºN, 54.5ºW. The storm moved toward the west-northwest at about 10 mph and slowly intensified during the next 24 hr." ATSR: "The wind reached tropical storm velocity at 1000Z on the 21st, and the first warning was issued at 211830Z. Anti-cyclonic flow at 200 mbs was well established at this time and steady intensification had begun."

August 22:

HWM analyzes a tropical storm of at most 1000 mb at 18.0N, 56.7W at 12Z. HURDAT lists a 70 kt hurricane at 17.9N, 56.9W at 12Z. Microfilm shows a closed low pressure of at most 1002 mb at 18.3N, 57.2W at 12Z. Ship highlights: 30 kt W and 1003 mb at 16.6N, 55.1W at 00Z (micro). Aircraft highlights: Penetration center fix measured a central pressure of 994 mb, estimated surface winds of 68 kt and an eye diameter of 25 nm at 18.1N, 57.4W at 1255Z (WALLET). Penetration center fix estimated surface winds of 55 kt and an eye diameter of 15 nm at 18.6N, 57.3W at 1635Z (WALLET/ATSR). Penetration center fix at 19.5N, 58.6W at 2330Z (WALLET).

MWR: "On August 22, Navy reconnaissance reported that Beulah had increased to hurricane intensity with a well-formed eye and central pressure 994 mb or 29.35 in. Winds of 78 mph were observed just east of the center. A change to a more northwestward course, which began during the afternoon, removed my threat to the Leeward Islands. The highest swells that hit Saint Maarten, Netherlands West Indies, were 4 ft. over the open waters." ATSR: "Hurricane intensity was reached 26 hours later as BEULAH progressed northwestward at 10 knots, apparently carrying her own stratospheric anti-cyclone with her. Aircraft reconnaissance on the 22nd showed a well-defined eye 15 miles in diameter with six-degree Centigrade temperature rise from outside the wall cloud to the center. A change to a more northerly direction also occurred on the 22nd."

August 23:

HWM analyzes a hurricane of at most 995 mb at 21.7N, 59.2W at 12Z. HURDAT lists an 85 kt hurricane at 21.3N, 59.1W at 12Z. Microfilm shows a closed low pressure of at most 1011 mb at 21.0N, 59.5W at 12Z. Ship highlights: 40 kt SE and 1011 mb at 21.1N, 56.5W at 00Z (micro). 40 kt ESE and 1004 mb at 22.1N, 57.5W at 06Z (micro). 35 kt ESE and 1008 mb at 22.6N, 56.1W at 12Z (micro). 40 kt SSE and 1009 mb at 21.5N, 58.5W at 18Z (micro). 40 kt SSW and 1002 mb at 21.1N, 58.4W at 21Z (micro). Aircraft highlights: Penetration center fix measured a central pressure of 978 mb, estimated surface winds of 90 kt and an eye diameter of 25 nm at 20.6N, 58.7W at 07Z (WALLET). Penetration center fix measured a central pressure of 979 mb at 21.8N, 59.6W at 15Z (WALLET). Penetration center fix measured a central pressure of 963 mb and estimated surface winds of 85 kt at 22.1N, 59.1W at 1740Z (WALLET). Penetration center fix measured a central pressure of 962 mb, estimated surface winds of 84 kt and an

RMW of 19 nm near 21.0N, 59.0W at 2030Z (NHRP). Penetration center fix measured a central pressure of 962 mb, estimated surface winds of 90 kt and an eye diameter of 29 nm at 22.1N, 59.3W at 22Z (WALLET/ATSR).

MWR: "The hurricane began to deepen more rapidly late on the 22nd and continued to intensify through the 23rd."

August 24:

HWM analyzes a hurricane of at most 990 mb at 23.7N, 59.6W at 12Z. HURDAT lists a 105 kt hurricane at 23.7N, 59.7W at 12Z. Microfilm shows a closed low pressure of at most 1008 mb at 23.0N, 60.0W at 12Z. Ship highlights: 40 kt SE and 1008 mb at 22.8N, 56.5W at 00Z (micro). 45 kt SE and 1006 mb at 22.0N, 57.2W at 03Z (micro). 60 kt E and 998 mb at 24.2N, 58.1W at 06Z (micro). 50 kt NW and 993 mb at 23.1N, 60.6W at 10Z (micro). 60 kt SE and 996 mb at 16.9N, 58.3W at 12Z (micro). 45 kt SE and 989 mb at 23.7N, 59.7W at 13Z (micro). 40 kt SSE and 1002 mb at 23.5N, 57.2W at 19Z (micro). Aircraft highlights: Radar center fix estimated an eye diameter of 29 nm at 22.6N, 58.1W at 0037Z (WALLET). Penetration center fix measured a central pressure of 958 mb and estimated an eye diameter of 20 nm at 23.0N, 59.6W at 0630Z (WALLET). Penetration center fix measured a central pressure of 961 mb, estimated surface winds of 96 kt and an RMW of 25 nm near 21.0N, 59.0W at 14Z (NHRP). Penetration center fix measured a central pressure of 961 mb, estimated surface winds of 102 kt and an eye diameter of 20 nm at 24.1N, 59.7W at 1450Z (WALLET). Penetration center fix measured a central pressure of 961 mb, estimated surface winds of 108 kt and an RMW of 20 nm near 21.0N, 59.0W at 1630Z (NHRP).

MWR: "The lowest central pressure observed during the life of the storm was 958 mb. (28.29 in.) at 0630 GMT August 24. Radar showed an elliptical eye with a 20- to 30-mi. diameter. It is estimated that maximum winds at this time were about 120 m.p.h. During the late forenoon, aircraft penetrating the center indicated the beginning of a filling trend with an observed central pressure of 961 mb or 28.38 in., and maximum winds of 115 mph." ATSR: "Maximum intensity of 105 knots was reached on the 24th, coinciding with a minimum central pressure of 958 millibars. Rapid de-intensification began very soon after this peak, as BEULAH began to move away from the 200 mb anticyclone and weakening continued for 24 hours."

August 25:

HWM analyzes a hurricane of at most 1000 mb at 26.5N, 61.0W at 12Z. HURDAT lists a 75 kt hurricane at 26.6N, 60.3W at 12Z. Microfilm shows a closed low pressure of at most 1011 mb at 27.0N, 60.0W at 12Z. Ship highlights: 45 kt SE and 1013 mb at 23.5N, 56.5W at 00Z (micro). 35 kt S and 1011 mb at 22.8N, 56.7W at 06Z (COADS). Aircraft highlights: Penetration center fix estimated flight level winds of 77 kt and an eye diameter of 30 nm at 25.6N, 60.5W at 0647Z (WALLET/ATSR). Penetration center fix measured a central pressure of 985 mb, estimated flight level winds of 60 kt and an eye diameter of 40 nm at 27.0N, 60.1W at 1310Z (WALLET). Penetration center fix measured a central pressure of 976 mb, estimated surface winds of 80 kt and an eye diameter of 60 nm at 28.0N, 60.4W at 19Z (WALLET). Penetration center fix measured a central pressure of 978 mb at 28.5N, 60.6W at 22Z (WALLET).

MWR: “The weakening stage, which persisted for the next 24 hr., was accompanied by an increase in the eye diameter to 60 mi. Maximum winds dropped to about 105 mph on the 25th. Beulah moved at 5 to 10 mph toward the north-northwest during the 2-day period covering the marked deepening and subsequent filling, then turned to the north mid began to accelerate.”

August 26:

HWM analyzes a hurricane of at most 995 mb at 31.8N, 58.2W with a stationary front to the northwest at 12Z. HURDAT lists an 85 kt hurricane at 31.6N, 58.3W at 12Z. Microfilm shows a closed low pressure of at most 1002 mb at 31.8N, 58.2W with a frontal boundary to the northwest at 12Z. Ship highlights: 45 kt NNW and 1004 mb at 31.9N, 60.4W at 1245Z (micro). 35 kt SW and 1015 mb at 26.2N, 57.5W at 18Z (micro). Aircraft highlights: Radar center fix at 28.9N, 60.4W at 0010Z (WALLET). Radar center fix at 29.8N, 59.6W at 05Z (WALLET). Penetration center fix measured a central pressure of 983 mb, estimated surface winds of 70 kt and an eye diameter of 50 nm at 32.1N, 57.8W at 1345Z (WALLET). Penetration center fix measured a central pressure of 979 mb, estimated surface winds of 90 kt and an eye diameter of 80 nm at 33.1N, 56.8W at 19Z (WALLET).

MWR: “By the 26th, forward speed had increased to 23 mph or more toward the northeast.” ATSR: “By the 26th, BEULAH came under the influence of a trough in the westerlies and began to accelerate toward the northeast.”

August 27:

HWM analyzes a hurricane of at most 990 mb at 38.8N, 52.2W with a weakening front just to the northwest at 12Z. HURDAT lists a 70 kt hurricane at 38.4N, 52.3W at 12Z. Microfilm shows a closed low pressure of at most 993 mb at 39.2N, 53.2W with a frontal boundary very close to the west at 12Z. Ship highlights: 35 kt NE and 1017 mb at 27.2N, 58.0W at 00Z (COADS). 40 kt SE and 1001 mb at 33.9N, 52.3W at 06Z (micro). 55 E and 985 mb at 40.3N, 53.0W at 12Z (COADS). 60 kt SSW and 988 mb at 40.5N, 50.4W at 15Z (micro). 65 kt S and 1002 mb at 42.0N, 46.5W at 18Z (COADS). 45 kt WSW and 1001 mb at 41.7N, 49.7W at 21Z (COADS). 50 kt NNW and 989 mb at 44.2N, 49.7W at 23Z (COADS).

MWR: “Under the influence of an upper trough off the United States east coast, the hurricane continued to accelerate and late on the 27th passed some 250 mi. east of Newfoundland, moving on a north-northeastward course at about 40 mph.” ATSR: “On the 27th, she passed some 250 miles east of Newfoundland, moving north-northeasterly at about 35 knots.”

August 28:

HWM analyzes a tropical storm of at most 980 mb at 51.7N, 40.3W with a warm front just to the north and a cold front to the south at 12Z. HURDAT lists a 60 kt extratropical cyclone at 51.6N, 41.0W at 12Z. Microfilm shows an extratropical cyclone of at most 996 mb at 51.7N, 39.8W at 12Z. Ship highlights: 70 kt E and 975 mb at 46.5N, 48.0W at 00Z (micro). 65 kt SW and 987 mb at 47.5N, 43.5W at 06Z (COADS). 60 kt

SSW and 1009 mb at 47.7N, 39.2W at 12Z (COADS). 55 kt SW at 50.0N, 40.9W at 18Z (COADS).

MWR: “By 0400 GMT August 28, it was considered extratropical, a cold front having entered the circulation.” ATSR: “By 0400Z on the 28th, she was considered extratropical, a cool air mass having entered the circulation.”

August 29:

HWM analyzes an extratropical cyclone of at most 990 mb at 52.5N, 23.0W at 12Z. HURDAT does not list an organized storm on this date. Microfilm shows that the system has moved off the map. Ship highlights: 50 kt W and 1004 mb at 52.7N, 35.5W at 00Z (COADS). 45 kt W and 1002 mb at 52.6N, 26.5W at 06Z (COADS). 50 kt W and 1008 mb at 52.6N, 27.8W at 12Z (COADS). 5 kt 0 W and 1003 mb at 53.1N, 21.0W at 18Z (COADS).

August 30:

HWM analyzes an extratropical cyclone of at most 985 mb at 51.0N, 11.0W at 12Z. Ship highlights: 50 kt W and 1006 mb at 53.2N, 21.5W at 00Z (COADS). 50 kt W and 991 mb at 54.4N, 17.6W at 06Z (COADS). 50 kt W and 997 mb at 54.3N, 18.0W at 12Z (COADS). 50 kt NW and 1005 mb at 54.2N, 19.0W at 18Z (COADS).

MWR: “However, maximum winds remained 70 mph or higher and when the low center reached the British Isles, on August 30, it was still accompanied by gales. There was no loss of life or property damage attributable to hurricane Beulah.”

August 31:

HWM analyzes an extratropical cyclone of at most 995 mb at 51.5N, 5.0W at 12Z. Ship highlights: 50 kt W at 50.7N, 10.2W at 00Z (COADS). 60 kt NW and 1010 mb at 49.9N, 14.5W at 06Z (COADS). 60 kt NW and 1016 mb at 50.0N, 15.3W at 12Z (COADS). 45 kt WNW and 1009 mb at 46.7N, 10.3W at 18Z (COADS).

September 1:

HWM analyzes an extratropical cyclone of at most 1000 mb at 49.0N, 0.5W at 12Z. Ship highlights: 40 kt NNW at 51.0N, 12.5W at 00Z (COADS). 35 kt NW and 1003 mb at 46.8N, 6.2W at 06Z (COADS).

September 2:

HWM analyzes an extratropical cyclone of at most 1010 mb at 53.0N, 0.0W at 12Z. Ship highlights: No gales or low pressures.

September 3:

HWM analyzes an extratropical cyclone of at most 1005 mb at 58.0N, 2.0E at 12Z. Ship highlights: 10 kt SE and 1004 mb at 56.5N, 3.0E at 12Z (COADS).

September 4:

HWM analyzes an extratropical cyclone of at most 1005 mb at 58.0N, 2.0E at 12Z. Ship highlights: 15 kt NNE and 1000 mb at 59.3N, 0.1W at 12Z (COADS).

September 5:

HWM analyzes an extratropical cyclone of at most 1005 mb at 66.0N, 5.0E at 12Z. Ship highlights: 10 kt NE and 1000 mb at 67.9N, 8.8E at 12Z (COADS).

September 6:

HWM analyzes an extratropical cyclone of at most 1005 mb at 71.0N, 8.0E at 12Z. Ship highlights: 25 kt NE and 1000 mb at 70.3N, 1.5W at 12Z (COADS).

September 7:

HWM analyzes an extratropical cyclone of at most 980 mb at 62.0N, 26.0E (Beulah appears to have been absorbed) at 12Z. Ship highlights: No gales or low pressures.

Hurricane Beulah developed from a tropical wave that left the African coast around August 11th based upon the Microfilm and Historical Weather Maps. The disturbance moved westward into an area of scarce ship data over the eastern and central Atlantic, thus the time of genesis is uncertain. A reconnaissance aircraft investigated the tropical disturbance late on August 19th while it was located about 900 nm east of the Lesser Antilles. The aircraft did not found a closed circulation but its observations and the synoptic data at 18Z on the 19th showed that a very sharp tropical wave was present. The first position is analyzed at 00Z on August 20th as a 25 kt tropical depression, twelve hours earlier than originally shown in HURDAT, based upon ship data showing a weak west wind and 20 kt SW. Minor track alterations are shown during the lifetime of this tropical cyclone. The tropical depression moved northwestward on the 20th while slowly organizing. A reconnaissance aircraft investigated the tropical cyclone at 1830Z on the 20th measuring a central pressure of 1006 mb and estimated surface winds of 30 kt. A central pressure of 1006 mb suggests maximum sustained winds of 35 kt from the south of 25N Brown et al. pressure-wind relationship. Based ship data showing winds below-gale force, an intensity of 30 kt is selected at 18Z on the 20th, same as originally shown in HURDAT. The first gales associated with this tropical cyclone were reported on August 21st, although it seems that some of the ships in the microfilm maps were either not plotted correctly or the ships reported the wrong position. Intensification to a tropical storm is analyzed at 06Z on the 21st, same as originally shown in HURDAT, based upon ship and reconnaissance data later in the day. A reconnaissance aircraft investigated Beulah at 1645Z on the 21st measuring a central pressure of 1005 mb and estimated surface winds of 45 kt. A central pressure of 1005 mb suggests maximum sustained winds of 37 kt from the south of 25N pressure-wind relationship. Based on a forward speed of about 10 kt and ship data also showing winds up to 45 kt, an intensity of 45 kt is selected at 18Z on the 21st, same as originally shown in HURDAT.

At 00Z on August 22nd, a ship passed close to the center of Beulah reporting 30 kt W and 1003 mb, suggesting that the system had continued to deepen. Thus, an intensity of 50 kt is selected at 00Z on the 22nd, up from 45 kt originally in HURDAT. A penetration center fix occurred at 1255Z on the 22nd measuring a central pressure of 994 mb, estimated surface winds of 68 kt and an eye diameter of 25 nm. A central pressure of 994 mb

suggests maximum sustained winds of 58 kt from the south of 25N and also intensifying subset of the pressure-wind relationship. An eye diameter of 25 nm suggests an RMW of about 19 nm and the climatological value is 15. An intensity of 60 kt is selected at 12Z on the 22nd, down from 70 kt originally shown in HURDAT, a minor intensity change. TIROS VII captured an image of the tropical cyclone around noon (Zulu time) on the 22nd, available in the MWL on page 10 in Volume 8, Number 1, January 1964. The satellite image shows a well-organized tropical cyclone with spiral bands and little to no signs of shear. Intensification to a hurricane is analyzed at 18Z on the 22nd, six hours later than originally shown in HURDAT. On August 23rd, Beulah made its closest approach to the Leeward Islands, passing a couple of hundred miles to the northeast. Also on this date, the track of the hurricane turned to the north-northwest and the system continued to intensify. A couple of ships reported gale-force winds on the 23rd but all remained in the periphery of Beulah. The next reconnaissance aircraft to make a penetration center fix arrived at 07Z on the 23rd measuring a central pressure of 977 mb, estimating surface winds of 90 kt and an eye diameter of 25 nm. A central pressure of 977 mb suggests maximum sustained winds of 82 kt from the south of 25N intensifying subset of the pressure-wind relationship. An eye diameter of 25 nm suggests an RMW of about 19 nm and the climatological value is 16. An intensity of 80 kt is selected at 06Z on the 23rd, down from 85 kt originally shown in HURDAT, a minor intensity change. The next reconnaissance aircraft found that Beulah had continued to strengthen, measuring a central pressure of 963 mb and estimating surface winds of 85 kt at 1740Z on the 23rd. A few hours later, at 2030Z on the 23rd, another penetration fix estimated an eye diameter of 25 nm. A central pressure of 963 mb suggests maximum sustained winds of 99 kt from the south of 25N intensifying subset of the pressure-wind relationship. An eye diameter of 25 nm suggests an RMW of about 19 nm and the climatological value is 18. Based on a slow forward speed of about 8 kt, an intensity of 95 kt is analyzed at 18Z on the 23rd, down from 100 kt originally shown in HURDAT, a minor intensity change. A penetration center fix at 22Z on the 23rd measured a central pressure of 962 mb, estimated surface winds of 90 kt and an eye diameter of 29 nm. An intensity of 95 kt is selected on August 24th at 00Z, down from 100 kt originally in HURDAT, a minor intensity change.

On the 24th, the tropical cyclone continued to slowly move away from the Leeward Islands into the central Atlantic. Various ships reported gale-force winds and even storm-force winds, up to 60 kt. A penetration center fix measured a central pressure of 958 mb and estimated an eye diameter of 20 nm at 0630Z on the 24th. A central pressure of 958 mb suggests maximum sustained winds of 102 kt from the south of 25N intensifying subset of the pressure-wind relationship. An eye diameter of 20 nm suggests an RMW of about 15 nm and the climatological value is 18. Based on a slow forward speed of about 6 kt, an intensity of 100 kt is analyzed at 06Z on the 24th, down from 105 kt originally shown in HURDAT, a minor intensity change. 100 kt is also the peak intensity of this tropical cyclone, down from 105 kt originally in HURDAT, a minor intensity change. The next penetration center fix occurred after 12Z on the 24th, measuring a central pressure of 961 mb at 1450Z and 1630Z. The peak intensity of 100 kt is analyzed for two consecutive time slots, 06Z and 12Z on the 24th, and based on the slight increase in central pressure, decreased to 95 kt at 18Z on the 24th, down from 100 kt originally in HURDAT, a minor intensity change. On August 25th, Beulah increased in forward speed

to the north and continued to weaken. A reconnaissance aircraft investigated the hurricane at 1310Z on the 25th measuring a central pressure of 985 mb, estimating flight level winds of 60 kt and an eye diameter of 40 nm. A central pressure of 985 mb suggests maximum sustained winds of 66 kt and 63 kt from the north of 25N and weakening subset of the pressure-wind relationship, respectively. An eye diameter of 40 nm suggests an RMW of about 30 nm and the climatological value is 20. An intensity of 65 kt is analyzed at 12Z on the 25th, down from 75 kt originally shown in HURDAT, a minor intensity change. Another penetration fix occurred at 19Z on the 25th measuring a central pressure of 976 mb, estimating surface winds of 80 kt and an eye diameter of 60 nm. A central pressure of 976 mb suggests maximum sustained winds of 77 kt and 81 kt from the north of 25N and intensifying subset of the pressure-wind relationship, respectively. An eye diameter of 60 nm suggests an RMW of about 45 nm and the climatological value is 20. An intensity of 75 kt is analyzed at 18Z on the 25th, down from 80 kt originally shown in HURDAT, a minor intensity change. Another reconnaissance aircraft penetration center fix occurred at 22Z on the 25th and measured a central pressure of 978 mb. An intensity of 75 kt is analyzed at 00Z on August 24th, down from 80 kt in HURDAT, a minor intensity change. The ships remained in the periphery of the hurricane and the highest winds reported on the 25th were 45 kt.

On the 26th, Beulah turned to the northeast ahead of a frontal boundary. A penetration center fix occurred at 1345Z on the 26th measuring a central pressure of 983 mb, estimated surface winds of 70 kt and an eye diameter of 50 nm. A central pressure of 983 mb suggests maximum sustained winds of 69 kt and 66 kt from the north of 25N and weakening subset of the pressure-wind relationship, respectively. An eye diameter of 50 nm suggests an RMW of about 38 nm and the climatological value is 21. Based on a fast forward speed of about 18 kt but large circulation, an intensity of 70 kt is analyzed at 12Z on the 26th, down from 85 kt originally shown in HURDAT, a minor intensity change. The final penetration fix measured a central pressure of 979 mb, estimated surface winds of 90 kt and an eye diameter of 80 nm at 19Z on the 26th. A central pressure of 979 mb suggests maximum sustained winds of 74 kt from the north of 25N pressure-wind relationship. An eye diameter of 80 nm suggests an RMW of about 60 nm and the climatological value is 22. Based on a fast forward speed of about 18 kt and large circulation, an intensity of 75 kt is analyzed at 18Z on the 26th, down from 85 kt originally shown in HURDAT, a minor intensity change. Synoptic observations late on the 27th indicated that Beulah was becoming embedded within the approaching frontal boundary. Transition to an extratropical cyclone is analyzed at 18Z on the 27th based upon ship data showing a substantial temperature gradient across the circulation. On August 28th, Beulah passed a couple of hundred miles east of Newfoundland and ships near the center reported winds up to 70 kt. On this date, the system turned to the east-northeast passing south of Greenland. Weakening below hurricane intensity is analyzed at 12Z on the 28th, same as originally shown in HURDAT. Late on August 29th and early on August 30th, Beulah passed south of Iceland. Late on the 30th, the extratropical cyclone approached northern Ireland and turned to the southeast. On August 31st, Beulah crossed northern Ireland and southwest Wales en route to France. Ship data indicates that it was still producing winds up to 60 kt. On September 1st, the extratropical cyclone moved over northwest France, later turning to the north and crossing into England on September 2nd.

Synoptic observations indicate that Beulah weakened below gale-force at 06Z on the 2nd. Early on September 3rd, ship data show that the weak cyclone moved into the North Sea and traveled northeastward passing west of Norway on September 4th and finally dissipating after 18Z on September 6th. The last position is analyzed at 18Z on the 6th, 8 days later than originally shown in HURDAT. A major change is to add eight days to the track as an extratropical cyclone.

Date	Original HURDAT Central Pressure	Evidence	Changes
Aug 20 18Z	1006 mb	Penetration center fix: 1006 mb at 1830Z on Aug 20th	Retained
Aug 21 18Z	1005 mb	Penetration center fix: 1005 mb at 1645Z on Aug 21st	
Aug 22 12Z	994 mb	Penetration center fix: 994 mb at 1255Z on Aug 22nd	
Aug 23 06Z		Penetration center fix: 977 mb at 07Z on Aug 23rd	977 mb
Aug 23 18Z	962 mb	Penetration center fix: 963 mb at 1740Z on Aug 23rd	963 mb
Aug 24 00Z		Penetration center fix: 962 mb at 22Z on Aug 23rd	962 mb
Aug 24 06Z	958 mb	Penetration center fix: 958 mb at 0630Z on Aug 24th	Retained
Aug 24 12Z		Penetration center fix: 961 mb at 14Z on Aug 24th	961 mb
Aug 24 18Z	961 mb	Penetration center fix: 961 mb at 1630Z on Aug 24th	Retained
Aug 25 12Z	985 mb	Penetration center fix: 985 mb at 1310Z on Aug 25th	
Aug 25 18Z	976 mb	Penetration center fix: 976 mb at 19Z on Aug 25th	
Aug 26 00Z	978 mb	Penetration center fix: 978 mb at 22Z on Aug 25th	
Aug 26 12Z	983 mb	Penetration center fix: 983 mb at 1345Z on Aug 26th	
Aug 26 18Z	979 mb	Penetration center fix: 979 mb at 19Z on Aug 26th	

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42790 09/10/1963 M= 6  3 SNBR= 926 NOT NAMED   XING=0 SSS=0
42790 09/09/1963 M= 6  4 SNBR= 926 NOT NAMED   XING=0 SSS=0
         **            *

(September 9th is new to HURDAT)
42793 09/09*  0   0   0    0*240 675  25    0*255 675  25    0*271 673  25    0*
                             *** ***  **      *** ***  **      *** ***  **

42795 09/10*  0   0   0    0*305 664  25    0*320 661  25 1007*329 639  25    0*
42795 09/10*287 670  25    0*303 664  25    0*319 655  30 1007*333 641  35 1003*
           *** ***  **      ***               *** ***  **      *** ***  ** ****

42800 09/11*338 618  25    0*348 597  35    0*358 576  35 1004*365 558  35    0*
42800 09/11*346 623  35    0*358 600  40    0*364 576  50    0*369 553  60  996*
           *** ***  **      *** ***  **      ***       **    * *** ***  **  ***

42805 09/12*370 542  35    0*371 526  45    0*372 513  50    0*379 510  50  992*
42805 09/12*374 538  65    0*377 529  70    0*379 522  70    0*383 514  65  990*
           *** ***  **      *** ***  **      *** ***  **      *** ***  **  ***

42810 09/13*388 517  50    0*397 510  50    0*410 497  50    0*432 478  50    0*
42810 09/13*390      60    0*402      55    0*416      50    0E435      50    0*
           *** ***  **      *** ***  **      *** ***          **** ***

42815 09/14*457 446  50    0*478 399  50  995*498 352  50    0E515 306  50    0*
42815 09/14E457 438  50    0E478 399  50    0E498 352  50    0*  0   0   0    0*
           *    ***         *                **                *  *   *   *

(September 15th has been removed)
42820 09/15E530 261  50    0E549 220  50    0*  0   0   0    0*  0   0   0    0*
42820 09/15*  0   0   0    0*  0   0   0    0*  0   0   0    0*  0   0   0    0*
           *  *   *   *     *  *   *   *

42825 TS
42825 H
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Minor changes to the track and major changes to the intensity shown in McAdie et al. (2009). A major alteration is to indicate that the tropical cyclone reached hurricane intensity. Evidence for these alterations comes from the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Monthly Weather Review, Mariners Weather Log, and NHC Storm Wallets.

September 8:

HWM analyzes a trough of low pressure extended from 20N-30N, 66W with a stationary front far to the northwest at 12Z. HURDAT does not list an organized system on this date. Microfilm shows a tropical wave or trough extended from 19N-28N, 66W at 12Z. Ship highlights: No gales or low pressures.

MWR: “Each year several storms occur which are not entirely tropical in character. Tropical cyclones derive their energy from latent heat of condensation while extratropical cyclones depend upon proper positioning of cold and warm air masses; i.e., cold air sinks and spreads under warm air causing air motion. At times “half-breed” cyclones develop over tropical oceans and tap both energy sources. In these cases it is difficult to decide whether a tropical cyclone name should be assigned to the Low. The Unnamed Storm in

September was of this type, as was the late May-early June storm. It was not until a critical ship log was received after the hurricane season that the decision could be made to include the September storm in the official list. Ship reports indicated a weak circulation north of Puerto Rico on September 8."

September 9:

HWM analyzes a spot low pressure at 28.0N, 67.0W and another spot low at 25.7N, 74.2W with a cold front to the northwest at 12Z. HURDAT does not list an organized system on this date. Microfilm shows a closed low pressure of at most 1011 mb at 25.7N, 67.3W at 12Z. Ship highlights: No gales or low pressures.

September 10:

HWM analyzes a closed low pressure of at most 1010 mb at 32.0N, 66.0W with a weakening cold front to the west at 12Z. HURDAT lists a 25 kt tropical depression at 32.0N, 66.1W at 12Z. Microfilm shows a closed low pressure of at most 1011 mb at 32.0N, 66.7W with another low pressure to the west and a frontal boundary to the north at 12Z. Ship highlights: 15 kt N and 1005 mb at 33.4N, 64.3W at 18Z (COADS).

MWR: "The depression drifted slowly northward passing over Bermuda during the afternoon of the 10th. The pressure on Bermuda dropped to 1007 mb, or 29.74 in, and winds increased to 25 mph."

September 11:

HWM analyzes a closed low pressure of at most 1005 mb at 36.5N, 57.5W with a cold front just to the west at 12Z. HURDAT lists a 35 kt tropical storm at 35.8N, 57.6W at 12Z. Microfilm shows a closed low pressure of at most 1011 mb at 37.5N, 58.0W with a frontal boundary extending to the southwest at 12Z. Ship highlights: 35 kt SSE and 1001 mb at 36.6N, 57.4W at 12Z (COADS). 40 kt N and 1011 mb at 36.4N, 60.7W at 12Z (COADS). 50 kt SSE and 1001 mb at 37.0N, 55.0W at 18Z (COADS). 25 kt WNW and 999 mb at 37.0N, 55.5W at 18Z (COADS). 5 kt SW and 1000 mb at 37.0N, 54.6W at 21Z (COADS).

MWR: "Tropical storm intensity was reached shortly before sunrise on the 11th."

September 12:

HWM analyzes a tropical storm of at most 1010 mb at 37.5N, 51.5W with a weakening stationary front just to the west and a warm front to the northeast at 12Z. HURDAT lists a 50 kt tropical storm at 37.2N, 51.3W at 12Z. Microfilm shows a closed low pressure of at most 1008 mb at 37.0N, 52.5W with a frontal boundary extending through the center at 12Z. Ship highlights: 45 kt N and 1012 mb at 36.8N, 54.8W at 00Z (COADS). 10 kt W and 998 mb at 37.4N, 52.5W at 06Z (COADS). 70 kt S and 996 mb at 37.4N, 52.2W at 09Z (COADS). 50 kt S and 1008 mb at 37.0N, 52.0W at 12Z (COADS). 15 kt SE and 992 mb at 38.5N, 50.9W at 18Z (micro). 45 kt SSE and 1000 mb at 38.0N, 51.6W at 15Z (COADS). 45 kt NW and 1005 mb at 37.9N, 52.3W at 18Z (COADS).

MWR: “Maximum intensity occurred on the 12th when the Freiburg experienced 78 mph winds, 27-ft. seas, and a pressure of 995 mb, or 29.39 in. The center remained small and tightly knit as the storm accelerated rapidly northeastward ahead of a cold front.”

September 13:

HWM analyzes a tropical storm of at most 1005 mb at 41.4N, 49.4W with a warm front just to the northeast at 12Z. HURDAT lists a 50 kt tropical storm at 41.0N, 49.7W at 12Z. Microfilm shows a closed low pressure of at most 1011 mb at 40.8N, 48.3W with a frontal boundary extending through the center at 12Z. Ship highlights: 35 kt N and 1014 mb at 43.1N, 45.7W at 12Z (COADS). 35 kt W and 1013 mb at 42.1N, 48.4W at 18Z (COADS).

September 14:

HWM analyzes a tropical storm of at most 1005 mb at 50.3N, 35.2W with a cold front just to the west at 12Z. HURDAT lists a 50 kt tropical storm at 49.8N, 35.2W at 12Z. Microfilm shows an extratropical cyclone of at most 1005 mb at 53.0N, 38.0W at 12Z. Ship highlights: 40 kt SSW and 1016 mb at 44.0N, 41.0W at 00Z (COADS). 45 kt SW and 1017 mb at 44.0N, 41.0W at 03Z (COADS). 35 kt SSW and 1016 mb at 44.5N, 39.6W at 06Z (COADS). 40 kt SW and 997 mb at 48.6N, 35.3W at 12Z (COADS).

MWR: “Tropical characteristics were lost on September 14.”

September 15:

HWM analyzes an extratropical cyclone of at most 1015 mb at 52.0N, 27.0W at 12Z. HURDAT lists a 50 kt extratropical cyclone at 54.9N, 22.0W at 06Z (last position). Microfilm shows a closed low pressure at 54.5N, 18.0W at 12Z (system exiting the map boundaries). Ship highlights: No gales or low pressures.

A tropical wave or trough of low pressure was located north of Puerto Rico on September 8th based upon Microfilm and Historical Weather Maps. The disturbance moved northward and became better organized. A 25 kt tropical depression is analyzed to have developed at 06Z on September 9th based on synoptic data in the microfilm maps, 24 hours earlier than originally shown in HURDAT. Minor track alterations are introduced during the lifetime of this tropical cyclone. The tropical depression turned to the northeast on September 10th ahead of an approaching frontal boundary. A central pressure of 1007 mb is present in HURDAT at 12Z on the 10th and has been retained based on the report of 15 kt SE and 1009 mb by Bermuda at 12Z on the 10th. Around 14Z on the 10th, the tropical depression passed about 10 nm west of Bermuda. At 18Z on the 10th, a ship reported 15 kt N and 1005 mb, suggesting a central pressure of 1003 mb, which has been added to HURDAT. A central pressure of 1003 mb suggests maximum sustained winds of 38 kt from the north of 25N Brown et al. pressure-wind relationship. Based upon a forward speed of about 21 kt but relatively low environmental pressures (1010 mb OCI) at this latitude, an intensity of 35 kt is selected at 18Z on the 10th, up from 25 kt originally in HURDAT, a minor intensity change. Intensification to a tropical storm is analyzed at 18Z on the 10th, twelve hours earlier than originally shown in HURDAT.

The tropical storm continued to the northeast on September 11th and rapidly intensified. The first gales were reported at 12Z on the 11th. At this time, microfilm shows a frontal boundary extended from the center to the southwest and another frontal boundary to the north, but HWM indicates that the small tropical cyclone was still ahead of the frontal boundary and in the warm sector. Synoptic observations are in better agreement with HWM and show that there is no temperature gradient across the circulation, thus it was still a tropical cyclone. A central pressure of 1004 mb is present in HURDAT at 12Z on the 11th and has been removed due to a ship report of 35 kt SSE and 1001 mb, suggesting a central pressure lower than what appears in HURDAT. A ship reported 50 kt SE and 1001 and another registered 25 kt NW and 999 mb. The latter ship observation indicates a central pressure of 996 mb, which has been added to HURDAT at 18Z on the 11th. A central pressure of 996 mb suggests maximum sustained winds of 55 kt from the north of 35N Landsea et al. pressure-wind relationship. Due to a forward speed of about 26 kt and normal environmental pressures (1014 mb OCI), an intensity of 60 kt is selected at 18Z on the 11th, up from 35 kt originally in HURDAT, a major intensity change.

On September 12th, the tropical cyclone decreased in forward speed and kept intensifying. Intensification to a hurricane is analyzed at 00Z on the 12th, a major change to HURDAT, which originally indicated that the tropical cyclone had peaked as a tropical storm. An intensity of 65 kt is selected at 00Z on the 12th based upon ship data later in the day, up from 35 kt originally in HURDAT, a major intensity change. A ship named "Freiburg" reported 70 kt S and 996 mb at 09Z on the 12th. Based on this data, a peak intensity of 70 kt is analyzed at 06Z and 12Z on the 12th, up from 45 kt and 50 kt, respectively, originally in HURDAT, major intensity changes. Originally HURDAT showed a peak intensity of 50 kt from September 12th at 12Z to September 14th at 12Z. At 18Z on the 12th, a ship reported 15 kt SE and 992 mb, suggesting a central pressure of 990 mb, which has been added to HURDAT replacing the existing 992 mb. A central pressure of 990 mb suggests maximum sustained winds of 63 kt from the north of 35N pressure-wind relationship. Based on a slow forward speed of 7 kt and also the earlier 70 kt ship report, an intensity of 65 kt is selected at 18Z on the 12th, up from 50 kt originally in HURDAT, a minor intensity change. On September 13th, the hurricane weakened and began to acquire extratropical characteristics. Weakening to a tropical storm is analyzed at 00Z on the 13th. An approaching frontal boundary and intensifying extratropical cyclone caused the small tropical storm to gain in forward speed. Synoptic observations at 18Z on the 13th indicate that a temperature gradient had developed across the circulation and frontogenesis had taken place. Thus, transition to an extratropical cyclone is analyzed at 18Z on the 13th, 30 earlier than originally shown. Late on the 13th, the extratropical cyclone passed a couple hundred miles southeast of Newfoundland, Canada. A central pressure of 995 mb appears in HURDAT at 12Z on the 14th, and has been removed due to a ship reporting 40 kt SW and 997 mb, indicating a lower central pressure. Ship data on September 14th indicate that the small extratropical cyclone was absorbed by the larger extratropical cyclone to the north. The last position is analyzed at 12Z on the 14th, 18 hours earlier than originally shown in HURDAT.

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42830 09/16/1963 M= 5  4 SNBR= 927 CINDY       XING=1 SSS=1
42830 09/16/1963 M= 5  5 SNBR= 927 CINDY       XING=1 SSS=1
                         *

42835 09/16*  0   0   0    0*  0   0   0    0*267 937  40    0*273 939  60    0*
42835 09/16*  0   0   0    0*  0   0   0    0*267 937  40    0*273 938  50    0*
                                                            ***  **

42840 09/17*280 939  70  996*287 941  65    0*294 944  65    0*298 944  65  997*
42840 09/17*280 939  55  996*287 941  55    0*294 943  55  997*298 945  50  996*
                     **                ***          ***  ***     ***  **  ***

42845 09/18*300 946  65    0*301 949  35    0*301 952  30    0*299 956  25    0*
42845 09/18*300 947  40    0*301 949  35    0*301 952  30    0*299 956  25    0*
                ***  **

42850 09/19*295 960  25    0*292 964  25    0*287 970  25    0*284 974  25    0*
42850 09/19*297 960  25    0*294 965  25    0*290 970  25    0*284 975  25    0*
          ***                  *** ***       ***                ***

42855 09/20*278 981  25    0*  0   0   0    0*  0   0   0    0*  0   0   0    0*
42855 09/20*276 981  25    0*  0   0   0    0*  0   0   0    0*  0   0   0    0*
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42860 HRCTX1
42860 TS
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U.S. Tropical Storm Landfall

09/17 14Z 29.6N 94.3W 55 kt TX - 997 mb

Minor changes to the track and major changes to the intensity, including a downgrade for the system from a hurricane to a tropical storm, shown in McAdie et al. (2009). Evidence for these alterations comes from the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Monthly Weather Review, Navy reconnaissance book, Mariners Weather Log, Surface Weather Observations, Mexican Surface Observations and NHC Storm Wallets.

September 13:

HWM and microfilm do not analyze an organized system at 12Z. HURDAT does not list an organized system on this date. Ship highlights: No gales or low pressures.

September 14:

HWM analyzes does not analyze an organized system at 12Z. HURDAT does not list an organized system on this date. Microfilm shows a spot low at 20.1N, 94.6W at 12Z. Ship highlights: No gales or low pressures.

MWR: “Weather conditions had been highly disturbed in the southwestern Gulf on the 14th and 15th.”

September 15:

HWM analyzes a spot low pressure at 24.2N, 92.8W at 12Z. HURDAT does not list an organized system on this date. Microfilm shows a spot low at 21.5N, 97.0W at 12Z. Ship highlights: 25 kt SE and 1004 mb at 21.0N, 92.4W at 12Z (micro).

September 16:

HWM analyzes a tropical storm of at most 1005 mb at 26.8N, 93.8W at 12Z. HURDAT lists a 40 kt tropical storm at 26.7N, 93.7W at 12Z (first position). Microfilm shows a trough of low pressure over the western Gulf of Mexico at 12Z. Ship highlights: 45 kt SE and 1009 mb at 27.1N, 93.2W at 15Z (micro). 50 kt W and 1008 mb (999 mb in MWL) at 27.2N, 94.0W at 18Z (COADS). 65 kt at 20Z (SS Sabine) (MWR). 45 kt E and 1005 mb at 28.2N, 93.5W at 21Z (micro). Aircraft highlights: Penetration center fix measured a central pressure of 996 mb, estimated surface winds of 55 kt and an eye diameter of 30 nm at 27.9N, 93.9W at 2325Z (ATSR). Radar highlights: Galveston radar center fix at 27.8N, 94.0W at 2047Z (WALLET). Galveston radar center fix at 28.1N, 93.7W at 2345Z (WALLET).

MWR: “Cindy, the first hurricane in the Gulf of Mexico in two years, formed in a trough of low pressure located about 200 mi. east-northeast of Brownsville, Tex., in the morning of September 16. Ship reports received around noon CST, indicated that the circulation was of tropical storm strength and was intensifying rapidly. By 2:00 p.m. the central eye was developed sufficiently to be located about 200 mi. east of Corpus Christi by the WSR-57 radar at Galveston. At the same hour, a report from the *SS Sabine* near the storm center indicated hurricane force winds, although there is some question whether the wind velocity recorder was read carefully, Cindy moved northward at an average speed of 8 mph during the afternoon and night of the 16th, remaining relatively small in area and with no further increase in intensity, although most of the circulation was still over the warm Gulf waters.” ATSR: “CINDY apparently formed on the trailing edge of a surface quasi-stationary front elongated east-west through the Northern Gulf of Mexico. A trough of low pressure at the upper levels was located in the Western Gulf. Hurricane CINDY, the third and most short-lived storm of the 1963 season, formed over the western Gulf of Mexico approximately 225 miles east of Brownsville, Texas. On the morning of 16 September, several ships reported winds and pressure which indicated the possible development of a tropical storm. Later ship reports indicated that a circulation had formed and was rapidly intensifying. Based on this information, the first of five numbered warnings was issued at 1900Z on the 16th. Warnings two, three, and four placed her in the category of a hurricane.” MWL: “Hurricane Cindy, the first in the Gulf of Mexico in two years, formed about 200 mi. east-northeast of Brownsville, Tex., on the morning of September 16. Ship reports received around 1800 GMT, indicated that the circulation was of tropical storm force and intensifying rapidly. Two hours later a report from the SABINE near the storm center indicated hurricane force winds. Cindy moved slowly northward toward the Texas coast, remaining relatively small in area and with no further increase in intensity.”

September 17:

HWM analyzes a closed low pressure of at most 1000 mb at 29.5N, 94.5W at 12Z. HURDAT lists a 65 kt hurricane at 29.4N, 94.4W at 12Z. Microfilm shows a closed low pressure of at most 1008 mb at 29.5N, 94.5W at 12Z. Ship highlights: 50 kt NE and 1009 mb at 27.4N, 95.1W at 00Z (COADS). 50 kt SE at 28.9N, 92.8W at 06Z (COADS). Land highlights: 45 kt (fastest mile, gusts to 65 kt) at Galveston, TX at 0815Z (WALLET). 1000 mb (min pressure) at Galveston, TX at 1129Z (WALLET). 997 mb (min pressure) at High Island, TX at 16Z (WALLET). 996 mb (min pressure) at Anahuac, TX at 2027-2045Z (WALLET). Radar highlights: Lake Charles radar center fix estimated an eye diameter of 30 nm at 28.4N, 93.6W at 0119Z (WALLET). Galveston radar center fix at 28.8N, 94.0W at 0645Z (WALLET). Galveston radar center fix at 29.6N, 94.4W at 1245Z (WALLET).

MWR: "Winds and tides along the coast from the Galveston area eastward increased during the evening, with winds reaching maximum values during the early morning hours of the 17th. Over the Gulf, highest sustained winds were estimated at 80 mph and highest gusts on the coast were 80 mph, measured near the eastern tip of Galveston Island. The Weather Bureau Office at Galveston recorded a fastest mile at the rate of 50 mph, and a peak gust of 74 mph on the 17th. In the Port Arthur area, the highest gusts were from 40 to 50 mph, while in Louisiana gusts were estimated as high as 60 mph at Grand Chenier and 45 mph at Cameron, but were generally in the 25 to 35 mph range. The central eye of Cindy, some 20 mi in diameter, moved on shore around High Island, about midway between Galveston and Port Arthur. The Corps of Engineers there reported "light winds and near calm" between 7:30 and 11:00 a.m., CST, on the 17th and a low barometer reading of 29.44 in. (997 mb.) at 10:00 am. A slightly lower pressure, 29.41 in. (996 mb.), was recorded inland at Anahuac between 2:27 and 2:45 pm." ATSR: "From her source area, CINDY moved on a northward course, reaching the shoreline on the 17th between Galveston and Port Arthur, Texas. Upon reaching shore, CINDY slowed considerably and began drifting westward, then finally southwestward until dissipation occurred just southwest of Houston, Texas. The highest winds accompanying CINDY were estimated to be near 80 knots while she was still over open waters, and 55-65 knots [likely gusts] while over land. Minimum pressure recorded was 996 millibars. CINDY, although a relatively small, short-lived storm, had captured several distinctions for the 1963 season. She was the only storm to originate in the Gulf of Mexico, and she was the only storm to hit the United States mainland. Winds accounted for little damage, but excessive precipitation and the slow movement caused damaged by heavy flooding. Since CINDY developed near land, the abnormal high tide which is generally associated with hurricanes was absent."

September 18:

HWM analyzes a closed low pressure of at most 1005 mb at 30.5N, 95.3W at 12Z. HURDAT lists a 30 kt tropical depression at 30.1N, 95.2W at 12Z. Microfilm shows a closed low pressure of at most 1011 mb at 29.8N, 95.5W at 12Z. Ship highlights: No gales or low pressures. Radar highlights: Lake Charles radar center fix at 29.8N, 94.5W at 0115Z (WALLET). Lake Charles radar center fix at 30.1N, 94.9W at 0545Z (WALLET).

MWR: "The storm center became almost stationary for about 18 hr. shortly after moving inland, then drifted very slowly westward and southwestward with slowly decreasing intensity through the Texas Coastal Plain on September 18 and 19. This unusually slow movement during the decay of the storm resulted in an extended period of heavy rainfall in its northeastern sector over extreme southeastern Texas and southwestern Louisiana. Storm rainfall totals were 15 to 20 in. in portions of Jefferson, Newton, and Orange Counties, Texas and Calcasieu and Vermilion Parishes, Louisiana. The heaviest rain occurred at Deweyville, in southern Newton County: a 3-day total of 23.50 in., including 20.60 in. in 24 hr. between 7 am CST, observations on September 17 and 18."

September 19:

HWM analyzes a closed low pressure of at most 1010 mb at 29.5N, 97.0W at 12Z. HURDAT lists a 25 kt tropical depression at 28.7N, 97.0W at 12Z. Microfilm shows a closed low pressure of at most 1011 mb at 29.0N, 96.5W at 12Z. Ship highlights: No gales or low pressures.

September 20:

HWM and microfilm do not analyze an organized system at 12Z. HURDAT lists a 25 kt tropical depression at 27.8N, 98.1W at 00Z (last position). Ship highlights: No gales or low pressures.

September 21:

HWM and microfilm do not analyze an organized system at 12Z. HURDAT does not list an organized system on this date. Ship highlights: No gales or low pressures.

MWR: "Property damage from wind was minor, consisting of roof damage to beach homes. Only minor flooding and some slight damage occurred from tides, but several roads were impassable for short periods, and waves destroyed several piers and caused some damage to boats. Considerable damage was produced by the flooding of streams arid drainage canals and ponding of water in the areas of extremely heavy rainfall over the lower Sabine Basin in both Texas and Louisiana. The flood waters areas most severe in the Port Arthur-Port Acres area of Jefferson County. Water entered about 4000 homes in Jefferson, Orange, and Newton Counties, remaining in some areas for extended periods. Overall property damage-mainly from the flooding-was estimated at $11.7 million. Principal crop damage, estimated near $500,000 in Testis and $360,000 in Louisiana, was to unharvested rice. Fortunately most of the crop had already been combined, and rainfall in most areas was considered more beneficial than damaging to crops and ranges."

A tropical wave or trough of low pressure was located over the western Gulf of Mexico on September 14th based upon the microfilm maps. An area of low pressure developed in the Bay of Campeche on September 15th and moved northward becoming better organized. Two ships reported low pressures (1004 mb and 1002 mb) at 12Z on the 15th but subsequent observations from the ships indicate that there likely was a low bias of a few millibars in the measurements. The first position is analyzed at 12Z on September 16th as a 40 kt tropical storm, same as originally shown in HURDAT. The time of genesis is uncertain because surface observations over the southwest Gulf of Mexico were sparse, but observations from South Texas and ships early on the 16th suggests that genesis may have occurred as early as late on the 15th or early on the 16th. Minor track alterations are made during the lifetime of this tropical cyclone. The first gale was reported by the ship SS SABINE at 15Z on the 16th, indicating 45 kt SE and 1009 mb. At 18Z on the 16th, SS SABINE reported 50 kt W and 999 mb. The MWR says that two hours after this report, 20Z, the SS SABINE reported hurricane-force winds but MWR questions the accuracy of the report. Nonetheless, this report was originally used by the forecasters to operationally upgrade the tropical cyclone to a hurricane. The hurricane-force wind report was not found on COADS, microfilm or MWL, even though other observations from this ship were present in all three sources. A few hours later, at 2325Z on the 16th, a reconnaissance aircraft made a center penetration measuring a central pressure of 996 mb, estimating surface winds of 55 kt and an eye diameter of 30 nm. A central pressure of 996 mb suggests maximum sustained winds of 50 kt from the north of 25N Brown et al. pressure-wind relationship. An eye diameter of 30 nm suggests an RMW of 23 nm and the climatological value is also 23 nm. Based upon the reliable ship data showing winds up to 50 kt, an intensity of 55 kt is analyzed at 00Z on September 17th, down from 70 kt originally in HURDAT, a minor intensity change. 55 kt is also the peak intensity of this tropical cyclone, down from 70 kt originally in HURDAT, a minor intensity change. It is analyzed that Cindy did not reach hurricane intensity as previously shown in HURDAT. A central pressure of 996 mb was present in HURDAT at 00Z on the 17th and has been retained.

Cindy moved slowly northward on the 17th making landfall around 14Z near High Island, Texas, as a 55 kt tropical storm. High Island, TX, reported near calm conditions and a minimum pressure of 997 mb, which has been added as a central pressure at landfall and to the 12Z time slot on the 17th. A radar image captured by the Galveston radar at 0950Z on the 17th shows a well-organized tropical cyclone with spiral bands over the eastern and northern quadrants. The highest sustained winds on land were 45 kt and gusts to 65 kt at Galveston, Texas, at 0815Z on the 17th. The slow-moving tropical storm remained close to the large Galveston Bay and a few hours after landfall, Anahuac, Texas, reported a minimum pressure of 996 mb. The minimum pressure was registered around 2030Z, thus it is used to replace the existing central pressure of 997 mb in HURDAT at 18Z on the 17th. On September 18th, Cindy turned to the west and southwest and weakened over southeast Texas. At 00Z on the 18th, an intensity of 40 kt is analyzed, down from 65 kt originally shown in HURDAT, a major intensity change. HURDAT originally unrealistically maintained Cindy as a hurricane for 10 hours after the small tropical

cyclone made landfall at barely hurricane intensity. Weakening to a tropical depression is analyzed at 12Z on the 18th, same as originally shown in HURDAT. Synoptic observations indicate that Cindy retained a closed low-level circulation on September 19th while moving southwest over South Texas and finally dissipated after 00Z on September 20th. The last position is analyzed at 00Z on the 20th, same as originally shown in HURDAT.

Tropical Storm Debra [September 19-24, 1963]

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42865 09/19/1963 M= 6  5 SNBR= 928 DEBRA       XING=0 SSS=0
42865 09/19/1963 M= 6  6 SNBR= 928 DEBRA       XING=0 SSS=0
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42870 09/19*  0   0   0    0*144 383  25    0*150 398  25 1011*157 412  30    0*
42870 09/19*  0   0   0    0*140 383  35    0*148 398  35    0*156 412  40    0*
                           **                **                 **


42875 09/20*164 426  30    0*172 440  25    0*179 453  25    0*188 467  30 1008*
42875 09/20*164 426  40    0*172 440  45    0*180 453  50    0*189 467  50    0*
                     **                **                **                 **    *


42880 09/21*199 479  35    0*209 485  40    0*219 488  50    0*230 489  65 1000*
42880 09/21*199 479  50    0*210 485  50    0*221 488  55    0*231 489  55 1000*
                     **      ***       **      ***       **      ***       **


42885 09/22*238 489  65    0*246 488  65    0*253 487  65 1002*260 485  65  999*
42885 09/22*238 489  55    0*246 488  55    0*253 487  55 1002*258 485  55  999*
                     **                **                **       ***       **


42890 09/23*266 482  65    0*273 479  55    0*280 477  50    0*288 475  45  999*
42890 09/23*265 482  50    0*272 479  50    0*280 477  50    0*288 475  50  999*
           ***       **      ***       **                **                 **


42895 09/24*302 475  40    0*317 479  35    0*334 484  35 1011E354 480  30    0*
42895 09/24*302 478  40    0*317 481  35    0*  0   0   0    0*  0   0   0    0*
                ***             ***          *  *   *   *    **  *   *   *


42900 HR
42900 TS
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Minor changes to the track and major changes to the intensity shown in McAdie et al. (2009). A major alteration is to indicate that the tropical cyclone did not reach hurricane intensity. Another major revision is to indicate that no extratropical transition took place in this cyclone. Evidence for these alterations comes from the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Monthly Weather Review, Navy reconnaissance book, Mariners Weather Log, Allison & Thompson (1966) and NHC Storm Wallets.

September 17:

HWM analyzes a spot low pressure at 12.0N, 27.0W at 12Z. HURDAT does not list an organized system on this date. Microfilm does not show an organized system on this date. Ship highlights: No gales or low pressures.

September 18:

HWM analyzes a closed low pressure of at most 1010 mb at 13.8N, 33.8W at 12Z. HURDAT does not list an organized system on this date. Microfilm does not show an organized system on this date. Ship highlights: No gales or low pressures.

September 19:

HWM analyzes a closed low pressure of at most 1010 mb at 15.0N, 39.7W at 12Z. HURDAT lists a 25 kt tropical depression at 15.0N, 39.8W at 12Z. Microfilm does not show an organized system at 12Z. Ship highlights: No gales or low pressures. Satellite highlights: TIROS fix center at 17.5N, 41.5W at 1205Z (WALLET).

MWR: "Hurricane Debra formed in the mid-tropical Atlantic and moved on a course well removed from any land areas. The first evidence of the circulation which later developed into Debra came from a ship report and a TIROS picture early on September 19." ATSR: "The first appearance of the disturbed area which was to develop into Hurricane DEBRA was reported at 190600Z by a ship near 14N 38W that encountered a overcast sky, light winds and a surface pressure several millibars below normal. A TIROS photograph at 191200Z indicated a possible vortex in the disturbed area, and a ship near 16N 40W reported winds easterly 25 knots and increasing, overcast skies and steady rain. DEBRA's course, from early development on the 19th until the storm was absorbed by a large extratropical low on the 24th, was predominately northerly. While at storm intensity, DEBRA was never well organized. The eye was poorly defined, and the wall cloud contained large open areas."

September 20:

HWM analyzes a closed low pressure of at most 1010 mb at 17.5N, 45.5W at 12Z. HURDAT lists a 25 kt tropical depression at 17.9N, 45.3W at 12Z. Microfilm does not show an organized system at 12Z. Ship highlights: 40 kt E and 1011 mb at 18.6N, 39.1W at 00Z (micro). 50 kt E and 1013 mb at 19.6N, 47.3W at 12Z (micro). Satellite highlights: TIROS fix center at 17.0N, 44.0W at 1225Z (WALLET). Aircraft highlights: Radar center fix at 19.3N, 47.2W and 25 kt W at 1654Z (ATSR).

MWR: "A reconnaissance aircraft was dispatched to investigate on the 20th and reached the southeast quadrant of the storm before being forced to return because of fuel limitation. The plane reported a radar eye and observed 30 mph west winds at the surface 20 mi. south of the center." ATSR: "A Navy weather reconnaissance aircraft departed Roosevelt Roads, Puerto Rico, at 201420Z, and, upon reaching the area at 202030Z, reported a developing eye near 19.3N 47.2W with westerly winds of 25 knots."

September 21:

HWM analyzes a tropical storm of at most 1005 mb at 21.8N, 48.8W at 12Z. HURDAT lists a 50 kt tropical storm at 21.9N, 48.8W at 12Z. Microfilm shows a closed low pressure of at most 1005 mb at 22.7N, 48.6W at 12Z. Ship highlights: 35 kt E and 1007 mb at 24.0N, 47.0W at 12Z (micro). 35 kt E and 1014 mb at 24.5N, 47.7W at 18Z

(COADS). 55 kt ENE and 1007 mb at 24.0N, 48.3W at 21Z (COADS). Aircraft highlights: Penetration center fix measured a central pressure of 1001 mb, estimated surface winds of 65 kt and an eye diameter of 5 nm at 23.0N, 49.0W at 1654Z (WALLET/ATSR). Satellite highlights: TIROS fix center at 21.5N, 46.3W at 1332Z (WALLET).

MWR: "The next day, September 21, a second reconnaissance aircraft found 75 mph winds and a central pressure of about 1000 mb or 29.53 in. Debra was at best barely a minimal hurricane for no more than 24 hr." ATSR: "DEBRA continued to intensity and by 211654Z the second reconnaissance aircraft found winds of 65 knots. A hurricane warning was issued at 211830Z, naming the storm."

September 22:

HWM analyzes a hurricane of at most 1000 mb at 25.5N, 48.5W at 12Z. HURDAT lists a 65 kt hurricane at 25.3N, 48.7W at 12Z. Microfilm shows a closed low pressure of at most 1002 mb at 25.5N, 48.5W at 12Z. Ship highlights: 45 kt NE at 26.0N, 49.0W at 06Z (micro). 35 kt SE and 1007 mb at 27.0N, 45.8W at 12Z (micro). 50 kt SE at 26.0N, 45.8W at 18Z (micro). Aircraft highlights: Penetration center fix measured a central pressure of 1002 mb, estimated surface winds of 45 kt and an eye diameter of 5 nm at 25.5N, 48.8W at 1350Z (WALLET/ATSR). Penetration center fix measured a central pressure of 999 mb, estimated surface winds of 65 kt and an eye diameter of 50 nm at 25.8N, 48.2W at 1830Z (WALLET).

MWR: "The storm continued northward slowly on the 22nd with little change in intensity." ATSR: "During the 18-hour period of hurricane intensity, DEBRA became better organized; however, the subsequent decrease in intensity after 221200Z brought rapid deterioration in organization."

September 23:

HWM analyzes a tropical storm of at most 1010 mb at 28.0N, 47.6W with a cold front to the northwest at 12Z. HURDAT lists a 50 kt tropical storm at 28.0N, 47.7W at 12Z. Microfilm shows a closed low pressure of at most 1011 mb at 28.8N, 47.4W at 12Z. Ship highlights: 40 kt SE and 1015 mb at 25.2N, 45.8W at 00Z (micro). Aircraft highlights: Penetration center fix at 28.5N, 47.6W at 1355Z (WALLET). Penetration center fix measured a central pressure of 999 mb, estimated surface winds of 50 kt and an eye diameter of 30 nm at 28.9N, 47.5W at 19Z (WALLET). Satellite highlights: TIROS fix center at 28.4N, 47.6W at 1316Z (WALLET).

MWR: "…then weakened and began accelerating on the 23rd."

September 24:

HWM analyzes a tropical storm of at most 1010 mb at 33.5N, 48.0W with a cold front just to the west at 12Z. HURDAT lists a 35 kt tropical storm at 33.4N, 48.4W at 12Z. Microfilm shows a closed low pressure of at most 1008 mb at 33.0N, 48.5W with a frontal boundary to the west at 12Z. Ship highlights: 35 kt S and 1009 mb at 38.7N, 46.9W at 12Z (COADS).

MWR: “It was finally absorbed by an extratropical Low on the 24th. There was no loss of life or property damage associated with Debra.”

September 25:

HWM analyzes a stationary front over the North Atlantic at 12Z. HURDAT does not list an organized system on this date. Microfilm shows a spot low at 34.0N, 53.0W at 12Z. Ship highlights: No gales or low pressures.

Tropical Storm Debra developed from a tropical wave that entered the eastern Atlantic Ocean around September 15th. Data over this part of the basin is sparse, thus the time of genesis is uncertain. The HWM show a spot low pressure near 13N, 17W on September 17th while the disturbance was located southwest of the Cape Verde Islands. TIROS VII captured an image of the tropical system at 13Z on the 17th showing a large area of organized cloudiness with a center near 13N, 43W. This position is about 10-15 degrees too far to the west based on ship and reconnaissance data over the next couple of days and may either reflect bad navigation of the satellite picture or there was a second wave in the vecinity. The disturbance moved westward and became better organized. Another satellite image was captured on September 19th at 1205Z near 18N, 42W showing a well-organized system. Once again, the position appears to be misplaced, but this time, by about 150 nm too far to the northwest based on ship data at the time the satellite image was taken. Due to the rudimentary technology of the day, it has been noticed with other satellite images of tropical cyclones over the open Atlantic Ocean that their estimated position has also been off by a few degrees. The first position is analyzed at 12Z on the 19th, same as originally shown in HURDAT, as a 35 kt tropical storm based upon the appearance of tropical cyclone in the satellite image, up from 25 kt originally shown in HURDAT, a minor intensity change. Intensification to a tropical storm is analyzed 42 hours earlier than originally shown in HURDAT. Minor track alterations are introduced during the lifetime of this tropical cyclone. (A few central pressure values were present in the original HURDAT between September 19th at 12Z and September 24th at 12Z. Some of these were obviously based upon observations of peripheral pressures and not central pressures. Thus, based on actual observations, some were retained and some were removed. Detailed information on these changes can be found in the table at the end.) Debra moved to the northwest on the 19th and slowly intensified. The first gale associated with Debra was reported on September 20th at 00Z by a ship, 40 kt E and 1011 mb. At 12Z on the 20th, another ship reported 50 kt E and 1013 mb. The first reconnaissance aircraft to investigate Debra reached the system at 1420Z on the 20th making a radar fix and estimating 25 kt westerly winds in the southern quadrant before departing due to fuel limitations. Based upon the 50 kt reported by the ship at 12Z on the 20th, the report of an eye visible in radar images by the reconnaissance aircraft, westerly winds of 25 kt in the southern quadrant and the satellite image on the 19th, an intensity of 50 kt is selected at 12Z on the 20th, up from 25 kt originally in HURDAT, a major intensity change. 50 kt is also analyzed at 18Z on the 20th, up from 30 kt originally in HURDAT, a major intensity change.

On September 21st, Debra turned to the north over the central Atlantic. At 12Z on the 21st, a ship reported 35 kt E and 1007 mb in the northeast quadrant of the tropical cyclone. At 1654Z on the 21st, a reconnaissance aircraft measured a central pressure of 1001 mb, estimated surface winds of 65 kt and an eye diameter of 5 nm. MWR indicates that the central pressure measured in this mission was 1000 mb, which was already in HURDAT and it has been retained. A central pressure of 1000 mb suggests maximum surface winds of 47 kt from the south of 25N Brown et al. pressure-wind relationship. An eye diameter of 5 nm suggests an RMW of about 4 nm and the climatological value is 19 nm. Based upon a forward speed of 10 kt, an RMW smaller than climatology and a ship report of 55 kt at 21Z on the 21st, an intensity of 55 kt is analyzed at 18Z on the 21st, down from 65 kt originally in HURDAT, a minor intensity change. 55 kt is also the peak intensity of this tropical cyclone, down from 65 kt originally in HURDAT, a minor intensity change. It is analyzed that Debra did not reach hurricane intensity as previously shown in HURDAT. On September 22nd, Debra continued to move northward at a slower forward speed. A couple of ships reported winds of tropical storm force on this day. The next reconnaissance aircraft to make a penetration fix occurred at 1350Z on the 22nd measuring a central pressure of 1002 mb, estimating surface winds of 45 kt and an eye diameter of 5 nm. A central pressure of 1002 mb suggests maximum surface winds of 40 kt and 43 kt from the north of 25N and south of 25N pressure-wind relationships, respectively. An eye diameter of 5 nm suggests an RMW of about 4 nm and the climatological value is 20 nm. Based upon an RMW smaller than the climatological value and a ship report of 50 kt at 18Z on the 22nd, an intensity of 55 kt is analyzed at 12Z on the 22nd, down from 65 kt originally shown in HURDAT, a minor intensity change. Another penetration fix occurred at 1830Z on the 22nd measuring a central pressure of 999 mb, estimating surface winds of 50 kt and an eye diameter of 50 nm. An eye diameter of 50 nm suggests an RMW of about 43 nm and the climatological value is 20 nm. A central pressure of 999 mb suggests maximum surface winds of 45 kt and 49 kt from the north of 25N and the south of 25N pressure-wind relationships, respectively. Based upon the ship report of 50 kt and a couple other ship reports of 40 kt at 18Z on the 22nd, an intensity of 55 kt is analyzed at 18Z on the 22nd, down from 65 kt originally in HURDAT, a minor intensity change. On September 23rd, Debra continued northward over the open Atlantic. A reconnaissance aircraft investigated the tropical storm at 19Z on the 23rd measuring a central pressure of 999 mb, estimating surface winds of 50 kt and an eye diameter of 30 nm. An eye diameter of 30 nm suggests an RMW of about 23 nm and the climatological value is also 23 nm. A central pressure of 999 mb suggests maximum surface winds of 45 kt from the north of 25N pressure-wind relationship. Based upon an eye diameter close to climatology and a forward speed of about 8 kt, an intensity of 50 kt is analyzed at 18Z on the 23rd, up from 45 kt originally in HURDAT, a minor intensity change. On September 24th, a frontal boundary approached Debra from the west. Synoptic observations after 06Z on the 24th indicate that Debra lost its closed circulation and was later absorbed by the frontal boundary. Last position is analyzed at 06Z on the 24th, twelve hours earlier than originally shown in HURDAT. It is also analyzed that Debra was absorbed before transitioning into an extratropical cyclone as previously shown in HURDAT.

Date	Original HURDAT Central Pressure	Evidence	Changes
Sep 19 12Z	1011 mb	25 kt E and 1010 mb reported by a ship near 16N, 40W	Removed
Sep 20 18Z	1008 mb	Peripheral pressure from an aircraft making a radar fix	
Sep 21 18Z	1000 mb	Penetration center fix: 1001 mb at 1654Z on Sep 21st	Retained
Sep 22 12Z	1002 mb	Penetration center fix: 1002 mb at 1350Z on Sep 22nd	
Sep 22 18Z	999 mb	Penetration center fix: 999 mb at 1830Z on Sep 22nd	
Sep 23 18Z	999 mb	Penetration center fix: 999 mb at 19Z on Sep 23rd	
Sep 24 12Z	1011 mb	Circulation not closed, thus it has been removed	Removed

Hurricane Edith [September 23-29, 1963]

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42905 09/23/1963 M= 7  6 SNBR= 929 EDITH       XING=0 SSS=0
42905 09/23/1963 M= 7  7 SNBR= 929 EDITH       XING=0 SSS=0
                       *

42910 09/23*  0   0   0    0*  0   0   0    0*110 520  25    0*115 530  25    0*
42910 09/23*  0   0   0    0*  0   0   0    0*112 515  25    0*117 525  30    0*
                                             *** ***          *** ***  **

42915 09/24*121 540  30 1005*125 553  30    0*129 565  35 1004*132 582  65 1000*
42915 09/24*122 537  35 1005*125 550  40    0*128 565  50 1004*132 581  60 1000*
           *** ***  **          ***  **      ***       **          ***  **

42920 09/25*137 596  85    0*139 606  75    0*144 616  85  993*147 627  85  990*
42920 09/25*136 595  70    0*139 607  75    0*143 618  75  993*147 629  75  990*
           *** ***  **          ***          *** ***  **          ***  **

42925 09/26*150 641  65    0*153 654  65  998*158 669  65 1000*168 673  65 1000*
42925 09/26*150 641  70    0*153 654  60  998*158 666  55 1000*168 673  55 1000*
                    **                **          ***  **                **

42930 09/27*178 675  65    0*181 690  65  996*187 693  65    0*195 699  65  999*
42930 09/27*177 679  60  996*181 687  60  996*186 694  55    0*194 701  50  999*
           *** ***  **  ***     ***  **      *** ***  **      *** ***  **

42935 09/28*202 705  40    0*207 709  35    0*213 715  35    0*218 720  35    0*
42935 09/28*200 705  45    0*205 709  40    0*211 715  40    0*218 722  35    0*
           ***       **      ***       **      ***       **          ***
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42940 09/29*226 723  30    0*231 720  30    0*  0   0   0    0*  0   0   0    0*
42940 09/29*226 728  30    0*234 725  30    0*242 715  30    0*250 705  30    0*
                ***          *** ***          *** ***          *** ***

42945 HR
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Hurricane Landfall

09/25 07Z 14.0N 60.9W 75 kt St. Lucia

Tropical Storm Landfall

09/27 10Z 18.4N 69.1W 60 kt Dominican Republic
09/28 18Z 21.8N 72.2W 35 kt Turks and Caicos Islands

Minor changes to the track and intensity shown in McAdie et al. (2009). Evidence for these alterations comes from the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Monthly Weather Review, Navy reconnaissance book, Mariners Weather Log, Allison & Thompson (1966) and NHC Storm Wallets.

September 22:

HWM and microfilm do not show an organized system at 12Z. HURDAT does not list an organized system on this date. Ship highlights: No gales or low pressures.

MWR: “Existence of a disturbance was first suspected when the Dutch tanker Acteon reported a south wind of 28 mph. and surface pressure of 1010.1 mb. (29.83 in.) as it moved southward through the inter-tropical Convergence Zone on September 22.”

September 23:

HWM analyzes a closed low pressure of at most 1010 mb at 11.0N, 52.0W at 12Z. HURDAT lists a 25 kt tropical depression at 11.0N, 52.0W at 12Z. Microfilm shows a closed low pressure of at most 1008 mb at 11.0N, 51.8W at 12Z. Ship highlights: No gales or low pressures. Aircraft highlights: Penetration center fix measured a central pressure of 1005 mb and estimated surface winds of 25 kt at 12.3N, 52.8W at 22Z (micro). TIROS highlights: Satellite center fix at 11.0N, 52.5W at 1156Z (WALLET).

MWR: “Photographs taken by TIROS VII at 1156 GMT September 23, showed a vortex and extensive circulation area centered near 11’ N., 52’ W. A reconnaissance aircraft reached the area late that afternoon and found winds of 29 mph and a surface pressure of 1005 mb (29.68 in.), but could see no definite spiral band pattern on radar.” ATSR: “EDITH’s discovery can be attributed primarily to photographs taken by TIROS VII on the 23rd of September at 1156Z. These photographs showed an abnormal mass of cloudiness with a possible vortex near 11N 52W. On the afternoon of the 23rd, a Navy reconnaissance plane was dispatched to the area and found winds of 25 knots and a surface pressure of 1005 millibars. This data prompted the issuance of a tropical depression warning by the Fleet Weather Facility, Miami.”

September 24:

HWM analyzes a tropical storm of at most 1005 mb at 13.0N, 56.0W at 12Z. HURDAT lists a 35 kt tropical storm at 12.9N, 56.5W at 12Z. Microfilm shows a closed low pressure of at most 1011 mb at 12.0N, 58.0W at 12Z. Ship highlights: 15 kt S and 1004 mb at 12.7N, 57.2W at 12Z (micro). 60 kt E and 1004 mb at 13.7N, 57.6W at 18Z (WALLET). Aircraft highlights: Penetration center fix measured a central pressure of 1004 mb, estimated surface winds of 60 kt and an eye diameter of 50 nm at 12.8N, 56.6W at 1315Z (WALLET). Penetration center fix measured a central pressure of 1000 mb, estimated surface winds of 70 kt and an eye diameter of 30 nm at 13.4N, 58.4W at 18Z (WALLET). TIROS highlights: Satellite center fix at 12.0N, 55.5W at 1217Z (WALLET).

MWR: "Hurricane Edith formed in the Atlantic east of the Lesser Antilles on September 24. Early morning reconnaissance on the 24th found winds of 70 mph, and a short time later Edith was reported to be of hurricane intensity with 80 mph winds. This location was some 120 mi. east of Barbados. Lowest pressure computed in Edith was 978 mb, or 28.88 in., on September 24." ATSR: "Subsequent reconnaissance flights indicated a gradual intensification to tropical storm status and the first of 20 numbered warnings was issued at 1600Z on the 24th. Warning number two indicated that EDITH bad rapidly intensified to hurricane strength."

September 25:

HWM analyzes a hurricane of at most 1000 mb at 14.4N, 61.3W at 12Z. HURDAT lists an 85 kt hurricane at 14.4N, 61.6W at 12Z. Microfilm shows a closed low pressure of at most 1008 mb at 14.0N, 61.5W at 12Z. Ship highlights: 20 kt NNW and 1004 mb at 14.0N, 62.0W at 06Z (micro). 40 kt NE and 1004 mb at 14.1N, 62.0W at 12Z (micro). Land highlights: 15 kt WSW and 1004 mb at Barbados at 00Z (micro). 60 kt N at St. Lucia at 06Z (micro). Calm at Port Castries, St. Lucia between 07-0815Z (WALLET). 995 mb (min pressure) at Fort-de-France, Martinique at 08Z (WALLET). 85 kt (direct reading) [likely gusts] at Caravelle, Martinique at 0750Z (WALLET). 55 kt at Le Lamentin, Martinique at 08Z (WALLET). Greater than 100 kt (115 kt registered before anemometer was blocked) [likely gusts] at Fort-de-France, Martinique between 0810Z and 10Z (WALLET). 35 kt SE and 1008 mb at Guadeloupe at 12Z (micro). Aircraft highlights: Radar center fix at 14.2N, 59.8W at 02Z (WALLET). Penetration center fix measured a central pressure of 993 mb, estimated surface winds of 90 kt and an eye diameter of 14-18 nm eye diameter at 14.3N, 61.7W at 1318Z (WALLET). Penetration center fix measured a central pressure of 990 mb and estimated surface winds of 90 kt at 14.7N, 62.8W at 1848Z (WALLET). Penetration center fix estimated an eye diameter of 40 nm at 14.9N, 63.9W at 2330Z (ATSR).

MWR: "Edith passed over the north portion of St. Lucia between midnight and daybreak on the 25th and was at her maximum intensity at about this time. Edith was weakened considerably by the mountains of the Lesser Antilles and was barely of hurricane intensity thereafter as it moved across the northeastern Caribbean and the Dominican

Republic. Martinique was heavily damaged, to the extent of $40 million, with 10 persons killed and 50 injured. Storm tides of 8 ft. above normal were noted. Fort de France reported a minimum pressure of 995 mb, or 29.33 in., with maximum winds of 127 mph. Damage on Dominica was $2,611,600 and winds reached 80 mph in gusts. There was no loss of life there. On St. Lucia, 40 to 50 percent of the bananas were destroyed and the cocoa crop was a total loss. Tides there were 8 to 10 ft. above normal and Port Castries reported a dead calm beginning at 2 a.m. (EST) which lasted 75 min. Maximum winds were 90 mph. There was no loss of life, but damage totaled $3,465,000. On Barbados, winds reached 60 to 65 mph in squalls on the northern tip of the island and damage was estimated at $145,000."

September 26:

HWM analyzes a hurricane of at most 1000 mb at 16.0N, 66.8W at 12Z. HURDAT lists a 65 kt hurricane at 15.8N, 66.9W at 12Z. Microfilm shows a closed low pressure of at most 1011 mb at 15.5N, 67.0W at 12Z. Ship highlights: 35 kt NE and 1008 mb at 15.0N, 65.2W at 00Z (COADS). Aircraft highlights: Penetration center fix estimated an eye diameter of 40 nm at 15.1N, 64.2W at 0105Z (ATSR). Penetration center fix measured a central pressure of 998 mb, estimated flight level winds of 60 kt and an eye diameter of 25 nm eye diameter at 15.3N, 65.5W at 0704Z (WALLET). Penetration center fix measured a central pressure of 1000 mb, estimated surface winds of 45 kt and an eye diameter of 80 nm at 15.8N, 67.1W at 13Z (WALLET). Penetration center fix measured a central pressure of 1000 mb and estimated an eye diameter of 12 nm eye diameter at 17.2N, 67.5W at 1945Z (WALLET).

MWR: "The hurricane then moved on a general west-northwest-ward course to a point some 120 mi. south of Puerto Rico…50 to 60 mph winds along the south and southwestern coasts of Puerto Rico, together with heavy rains, caused $400,000 damage there." ATSR: "Hurricane EDITH moved on a general west-northwest course to a point some 120 miles south of Puerto Rico."

September 27:

HWM analyzes a tropical storm of at most 1010 mb at 19.0N, 69.0W at 12Z. HURDAT lists a 65 kt hurricane at 18.7N, 69.3W at 12Z. Microfilm shows a closed low pressure of at most 1008 mb at 19.0N, 69.5W at 12Z. Ship highlights: 35 kt E and 1010 mb at 17.9N, 68.2W at 00Z (COADS). 60 kt E and 1009 mb at 18.7N, 67.6W at 06Z (COADS). 40 kt SSE at 19.5N, 68.9W at 12Z (micro). 35 kt SSE and 1012 mb at 19.4N, 67.6W at 15Z (micro). 35 kt S and 1009 mb at 19.6N, 68.5W at 18Z (COADS). Aircraft highlights: Penetration center fix measured a central pressure of 996 mb and estimated an eye diameter of 20 nm at 17.9N, 68.0W at 01Z (ATSR). Penetration center fix measured a central pressure of 996 mb at 17.8N, 68.7W at 0829Z (WALLET). Radar center fix at 18.9NM, 69.3W at 1236Z (WALLET). Radar center fix calculated a central pressure of 999 mb and estimated surface winds of 40 kt at 19.5N, 70.3W at 1850Z (WALLET). Land highlights: 20 kt NW and 1005 mb at Puerto Plata, Dominican Republic at 18Z (micro). TIROS highlights: Satellite center fix at 18.5N, 69.5W at 1243Z (WALLET).

MWR: "and then turned to a more northwestward course passing over the eastern portion of the Dominican Republic before dissipating as it moved out north of Hispaniola. In the

Dominican Republic damage was minor…" ATSR: "…then turned to a more northwesterly course, passing over the eastern portion of Hispaniola."

September 28:

HWM analyzes a tropical storm of at most 1005 mb at 21.5N, 71.8W with a warm front to the north at 12Z. HURDAT lists a 35 kt tropical storm at 18.7N, 69.3W at 12Z. Microfilm shows a closed low pressure of at most 1008 mb at 19.0N, 69.5W with a frontal boundary to the north at 12Z. Ship highlights: 35 kt S and 1006 mb at 20.0N, 69.8W at 00Z (COADS). 35 kt S and 1006 mb at 20.2N, 70.8W at 03Z (micro). 20 kt NE and 1005 mb at 20.3N, 71.4W at 06Z (COADS). 40 kt NE and 1005 mb at 21.5N, 72.4W at 12Z (micro). Land highlights: 15 kt NW and 1005 mb at Puerto Plata, Dominican Republic at 00Z (micro). 20 kt ESE and 1005 mb at Grand Turk at 09Z (micro). 20 kt E and 1004 mb at South Caicos at 18Z (micro).

MWR: "On the 28th as Edith was dissipating north of Hispaniola, the upper trough had flattened out into general easterly flow with no particularly well marked divergent or convergent pattern. The frontal wave development moving across to the north of Edith weakened the pressure gradient markedly over and east of the Bahamas, thus lessening greatly the easterly low-level flow north of Edith and probably was a major factor in the storm's dissipation. As it moved out into an area of very flat pressure gradient and poor low-level inflow underneath a non-divergent pattern in the upper atmosphere, Edith was unable to recover from the distortion effects of the mountains of eastern Hispaniola." ATSR: "Gradual dissipation occurred after EDITH passed over Hispaniola and the final numbered warning was issued at 2200Z on the 28th."

September 29:

HWM analyzes a spot low at 23.0N, 71.8W with a dissipating warm front to the northeast at 12Z. HURDAT lists a 30 kt tropical depression at 23.1N, 72.0W at 06Z (final position). Microfilm shows a closed low pressure of at most 1008 mb at 24.5N, 71.5W with a frontal boundary to the northeast at 12Z. Ship highlights: 35 kt S and 1012 mb at 25.1N, 68.3W at 18Z (COADS). TIROS highlights: Satellite center fix at 23.0N, 71.5W at 1229Z (WALLET).

September 30:

HWM analyzes frontal boundaries over the western Atlantic at 12Z. HURDAT does not list an organized system on this date. Microfilm shows an extratropical cyclone of at most 1002 mb at 37.0N, 69.0W at 12Z (Edith appears to have been absorbed). Ship highlights: No gales or low pressures.

The disturbance that spawned Edith was a tropical wave that left the African coast around September 16th. The system moved westward and slowly became better organized. On September 22nd, surface observations between the Lesser Antilles and Africa indicated that a circulation was developing. The first position, not genesis, is analyzed at 12Z on September 23rd as a 25 kt tropical depression, as originally shown in HURDAT. Time of genesis is uncertain due to the sparse observations over the central Atlantic. A TIROS

satellite center fix, image not available, at 1156Z on the 23rd was available in the Storm Wallets and appears to have been the basis for starting the tropical cyclone in HURDAT. Operationally, the first advisory was issued at 01Z on September 24th. Minor alterations to the track were introduced during the lifetime of this tropical cyclone. The first reconnaissance aircraft to investigate the tropical depression arrived at late on the 23rd making a center penetration at 22Z and measuring a central pressure of 1005 mb and estimating surface winds of 25 kt. A central pressure of 1005 mb suggests maximum surface winds of 37 kt from the south of 25N Brown et al. pressure-wind relationship. Based on a forward speed of 13 kt, an intensity of 35 kt is analyzed at 00Z on September 24th, up from 30 kt originally in HURDAT, a minor intensity change. Intensification to a tropical storm is analyzed at 00Z on the 24th, twelve hours earlier than originally shown in HURDAT. (Central pressures values were present for many of the times in the original HURDAT between September 24nd at 18Z and September 27th at 18Z. All the original central pressure values were retained and one added. Detailed information on these changes can be found in the table at the end.) Edith rapidly intensified on the 24th based on ship and reconnaissance data. The next reconnaissance aircraft made a center penetration at 1315Z on the 24th measuring a central pressure of 1004 mb, estimating surface winds of 60 kt and an eye diameter of 50 nm. A central pressure of 1004 mb suggests maximum surface winds of 39 kt from the south of 25N pressure-wind relationship. An eye diameter of 50 nm suggests an RMW of about 38 nm and the climatological value is 13 nm. Based on a forward speed of 17 kt, a ship report of 60 kt at 18Z on the 24th and putting some weight on the visual estimate, an intensity of 50 kt is selected at 12Z on the 24th, up from 35 kt originally in HURDAT, a minor intensity change. At 18Z on the 24th, another reconnaissance aircraft measured a central pressure of 1000 mb, estimated surface winds of 70 kt and an eye diameter of 30 nm. A central pressure of 1000 mb suggests maximum surface winds of 47 kt from the south of 25N pressure-wind relationship. An eye diameter of 30 nm suggests an RMW of about 23 nm and the climatological value is 13 nm. Based upon the ship report of 60 kt E and 1004 mb at 18Z on the 24th and a forward speed of about 15 kt, an intensity of 60 kt is analyzed at 18Z on the 24th, down from 65 kt originally in HURDAT, a minor intensity change. MWR and the Storm Wallets have the measurement of 1000 mb as 978 mb but the ATSR book clearly indicates that the measurement was 1000 mb, which makes more sense with the data available before and after this measurement. The original HURDAT showed a dramatic 30 kt 6 hr increase in intensity from 35 kt at 12Z on the 24th to 65 kt at 18Z on the 24th but based on the data available, this rapid increase in intensity does not appear to have occurred.

On September 25th, Edith crossed the Lesser Antilles into the eastern Caribbean Sea. Intensification to a hurricane is analyzed at 00Z on the 25th based on synoptic and reconnaissance observations later in the day. Intensification to a hurricane is analyzed six hours later than originally shown in HURDAT. Edith made landfall in northern Saint Lucia around 07Z on the 25th as a 75 kt hurricane. Calm conditions were reported between 07Z and 0815Z at Port Castries, the capital of Saint Lucia, indicating the passage of the eye of the hurricane. In Saint Lucia, the strongest sustained winds appear to have been 60 kt reported in the microfilm at 06Z on the 25th. The island of Martinique, about 20 nm north of Saint Lucia, reported gusts up to 115 kt and a minimum pressure of 995

mb. At 1318Z on the 25th, a reconnaissance aircraft measured a central pressure of 993 mb, estimated surface winds of 90 kt and an eye diameter 14-18 nm. A central pressure of 993 mb suggests maximum surface winds of 59 kt from the south of 25N pressure-wind relationship. An eye diameter of 14-18 nm suggests an RMW of about 11-14 nm and the climatological value is 13 nm. Based upon a forward speed of 12 kt, observations in the Lesser Antilles and putting some weight on the visual estimate, an intensity of 75 kt is selected at 12Z on the 25th, down from 85 kt originally in HURDAT, a minor intensity change. 75 kt is also the peak intensity of this tropical cyclone, down from 85 kt originally shown in HURDAT, a minor intensity change. At 1848Z on the 25th, another penetration center fix measured a central pressure of 990 mb and estimated surface winds of 90 kt. A central pressure of 990 mb suggests maximum surface winds of 64 kt from the south of 25N pressure-wind relationship. Based on a forward speed of 12 kt and putting some weight on the visual estimate, an intensity of 75 kt is analyzed at 18Z on the 25th, down from 85 kt originally in HURDAT, a minor intensity change. On September 26th, Edith moved generally northwestward and weakened. A ship reported 35 kt at 00Z on the 26th, the only synoptic gale-force winds associated with Edith on this date. A reconnaissance aircraft investigated the tropical cyclone early on the 26th making a penetration center fix at 0704Z and measuring a central pressure of 998 mb and estimating an eye diameter of 25 nm. A central pressure of 998 mb suggests maximum surface winds of 51 kt from the south of 25N pressure-wind relationship. An eye diameter of 25 nm suggests an RMW of about 19 nm and the climatological value is 13 nm. Based upon a forward speed of 14 kt, an intensity of 60 kt is analyzed at 06Z on the 26th, down from 65 kt originally shown in HURDAT, a minor intensity change. Another penetration center fix occurred at 13Z on the 26th measuring a central pressure of 1000 mb, estimating surface winds of 45 kt and an eye diameter of 80 nm. A central pressure of 1000 mb suggests maximum surface winds of 47 kt from the south of 25N pressure-wind relationship. An eye diameter of 80 nm suggests an RMW of about 60 nm and the climatological value is 14 nm. Based upon a forward speed of 12 kt, an intensity of 55 kt is selected at 12Z on the 26th, down from 65 kt originally in HURDAT, a minor intensity change. The next penetration center fix occurred at 1945Z on the 26th also measuring a central pressure of 1000 mb. An intensity of 55 kt is selected at 18Z on the 26th, down from 65 kt originally in HURDAT, a minor intensity change.

On September 27th, Edith maintained a northwestward course impacting Hispaniola. The first reconnaissance aircraft to investigate the tropical cyclone on the 27th made a penetration center fix at 01Z measuring a central pressure of 996 mb and an eye diameter of 20 nm. A central pressure of 996 mb suggests maximum surface winds of 54 kt from the south of 25N pressure-wind relationship. An eye diameter of 20 nm suggests an RMW of about 15 nm and the climatological value is also 15 nm. Based upon a forward speed of about 11 kt and a ship report of 60 kt at 06Z on the 27th, an intensity of 60 kt is selected at 00Z on the 27th, down from 65 kt originally in HURDAT, a minor intensity change. Another penetration center fix measured a central pressure of 996 mb at 0829Z on the 27th and an intensity of 60 kt is selected at 06Z on the 27th, down from 65 kt originally in HURDAT, a minor intensity change. Landfall in southeastern Dominican Republic is analyzed around 10Z on the 27th as a 60 kt tropical storm. TIROS captured an image of the tropical storm at 1243Z on the 27th showing a large area of convection over

the Dominican Republic with no hints of an eye. Around 19Z on the 27th, Edith reached the Atlantic Ocean after emerging north of Hispaniola. A reconnaissance aircraft measured a central pressure of 999 mb and estimated surface winds of 40 kt at 1850Z on the 27th. A central pressure of 999 mb suggests maximum surface winds of 49 kt from the south of 25N pressure-wind relationship. Based upon a forward speed of about 12 kt, an intensity of 50 kt is analyzed at 18Z on the 27th, down from 65 kt originally in HURDAT, a minor intensity change. On September 28th, Edith continued northwestward and further weakened. Gale-force winds were reported by ships at 00Z and 12Z on the 28th. The center of Edith crossed the Turks and Caicos at 18Z on the 28th as a 35 kt tropical storm. On September 29th, a frontal boundary north of the Bahamas caused Edith to turn to the northeast. Weakening to a tropical depression is analyzed at 00Z on the 29th, same as originally shown in HURDAT. The last position originally in HURDAT was at 06Z on the 29th but synoptic observations and a TIROS image at 1229Z indicate that the system was still a tropical cyclone. The satellite image shows a large area of convection with some banding. Synoptic observations after 18Z on the 29th indicate that Edith weakened into a trough of low pressure and was likely absorbed by a developing extratropical cyclone off the East Coast of the United States on September 30th. Thus, the last position is analyzed at 18Z on the 29th, twelve hours later than originally shown in HURDAT.

Date	Original HURDAT Central Pressure	Evidence	Changes
Sep 24 00Z	1005 mb	Penetration center fix: 987 mb at 1642Z on Aug 02nd	Retained
Sep 24 12Z	1004 mb	Penetration center fix: 1004 mb at 1315Z on Sep 24th	
Sep 24 18Z	1000 mb	Penetration center fix: 1000 mb at 18Z on Sep 24th	
Sep 25 12Z	993 mb	Penetration center fix: 993 mb at 1318Z on Sep 25th	
Sep 25 18Z	990 mb	Penetration center fix: 990 mb at 1848Z on Sep 25th	
Sep 26 06Z	998 mb	Penetration center fix: 998 mb at 0704Z on Sep 26th	
Sep 26 12Z	1000 mb	Penetration center fix: 1000 mb at 13Z on Sep 26th	
Sep 26 18Z	1000 mb	Penetration center fix: 1000 mb at 1945Z on Sep 26th	
Sep 27 00Z		Penetration center fix: 996 mb at 01Z on	996 mb

		Sep 27th	
Sep 27 06Z	996 mb	Penetration center fix: 996 mb at 0829Z on Sep 27th	Retained
Sep 27 18Z	999 mb	Penetration center fix: 999 mb at 1850Z on Sep 27th	

Hurricane Flora [September 26 – October 13, 1963]

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42950 09/26/1963 M=18  7 SNBR= 930 FLORA       XING=0 SSS=0
42950 09/26/1963 M=18  8 SNBR= 930 FLORA       XING=0 SSS=0
                       *

42955 09/26*  0   0   0    0*  0   0   0    0* 80 330  25    0* 81 348  25    0*

42960 09/27* 82 365  25    0* 83 383  30    0* 85 400  30    0* 87 416  30    0*
42960 09/27* 82 365  25    0* 83 383  30    0* 85 402  30    0* 87 421  30    0*
                                             ***               ***

42965 09/28* 88 432  30    0* 90 447  30    0* 92 463  30    0* 95 479  30    0*
42965 09/28* 88 437  30    0* 90 451  30    0* 92 465  30    0* 95 480  30    0*
                ***               ***               ***               ***

42970 09/29* 98 495  30    0* 99 511  30    0*100 528  40 1000*101 544  55    0*
42970 09/29* 97 495  30    0* 99 511  35    0*100 528  40    0*101 544  45    0*
              **                    **                          *          **

42975 09/30*103 560  70    0*104 576  85    0*107 591 100  994*112 607 105  978*
42975 09/30*103 560  55    0*104 576  65    0*107 591  80  994*112 607 100  974*
                     **                **                **               ***  ***

42980 10/01*116 620 110  981*120 633 110  981*125 648 115  974*130 660 115  975*
42980 10/01*116 620 100  975*120 633 100    0*125 647 100    0*130 660 100  975*
                    ***  ***          ***    *     *** ***    *          ***

42985 10/02*136 673 120  970*141 683 120    0*146 692 120  968*151 700 120  968*
42985 10/02*136 673 105  970*142 683 105  964*147 692 105    0*151 700 105  960*
                    ***  *** ***     ***  *** ***     ***    *          ***  ***

42990 10/03*155 706 120    0*159 714 125    0*165 720 125  940*171 725 125  944*
42990 10/03*155 707 110    0*159 714 115    0*165 720 120    0*172 725 125  936*
                ***  ***               ***               ***    * ***          ***

42995 10/04*180 731 125  944*191 742 105  995*193 745 105  970*203 749 105  970*
42995 10/04*181 729 125    0*188 738 105    0*194 744 105  970*200 749 105  973*
            ***  ***        * ***  ***      * ***  ***         ***          ***

43000 10/05*208 759 110    0*208 765 110    0*208 768 105  985*205 770 100    0*
43000 10/05*207 757  95    0*209 764  85    0*208 768  75    0*207 770  70    0*
            ***  ***  **      ***  ***  **                ***    * ***      **

43005 10/06*204 774 100    0*203 776  95    0*202 779  90  985*205 781  85    0*
43005 10/06*206 773  75    0*205 776  85    0*204 779  85    0*205 782  85    0*
            ***  ***  **      ***       **      ***       **   *      ***

43010 10/07*206 783  85    0*207 782  80    0*208 781  80  986*210 780  75    0*
43010 10/07*207 782  85    0*208 781  85    0*209 780  75    0*210 779  65    0*
            ***  ***          ***  ***  **      ***  ***  **    *     ***  **

43015 10/08*213 777  75    0*212 770  75  989*211 762  70  990*215 754  75  990*
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43015 10/08*211 776  60    0*211 770  55    0*211 762  55    0*213 754  65    0*
           *** ***  **       ***      **    *          **     * ***      **     *

43020 10/09*217 744  75  983*223 728  75    0*235 716  80  975*250 700  85  965*
43020 10/09*217 743  75  983*223 729  85  977*233 716  90  976*246 700 100  965*
                 ***              ***  **  *** ***      **  *** ***     ***

43025 10/10*260 683  95  965*271 665  95  969*281 649 100  969*299 622 100  972*
43025 10/10*258 683 100  965*269 665 100    0*280 648  95  969*299 624  95  972*
           ***     ***      ***     ***    * *** ***  **          ***  **

43030 10/11*322 598  95    0*343 583  90  970*362 570  85  963*383 560  80  963*
43030 10/11*322 598  95  968*342 583  95  970*362 570  90  963E381 560  90    0*
                        ***          **                **     ****      **     *

43035 10/12*401 540  80    0*420 520  75    0*435 498  75  985E452 475  75    0*
43035 10/12E398 550  90    0E415      85    0E430      80    0E445 475  75    0*
           **** ***  **     **** ***  **     **** ***  **    * ***

43040 10/13E470 450  70    0E492 428  70    0E515 410  70    0*  0   0   0    0*
43040 10/13E460 440  70    0*  0   0   0    0*  0   0   0    0*  0   0   0    0*
           *** ***          *  *   *   *     *  *   *   *

43045 HR
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Hurricane Landfall

09/30 18Z 11.2N 60.7W 100 kt Tobago
10/04 01Z 18.2N 73.0W 125 kt Haiti
10/04 18Z 20.0N 74.9W 105 kt Cuba
10/07 06Z 20.8N 78.1W 85 kt Cuba
10/09 06Z 22.3N 72.8W 85 kt Mayaguana, Bahamas

Minor changes to the track and major changes to the intensity shown in McAdie et al. (2009). A major alteration is to show transition to an extratropical cyclone 24 hours earlier than originally shown in HURDAT. Evidence for these alterations comes from the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Monthly Weather Review, Navy reconnaissance book, Mariners Weather Log, Cuban surface maps (CUBA), National Hurricane Research Project (NHRP), Advisories Perez et al., correspondence with Maritza Ballester from the Cuban Meteorological Institute and NHC Storm Wallets.

September 25:

HWM and microfilm do not show an organized system at 12Z. HURDAT does not list an organized system on this date. Ship highlights: No gales or low pressures.

September 26:

HWM and microfilm do not show an organized system at 12Z. HURDAT lists a 25 kt tropical depression at 8.0N, 33.0W at 12Z. Ship highlights: No gales or low pressures.

MWR: “At 8:50 am, EST, on September 26, the National Hurricane Center in Miami received an advisory from the Weather Bureau's National Weather Satellite Center stating

that TIROS VII at 4:40 am., EST, had sighted a poorly organized vortex at approximately 11.5" N., 35.0" W., with a central overcast area about 4" in diameter with some banding to the north and east. Actually the TIROS satellite had sighted a complex cloud system with two principal areas of cloud concentration. The northern center mentioned in the advisory was probably associated with an upper-level vortex, and Flora eventually developed from the second cloud mass located at about 8.0" N., 32.5" W., which was associated with a very weak depression in the Intertropical Convergence Zone (ITC)." ATSR: "The incipient stage of Hurricane FLORA is believed to have been observed by satellite as early as 26 September when photographs showed a cloud mass in the mid-Atlantic near 38W."

September 27:

HWM analyzes a closed low pressure of at most 1010 mb at 8.0N, 40.2W at 12Z. HURDAT lists a 30 kt tropical depression at 8.5N, 40.0W at 12Z. Microfilm shows a tropical wave along longitude 40W at 12Z. Ship highlights: No gales or low pressures.

MWR: "On the next day, September 27, TIROS VII photographed the same complex cloud system, which retained rather remarkable resemblance to that of the day before. The center of the southern cloud mass had moved to 8.0" N., 40.0" W. The cloud mass had grown somewhat in size but there were still no indications of spiral bands and apparently it was still associated with an ordinary depression in the ITC." ATSR: "On the following day a photograph from the satellite, again, indicated an area of unsettled conditions near 8N 40W."

September 28:

HWM analyzes a closed low pressure of at most 1010 mb at 9.0N, 46.5W at 12Z. HURDAT lists a 30 kt tropical depression at 9.2N, 46.3W at 12Z. Microfilm shows a tropical wave along longitude 46W at 12Z. Ship highlights: No gales or low pressures.

September 29:

HWM analyzes a tropical storm of at most 1005 mb at 9.8N, 52.6W at 12Z. HURDAT lists a 40 kt tropical storm at 10.0N, 52.8W at 12Z. Microfilm does not show an organized storm at 12Z. Ship highlights: 1000 mb at 2230Z (MWR).

MWR: "TIROS was not in a position to photograph the cloud system on September 28 and 29 and there were not sufficient ship reports to indicate the existence of a circulation. However, on the 29th, the San Juan Hurricane Center requested surface observations from all ships in the area, and a Navy hurricane reconnaissance flight was arranged for daybreak on September 30. A series of ship reports began to arrive early in the morning, September 30. A much delayed weather observation from the Sinon arrived around 3:30 am EST. The report stated that the barometer at 5:30 pm the afternoon before had dipped to 1000 mb (29.54 in.) with a wind shift from northwest to southwest, but nothing was said about the strength of the winds."

September 30:

HWM analyzes a hurricane of at most 1000 mb at 10.8N, 59.1W at 12Z. HURDAT lists a 100 kt hurricane at 10.7N, 59.1W at 12Z. Microfilm shows a closed low

pressure of at most 1005 mb at 10.7N, 59.2W at 12Z. Ship highlights: 35 kt NE and 1007 mb at 10.9N, 58.3W at 06Z (COADS). 45 kt SSE at 10.4N, 59.1W at 10Z (micro). 35 kt NE at 12.0N, 62.0W at 18Z (micro). Land highlights: 2 kt W and 974 mb (uncorrected) at Crown Point, Tobago at 1840Z (WALLET). Aircraft highlights: Penetration center fix measured a central pressure of 994 mb, estimated surface winds of 110 kt and an eye diameter of 25 nm at 10.8N, 59.8W at 1407Z (WALLET). Radar center fix with peripheral pressure of 986 mb at 11.1N, 60.2W at 1630Z (WALLET). Penetration center fix measured a central pressure of 975 mb, estimated surface winds of 130 kt and an eye diameter of 10 nm at 11.4N, 61.5W at 2110Z (WALLET).

MWR: “The SS Del Alba forwarded all observation made at 1:00 a.m., EST, which arrived around 4:30 am., indicating winds from the northeast of 35 kt., and a barometer reading of 1006.8 mb with a fall of 5 mb in the past 3 hr. At 10:00 am, EST, much too late for adequate warning to Tobago, the Del Alba sent in a complete report as follows: "PASSED THROUGH STORM AREA COMMENCING 4 PM ON THE 29TH- PASSED NORTH OF CENTER 2 AM ON THE 30TH- ESTIMATED POSITION AT 6 AM 11.0 57.5- WINDS FROM THE NORTHWEST AT 4 PM TO NORTHEAST 28 MPH AT 10 PM TO EAST 40 MPH AT 2 AM-PRESENT POSITION AT 10 AM 10.9N 56.3W WIND EASTSOUTHEAST TO SOUTHEAST 16 MPH BAROMETER 29.94 INCHES RISING SOUTHEAST SEAS ROUGH WITH MODERATE HEAVY SWELL-HAVE PASSED STORM." At 9:07 am, EST, the hurricane hunter plane reached the center of the storm, found a circular eye well defined, central pressure 994 mb, surface winds in excess of hurricane force, and the wall cloud around the eye 8 mi. wide. This observation indicated that hurricane Flora was the most concentrated and best organized tropical cyclone of the past two years. The San Juan Weather Bureau office issued a bulletin at 9 am, and the first formal hurricane advisory on Flora at 11 am, EST. The eye of hurricane Flora passed over Tobago at 1:40 pm, EST, with lowest pressure 28.77 in, 974 mb (uncorrected) and maximum sustained winds 90 to 100 mph. Seventeen people were killed and crop and property damage was around $30 million. On Trinidad, maximum winds were estimated at about 55 mph in extreme gusts from the southwest. There was only minor damage over most of Trinidad due to the protection afforded by the mountain range along the north coast. However, when the wind shifted to the southwest, many small boats in the harbor, which is an open roadstead to the west, were sunk. The large vessels had put out to sea. At Northwest Point on the northern slope of the mountains, the marine reporting station estimated winds up to 70 mph with torrential rains. An amateur radio operator about 10 mi. east of Northwest Point and on the slope about ½ mi. from the shore, estimated the winds at 65 mph in gusts and zero visibility due to the heavy driving rain.” ATSR: “However, it wasn’t until the night of 29 September that ships began reporting heavy seas, falling pressures and westerly winds, which prompted a disturbance warning to be issued by Fleet Weather Facility, Miami the following morning at 301100Z. A navy reconnaissance aircraft from Roosevelt Roads

was dispatched into the area the morning of the 30th. The aircraft found the circulation approximately 120 miles to the easy of Trinidad. The disturbance had intensified into a well-developed hurricane with a well-defined wall cloud and central pressure of 994 mbs. Warning number one on Hurricane FLORA was issued at 301600Z."

October 1:

HWM analyzes a hurricane of at most 1000 mb at 12.8N, 64.8W at 12Z. HURDAT lists a 115 kt hurricane at 12.5N, 64.8W at 12Z. Microfilm shows a closed low pressure of at most 1008 mb at 13.0N, 65.5W at 12Z. Ship highlights: 35 kt E and 1013 mb at 14.2N, 66.4W at 18Z (micro). Aircraft highlights: Radar center fix at 11.6N, 62.3W at 01Z (WALLET). Radar center fix measured a peripheral pressure of 981 mb and estimated an eye diameter of 13-20 nm at 12.2N, 63.8W at 07Z (WALLET). Penetration center fix measured a central pressure of 974 mb, estimated surface winds of 120 kt and an eye diameter of 13 nm at 13.1N, 65.9W at 16Z (WALLET/ATSR). Penetration center fix measured a central pressure of 975 mb, estimated surface winds of 120 kt and an eye diameter of 13 nm at 13.2N, 66.2W at 19Z (WALLET). Penetration center fix measured a central pressure of 970 mb and estimated eye diameter of 11 nm at 13.5N, 66.7W at 2110Z (WALLET).

MWR: "On Grenada damage was minor but six people lost their lives by drowning. After leaving the southern Windwards, hurricane Flora moved on a fairly smooth and regular track toward the southwestern Haitian peninsula gradually acquiring a more northward component."

October 2:

HWM analyzes a hurricane of at most 1000 mb at 14.8N, 69.2W at 12Z. HURDAT lists a 120 kt hurricane at 14.6N, 69.2W at 12Z. Microfilm shows a closed low pressure of at most 1008 mb at 14.5N, 69.0W at 12Z. Ship highlights: 40 kt NE and 1012 mb at 17.4N, 69.8W at 12Z (COADS). 50 kt ESE and 1008 mb at 15.2N, 68.6W (COADS/MWL). Aircraft highlights: Penetration center fix at 13.5N, 67.1W at 02Z (ATSR). Penetration center fix measured a central pressure of 964 mb, estimated flight level winds of 145 kt and an eye diameter of 11 nm at 14.4N, 68.3W at 0710Z (WALLET). Radar center fix measured a peripheral pressure of 968 mb, estimated surface winds of 130 kt and an eye diameter of 11 nm at 14.8N, 69.6W at 1342Z (WALLET). Penetration center fix measured a central pressure of 960 mb, estimated surface winds of 120 kt and an eye diameter of 16 nm at 15.1N, 70.1W at 1946Z (WALLET).

October 3:

HWM analyzes a hurricane of at most 1000 mb at 16.8N, 72.0W at 12Z. HURDAT lists a 125 kt hurricane at 16.5N, 72.0W at 12Z. Microfilm shows a closed low pressure of at most 1008 mb at 15.0N, 72.0W at 12Z. Ship highlights: 35 kt E and 1011 mb at 16.7N, 68.5W at 00Z (COADS). 45 kt ESE and 1004 mb at 16.1N, 68.9W at 06Z (COADS). 35 kt SE and 1005 mb at 15.2N, 69.4W at 12Z (COADS). Land highlights: 1001 mb at Barahona, Dominican Republic at 21Z (WALLET). 42 kt (gusts to 55 kt) at

Port-au-Prince, Haiti at 23Z (WALLET). Aircraft highlights: Radar center fix measured a peripheral pressure of 963 mb, estimated surface winds of 140 kt and an eye diameter of 16 nm at 15.5N, 70.8W at 0046Z (WALLET). Radar center fix measured a peripheral pressure of 954 mb, estimated flight level winds of 140 kt and an eye diameter of 15 nm at 15.9N, 71.6W at 0617Z (WALLET). Penetration center fix estimated surface winds of 110 kt and an eye diameter of 18 nm at 16.6N, 72.2W at 1342Z (WALLET). Penetration center fix measured a central pressure of 936 mb, estimated surface winds of 130 kt and an eye diameter of 15 nm at 16.8N, 72.4W at 1620Z (WALLET). Penetration center fix estimated surface winds of 143 kt and an eye diameter of 12 nm at 17.2N, 72.6W at 1838Z (WALLET).

MWR: "Flora intensified slowly until it began to deepen rapidly on October 3. At 11:2O am. EST, the Navy reconnaissance plane reported a central pressure of 936 mb, or 27.64 in. Flight level winds of 167 mph were measured on the 2nd and about the same on the 3rd. Probably some further intensification continued on the 3rd until the center reached the coastline around 8 pm, EST. At this time it was estimated sustained winds on the surface were around 140 mph with gusts 180-200 mph. Thus at this time, Flora was comparable to hurricane Donna when it crossed the Florida Keys in 1960 and Carla when it reached the Texas coast in 1961."

October 4:

HWM analyzes a hurricane of at most 995 mb at 19.7N, 74.3W at 12Z. HURDAT lists a 105 kt hurricane at 19.3N, 74.5W at 12Z. Microfilm shows a closed low pressure of at most 1005 mb at 19.0N, 75.0W at 12Z. Ship highlights: 20 kt NW and 1004 mb at 17.2N, 74.5W at 06Z (COADS). 65 kt NW and 988 mb at 18Z (micro). Land highlights: calm for 15 minutes at Fonds des Negres, Haiti starting at 0245Z (WALLET). calm for an 1 hour, 10 minutes at Ause a Veau, Haiti starting at 04Z (WALLET). 978 mb (min pressure) at Port-au-Prince, Haiti at 0430Z (WALLET). 55 kt NE and 1006 mb at Punta de Maisi, Cuba at 06Z (CUBA). 50 kt E and 1005 mb at Punta de Maisi, Cuba at 12Z (CUBA). 83 kt ESE at Punta de Maisi, Cuba at 16Z-18Z (WALLET). 70 kt E and 1000 mb at Punta de Maisi, Cuba at 18Z (micro). 30 kt NW and 995 mb at Guantanamo Bay, Cuba at 18Z (micro). Aircraft highlights: Radar center fix estimated an eye diameter of 12 nm at 18.4N, 73.3W at 01Z (WALLET). Radar center fix measured a peripheral pressure of 995 mb, estimated surface winds of 80 kt and an eye diameter of 8-12 nm at 19.1N, 74.0W at 05Z (WALLET). Penetration center fix measured a central pressure of 970 mb, estimated surface winds of 110 kt and an eye diameter of 17 nm at 19.3N, 74.6W at 1231Z (WALLET). Penetration center fix measured a central pressure of 973 mb, estimated surface winds of 100 kt and an eye diameter of 20 nm at 19.5N, 74.8W at 1540Z (WALLET).

MWR: "The vortex entered the Haitian south coast at Cotes de Fer and calms were noted at Fond des Negres and Anse a Veau. Winds of 102 mph were noted at Cotes de Fer at 7 pm, EST October 3 and 120 mph at the Army base near Durez. The total rainfall at Miragoane during the period when western Haiti was under the influence of Flora probably exceeded 75 in. On October 6-8 when Miragoane was under the principal rain band feeding into Flora, the rain gage at the Reynolds Haitian Mines, Inc., which holds

19 in., was observed overflowing three times and was emptied. Thus at least 57 in. fell during this 3-day period. This does not include rainfall during the passage of the center nearby on October 3 and 4, or some rain which fell on the 5th. Destruction over the mountainous terrain of the Haitian peninsula ranged from severe to complete. Flash floods washed away sections of many towns and landslides buried others. The height of the storm surge on the south shore is unknown but could easily have been 12 ft. or more. Crops were totally destroyed. About 3,500 bodies were counted and several thousand persons are missing. Of the missing, normally about half are eventually found to be casualties and half turn up sooner or later in some other locality. Therefore, an estimate of 5,000 deaths appears reasonable. Property and crop damage is estimated at $125 million with some reliable figures as high as $180 million. In the Dominican Republic, preliminary information indicates that damage, mostly from floods but to some extent from wind, to agriculture, livestock, communication lines, etc., is estimated at $60 million. There was also considerable damage to bridges and roads. In the western section of the Republic 10,000 km^2 were inundated. The known loss of life is 29 but is estimated in excess of 400. Floods were the most extensive of record, and several months after the storm roads were still impassable and communication channels in many western sections unrestored. As Flora entered Cuba about 30 mi. east of Guantanamo Bay late on the forenoon of October 4, a warm High at sea level was located over Lake Huron." ATSR: "The hurricane reached maximum intensity on 4 October just prior to passing over the southwestern peninsula of Haiti. Later information from Haiti indicated that winds of 135 knots with gusts to 175 knots occurred as FLORA passed over the peninsula. Minimum pressure of 936 mbs was reported by aircraft. Reconnaissance aircraft from Airborne Early Warning Squadron FOUR maintained almost constant surveillance during FLORA's passage through the Caribbean. The meteorological information provided to the hurricane forecasters resulted in accurate tracking of the storm's path and assisted in the prediction of the expansive wind fields which eventually devastated portions of Haiti."

October 5:

HWM analyzes a hurricane of at most 1000 mb at 21.8N, 76.7W with a weakening front far to the north at 12Z. HURDAT lists a 105 kt hurricane at 20.8N, 76.8W at 12Z. Microfilm shows a closed low pressure of at most 999 mb at 20.4N, 76.5W at 12Z. Ship highlights: 45 kt SE and 1008 mb at 21.9N, 73.0W at 00Z (micro). 25 kt SW and 1004 mb at 18.9N, 76.0W at 06Z (COADS). 35 kt SE and 1008 mb at 19.8N, 75.1W at 12Z (COADS). 45 kt SE and 1003 mb at 19.2N, 75.2W at 15Z (COADS). 40 kt SE and 1008 mb at 19.3N, 75.2W at 18Z (COADS). Land highlights: 95 kt E (max winds) and 995 mb at Punta Lucrecia, Cuba at 00Z (CUBA). 60 kt ESE and 1003 mb at Punta Lucrecia, Cuba at 06Z (micro). 60 kt SE and 1001 mb at Santiago de Cuba, Cuba at 12Z (micro). 60 kt SSE and 1003 mb at Santiago de Cuba, Cuba at 18Z (CUBA). 75 kt at Camagüey, Cuba at 21Z-22Z (WALLET).

October 6:

HWM analyzes a hurricane of at most 995 mb at 20.5N, 78.2W with a warm front far to the northeast at 12Z. HURDAT lists a 90 kt hurricane at 20.2N, 77.9W at 12Z. Microfilm shows a closed low pressure of at most 990 mb at 20.5N, 77.7W at 12Z. Ship highlights: 40 kt SSW and 1008 mb at 18.5N, 75.6W at 00Z (micro). 35 kt E and 1012 mb at 23.8N, 74.6W at 06Z (COADS). 40 kt ENE and 1013 mb at 25.0N, 75.2W at 12Z (COADS). 45 kt ENE and 1014 mb at 26.1N, 75.6W at 18Z (COADS). Land highlights: 75 kt SE and 1003 mb at Santiago de Cuba, Cuba at 00Z (CUBA). 80 kt NE (gusts to 100 kt) and 1002 mb at Camagüey, Cuba at 06Z (micro). 50 kt NE and 1000 mb at Camagüey, Cuba at 12Z (micro). 60 kt SE and 1003 mb at Santiago de Cuba, Cuba at 18Z (CUBA). Aircraft highlights: Radar center fix at 20.3N, 78.0W at 11Z (WALLET). Radar center fix at 20.5N, 78.3W at 1835Z (WALLET).

ATSR: “The initial track of Hurricane FLORA was predominately influenced by the easterlies as FLORA passed over the island of Tobago in the Southern Windwards, across the Caribbean and into Eastern Cuba. At this point, lacking sufficient tropospheric steering, FLORA stalled for more than four days over Cuba.”

October 7:

HWM analyzes a hurricane of at most 985 mb at 21.0N, 78.5W with a stationary front far to the northeast at 12Z. HURDAT lists an 80 kt hurricane at 20.8N, 78.1W at 12Z. Microfilm shows a closed low pressure of at most 990 mb at 20.8N, 78.2W at 12Z. Ship highlights: 40 kt S and 1003 mb at 17.3N, 74.9W at 00Z (COADS). 35 kt S and 1003 mb at 18.2N, 76.3W at 06Z (COADS). 35 kt SE and 1001 mb at 18.4N, 75.3W at 12Z (COADS). 45 kt ENE and 1014 mb at 26.1N, 75.6W at 18Z (MWL). Land highlights: 55 kt SE and 1003 mb at Santiago de Cuba, Cuba at 00Z (CUBA). 55 kt SE and 1004 mb at Santiago de Cuba, Cuba at 06Z (CUBA). 70 kt SE and 1002 mb at Santiago de Cuba, Cuba at 12Z (CUBA). 35 kt SW and 996 mb at Cabo Cruz, Cuba at 18Z (CUBA). 35 kt NE at Caibarien, Cuba at 21Z-22Z (WALLET). Aircraft highlights: Radar center fix near 21.0N, 78.0W at 1115Z (WALLET). Radar center fix estimated a peripheral pressure of 986 mb and surface winds of 55 kt at 21.1N, 78.1W at 1315Z (WALLET/ATSR).

MWR: “During October 7 and 8 Flora moved slowly eastward to east-northeastward almost directly over the same portion of eastern Cuba it had traversed two days before.”

October 8:

HWM analyzes a hurricane of at most 985 mb at 21.5N, 76.2W at 12Z. HURDAT lists a 70 kt hurricane at 21.1N, 76.2W at 12Z. Microfilm shows a closed low pressure of at most 993 mb at 21.1N, 76.2W at 12Z. Ship highlights: 35 kt NE and 1005 mb at 22.2N, 73.4W at 00Z (COADS). 35 kt S and 1000 mb at 18.9N, 74.9W at 06Z (COADS). 35 kt SE and 1000 mb at 20.6N, 73.9W at 12Z (COADS/micro). 60 kt E and 994 mb at 22.4N, 74.4W at 18Z (COADS/MWL). 55 kt NNE and 991 mb at 21.5N, 76.1W at 20Z (MWL). Land highlights: 35 kt NE and 1009 mb at North Eleuthera, Bahamas at 00Z (micro). 60 kt S (possible high bias) and 999 mb at Santiago de Cuba, Cuba at 06Z (micro). 35 kt SE and 1000 mb at Punta de Maisi, Cuba at 12Z (micro). 80 kt S at Punta

de Maisi, Cuba at 17Z (WALLET). Aircraft highlights: Penetration center fix measured a central pressure of 983 mb and estimated surface winds of 100 kt at 21.5N, 75.0W at 2215Z (WALLET).

MWR: “By October 8, another active short wave was morning into the long-wave trough position off the east coast and accelerating the southwesterly flow in the area of the hurricane. Thus Flora began to follow a more normal northeastward course at a gradually increasing forward speed into higher latitudes.” ATSR: “Recurvature to the northeast and acceleration occurred on 8 October as FLORA left the North Cuban coast and emerged into the Atlantic after passing Mayaguana Island in the Southeastern Bahamas.”

October 9:

HWM analyzes a hurricane of at most 985 mb at 23.5N, 71.2W with a weakening warm front to the northeast at 12Z. HURDAT lists an 80 kt hurricane at 23.5N, 71.6W at 12Z. Microfilm shows a closed low pressure of at most 996 mb at 23.8N, 71.3W at 12Z. Ship highlights: 45 kt S and 998 mb at 19.7N, 73.7W at 00Z (micro). 40 kt ESE and 998 mb at 24.0N, 72.1W at 06Z (micro). 50 kt S and 998 mb at 21.7N, 68.7W at 12Z (micro). 35 kt SSE and 1006 mb at 24.6N, 66.5W at 15Z (COADS). 55 kt NNE and 1003 mb at 26.8N, 67.3W at 18Z (MWL). Land highlights: 40 kt SSW and 989 mb at Matthew Town, Bahamas at 00Z (micro). 977 mb at Mayaguana, Bahamas at 0545Z (WALLET). 35 kt SE and 998 mb at Grand Turk at 06Z (micro). 40 kt SW and 999 mb at Grand Turk at 12Z (micro). Aircraft highlights: Penetration center fix measured a central pressure of 976 mb, estimated surface winds of 70 kt and an eye diameter of 30 nm at 23.2N, 72.0W at 11Z (WALLET). Penetration center fix measured a central pressure of 975 mb, estimated surface winds of 120 kt and an eye diameter of 35 nm at 23.9N, 71.1W at 14Z (WALLET). Penetration center fix measured a central pressure of 965 mb, estimated surface winds of 130 kt and an eye diameter of 70 nm at 25.0N, 69.5W at 19Z (WALLET). Radar center fix measured a central pressure of 965 mb, doppler estimated surface winds of 105 kt and an eye diameter of 40 nm at 25.7N, 68.4W at 2321Z (WALLET).

MWR: “Hurricane Flora passed through the southeastern Bahamas on the night of October 8. On Inagua, Flora was described as the “worst hurricane ever experienced there within living memory.” Winds were estimated at 75 to 80 m.p.h. Two wharves were destroyed, the sea wall was damaged, and there was extensive damage to crops, roofs, and roads. The eye passed over Mayaguana shortly after midnight with maximum winds at 1:30 a.m. EST of 83 m.p.h. The sea wall was washed away and crop destruction was total. There was extensive damage to roofs and communication lines. One person was drowned. Exuma, Long, Acklins, Crooked Islands, and Long Cay reported some damage to roads and property and crop damage ranged from moderate to total.”

October 10:

HWM analyzes a hurricane of at most 985 mb at 28.4N, 64.9W with a weakening stationary front to the northeast at 12Z. HURDAT lists a 100 kt hurricane at 28.1N, 64.9W at 12Z. Microfilm shows a closed low pressure of at most 999 mb at 27.5N, 64.8W with a frontal boundary to the northwest at 12Z. Ship highlights: 75 kt SE and 990 mb at 25.5N, 68.0W at 00Z (micro). 60 kt WNW and 1003 mb at 25.3N, 67.7W at 06Z

(micro). 75 kt S and 983 mb at 27.0N, 64.3W at 12Z (COADS). 50 kt S and 1002 mb at 27.6N, 60.0W at 18Z (COADS). 35 kt N and 1022 mb at 35.8N, 74.4W at 21Z (COADS). 50 kt E and 998 mb at 33.9N, 61.0W at 23Z (COADS). Aircraft highlights: Radar center fix estimated a peripheral pressure of 968 mb at 26.3N, 67.2W at 0109Z (WALLET). Penetration center fix measured a central pressure of 969 mb, estimated surface winds of 120 kt and an eye diameter of 70 nm at 27.8N, 64.4W at 1307Z (WALLET). Penetration center fix measured a central pressure of 972 mb and estimated flight level winds of 85 at 30.3N, 61.8W at 19Z (WALLET). Penetration center fix measured a central pressure of 968 mb, estimated surface winds of 122 kt and an eye diameter of 50 nm at 31.4N, 60.5W at 2220Z (WALLET).

October 11:

HWM analyzes a hurricane of at most 985 mb at 36.7N, 56.9W with a frontal boundary just to the west at 12Z. HURDAT lists an 85 kt hurricane at 36.2N, 57.0W at 12Z. Microfilm shows a closed low pressure of at most 999 mb at 36.5N, 57.0W with a frontal boundary to the west and another to the southwest at 12Z. Ship highlights: 40 kt WSW and 1006 mb at 27.0N, 60.0W at 00Z (COADS). 40 kt N and 999 mb at 33.7N, 62.3W at 06Z (MWL). 60 kt ESE and 1001 mb at 40.1N, 56.3W at 12Z (COADS). 70 kt NE and 990 mb at 40.1N, 57.2W at 15Z (COADS). 70 kt SE and 961 mb at 38.3N, 55.6W at 18Z (COADS/micro). 100 kt NE at 40.2N, 55.3W at 18Z (micro). 70 kt N and 978 mb at 40.1N, 57.2W at 21Z (COADS). Aircraft highlights: Radar center fix at 32.6N, 59.7W at 0106Z (WALLET). Penetration center fix measured a central pressure of 963 mb, estimated flight level winds of 80 kt and an eye diameter of 80 nm at 36.9N, 56.8W at 1315Z (WALLET). Penetration center fix estimated flight level winds of 75 kt at 38.6N, 56.0W at 1915Z (WALLET).

October 12:

HWM analyzes a hurricane of at most 980 mb at 43.7N, 50.0W with a warm front to the northeast and a cold front to the south and an extratropical cyclone at 50.0 N, 66.0W at 12Z. HURDAT lists a 75 kt hurricane at 43.5N, 49.8W at 12Z. Microfilm shows an extratropical cyclone of at most 993 mb at 43.0N, 51.0W at 12Z. Ship highlights: 75 kt NE and 988 mb at 42.4N, 54.3W at 00Z (COADS/MWL). 100 kt NW and 983 mb at 39.6N, 56.3W at 00Z (micro). 80 kt E at 43.2N, 52.0W at 03Z (micro). 70 kt NW and 983 mb at 41.1N, 56.3W at 06Z (COADS). 60 kt N and 982 mb at 42.5N, 52.8W at 12Z (COADS/micro). 60 kt WSW and 999 mb at 40.4N, 49.1W at 18Z (COADS). 50 kt SW and 1001 mb at 41.5N, 45.3W at 21Z (COADS).

ATSR: “FLORA passed southeast of Newfoundland on the 12th, and soon became extratropical after coming under the influence of a cool air mass. The last of 49 warnings was transmitted at 121600Z.”

October 13:

HWM analyzes a hurricane of at most 970 mb at 51.5N, 41.8W at 12Z. HURDAT lists a 70 kt extratropical cyclone at 51.5N, 41.0W at 12Z (last position). Microfilm shows an extratropical cyclone of at most 969 mb at 53.5N, 43.5W at 12Z. Ship highlights: 70 kt SW and 995 mb at 44.1N, 44.5W at 00Z (COADS). 50 kt WSW and

1009 mb at 44.1N, 41.0W at 06Z (COADS). 50 kt ENE and 987 mb at 55.2N, 41.2W at 12Z (COADS). 35 kt NNE and 969 mb at 53.4N, 44.1W at 12Z (COADS). 65 kt N and 971 mb at 55.1N, 43.2W at 18Z (COADS).

MWR: “However, for portions of five days, completely boxed in by the high-pressure areas to the west, the north, and the east, the hurricane meandered back and forth over eastern Cuba with winds of hurricane or near hurricane force and torrential rain. Members of the staff of the National Observatory at Havana jointly with personnel of the National Academy of Sciences (Cuba) carefully surveyed the hurricane area and on the basis of the survey and hourly observations during the storm, determined the track as shown in figure 2. Although Flora had not completely regained its former intensity by the time it entered Cuba, nevertheless winds of 70 to 100 mph lashed eastern Cuba for 100 hr. or more. Cuba’s productive valleys and lowlands remained flooded for many days and crop damage was tremendous. Rainfall amounts were enormous. Radio broadcasts from Cuba mentioned a total of 90 in. near Velasco. At Guantanamo Bay, the rainfall from hurricane Flora greatly exceeded the recorded amount for the entire year of 1962. Dr. Luis Larragoiti Alonso, Director of the National Observatory, has forwarded rainfall accumulations in Cuba during the storm period as shown in table 2. The last official announcement listed 1159 people dead with more than 1000 people missing. Applying the same estimating procedure as in Haiti, gives a death toll of at least 1750. No official estimate of crop and property damage is available so far. Based on reports emanating from Cuba, estimates of damage to the sugar crop range from 15 to 60 percent; to tobacco 15 to 50 percent; to coffee and cocoa 25 to 100 percent; and to rice 50 to 75 percent. There were heavy losses in cattle, poultry, vegetables, bananas, pineapples, and cotton, and extensive damage to factories, roads, and bridges. Estimates of total damage have ranged upward to $500 million, but at the present time it is believed $300 million is reasonably realistic. Dr. Mario E. Rodriguez Ramirez, Chief of the Meteorological Division of the Civil Aviation Department of Cuba, lists three other prolonged Cuban hurricanes: 1851, August 19-21. Crossed the island from Oriente to Pinar del Rio. 1886, August 16-18. Took three days to travel from Oriente to Havana. 1910, October 13-17. Famous “huracan de cinco dias” which lashed the provinces of Pinar del Rio and La Havana. Dr. Jose Carlos Millas has recently discovered a prolonged hurricane, which occurred during the last days of September 1616 and resulted in a great disaster around Bayamo similar to that caused by Flora. While only peripheral effects were felt in Jamaica, there was considerable damage including: waterworks $420,000; bananas $5,600,000; other crops $1,400,000; roads and bridges $4,200,000; houses, etc. $280,000, or a total of $11,900,000. There were 11 fatalities mostly from flash floods. Some rainfall amounts are as follows: Palisadoes Airport 16.70 in.; Hope Gardens 14.11; Constant Spring 15.66; St. Georges College 18.38; Hermitage Dam 44.32; Hope Filter Plant 21.99; Seaview 31.94; Caraliers 19.72; Jack’s Hill 22.36. Gordon Town 35.00; Castleton

Gardens 47.00; Cedar Valley 51.7; and Spring Hill 60.00 in. Flora is an historic hurricane-the second most deadly tropical cyclone ever to occur in the Atlantic area. The currently estimated total of 7,186 deaths considerably exceeds the death toll of the Galveston hurricane in 1900. Also, there are many small boats missing in the Caribbean with two to seven or more crewmen and passengers aboard each. These missing persons have not been included but may total 100 or more. In the great hurricane which devastated the Windward and Leeward Islands from October 10-12, 1780, apparently over 20,000 persons perished; 4,326 on Barbados; 9,000 on Martinique; 4,500 on St. Eustatius; several thousand sailors in the Spanish, Dutch, British, and French Fleets; mid a smaller number on other islands. The estimate of some $528,550,000 damage to crops and property from Flora is conservative. There are, of course, indirect additional losses, which will be incurred from loss of work, and long-period effects on crops which, in some cases, will materially lessen crop production for the next five to eight years. Since the time Columbus discovered the New World, no hurricane has dealt such a devastating blow to the countries of Haiti and Cuba."

The tropical wave that developed into Hurricane Flora entered the eastern Atlantic late on September 23th or early on September 24th according to the Historical Weather Maps, and moved westward slowly becoming better organized. The disturbance was first detected in a TIROS VII satellite image (not available) on September 26th over the central Atlantic. MWR indicates that the disturbance was a large area of convection with possibly multiple centers. The time of genesis is uncertain due to the sparse ship traffic over the central Atlantic. Thus, the first position is analyzed at 12Z on September 26th as a 25 kt tropical depression, same as originally shown in HURDAT. Minor track alterations are introduced during the lifetime of this tropical cyclone. (Central pressures values for many of the six hour periods were present in the original HURDAT between September 29th at 12Z and October 12th at 12Z. Some of these were obviously analyses that were added in, not based upon actual observations. Thus, based on actual observations, some were retained and new central pressure values added. Detailed information on these changes can be found in the table at the end.) The tropical depression moved just north of due west on September 27th and 28th with little change in intensity. On September 29th around 2230Z, a ship passed near the center of the tropical cyclone measuring a peripheral pressure of 1000 mb. A peripheral pressure of 1000 mb suggests maximum surface winds greater than 47 kt from the south of 25N Brown et al. pressure-wind relationship. Intensities of 45 kt at 18Z on the 29th and 55 kt at 00Z on the 30th are assessed (down from 55 kt an 70 kt originally). Intensification to a tropical storm is analyzed at 06Z on October 29th, six hours earlier than originally shown in HURDAT, a minor intensity change. On September 30th, Flora rapidly intensified while approaching and later

impacting the Windward Islands. At 1407Z on the 30th, a reconnaissance aircraft reached Flora measuring a central pressure of 994 mb, estimated surface winds of 110 kt, and an eye diameter of 25 nm. A central pressure of 994 mb suggests maximum surface winds of 58 kt from the south of 25N pressure-wind relationship. An eye diameter of 25 nm suggests an RMW of 19 nm and the climatological value is 11 nm. Based upon a forward speed of about 17 kt, small size of the circulation (ROCI about 120 nm) and putting some weight on the visual estimate, an intensity of 80 kt is analyzed at 12Z on the 30th, down from 100 kt originally in HURDAT, a major intensity change. Intensification to a hurricane is analyzed at 06Z on the 30th, six hours later than originally shown in HURDAT. The analyzed intensity at 06Z on the 30th is 65 kt, down from 85 kt originally shown in HURDAT, a major intensity change. Around 18Z on the 30th, the center of Flora made landfall in Tobago and a central pressure of 974 mb was measured. A central pressure of 974 mb suggests maximum surface winds of 85 kt and 86 kt from the south of 25N and the intensifying subset pressure-wind relationship, respectively. Due to the forward speed of about 15 kt and small circulation, an intensity of 100 kt is analyzed at 18Z on the 30th, down from 105 kt originally in HURDAT, a minor intensity change. Intensification to a major hurricane is analyzed at 18Z on the 30th, six hours later than originally shown in HURDAT.

On October 1st, Flora was located over the eastern Caribbean Sea moving west-northwest with no appreciable changes in intensity. Reconnaissance aircrafts made made penetration center fixes at 16Z, 19Z and 2110Z measuring a central pressure of 974 mb, 975 mb and 970 mb, respectively. An intensity of 100 kt is analyzed at all time slot on the 1st, down from 110 kt at 00Z and 06Z and down from 115 kt at 12Z and 18Z as originally shown in HURDAT, all minor intensity changes. Ship data over the southeastern Caribbean Sea is sparse and only one ship reported gale-force winds on the 1st. The penetration center fix at 2110Z also estimated surface winds of 120 kt and an eye diameter of 13 nm. A central pressure of 970 mb suggests maximum surface winds of 90 kt from the south of 25N pressure-wind relationship. An eye diameter of 13 nm suggests an RMW of 10 nm and the climatological value is 11 nm. Based upon a forward speed of about 14 kt, small circulation and putting some weight on the visual estimate, an intensity of 105 kt is analyzed at 00Z on October 2nd, down from 120 kt originally in HURDAT, a minor intensity change. On the 2nd, Flora continued west-northwestward passing north of the ABC Islands. At 0710Z on the 2nd, a penetration center fix measured a central pressure of 964 mb and an eye diameter of 11 nm. A central pressure of 964 mb suggests maximum surface winds of 97 kt from the south of 25N pressure-wind relationship. An eye diameter of 11 nm suggests an RMW of about 8 nm and the climatological value is 12 nm. Based upon a forward speed of about 11 kt and an RMW smaller than the climatological value, an intensity of 105 kt is analyzed at 06Z on the 2nd, down from 120 kt originally in HURDAT, a minor intensity change. The next penetration center fix at

1946Z on the 2nd, measured a central pressure of 960 mb, estimated surface winds of 120 kt and an eye diameter of 16 nm. A central pressure of 960 mb suggests maximum surface winds of 100 kt from the south of 25N pressure-wind relationship. An eye diameter of 16 nm suggests an RMW of about 12 nm and the climatological value is also 12 nm. Based upon a forward speed of about 7 kt and an RMW close to the climatological value, an intensity of 105 kt is analyzed at 18Z on the 2nd, down from 120 kt originally in HURDAT, a minor intensity change. A few ships reported gale-force winds on the 2nd, and also a storm-force wind report of 50 kt at 18Z. On October 3rd, Flora continued to slow its forward speed and turned to the northwest while gaining in strength. At 0617Z on the 3rd, a reconnaissance aircraft measured a peripheral pressure of 954 mb and an eye diameter of 15 nm. A peripheral pressure of 954 mb suggests maximum surface winds greater than 107 kt from the south of 25N pressure-wind relationship. An eye diameter of 15 nm suggests an RMW of about 11 nm and the climatological value is also 11 nm. Based upon a forward speed of about 8 kt and an RMW close to the climatological value, an intensity of 115 kt is analyzed at 06Z on the 3rd, down from 125 kt originally in HURDAT, a minor intensity change. At 1620Z on the 3rd, a penetration center fix measured a central pressure of 936 mb, estimated surface winds of 130 kt and an eye diameter of 15 nm. A central pressure of 936 mb suggests maximum surface winds of 127 kt from the south of 25N intensifying subset pressure-wind relationship. An eye diameter of 15 nm suggests an RMW of about 11 nm and the climatological value is also 11 nm. Based upon a forward speed of about 8 kt, an intensity of 125 kt is analyzed at 18Z on the 3rd, same as originally shown in HURDAT. 125 kt is also the peak intensity of Hurricane Flora, same as originally shown in HURDAT.

Hurricane Flora made landfall in southwestern Haiti around 01Z on October 4th as a 125 kt hurricane. The intensity at landfall may have been substantially higher than analyzed since the hurricane was intensifying as it was moving toward Hispaniola and the last center penetration occurred about nine hours before landfall. Calm conditions were experienced at Fonds des Negres, Haiti, for about 15 minutes and at Aude a Veau, Haiti, for over one hour. The hurricane crossed the Tiburon Peninsula of Haiti in about two hours and continued northwestward toward eastern Cuba. A reconnaissance aircraft made a center penetration fix at 1231Z on the 4th and measured a central pressure of 970 mb, estimated surface winds of 110 kt and an eye diameter of 17 nm. A central pressure of 970 mb suggests maximum surface winds of 90 kt from the south of 25N pressure-wind relationship. An eye diameter of 17 nm suggests an RMW of about 13 nm and the climatological value is 14 nm. Due to some weighting of the visual surface winds and the synoptic observations over eastern Cuba later in the day and at 00Z on October 5th, an intensity of 105 kt is analyzed at 12Z on the 4th, same as originally shown in HURDAT. Flora made landfall in Cuba around 18Z on the 4th as a 105 kt hurricane, category 3 impact. The Storm Wallets indicate that Punta de Maisi, Cuba's easternmost point,

experienced sustained winds of 83 kt between 16Z and 18Z on the 4th. Over eastern Cuba, Flora changed course and began to move slowly westward on the 5th. At 00Z on the 5th, Punta Lucrecia, Cuba, reported 95 kt E and 995 mb. In an email communication with Maritza Ballester, it was confirmed that this was indeed a sustained wind measurement and not a gust. Maritza also mentions that the station is very close to the coast at a height of 4 meters. This 95 kt measurement six hours after landfall in Cuba is consistent with an 105 kt intensity at landfall. Note that category 3 at landfall in Cuba is higher than the assessment of Perez et al. of the intensity of Flora at landfall in Cuba as category 2 in the Saffir-Simpson scale. Maritza comments that a landfall intensity of 90 kt was estimated from a gust measurement of 110 kt and data from the last aircraft reconnaissance investigation before landfall. After approaching the northern coast of Cuba near Punta Lucrecia around 00Z on the 5th, Flora turned to the west and moved toward the Gulf of Guacanayabo, emerging over the Caribbean around 22Z. The Kaplan and DeMaria model was run starting with 95 kt at 00Z for 06Z, 12Z and 18Z on the 5th, yielding 69 kt, 52 kt and 50 kt, respectively. On the 5th, 60 kt were registered at 06Z at Punta Lucrecia, 55 kt at Punta Lucrecia and 60 kt at Santiago de Cuba at 12Z and 50 kt at Punta Lucrecia and 55 kt at Santiago de Cuba at 18Z. An intensity of 85 kt is selected for 06Z, 75 kt at 12Z and 70 kt at 18Z on the 5th (down from 110 kt at 06Z, 105 kt at 12Z and 100 kt at 18Z on the 5th, respectively, originally in HURDAT), major intensity changes. The observations from Santiago de Cuba appear to have a high bias and this is not the first time we notice this problem, similar situation occurred during the reanalysis of Tropical Storm Gerda, 1961. Maritza mentioned in the email that currently the station is at a height of 45 meters but she was not sure if in 1963 it was at the same elevation. At 00Z on October 6th, Santiago de Cuba reported 75 kt and at this time the hurricane was about 100 nm to the northwest. The analyzed intensities at 06Z, 12Z and 18Z on the 5th were above that suggested by Kaplan-DeMaria due to a report of 80 kt by Camagüey, Cuba, at 06Z on October 6th. Maritza commented that Camagüey is currently at a height of 119 meters but was not sure about the station's altitude in 1963. Nevertheless, it does appear suspicious. On the 6th, Flora came to almost a halt over the Gulf of Guacanayabo and some gradual intensification is shown. Observations near the center were sparse on this day but the system likely regained some of its strength over the warm waters of the gulf. Reconnaissance aircrafts investigated the hurricane around 12Z and 18Z but only radar center fixes were obtained. Synoptic observations indicate that the circulation of Flora expanded after crossing eastern Cuba. The ROCI had expanded to about 330 nm by 18Z on the 6th, compared to about 120 nm on the 1st. A couple of ships reported gale-force winds on the 6th. On October 7th, Flora moved slowly northward making landfall in Camagüey at 06Z as an 85 kt hurricane, just a few miles to the west of Santa Cruz del Sur. A few ships reported gale-force winds on the 7th. After making landfall, Flora moved generally eastward over eastern Cuba and weakened. The Kaplan and DeMaria model

was run for 12Z and 18Z on the 7th and 00Z and 06Z on the 8th, yielding 60 kt at 12Z and 49 kt at 18Z on the 7th and 40 kt at 00Z and 43 kt on the 8th. The highest recorded winds were 70 kt and 60 kt at Santiago de Cuba at 12Z and 18Z on the 7th, respectively, and 55 kt and 60 kt at Santiago de Cuba at 00Z and 06Z on the 8th, respectively. An intensity of 75 kt is selected at 12Z, and 65 kt at 18Z on the 7th, 60 kt at 00Z and 55 kt at 06Z on the 8th, down from 80 kt originally in HURDAT at 12Z, and 75 kt at 18Z on the 7th, 00Z and 06Z on the 8th. Minor intensity changes to HURDAT at 12Z and 18Z on the 7th and 00Z on the 8th, and major intensity change at 06Z on the 8th. The original HURDAT did not show Flora weakening to a tropical storm.

Flora entered the Atlantic Ocean after 12Z on the 8th near the city of Gibara, Holguín, Cuba. The tropical cyclone immediately began to intensify and it is analyzed to have regained hurricane intensity at 18Z on the 8th. A ship reported 60 kt E and 994 mb at 18Z and another registered 55 kt NNE and 991 mb at 20Z. At 2215Z on the 8th, a reconnaissance aircraft made a penetration center fix measuring a central pressure of 983 mb and estimated surface winds of 100 kt. A central pressure of 983 mb suggests maximum surface winds of 74 kt from the south of 25N pressure-wind relationship. Based on a forward speed of about 11 kt, an intensity of 75 kt is analyzed at 00Z on October 9th, same as originally shown in HURDAT. On the 9th, Flora continued to move away from Cuba impacting the eastern Bahamas as it gained in forward speed to the northeast. The hurricane made landfall in Mayaguana, Bahamas, around 06Z on the 9th. The eye went over the location and a central pressure of 977 mb was measured. A central pressure of 977 mb suggests maximum surface winds of 81 kt from the south of 25N pressure-wind relationship. Due to a forward speed of about 17 kt, an intensity of 85 kt is analyzed at 06Z on the 9th, up from 75 kt originally in HURDAT, a minor intensity change. At 11Z on the 9th, a penetration center fix measured a central pressure of 976 mb, estimated surface winds of 70 kt and an eye diameter of 30 nm. A central pressure of 976 mb suggests maximum surface winds of 83 kt from the south of 25N pressure-wind relationship. An eye diameter of 30 nm suggests an RMW of about 23 nm and the climatological value is 19 nm. Due to a forward speed of about 17 kt, an intensity of 90 kt is selected at 12Z on the 9th, up from 80 kt originally in HURDAT, a minor intensity change. At 19Z on the 9th, another penetration center fix measured a central pressure of 965 mb, estimated surface winds of 130 kt and an eye diameter of 70 nm. A central pressure of 965 mb suggests maximum surface winds of 86 kt from the south of 25N and 90 kt from the north of 25N pressure-wind relationship. An eye diameter of 70 nm suggests an RMW of about 53 nm and the climatological value is 19 nm. Due to a forward speed of about 23 kt, an intensity of 100 kt is selected at 18Z on the 9th, up from 85 kt originally in HURDAT, a minor intensity change. It is analyzed that Flora regained major hurricane intensity at 18Z on the 9th, 18 hours earlier than originally shown in HURDAT. A final penetration fix on the 9th measured a central pressure of 965 mb at

2321Z, thus an intensity of 100 kt is also analyzed at 00Z on October 10th, up from 95 kt originally in HURDAT, a minor intensity change. A couple of ships recorded tropical storm force winds on the 9th, up to 55 kt. On the 10th, Flora continued to move rapidly to the northeast over the western Atlantic. A few ships reported hurricane-force winds on the 10th, including 75 kt SE and 990 mb at 00Z. At 1307Z on the 10th, a penetration center fix measured a central pressure of 969 mb, estimated surface winds of 120 kt and an eye diameter of 70 nm. A central pressure of 969 mb suggests maximum surface winds of 86 kt from the north of 25N pressure-wind relationship. An eye diameter of 70 nm suggests an RMW of about 53 nm and the climatological value is 24 nm. Due to a forward speed of about 31 kt, an intensity of 95 kt is selected at 12Z on the 10th, down from 100 kt originally in HURDAT, a minor intensity change. Weakening below major hurricane intensity is analyzed at 12Z on the 10th, twelve hours earlier than originally shown in HURDAT. Another penetration center fix measured a central pressure of 972 mb at 19Z on the 10th. A central pressure of 972 mb suggests maximum surface winds of 82 kt from the north of 25N pressure-wind relationship. Due to a forward speed of about 35 kt, an intensity of 95 kt is selected at 18Z on the 10th, down from 100 kt originally in HURDAT, a minor intensity change. Finally, at 2220Z on the 10th, a penetration center fix measured a central pressure of 968 mb, estimated surface winds of 122 kt and an eye diameter of 50 nm. A central pressure of 968 mb suggests maximum surface winds of 87 kt from the north of 25N pressure-wind relationship. An eye diameter of 50 nm suggests an RMW of about 38 nm and the climatological value is 24 nm. Due to a forward speed of about 35 kt, an intensity of 95 kt is selected at 00Z on October 11th, same as originally shown in HURDAT.

At 1315Z on the 11th, a penetration center fix measured a central pressure of 963 mb and an eye diameter of 80 nm. A central pressure of 963 mb suggests maximum surface winds of 88 kt from the Landsea et al. north of 35N pressure-wind relationship. An eye diameter of 80 nm suggests an RMW of about 60 nm and the climatological value is 29 nm. Due to a forward speed of about 21 kt but large RMW, an intensity of 90 kt is selected at 12Z on the 11th, up from 85 kt originally in HURDAT, a minor intensity change. Hurricane Flora began to lose its tropical characteristics on the 11th as a frontal boundary approached from the west and the tropical cyclone moved into the mid-latitudes. Synoptic observations indicate that the transition into an extratropical cyclone occurred around 18Z on the 11th as the temperature gradient became more pronounced between the eastern and western quadrants and frontogenesis occurred. Transition into an extratropical cyclone is analyzed at 18Z on the 11th, 24 hours earlier than originally shown in HURDAT. A couple of ships reported tropical storm force winds on the 11th and even a few experienced hurricane-force winds, including 100 kt at 18Z, although the two ships that reported 100 kt appears to have a high wind bias in comparison with nearby ships. On October 12th, Flora began to interact with an extratropical cyclone to the

northwest as both cyclones moved to the northeast. Flora remained a very powerful extratropical cyclone on the 12th as ships continued to report hurricane-force winds up to 75 kt, but the system was gradually weakening. Synoptic observations around 06Z on the 13th indicate that Flora had merged with the other extratropical cyclone, thus the last position is analyzed at 00Z on the 13th, twelve hours earlier than originally shown in HURDAT.

Date	Original HURDAT Central Pressure	Evidence	Changes
Sep 29 12Z	1000 mb	Ship report around 2230Z on the 29th and does not suggest it was a central pressure measurement	Removed
Sep 30 12Z	994 mb	Penetration center fix: 994 mb at 1407Z on Sep 30th	Retained
Sep 30 18Z	978 mb	Tobago: 2 kt W and 974 mb at 1840Z on Sep 30th	974 mb
Oct 01 00Z	981 mb	Penetration center fix: 975 mb at 2110Z on Sep 30th	975 mb
Oct 01 06Z	981 mb	Peripheral pressure at 07Z on Oct 1st	Removed
Oct 01 12Z	974 mb	Penetration center fix at 16Z on Oct 1st, closer to the 18Z time slot than 12Z	
Oct 01 18Z	975 mb	Penetration center fix: 975 mb at 19Z on Oct 1st	Retained
Oct 02 00Z	970 mb	Penetration center fix: 970 mb at 22Z on Oct 1st	
Oct 02 06Z		Penetration center fix: 964 mb at 0710Z on Oct 2nd	964 mb
Oct 02 12Z	968 mb	Peripheral pressure at 13427Z on Oct 2nd	Removed
Oct 02 18Z	968 mb	Penetration center fix: 960 mb at 1946Z on Oct 2nd	960 mb
Oct 03 12Z	940 mb	No central pressure was reported by the reconnaissance aircraft around 12Z on Oct 3rd	Removed
Oct 03 18Z	944 mb	Penetration center fix: 936 mb at 1620Z on	936 mb

		Oct 3rd	
Oct 04 00Z	944 mb	Only radar center fixes were made around 00Z on Oct 4th near the time of landfall	Removed
Oct 04 06Z	995 mb	Peripheral pressure at 05Z on Oct 4th	
Oct 04 12Z	970 mb	Penetration center fix: 970 mb at 1231Z on Oct 4th	Retained
Oct 04 18Z	970 mb	Penetration center fix: 973 mb at 1540Z on Oct 4th	973 mb
Oct 05 12Z	985 mb	Between October 5th and October 8th, the center of Flora meandered over eastern Cuba and the nearby waters of the Caribbean Sea. The reconnaissance aircraft observations were radar center fixes and the synoptic data available is not sufficient to estimate the central pressure during these time slots	Removed
Oct 06 12Z	985 mb		
Oct 07 12Z	986 mb		
Oct 08 06Z	989 mb		
Oct 08 12Z	990 mb		
Oct 08 18Z	990 mb	Ship: 55 kt NE and 991 mb at 20Z on Oct 18th	
Oct 09 00Z	983 mb	Penetration center fix: 983 mb at 2215Z on Oct 8th	Retained
Oct 09 06Z		Penetration center fix: 977 mb at 0545Z on Oct 9th	977 mb
Oct 09 12Z	975 mb	Penetration center fix: 976 mb at 11Z on Oct 9th	976 mb
Oct 09 18Z	965 mb	Penetration center fix: 965 mb at 19Z on Oct 9th	Retained
Oct 10 00Z	965 mb	Penetration center fix: 965 mb at 2321Z on Oct 9th	
Oct 10 06Z	969 mb	No reconnaissance aircraft was present around 06Z on Oct 10th, nor there was a ship observation near the center	Removed
Oct 10 12Z	969 mb	Penetration center fix: 969 mb at 1307Z on Oct 10th	Retained
Oct 10 18Z	972 mb	Penetration center fix: 972 mb at 19Z on Oct 10th	
Oct 11 00Z		Penetration center fix: 968 mb at 2220Z on Oct 10th	968 mb
Oct 11 06Z	970 mb	No reconnaissance aircraft was present around 06Z on Oct 11th but appears	Retained

		reasonable	
Oct 11 12Z	963 mb	Penetration center fix: 963 mb at 1315Z on Oct 11th	
Oct 11 18Z	963 mb	Synoptic data suggests a lower central pressure	Removed
Oct 12 12Z	985 mb		

Hurricane Ginny [October 17-30, 1963]

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43050 10/16/1963 M=15  8 SNBR= 931 GINNY       XING=0 SSS=0
43050 10/17/1963 M=14  9 SNBR= 931 GINNY       XING=0 SSS=0
         **         **  *

(October 16th has been removed from HURDAT)
43055 10/16*  0   0   0    0*  0   0   0    0*210 720  20    0*218 719  20    0*
43055 10/16*  0   0   0    0*  0   0   0    0*  0   0   0    0*  0   0   0    0*
                                              *   *   *        *   *   *

43060 10/17*225 718  20    0*233 717  20    0*240 716  20    0*248 715  20    0*
43060 10/17*  0   0   0    0*  0   0   0    0*  0   0   0    0*255 720  20    0*
              *   *   *        *   *   *        *   *   *      *** ***

43065 10/18*255 714  20    0*263 713  25    0*270 712  30    0*278 712  30    0*
43065 10/18*260 717  20    0*265 714  25    0*270 712  30    0*278 712  30    0*
           *** ***           *** ***

43070 10/19*285 712  30    0*295 713  30    0*308 718  35 1000*322 726  45    0*
43070 10/19*285 712  30    0*295 713  35    0*308 718  45    0*320 726  55    0*
                                  **                **    *          **

43075 10/20*334 735  55    0*336 743  60    0*335 750  65  983*338 755  70    0*
43075 10/20*328 735  60  989*334 743  60    0*335 750  65  983*337 755  70    0*
           ***       **  *** ***                             ***

43080 10/21*340 755  75    0*342 750  75    0*340 745  75    0*336 742  75    0*
43080 10/21*340 755  75    0*342 750  80    0*340 746  80    0*336 742  80    0*
                                  **          ***  **              **

43085 10/22*330 740  70    0*322 744  70    0*315 748  70    0*308 753  70  989*
43085 10/22*330 740  75    0*322 744  70    0*315 748  65    0*308 753  65  989*
                    **                                **              **

43090 10/23*303 760  65  987*296 769  60  988*289 777  60  995*288 782  65  990*
43090 10/23*302 760  65  987*296 769  65  988*290 777  65  990*288 782  65  990*
                                  **       ***      **  ***

43095 10/24*288 785  65  988*290 790  65    0*294 796  65  990*298 797  70  987*
43095 10/24*288 786  70  988*290 790  70    0*293 795  70  990*297 797  70  985*
                 ***  **                **      *** ***  **      ***          ***

43100 10/25*303 796  75  982*311 797  85    0*318 796  90  976*321 790  90  985*
43100 10/25*304 797  75  982*311 797  80    0*318 796  80  976*321 790  70  985*
           *** ***                  **                **                **

43105 10/26*324 781  85    0*332 773  80  988*332 769  80  986*329 765  75  978*
43105 10/26*325 782  70  987*331 775  70  983*332 769  70  986*330 765  75  978*
           *** ***  **  *** *** ***  **  ***          **      ***      **

43110 10/27*330 760  70  979*329 759  70  980*329 753  70  972*327 746  75  975*
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43110 10/27*329 762  75  979*329 759  75  980*329 754  80  972*327 746  80  975*
           *** ***  **               **          ***  **               **
43115 10/28*326 734  75    0*332 729  80    0*339 723  80  968*351 715  85  963*
43115 10/28*327 737  85  970*332 730  85    0*339 723  90  968*351 715  95  963*
           *** ***  **  ***     ***  **                **               **
43120 10/29*363 703  95    0*378 688  95    0*408 672  95  958E440 660  90    0*
43120 10/29*363 703  95    0*381 688  95    0E408 672  95  958E440 657  90  948*
                             ***              *                    ***      ***
43125 10/30E470 640  80    0E490 630  80    0*  0   0   0    0*  0   0   0    0*
43125 10/30E470 640  70    0E490 630  50    0*  0   0   0    0*  0   0   0    0*
                     **               **
43130 HR
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U.S. Tropical Storm Impact

09/26 06Z 33.1N 76.9W 55 kt North Carolina
09/29 06Z 38.1N 68.8W 35 kt Massachusetts

Minor changes to the track and intensity shown in McAdie et al. (2009). Evidence for these alterations comes from the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Monthly Weather Review, Navy reconnaissance book, Mariners Weather Log, Allison & Thompson (1966) and NHC Storm Wallets.

October 15:

HWM and microfilm do not show an organized system at 12Z. HURDAT does not list an organized system on this date. Ship highlights: 45 kt ESE at 28.7N, 71.1W at 18Z (micro).

October 16:

HWM analyzes a closed low pressure of at most 1010 mb at 21.0N, 72.0W at 12Z. HURDAT lists a 20 kt tropical depression at 21.0N, 72.0W at 12Z (first position). Microfilm shows a closed low pressure of at most 1011 mb at 22.0N, 72.0W at 12Z. Ship highlights: No gales or low pressures.

MWR: “The depression which grew into hurricane Ginny developed in the southeastern Bahamas during October 16. Although there was a weak surface circulation at this time, there was a marked trough, surface and aloft, extending northeastward toward Bermuda, which represented a fracture from a polar trough. Consequently the trough was cold and the air mass baroclinic.”

October 17:

HWM analyzes a closed low pressure of at most 1010 mb at 24.0N, 72.0W at 12Z. HURDAT lists a 20 kt tropical depression at 24.0N, 71.6W at 12Z. Microfilm shows a closed low pressure of at most 1011 mb at 27.0N, 69.0W at 12Z. Ship highlights: No gales or low pressures.

October 18:

HWM analyzes a closed low pressure of at most 1010 mb at 27.0N, 72.0W with a stationary front to the north at 12Z. HURDAT lists a 30 kt tropical depression at 27.0N, 71.2W at 12Z. Microfilm shows a trough of low pressure north of the eastern Bahamas at 12Z. Ship highlights: No gales or low pressures.

ATSR: "The first sustained closed circulation appeared on the 18th, after the center of lowest pressure had moved north-northeast for the two days remaining under the trough line aloft. Lowest surface pressure at this time was estimated to be 1008 mbs. Slow intensification began and the system had all indications of remaining a cold core extratropical circulation."

October 19:

HWM analyzes a tropical storm of at most 1000 mb at 30.9N, 71.4W with a warm front to the northeast at 12Z. HURDAT lists a 35 kt tropical storm at 30.8N, 71.8W at 12Z. Microfilm shows a closed low pressure of at most 1011 mb at 29.0N, 73.0W with a frontal boundary extended to the northeast at 12Z. Ship highlights: 35 kt NE and 1015 mb at 32.6N, 74.3W at 00Z (COADS). 35 kt NE and 1011 mb at 31.1N, 74.7W at 03Z (COADS). 35 kt NE and 1015 mb at 34.5N, 71.8W at 09Z (COADS). 40 kt NE and 1009 mb at 33.0N, 73.0W at 12Z (COADS). 993 mb at 32.0N, 72.5W at 18Z (micro). 50 kt NNE and 1007 mb at 32.6N, 73.8W at 18Z (COADS). 40 kt E and 1007 mb at 34.0N, 71.0W at 21Z (COADS). Aircraft highlights: Estimated surface winds of 60 kt and an eye diameter of 80 nm near 31.0N, 73.0W around 20Z (ATSR).

MWR: "In reality, the depression was not tropical and neither was the storm, which developed later on the 19th. There was no warm core." ATSR: "Intensification accelerated on the 19th as the circulation became closed through the 200 mb level and cold advection had increased in the upper tropospheric levels. Storm velocity of 48 knots was attained this day. The first reconnaissance flight was dispatched this date from Naval Air Station, Jacksonville to investigate an area in the vicinity of 31N 73W. A cyclonic circulation 80 miles in diameter was observed; however, no radar eye or warm core was discernible."

October 20:

HWM analyzes a hurricane of at most 985 mb at 33.8N, 75.0W with a warm front to the northeast at 12Z. HURDAT lists a 65 kt hurricane at 33.5N, 75.0W at 12Z. Microfilm shows a closed low pressure of at most 996 mb at 33.5N, 75.2W at 12Z. Ship highlights: 55 kt NE and 1011 mb at 33.8N, 75.6W at 00Z (COADS). 30 kt SE and 992 mb at 32.6N, 72.8W at 00Z (COADS/micro). 55 kt SSW and 994 mb at 31.7N, 72.6W at 03Z (micro). 45 kt ENE and 996 mb at 32.6N, 75.5W at 06Z (COADS). 55 kt NNW and 994 mb at 32.8N, 75.8W at 09Z (micro). 55 kt NNE and 1005 mb at 33.9N, 75.9W at 12Z (COADS). 35 kt E and 988 mb at 33.9N, 75.2W at 12Z (COADS). 60 kt NE and 999 mb at 34.1N, 75.6W at 15Z (micro). 70 kt NE and 990 mb at 34.0N, 75.1W at 18Z (micro). 75 kt S and 999 mb at 33.8N, 74.0W at 21Z (micro). 60 kt SE and 983 mb at 34.0N, 75.2W at 21Z (micro). 65 kt NNE and 991 mb at 34.2N, 75.8W at 21Z (MWL).

ATSR: “A high pressure area had become well established over the middle Atlantic states through the lower half of the troposphere as GINNY progressed along her northerly track. This caused a tightening of the gradient in the northern semi-circle with accompanying winds of hurricane velocity, on the 20th. At this time, GINNY was 120 miles south-southeast of Cape Hatteras and in all respects appeared to be a well-developed “Hatteras Low,” which is well known along the Atlantic seaboard for its extensive precipitation, high winds and angry seas.”

October 21:

HWM analyzes a hurricane of at most 995 mb at 34.5N, 74.5W with a cold front to the north at 12Z. HURDAT lists a 75 kt hurricane at 34.0N, 74.5W at 12Z. Microfilm shows a closed low pressure of at most 1002 mb at 34.0N, 74.5W at 12Z. Ship highlights: 75 kt S and 999 mb at 33.8N, 74.2W at 00Z (COADS). 60 kt ESE and 1000 mb at 35.0N, 74.8W at 03Z (micro). 80 kt N and 1000 mb at 34.3N, 76.1W at 06Z (COADS/MWL). 55 kt NE and 1003 mb at 33.4N, 77.4W at 09Z (micro). 60 kt N and 1002 mb at 34.5N, 75.8W at 12Z (COADS). 50 kt N and 1003 mb at 34.8N, 75.5W at 15Z (MWL). 55 kt NNW and 1007 mb at 34.3N, 76.1W at 18Z (COADS). 80 kt SW and 999 mb at 33.6N, 76.4W at 21Z (MWL). Aircraft highlights: Radar center fix measured a peripheral pressure of 1005 mb and estimated surface winds of 60 kt at 33.5N, 76.2W at 1125Z (ATSR). Radar highlights: Cape Hatteras radar center fix at 34.2N, 75.1W at 0644Z (WALLET). Cape Hatteras radar center fix at 33.8N, 74.1W at 1742Z (WALLET). Cape Hatteras radar center fix at 33.6N, 74.2W at 2343Z (WALLET).

ATSR: “On the 21st, Hurricane GINNY had come to a virtual stand-still over the warmer waters of the Gulf Stream off the coast of Hatteras. This temporary respite in such a favored location was undoubtedly the beginning of its transition from cold to warm core. Additionally, anticyclonic flow at the 200 mb level was observed moving in from the west. On the 21st, reconnaissance flights out of NAS Jacksonville were diverted to search for and later maintain overhead contact with a disabled naval vessel which had become adrift near the center of GINNY. This limited the reconnaissance during the transition from extratropical to tropical.”

October 22:

HWM analyzes a hurricane of at most 1000 mb at 31.5N, 74.8W with a weakening front to the north at 12Z. HURDAT lists a 70 kt hurricane at 31.5N, 74.8W at 12Z. Microfilm shows a closed low pressure of at most 1008 mb at 32.0N, 75.0W with a frontal boundary to the north at 12Z. Ship highlights: 60 kt W and 1003 mb at 32.3N, 74.4W at 00Z (COADS). 65 kt NNW and 1005 mb at 33.4N, 76.4W at 03Z (micro). 60 kt W and 990 mb at 32.4N, 74.8W at 06Z (COADS). 55 kt NNW and 999 mb at 31.9N, 75.6W at 09Z (micro). 60 kt ENE and 1007 mb at 32.6N, 75.5W at 12Z (COADS). 60 kt S and 1007 mb at 30.6N, 73.6W at 15Z (COADS). 50 kt W and 1000 mb at 30.6N, 75.1W at 18Z (micro). 55 kt SE and 1000 mb at 31.0N, 74.5W at 21Z (micro). Aircraft highlights: Penetration center fix measured a central pressure of 989 mb, estimated surface winds of 55 kt and an eye diameter of 80 nm at 30.8N, 75.2W at 1620Z (WALLET). Penetration center fix measured a central pressure of 992 mb, estimated surface winds of 50 kt and an eye diameter of 60 nm at 30.1N, 76.2W at 2252Z

(WALLET). Radar highlights: Cape Hatteras radar center fix at 33.1N, 74.6W at 0345Z (WALLET).

MWR: "Even though hurricane-force winds were observed on the 20th, it was not until the morning of the 22nd that aircraft reconnaissance found a thermal structure that was more like a hurricane, rather than the late-season, hybrid type of the previous days. An eye of 20-mi. diameter had formed on the morning of the 22nd; however, definition was reported poor." ATSR: "By the 22nd, GINNY had completed a clockwise loop off Hatteras and had begun to accelerate toward the southwest. At the same time, she was moving away from the Gulf Stream."

October 23:

HWM analyzes a tropical storm of at most 1005 mb at 29.0N, 77.7W at 12Z. HURDAT lists a 60 kt tropical storm at 28.9N, 77.7W at 12Z. Microfilm shows a closed low pressure of at most 1005 mb at 29.0N, 77.0W at 12Z. Ship highlights: 50 kt SE and 1011 mb at 29.7N, 73.3W at 00Z (micro). 50 kt NNE and 1017 mb at 33.2N, 77.7W at 03Z (MWL). 45 kt NE and 1013 mb at 31.6N, 77.4W at 06Z (COADS). 45 kt S and 1010 mb at 27.8N, 74.6W at 09Z (micro). 40 kt N and 1008 mb at 29.0N, 79.2W at 12Z (COADS). 45 kt N and 1018 mb at 30.7N, 80.7W at 15Z (micro). 45 kt NE and 1020 mb at 33.7N, 74.1W at 18Z (COADS). 55 kt NNE and 1008 mb at 29.5N, 79.5W at 21Z (micro). Aircraft highlights: Radar center fix measured a central pressure of 987 mb and an eye diameter of 45 nm at 30.1N, 76.0W at 0055Z (WALLET). Penetration center fix measured a central pressure of 988 mb and estimated an eye diameter of 45 nm at 29.7N, 76.8W at 04Z (WALLET). Penetration center fix measured a central pressure of 995 mb, estimated surface winds of 55 kt and an eye diameter of 40 nm at 28.9N, 77.8W at 13Z (WALLET). Penetration center fix measured a central pressure of 990 mb and estimated an eye diameter of 40 nm at 28.8N, 77.8W at 1445Z (WALLET). Penetration center fix measured a central pressure of 990 mb, estimated surface winds of 45 kt and an eye diameter of 40 nm at 28.8N, 78.3W at 18Z (WALLET). Penetration center fix measured a central pressure of 988 mb, estimated surface winds of 60 kt and an eye diameter of 38 nm at 28.8N, 78.4W at 2145Z (WALLET). Radar highlights: Patrick AFB radar center fix at 28.7N, 77.9W at 1320Z (WALLET). Patrick AFB radar center fix at 28.8N, 77.7W at 18Z (WALLET).

MWR: "During the 23rd, some weakening of the hurricane occurred and there was probably a period of 10 hr. when the tropical cyclone was only of storm intensity. Ginny quickly returned to hurricane force and there were only minor variations in intensity during the remainder of its life history although very slow intensification took place from this time until landfall was made on Nova Scotia on the 29th."

October 24:

HWM analyzes a hurricane of at most 1000 mb at 29.6N, 79.6W with a cold front to the northeast at 12Z. HURDAT lists a 65 kt hurricane at 29.4N, 79.6W at 12Z. Microfilm shows a closed low pressure of at most 999 mb at 29.5N, 79.5W at 12Z. Ship highlights: 75 kt ENE and 999 mb at 29.4N, 78.0W at 00Z (micro). 65 kt NE and 1007 mb at 29.3N, 79.1W at 03Z (micro). 50 kt ENE and 1010 mb at 30.5N, 79.9W at 06Z (COADS). 65 kt NE and 1000 mb at 29.6N, 78.8W at 09Z (micro). 65 kt ESE and 999

mb at 29.6N, 78.6W at 12Z (micro). 65 kt E and 1002 mb at 29.5N, 78.4W at 15Z (micro). 15 kt E and 987 mb at 29.8N, 79.7W at 18Z (micro). 65 kt SE and 1002 mb at 29.8N, 79.7W at 18Z (micro). 55 kt SSW and 1001 mb at 29.4N, 79.2W at 20Z (COADS). Aircraft highlights: Penetration center fix estimated an eye diameter of 35 nm at 28.8N, 78.5W at 0130Z (WALLET). Penetration center fix estimated flight level winds of 50 kt and an eye diameter of 35 nm at 29.1N, 79.0W at 07Z (ATSR). Penetration center fix measured a central pressure of 990 mb, estimated surface winds of 75 kt and an eye diameter of 30 nm at 29.5N, 79.7W at 14Z (WALLET). Penetration center fix measured a central pressure of 987 mb, estimated surface winds of 85 kt and an eye diameter of 44 nm at 29.7N, 79.8W at 17Z (WALLET). Penetration center fix measured a central pressure of 982 mb, estimated surface winds of 75 kt and an eye diameter of 40 nm at 30.0N, 79.7W at 2215Z (WALLET). Radar highlights: Daytona Beach radar center fix at 29.0N, 78.4W at 0020Z (WALLET). Daytona Beach radar center fix at 29.3N, 79.0W and an eye diameter of 40 nm at 0615Z (WALLET). Daytona Beach radar center fix at 29.6N, 79.5W and an eye diameter of 42 nm at 1215Z (WALLET). Daytona Beach radar center fix at 29.8N, 79.7W and an eye diameter of 44 nm at 1745Z (WALLET).

October 25:

HWM analyzes a hurricane of at most 1005 mb at 32.0N, 79.5W with a warm front to the east at 12Z. HURDAT lists a 90 kt hurricane at 31.8N, 79.6W at 12Z. Microfilm shows a closed low pressure of at most 1002 mb at 31.5N, 79.0W at 12Z. Ship highlights: 65 kt S and 1007 mb at 30.3N, 78.5W at 00Z (COADS). 50 kt SE and 1012 mb at 31.8N, 78.2W at 06Z (micro). 45 kt E and 1007 mb at 32.4N, 78.4W at 12Z (COADS). 35 kt SE and 1009 mb at 31.1N, 77.8W at 15Z (micro). 40 kt SSW and 1004 mb at 31.0N, 78.4W at 18Z (micro). Aircraft highlight: Radar center fix at 30.1N, 79.6W at 00Z (WALLET). Penetration center fix measured a central pressure of 976 mb, estimated surface winds of 80 kt and an eye diameter of 30 nm at 31.8N, 79.6W at 12Z (WALLET). Penetration center fix measured a central pressure of 985 mb and an eye diameter of 30 nm at 32.1N, 79.0W at 1859Z (WALLET). Penetration center fix measured a central pressure of 987 mb, estimated surface winds of 95 kt and an eye diameter of 30 nm at 32.2N, 78.5W at 22Z (WALLET/ATSR). Radar highlights: Charleston radar center fix at 30.3N, 79.5W and an eye diameter of 23 nm at 0015Z (WALLET). Daytona Beach center fix at 31.1N, 79.8W and an eye diameter of 30 nm at 0545Z (WALLET). Charleston radar center fix at 31.8N, 79.4W and an eye diameter of 32 nm at 1222Z (WALLET). Charleston radar center fix at 32.1N, 79.1W and an eye diameter of 18 nm at 1818Z (WALLET).

October 26:

HWM analyzes a hurricane of at most 1000 mb at 33.5N, 76.5W with a warm front to the east at 12Z. HURDAT lists an 80 kt hurricane at 33.2N, 76.9W at 12Z. Microfilm shows a closed low pressure of at most 1005 mb at 33.0N, 77.0W at 12Z. Ship highlights: 35 kt W and 1000 mb at 32.0N, 78.8W at 00Z (COADS). 45 kt SW and 1012 mb at 31.2N, 75.7W at 06Z (COADS). 60 kt S and 990 mb at 31.4N, 76.7W at 12Z (COADS). 60 kt NW and 1002 mb at 32.5N, 77.5W at 18Z (COADS). Aircraft highlights: Penetration center fix estimated flight level winds of 53 kt and an eye

diameter of 20 nm at 32.4N, 78.0W at 01Z (WALLET). Penetration center fix measured a central pressure of 988 mb and estimated flight level winds of 53 kt at 32.8N, 77.6W at 0359Z (WALLET). Penetration center fix measured a central pressure of 983 mb, estimated flight level winds of 55 kt and an eye diameter of 21 nm at 33.1N, 77.4W at 0559Z (WALLET/ATSR). Penetration center fix measured a central pressure of 986 mb, estimated surface winds of 90 kt and an eye diameter of 25 nm at 33.2N, 76.9W at 12Z (WALLET). Penetration center fix measured a central pressure of 978 mb, estimated surface winds of 80 kt and an eye diameter of 16 nm at 32.9N, 76.4W at 19Z (WALLET). Radar highlights: Charleston radar center fix at 32.5N, 77.9W and an eye diameter of 24 nm at 0015Z (WALLET). Charleston radar center fix at 33.1N, 77.3W at 0540Z (WALLET). Charleston radar center fix at 33.3N, 77.0W and an eye diameter of 30-50 nm at 1244Z (WALLET). Hatteras radar center fix at 33.2N, 76.1W at 1745Z (WALLET).

MWR: “Highest wind at any land station was 70 mph, with gusts to 100, reported at Cape Fear at the Oak Island, NC, observation point when the center took a temporary odd turn toward the North Carolina coast.” NC State Climatologist: “Reports from other than First-Order stations were received erratically, but most reports gave winds at less than 50 miles per hour at all times. The exception was Oak Island Life Boat Station, which gave consistently higher winds than any other point. These reports indicated sustained winds as high as 70 miles per hour, with one gusts to 100 mph reported on the 260255E report. On some of the Oak Island reports winds were marked “estimated” and it is believed that many of the speeds were overestimated. Lowest pressure at Oak Island, the lowest reported other than that at Hatteras, was given as 29.62 inches from about 260400-260600E.”

October 27:

HWM analyzes a hurricane of at most 995 mb at 33.1N, 75.0W with a warm front to the northeast at 12Z. HURDAT lists a 70 kt hurricane at 32.9N, 75.3W at 12Z. Microfilm shows a closed low pressure of at most 1002 mb at 33.0N, 75.0W at 12Z. Ship highlights: 60 kt E and 999 mb at 33.6N, 75.3W at 00Z (COADS). 50 kt W and 1004 mb at 31.5N, 75.9W at 06Z (COADS). 45 kt WNW and 1006 mb at 31.4N, 76.1W at 12Z (COADS). 45 kt NNE and 1009 mb at 33.7N, 77.0W at 15Z (micro). 50 kt NW and 1006 mb at 32.0N, 76.7W at 18Z (COADS). 55 kt SSE and 989 mb at 32.3N, 73.5W at 20Z (MWL). Aircraft highlights: Penetration center fix measured a central pressure of 979 mb, estimated surface winds of 75 kt and an eye diameter of 28 nm at 32.9N, 76.3W at 0157Z (WALLET). Penetration center fix measured a central pressure of 980 mb, estimated surface winds of 85 kt and an eye diameter of 22 nm at 33.0N, 75.8W at 0645Z (WALLET/ATSR). Penetration center fix measured a central pressure of 972 mb and estimated surface winds of 85 kt at 32.9N, 75.4W at 0945Z (WALLET). Penetration center fix at 32.9N, 75.3W at 13Z (WALLET). Penetration center fix measured a central pressure of 975 mb, estimated surface winds of 90 kt and an eye diameter of 30 nm at 32.6N, 74.5W at 19Z (WALLET). Radar highlights: Hatteras radar center fix at 33.1N, 76.0W at 0045Z (WALLET). Hatteras radar center fix at 32.9N, 75.5W at 0545Z (WALLET). Hatteras radar center fix at 32.8N, 74.8W at 1215Z (WALLET). Hatteras

radar center fix at 32.8N, 74.4W at 1744Z (WALLET). Hatteras radar center fix at 32.8N, 73.4W at 2345Z (WALLET).

October 28:

HWM analyzes a hurricane of at most 990 mb at 34.1N, 72.5W with a cold front to the north at 12Z. HURDAT lists an 80 kt hurricane at 33.9N, 72.3W at 12Z. Microfilm shows a closed low pressure of at most 1008 mb at 33.9N, 72.3W with a frontal boundary to the northwest at 12Z. Ship highlights: 55 kt SSE and 989 mb at 32.3N, 73.5W at 00Z (COADS). 50 kt WNW and 997 mb at 31.9N, 74.0W at 03Z (micro). 40 kt WNW and 1001 mb at 31.6N, 74.4W at 06Z (COADS). 40 kt SE and 999 mb at 34.1N, 70.0W at 12Z (micro). 50 kt E and 988 mb at 34.0N, 71.0W at 18Z (COADS). 50 kt S and 999 mb at 35.5N, 68.0W at 21Z (micro). Aircraft highlights: Penetration center fix measured a central pressure of 970 mb and estimated an eye diameter of 40 nm at 32.8N, 73.3W at 0130Z (WALLET). Penetration center fix estimated an eye diameter of 32 nm at 33.3N, 73.1W at 0722Z (WALLET). Penetration center fix measured a central pressure of 968 mb, estimated surface winds of 75 kt and an eye diameter of 25 nm at 34.1N, 72.1W at 13Z (WALLET). Penetration center fix measured a central pressure of 963 mb, estimated surface winds of 100 kt and an eye diameter of 25 nm at 35.3N, 71.4W at 19Z (WALLET).

October 29:

HWM analyzes a hurricane of at most 980 mb at 41.0N, 67.0W with a cold front just to the west and a warm front just to the north at 12Z. HURDAT lists a 95 kt hurricane at 40.8N, 67.2W at 12Z. Microfilm shows a closed low pressure of at most 993 mb at 41.0N, 67.0W with a frontal boundary going through the center at 12Z. Ship highlights: 75 kt NNW and 996 mb at 36.4N, 71.5W at 00Z (micro). 65 kt E and 977 mb at 37.0N, 70.3W at 00Z (COADS). 60 kt N and 996 mb at 38.3N, 72.1W at 03Z (micro). 65 kt NW and 981 mb at 35.0N, 71.5W at 06Z (COADS). 55 kt S and 995 mb at 39.3N, 64.2W at 09Z (COADS). 85 kt NW and 975 mb at 39.5N, 68.0W at 12Z (MWL). 70 kt S and 964 mb at 41.3N, 65.8W at 15Z (micro). 65 kt NW and 987 mb at 43.0N, 68.5W at 18Z (micro). Land highlights: 35 kt NNE and 997 mb at Nantucket, MA at 06Z (micro). 48 kt N (gusts to 66 kt) and 988 mb at Nantucket, MA at 1259Z (SWO). 55 kt NE and 994 mb at Nantucket Lightship, MA at 23Z (SWO/MWR). Aircraft highlights: Radar center fix at 36.9N, 71.0W at 0215Z (WALLET). Radar center fix at 37.9N, 68.7W at 06Z (WALLET). Penetration center fix measured a central pressure of 958 mb, estimated surface winds of 120 kt and an eye diameter of 25 nm at 41.4N, 66.9W at 1315Z (WALLET). Penetration center fix measured a central pressure of 948 mb and estimated surface winds of 120 kt at 43.1N, 66.2W at 1630Z (WALLET).

MWR: “Later the hurricane threatened New England but gale warnings, which were in effect were ample. The fastest mile on the New England coast was 65 mph reported at Nantucket. The Coast Guard vessel Cowslip, off Portland, Maine, reported seas 30 to 40 ft. high and the anemometer broke at about 105 mph. The lowest barometer reading was 28.98 in.”

October 30:

HWM analyzes an extratropical cyclone of at most 985 mb at 43.0N, 65.5W at 12Z. HURDAT lists an 80 kt extratropical cyclone at 49.0N, 63.0W at 06Z (last position). Microfilm shows a closed low pressure of at most 996 mb at 45.0N, 62.0W with a large extratropical cyclone to the south at 12Z. Ship highlights: 45 kt NW and 997 mb at 43.1N, 68.5W at 00Z (COADS). Land highlights: 75 kt (likely gusts) (time unknown) at Saint John, Canada (Canada). 35 kt SW and 977 mb at Moncton, Canada at 00Z (micro). 40 kt WSW and 994 mb at Ile du Havre, Canada at 06Z (micro). 30 kt N and 991 mb at 50.1N, 64.2W at 06Z (COADS).

MWR: "The track of Ginny was most unusual although not unique. Many hurricanes have looped and a few others have had rather long trajectories toward the southwest. The reader is referred to the "Yankee Storm" of October 30-November 8, 1935, and to hurricane Able of May 15-24, 1951. It would seem that these two storms and Ginny certainly had an affinity for the warm Gulf Stream. Operationally, aside from the erratic track, Ginny was a most difficult hurricane in that a large part of its life history was uncomfortably close to land. For eight consecutive days while Ginny was meandering off the southeastern coast, the center was within 250 n. mi. of the United States mainland and during one day the wall cloud was less than 50 mi. from the Cape Canaveral-Daytona Beach, Fla. area. Two persons apparently perished in the snow storm and there was one other fatality. Possibly four others were lost on the Tug Otho. Damage resulted from minor beach erosion and relatively small structural loss to boats, houses, autos, etc., mainly in Maine and on Cape Cod. Total damage in the United States probably did not exceed $400,000. According to reports, damage in the Canadian Maritime Provinces was confined to small boats and from minor flooding with no known deaths."

Ginny originated from a tropical wave that entered the Caribbean Sea on October 14th. The disturbance moved westward over the Greater Antilles becoming better organized north of Hispaniola on October 16th. Based upon synoptic observations, the low-level circulation became better defined on October 17th while drifting northward and a 20 kt tropical depression is analyzed to have developed at 18Z on the 17th, 30 hours later than originally shown in HURDAT. Observations on the 16th and early on the 17th indicate that the disturbance was a sharp tropical wave or trough over the eastern Bahamas, thus genesis was delayed from the original HURDAT. Minor track alterations are introduced during the lifetime of this tropical cyclone. (Central pressures values for many six hour period were present in the original HURDAT between October 19th at 12Z and October 29st at 18Z. Some of these were obviously analyses that were added in, not based upon actual observations. Thus, based on actual observations, some were retained and new central pressure values added. Detailed information on these changes can be found in the table at the end.) On October 18th, the tropical depression moved northward and slowly intensified. Synoptic observations indicate that the tropical cyclone had a large circulation, radius of OCI about 240 nm, and it was interacting with a stationary boundary over the western Atlantic, and thus this system had some subtropical characteristics during the first few days of its existence. At 00Z on October 19th, gales

were reported about 300 nm northwest of the center but the observations were outside the outermost closed isobar and therefore, not considered part of the circulation and were instead due to the large scale synoptic pressure gradients. Ginny turned to the northwest on the 19th and quickly strengthened. Intensification to a tropical storm is analyzed at 06Z on the 19th, six hours earlier than originally shown in HURDAT. A couple of ships reported gale-force winds on the 19th, including storm-force winds of 50 kt N at 18Z. An intensity of 55 kt is analyzed at 18Z on the 19th based on the synoptic data, up from 45 kt originally in HURDAT, a minor intensity change. On October 20th, Ginny turned to the west and slowed its forward speed. A ship reported 30 kt SE and 992 mb at 00Z on the 20th, suggesting a central pressure of 989 mb. A central pressure of 989 mb suggests maximum surface winds of 61 kt from the north of 25N Brown et al. pressure-wind relationship. Based on a forward speed of 16 kt, an intensity of 60 kt is analyzed at 00Z on the 20th, up from 55 knots originally shown in HURDAT, a minor intensity change. Also on the 20th, numerous ships reported tropical storm force winds and even hurricane-force winds at 18Z. Based on the synoptic data available, intensification to a hurricane is analyzed at 12Z on the 20th, same as originally shown in HURDAT. On October 21st, Ginny made a clock-wise loop off the North Carolina coast. The hurricane continued to intensify on the 21st and reached a first peak of 80 kt at 06Z, up from 75 kt originally in HURDAT, a minor intensity change. A ship at 06Z on the 21st reported 80 kt N and 1000 mb. On October 22nd, the hurricane turned to the south and later southwest while gradually weakening. A reconnaissance aircraft made a penetration center fix at 1620Z on the 22nd measuring a central pressure of 989 mb, estimating surface winds of 55 kt and an eye diameter of 80 nm. A central pressure of 989 mb suggests maximum surface winds of 61 kt from the north of 25N pressure-wind relationship. An eye diameter of 80 nm suggests an RMW of 60 nm and the climatological value is 25 nm. At 1815Z on the 22nd, TIROS VII captured an image of Ginny showing a large area of convection with a poorly-defined eye and banding features. Based upon a forward speed of about 9 kt and the TIROS satellite image, an intensity of 65 kt is analyzed at 18Z on the 22nd, down from 70 kt originally in HURDAT, a minor intensity change. On October 23rd, Ginny continued on a southwestward track with no appreciable changes in intensity. A few reconnaissance aircrafts made penetration center fixes throughout the day and the central pressure of the tropical cyclone fluctuated between 988 mb and 995 mb. The intensity is analyzed at 65 kt at every time slot on the 23rd, same as originally shown in HURDAT at 00Z and 18Z, and up from 60 kt at 06Z and 12Z, which are minor changes in intensity. Numerous ships reported gale and storm-force winds on the 23rd.

On October 24th, Ginny made its closest approach to Florida, passing about 75 nm east of Daytona Beach, before turning to the north. The radar images from Daytona Beach showed a well-defined eyewall about 40 nm in diameter. The hurricane slightly intensified on the 24th based upon data from the reconnaissance aircraft and ship observations. Various ships reported tropical storm force winds and a couple even experienced hurricane-force winds. At 18Z on the 24th, a ship reported 15 kt E and 987 mb, suggesting a central pressure of 985 mb. A central pressure of 985 mb suggests maximum surface winds of 69 kt from the north of 25N intensifying subset pressure-wind relationship. A reconnaissance aircraft investigating Ginny estimated surface winds of 85 kt and an eye diameter of 44 nm at 17Z. An eye diameter of 44 nm suggests an RMW of

about 33 nm and the climatological value is 24. An intensity of 70 kt is selected at 18Z on the 24th, same as originally shown in HURDAT. On October 25th, Ginny moved slowly to the north and late on the day turned to the northeast passing about 60 nm southeast of South Carolina. A penetration center fix occurred at 2215Z on the 24th measuring a central pressure of 982 mb, estimating surface winds of 75 kt and an eye diameter of 40 nm. A central pressure of 982 mb suggests maximum surface winds of 73 kt from the north of 25N intensifying subset pressure-wind relationship. An eye diameter of 40 nm suggests an RMW of about 30 nm and the climatological value is 23 nm. An intensity of 75 kt is selected at 00Z on the 25th, same as originally shown in HURDAT. The next penetration center fix measured a central pressure of 976 mb, estimated surface winds of 80 kt and an eye diameter of 30 nm. A central pressure of 976 mb suggests maximum surface winds of 81 kt from the north of 25N intensifying subset pressure-wind relationship. An eye diameter of 30 nm suggests an RMW of about 23 nm and the climatological value is 24 nm. An intensity of 80 kt is selected at 12Z on the 25th, down from 90 kt originally in HURDAT, a minor intensity change. 80 kt is a second peak in intensity as reconnaissance data indicated that Ginny began to weaken late on the 25th. TIROS VII captured an image of the hurricane at 1741Z on the 25th showing a large area of convection with some banding features. A penetration center fix measured a central pressure of 985 mb and an eye diameter of 30 nm at 1859Z on the 25th. A central pressure of 985 mb suggests maximum surface winds of 66 kt and 63 kt from the north of 25N and the weakening subset pressure-wind relationship, respectively. An eye diameter of 30 nm suggests an RMW of about 23 nm and the climatological value is 24 nm. Based upon a forward speed of about 5 kt and satellite image, an intensity of 70 kt is analyzed at 18Z on the 25th, down from 90 kt originally in HURDAT, a major intensity change.

On October 26th, Ginny moved generally northeastward at a slow forward speed and made its closest approach to North Carolina, passing about 50 nm southeast of Cape Fear. Around 06Z on the 26th, Oak Island, North Carolina, experienced tropical storm force winds up to 60 kt according to the NC State Climatologist. The report also states that some of the wind reports were estimates and some may have been overestimated. The Schwerdt et al. parametric hurricane wind model suggests that the highest sustained winds that impacted North Carolina, especially in the Cape Fear area, reached 55 kt. Thus, Ginny is analyzed as a tropical storm impact for North Carolina. A penetration center fix at 0559Z on the 26th measuring a central pressure of 983 mb and estimating an eye diameter of 21 nm. A central pressure of 983 mb suggests maximum surface winds of 69 kt from the north of 25N pressure-wind relationship. An eye diameter of 21 nm suggests an RMW of about 16 nm and the climatological value is 26 nm. Based upon an RMW smaller than the climatological value but slow forward speed of about 6 kt, an intensity of 70 kt is analyzed at 06Z on the 26th, down from 80 kt originally shown in HURDAT, a minor intensity change. A couple of ships reported gale and storm-force winds on the 26th, up to 60 kt at 12Z and 18Z. Another penetration center fix occurred at 19Z on the 26th measuring a central pressure of 978 mb, estimated surface winds of 80 kt and an eye diameter of 16 nm. A central pressure of 978 mb suggests maximum surface winds of 75 kt and 78 kt from the north of 25N and the intensifying subset pressure-wind relationship, respectively. An eye diameter of 16 nm suggests an RMW of about 12 nm and the climatological value is 26 nm. Based upon an RMW smaller than the

climatological value but slow forward speed of about 6 kt, an intensity of 75 kt is analyzed at 18Z on the 26th, same as originally shown in HURDAT. On October 27th, Ginny continued slowly moving to the east and finished a large clockwise loop off the southeast coast of the United States. At 0157Z on the 27th, a penetration center fix measured a central pressure of 979 mb and 980 mb was measured at 0645Z, thus the intensity at 00Z and 06Z on the 27th is analyzed at 75 kt, up from 70 kt originally in HURDAT, respectively, minor intensity changes. At 0945Z on the 27th, a reconnaissance aircraft measured a central pressure of 972 mb and estimated surface winds of 85 kt. A central pressure of 972 mb suggests maximum surface winds of 82 kt from the north of 25N pressure-wind relationship. An intensity of 80 kt is analyzed at 12Z on the 27th, up from 70 kt originally in HURDAT, a minor intensity change. At 1646Z on the 27th, TIROS VII captured an image of Ginny showing a well-organized eye surrounded by a large area of convection and banding features. At 19Z on the 27th, a penetration center fix measured a central pressure of 975 mb, estimated surface winds of 90 kt and an eye diameter of 30 nm. A central pressure of 975 mb suggests maximum surface winds of 79 kt from the north of 25N pressure-wind relationship. An eye diameter of 30 nm suggests an RMW of about 23 nm and the climatological value is 26 nm. Based on a forward speed of about 10 kt and the satellite image, an intensity of 80 kt is analyzed at 18Z on the 27th, up from 75 kt originally in HURDAT, a minor intensity change. On October 28th, Ginny turned to the northeast and began to accelerate ahead of an approaching frontal boundary. The first reconnaissance aircraft to investigate the hurricane on the 28th measured a central pressure of 970 mb and estimated an eye diameter of 40 nm at 0130Z. A central pressure of 970 mb suggests maximum surface winds of 84 kt from the north of 25N pressure-wind relationship. An eye diameter of 40 nm suggests an RMW of about 30 nm and the climatological value is 26 nm. Based upon a forward speed of 8 kt, an intensity of 85 kt is analyzed at 00Z on the 28th. At 13Z on the 28th, another penetration center fix measured a central pressure of 968 mb, estimated surface winds of 75 kt and an eye diameter of 25 nm. A central pressure of 968 mb suggests maximum surface winds of 87 kt from the north of 25N Brown et al. pressure-wind relationship and 84 kt from the north of 35N Landsea et al. pressure-wind relationship. An eye diameter of 25 nm suggests an RMW of about 19 nm and the climatological value is 28 nm. Based on a forward speed of about 14 kt and an RMW smaller than climatology, an intensity of 90 kt is analyzed at 12Z on the 28th, up from 80 kt originally in HURDAT, a minor intensity change. At 1709Z on the 28th, TIROS VII captured an image of Ginny showing a large area of convection with a well-defined eye ahead of a frontal boundary. At 19Z on the 28th, another penetration center fix measured a central pressure of 963, estimated surface winds of 100 kt and an eye diameter of 25 nm. A central pressure of 963 mb suggests maximum surface winds of 96 kt from the north of 25N pressure-wind relationship intensifying subset and 88 kt from the north of 35N pressure-wind relationship. An eye diameter of 25 nm suggests an RMW of about 19 nm and the climatological value is 27 nm. Based on a forward speed of about 14 kt and an RMW smaller than climatology, an intensity of 95 kt is analyzed at 18Z on the 28th, up from 85 kt originally in HURDAT, a minor intensity change. 95 kt is also the peak intensity of this hurricane, same as originally shown in HURDAT.

On October 29th, Ginny continued to increase in forward speed to the northeast impacting parts of New England and Atlantic Canada. At 06Z on the 29th, Nantucket, MA, registered sustained winds of 35 kt, thus Massachusetts is added as a tropical storm impact. Ginny produced sustained winds up to 48 kt in Nantucket later on as a non-tropical cyclone. The Nantucket Lightship measured 55 kt at 23Z on the 29th; the anemometer was 60 feet in height. Synoptic observations early on the 29th showed that Ginny had begun to acquire extratropical characteristics with an increase in the temperature gradient across the circulation. Transition to an extratropical cyclone is analyzed at 12Z on the 29th, six hours earlier than originally shown in HURDAT. Ginny was a very strong extratropical cyclone as penetration center fixes at 1315Z and 1630Z on the 29th measured central pressures of 958 mb and 948 mb, respectively. The strongest winds remained offshore but heavy rain and high waves impacted coastal New England as Ginny moved to eastern Canada. In Canada, hurricane-force winds, especially in gusts, affected the provinces of Nova Scotia and New Brunswick. A developing extratropical cyclone off the East Coast of the United States began to interact with Ginny late on the 29th and Ginny appears to have been absorbed after 06Z on October 30th. The last position is analyzed at 06Z on the 30th, same as originally shown in HURDAT.

Date	Original HURDAT Central Pressure	Evidence	Changes
Oct 19 12Z	1000 mb	No central pressure reports around 12Z and it does not appear reasonable based on the synoptic data available	Removed
Oct 20 00Z		Ship: 30 kt NE and 992 mb at 00Z on Oct 20th	989 mb
Oct 20 12Z	983 mb	No central pressure report but looks reasonable, ship report of 35 kt E and 988 mb at 12Z on Oct 20th	Retained
Oct 22 18Z	989 mb	Penetration center fix: 989 mb at 1620Z on Sep 22nd	
Oct 23 00Z	987 mb	Penetration center fix: 987 mb at 0055Z on Oct 23rd	
Oct 23 06Z	988 mb	Penetration center fix: 988 mb at 04Z on Oct 23rd	
Oct 23 12Z	995 mb	Penetration center fix: 990 mb at 1445Z on Oct 23rd	990 mb
Oct 23 18Z	990 mb	Penetration center fix: 990 mb at 18Z on Oct 23rd	Retained

Oct 24 00Z	988 mb	Penetration center fix: 988 mb at 2145Z on Oct 23rd	
Oct 24 12Z	990 mb	Penetration center fix: 990 mb at 14Z on Oct 24th	
Oct 24 18Z	987 mb	Ship: 15 kt E and 987 mb at 18Z on Oct 24th	985 mb
Oct 25 00Z	982 mb	Penetration center fix: 982 mb at 2215Z on Oct 24th	Retained
Oct 25 12Z	976 mb	Penetration center fix: 976 mb at 12Z on Oct 25th	
Oct 25 18Z	985 mb	Penetration center fix: 985 mb at 1859Z on Oct 25th	
Oct 26 00Z		Penetration center fix: 987 mb at 22Z on Oct 25th	987 mb
Oct 26 06Z	988 mb	Penetration center fix: 983 mb at 0559Z on Oct 26th	983 mb
Oct 26 12Z	986 mb	Penetration center fix: 986 mb at 12Z on Oct 26th	Retained
Oct 26 18Z	978 mb	Penetration center fix: 978 mb at 19Z on Oct 26th	
Oct 27 00Z	979 mb	Penetration center fix: 979 mb at 0157Z on Oct 27th	
Oct 27 06Z	980 mb	Penetration center fix: 980 mb at 0645Z on Oct 27th	
Oct 27 12Z	972 mb	Penetration center fix: 972 mb at 0945Z on Oct 27th	
Oct 27 18Z	975 mb	Penetration center fix: 975 mb at 19Z on Oct 27th	
Oct 28 00Z		Penetration center fix: 970 mb at 0130Z on Oct 28th	970 mb
Oct 28 12Z	968 mb	Penetration center fix: 968 mb at 13Z on Oct 28th	Retained
Oct 28 18Z	963 mb	Penetration center fix: 963 mb at 19Z on Oct 28th	
Oct 29 12Z	958 mb	Penetration center fix: 958 mb at 1315Z on Oct 29th	

Oct 29 18Z		Penetration center fix: 948 mb at 1630Z on Oct 29th	948 mb

Tropical Storm Helena [October 25-30, 1963]

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43135 10/25/1963 M= 5  9 SNBR= 932 HELENA      XING=0 SSS=0                    L
43135 10/25/1963 M= 6 10 SNBR= 932 HELENA      XING=0 SSS=0                    L
                   * **

43140 10/25*  0   0   0    0*  0   0   0    0*152 589  25    0*153 594  35 1005*
43140 10/25*  0   0   0    0*  0   0   0    0*152 589  30    0*153 595  40 1005*
                                             **          ***  **

43145 10/26*154 601  40 1001*155 606  45    0*156 612  30    0*157 616  30    0*
43145 10/26*154 601  40    0*155 606  45    0*156 612  45 1004*157 616  40 1005*
                           *                 **  ****          **  ****

43150 10/27*157 621  30 1006*159 622  30    0*161 623  35    0*165 621  35    0*
43150 10/27*158 619  35 1006*159 621  35    0*161 622  40    0*165 622  40 1002*
            *** ***  **          ***  **          ***  **          ***  **  ****

43155 10/28*169 619  35    0*172 614  35    0*175 610  35    0*180 605  35    0*
43155 10/28*169 620  35    0*172 614  35    0*174 609  35 1007*178 605  35    0*
                ***                          *** ***     **** ***

43160 10/29*186 601  25    0*193 600  20    0*200 600  20    0*208 599  15    0*
43160 10/29*186 601  30    0*193 595  25    0*200 588  25    0*208 580  25    0*
                     **          ***  **          ***  **          ***  **

(October 30th is new to HURDAT)
43163 10/30*215 567  25    0*223 553  25    0*230 540  25    0*  0   0   0    0*
            *** ***  **      *** ***  **      *** ***  **
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43165 TS

Tropical Storm Landfall

10/28 02Z 17.0N 61.8W 35 kt Antigua

Minor changes to the track and intensity shown in McAdie et al.(2009). Evidence for these alterations comes from the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Monthly Weather Review, Navy reconnaissance book, Mariners Weather Log, Allison & Thompson (1966) and NHC Storm Wallets.

October 24:

HWM and microfilm do not analyze an organized system at 12Z. HURDAT does not list an organized system on this date. Ship highlights: No gales or low pressures.

October 25:

HWM analyzes a closed low pressure of at most 1010 mb at 15.2N, 59.0W at 12Z. HURDAT lists a 25 kt tropical depression at 15.2N, 58.9W at 12Z (first position).

Microfilm shows a closed low pressure of at most 1011 mb at 16.3N, 59.3W at 12Z. Ship highlights: 40 kt S and 1011 mb at 13.4N, 58.8W at 18Z (micro). Aircraft highlights: Penetration center fix measured a central pressure of 1005 mb and estimated surface winds of 65 kt at 15.4N, 59.6W at 2005Z (WALLET/ATSR).

MWR: "Tropical Storm Helena developed in an easterly wave a short distance east of the Lesser Antilles on October 25. An extensive cloud mass, apparently associated with the easterly wave, was observed by the TIROS satellite near 15ºN, 55ºW, on the previous day. Two ships in the disturbed area during the early afternoon of October 25 reported southerly winds of 32 and 40 kt. with continuous rain. A reconnaissance aircraft later in the day found similar conditions and a central pressure of 1005 mb, or 29.68 in. The system was described as ill-defined with no wall cloud but with squall bands in the eastern semicircle. The storm intensified slightly as it moved west-northwestward but later weakened to below storm force after passing between Dominica and Guadeloupe. The 5000-ft. mountains of the islands evidently disrupted the poorly organized circulation." ATSR: "Tropical Storm HELENA developed on an easterly wave approximately 110 miles east of the island of Dominica, in the Lesser Antilles, during the morning of 25 October. A Navy reconnaissance aircraft was dispatched on the 25th as a result of several ship reports and a TIROS photograph which had indicated a disturbed area near 15N 55W on the previous day. At 2000Z, the aircraft encountered a cyclonic circulation near 15.4N 61.3W and reported a poorly defined eye with maximum observed surface winds of 35 knots. At 252135Z, the aircraft reported a "second eye" approximately 25 miles southeast of the original eye. There were no later sightings of the second eye, and it is assumed to have dissipated."

October 26:

HWM analyzes a closed low pressure of at most 1010 mb at 15.0N, 62.0W at 12Z. HURDAT lists a 30 kt tropical depression at 15.6N, 61.2W at 12Z. Microfilm shows a closed low pressure of at most 1005 mb at 15.7N, 61.5W at 12Z. Ship highlights: No gales or low pressures. Land highlights: 35 kt (gusts to 40 kt) at St. Lucia at 12Z (micro). Aircraft highlights: Penetration center fix measured a central pressure of 1005 mb at 15.3N, 61.1W at 1045Z (ATSR). Penetration center fix measured a central pressure of 1004 mb, estimated surface winds of 40 kt and an eye diameter of 30 nm at 15.7N, 61.3W at 1330Z (WALLET/ATSR). Penetration center fix measured a central pressure of 1005 mb and estimated surface winds of 30 kt at 15.7N, 61.5W at 16Z (WALLET). Penetration center fix measured a central pressure of 1006 mb, estimated surface winds of 31 kt and an eye diameter of 24-93 nm at 15.8N, 62.6W at 2155Z (WALLET).

ATSR: "The storm intensified slightly as it moved west-northwest until it passed between the islands of Dominica and Guadeloupe during the early hours of the 26th when the wind reached 45 knots for brief periods. The close proximity to the two mountainous islands disrupted the circulation and weakened the storm, which had never become well organized since the formation."

October 27:

HWM analyzes a tropical storm of at most 1005 mb at 16.5N, 62.5W at 12Z. HURDAT lists a 35 kt tropical storm at 16.1N, 62.3W at 12Z. Microfilm shows a closed low pressure of at most 1008 mb at 16.2N, 62.0W at 12Z. Ship highlights: 40 kt SSW and 1008 mb at 15.4N, 62.5W at 18Z (micro). Aircraft highlights: Penetration center fix measured a central pressure of 1008 mb, estimated surface winds of 55 kt and an eye diameter of 35 nm at 15.9N, 62.3W at 1247Z (WALLET/ATSR). Penetration center fix measured a central pressure of 1002 mb and estimated surface winds of 30-35 kt at 16.6N, 62.3W at 19Z (WALLET).

MWR: "During the night of the 26th, Helena became almost stationary then turned northward and intensified slightly the next day. Central pressure dropped to 1002 mb (29.59 in.) and reconnaissance aircraft reported winds of 58 mph in squalls between Guadeloupe and Dominica." ATSR: "During the late hours of the 26th, HELENA became nearly stationary, and then began drifting north-northeastward on the 27th, which slight reintensification. Since upper level conditions were not favorable for further development, and the absence of a high pressure ridge to the north did not provide a strong surface pressure gradient, HELENA's reintensification was very slight…"

October 28:

HWM analyzes a tropical storm of at most 1010 mb at 18.0N, 61.0W at 12Z. HURDAT lists a 35 kt tropical storm at 17.5N, 61.0W at 12Z. Microfilm shows a closed low pressure of at most 1011 mb at 17.5N, 60.8W at 12Z. Ship highlights: 35 kt SSW and 1009 mb at 16.2N, 60.0W at 00Z (COADS).

MWR: "Most of the squalliness was confined to a small area in the eastern quadrant of the storm as the center moved northeastward from the vicinity of Antigua on the night of the 27th." ATSR: "…by 280000Z, the storm was weakening again. Aircraft reconnaissance at 281300Z reported that the circulation was very weak and, by 281800Z, the circulation could no longer be located."

October 29:

HWM analyzes a closed low pressure of at most 1010 mb at 20.0N, 60.0W at 12Z. HURDAT lists a 20 kt tropical depression at 20.0N, 20.0W at 12Z. Microfilm shows a closed low pressure of at most 1011 mb at 18.5N, 60.0W at 12Z. Ship highlights: No gales or low pressures.

MWR: "During the next 24 hours the storm assumed a more northward course and gradually weakened. Reconnaissance aircraft on the 29th found only an area of squally weather with highest winds about 23 mph. Although Helena was never a well-defined storm, it caused considerable damage to small craft and roads in the Windward Islands. On Guadeloupe, five persons were reported dead, 500 homeless, and 14 seriously injured. A number of barges and fishing craft were sunk or seriously damaged. Total damage is estimated at no more than $500,000." ATSR: "Aircraft reconnaissance on the 29th reported scattered squalls and maximum surface winds of less than 15 knots."

October 30:

HWM analyzes a closed low pressure of at most 1010 mb at 24.0N, 56.5W with a cold front far to the west at 12Z. HURDAT does not list an organized system on this date. Microfilm shows a closed low pressure of at most 1011 mb at 23.5N, 54.5W at 12Z. Ship highlights: No gales or low pressures.

October 31:

HWM analyzes a closed low pressure of at most 1010 mb at 27.5N, 50.2W with a cold front just to the west at 12Z. HURDAT does not list an organized system on this date. Microfilm shows a closed low pressure of at most 1011 mb at 24.0N, 54.0W with a frontal boundary just to the west at 12Z. Ship highlights: No gales or low pressures.

November 1:

HWM analyzes a cold front over the central Atlantic at 12Z. HURDAT does not list an organized system on this date. Microfilm shows a closed low pressure of at most 1011 mb at 24.0N, 54.0W with a frontal boundary just to the west at 12Z. Ship highlights: No gales or low pressures.

Tropical Storm Helena developed late in October from a westward-moving easterly wave. Synoptic data east of the Lesser Antilles is scarce and the time of genesis is uncertain. There were very few signs for the islands that a tropical cyclone was developing to the east. Pressure reports indicate only a slight decrease (about 1 mb) in the values between October 24th at 12Z and October 25th at 12Z. The winds did change from easterly at about 10 kt to variable at about 5 kt. The first position is analyzed at 12Z on the 25th, same as originally shown in HURDAT, as a 30 kt tropical depression, 5 kt higher than originally shown in HURDAT. Minor track alterations are introduced during the lifetime of this tropical cyclone. The TIROS VII satellite captured an image of the tropical cyclone at 1607Z on the 25th showing a large area of convection, circular in shape, with some indications of a westerly shear pattern. Intensification to a tropical storm is analyzed at 18Z on the 25th based on a ship report of 40 kt S and 1010 mb and data from a reconnaissance aircraft. At 2005Z on the 25th, a reconnaissance aircraft made a center penetration measuring a central pressure of 1005 mb and estimated surface winds of 65 kt. A central pressure of 1005 mb suggests maximum surface winds of 37 kt from the south of 25N Brown et al. pressure-wind relationship. Based on the ship report, an intensity of 40 kt is analyzed at 18Z on the 25th, up from 35 kt originally shown in HURDAT, a minor intensity change. A central pressure of 1005 mb was present in HURDAT at 18Z on the 25th and has been retained. On October 26th, Helena continued moving westward at a slow forward speed. A central pressure of 1001 mb was present in HURDAT at 00Z on the 26th and has been removed since no reconnaissance aircraft was investigating the tropical cyclone at this time, nor a ship reported a central pressure. A reconnaissance aircraft investigated Helena at 1330Z on the 26th measuring a central pressure of 1004 mb and estimating surface winds of 40 kt. A central pressure of 1004 mb suggests maximum surface winds of 39 kt from the south of 25N pressure-wind relationship. Based on the pressure-wind relationship and synoptic data, an intensity of 45

kt is selected at 12Z on the 26th, up from 30 kt originally shown in HURDAT, a minor intensity change. 45 kt is also the peak intensity of this tropical storm, same as originally shown in HURDAT. A central pressure of 1004 mb is added to HURDAT at 12Z on the 26th. HURDAT originally showed Helena weakening to a tropical depression at 12Z on the 26th as it passed between the islands of Guadeloupe and Dominica but data from the reconnaissance aircraft and surface observations indicate that the tropical cyclone likely maintained gale-force winds. Around 12Z on the 26th, St. Lucia reported sustained winds of 35 kt. At 16Z on the 26th, another reconnaissance aircraft made a penetration fix measuring a central pressure of 1005 mb and estimated surface winds of 30 kt. A central pressure of 1005 mb suggests maximum surface winds of 37 kt from the south of 25N pressure-wind relationship. Due to the slow forward speed of about 3 knots, an intensity of 40 kt is selected at 18Z on the 26th, up from 30 kt originally shown in HURDAT, a minor intensity change. A central pressure of 1005 mb is added to HURDAT at 18Z on the 26th. The next penetration center fix measured a central pressure of 1006 mb at 2155Z on the 26th and estimated surface winds of 31 kt. An intensity of 35 kt is selected at 00Z on September 27th, up from 30 kt originally in HURDAT, a minor intensity change. A central pressure of 1006 mb was present in HURDAT at 00Z on the 27th and has been retained.

On the 27th, Helena turned to the north over the extreme northeastern Caribbean Sea. Early on this day, the weak tropical storm was almost stationary about 50 nm west of Guadeloupe. A reconnaissance aircraft investigated Helena at 1247Z on the 27th and indicated a central pressure of 1008 mb and estimated surface winds of 55 kt. The central pressure value is considered to be inaccurate based on another penetration fix later in the day, thus it is not added to HURDAT as a central pressure. TIROS VII captured an image of Helena showing a large area of cloudiness between 15N and 25N and 65W and 50W. The satellite image indicates that westerly shear was impacting the tropical cyclone. A ship reported 40 kt SSW at 18Z on the 27th. Another penetration center fix measured a central pressure of 1002 mb and estimated surface winds of 30-35 kt at 19Z on the 27th. A central pressure of 1002 mb suggests maximum surface winds of 43 kt from the south of 25N pressure-wind relationship. Based upon the ship report of 40 kt and a slow forward speed of about 5 kt, an intensity of 40 kt is analyzed at 18Z on the 27th, up from 35 kt originally in HURDAT, a minor intensity change. A central pressure of 1002 mb is added to HURDAT at 18Z on the 27th. Early on the 28th, the center of Helena crossed Antigua as a 35 kt tropical storm and the system was once again over the open Atlantic Ocean. The last gale-force wind report associated with Helena occurred at 00Z on the 28th, 35 kt SW and 1008 mb. A reconnaissance aircraft investigated the tropical cyclone at 1450Z on the 28th measuring a central pressure of 1007 mb and estimated surface winds of 30 kt. A central pressure of 1007 mb suggests maximum surface winds of 32 kt from the south of 25N pressure-wind relationship. An intensity of 35 kt is selected at 12Z on the 28th, same as originally shown in HURDAT, a minor intensity change. Helena continued northeastward, moving away from the Leeward Islands, and it is analyzed to have weakened to a tropical depression at 00Z on October 29th, same as originally shown in HURDAT. The last position in HURDAT originally was at 18Z on the 29th, but synoptic observations indicate that the tropical cyclone continued moving northeastward into the central Atlantic ahead of a frontal boundary. The last position is analyzed at 12Z on

October 30th, 18 hours later than originally shown in HURDAT. The last position is uncertain as it is possible that Helena could have lasted about 24-30 more hours longer than analyzed as a weak tropical depression based on synoptic observations but the data are inconclusive.

1963 - Additional Notes

1. September 23-30: Microfilm shows a tropical wave or trough of low pressure over the eastern Gulf of Mexico on September 22nd and a tropical disturbance develops over the Bay of Campeche on September 23rd and appears to have become a tropical depression later that day based upon synoptic data and an aircraft reconnaissance flight. A frontal boundary reached the northern Gulf of Mexico on the 23rd and remained stationary over the area for the next couple of days. On September 24th, the frontal boundary reached the central Gulf of Mexico generating gales over the northern gulf while the tropical depression remained almost stationary over the eastern Bay of Campeche. On September 25th, synoptic observations indicate that the tropical depression had a well-defined low-level circulation in an environment of low environmental pressures (OCI 1007 mb). The tropical cyclone moved slowly eastward on the 25th and made landfall in western Yucatan late on the day. Late on September 26th, the tropical depression moved back over the eastern Bay of Campeche. On September 27th, the tropical depression remained almost stationary. The ships near the system reported pressures below 1005 mb but no gales. On September 28th, the tropical system begins to move northeastward and the Microfilm surface analysis depicts the cyclone attached to the frontal boundary and shows a north-south elongation of the circulation. Very low environmental pressures, below 1010 mb, encompass the Gulf of Mexico. Ships reported gales in the southern quadrant of the circulation starting at 12Z on the 28th but they were about 180 nm away from the center. It is possible that the tropical depression may have become a subtropical cyclone at that point but the data is inconclusive, especially since we do not have satellite images to observe the structure of the system. On September 29th, the system continues to gain in forward speed to the northeast and became embedded within the frontal boundary. The non-tropical system continued northeastward dissipating over the western Atlantic on October 1st. Therefore, because the data available does not suggest that it was a tropical cyclone when it produced gales, it is not added to HURDAT. This disturbance was in Jack Beven's List of Suspects.

Day	Latitude	Longitude	Status
September 22	20N	89W	Tropical Wave
September 23	20N	93W	Tropical Depression

September 24	20N	91W	Tropical Depression
September 25	20N	91W	Tropical Depression
September 26	19N	91W	Tropical Depression
September 27	19N	92W	Tropical Depression
September 28	23N	91W	Subtropical Storm?
September 29	27N	85W	Extratropical
September 30	36N	74W	Extratropical
October 1			Dissipated

2. September 25 – October 3: Historical Weather Maps indicate that a extratropical cyclone developed along a stationary front on September 26th east of Florida. The system moved eastward producing gales and on September 29th it became an occluded cyclone over the central Atlantic. As the cyclone began to lose its non-tropical characteristics, the winds dropped below gale-force and the system slowly weakened until it dissipated on October 3rd over the eastern Atlantic. Therefore, because the system did not acquire tropical characteristics, it is not added to HURDAT. This disturbance was in Jack Beven's List of Suspects.

Day	Latitude	Longitude	Status
September 25	Eastern Gulf of Mexico to Western Atlantic		Stationary front
September 26	29N	77W	Extratropical
September 27	30N	70W	Extratropical
September 28	33N	57W	Extratropical
September 29	33N	51W	Occluded
September 30	30N	49W	Occluded
October 1	29N	45W	Occluded
October 2	28N	41W	Occluded
October 3			Dissipated

3. October 7-11: A tropical wave left the African coast on October 6th and synoptic data indicates that it may have reached tropical storm intensity on October 8th while it was passing south of the Cape Verde Islands. A ship reported peripheral pressure of 1005 mb on October 8th at 12Z and 45 kt E and 1006 mb at 18Z. Other ship data suggests that the gale-force winds have a high wind bias. Therefore, because there is not enough evidence to suggest that it attained tropical storm intensity, it is not added to HURDAT. This disturbance was in Ryan Truchelut's List of Suspects.

Day	Latitude	Longitude	Status
October 7	14N	21W	Tropical Depression?
October 8	14N	23W	Tropical Storm?
October 9	14N	25W	Tropical Depression?
October 10	14N	29W	Tropical Depression?
October 11			Dissipation

4. October 12-16: The Historical Weather Maps suggests that a tropical wave left the African coast on October 11th. A ship reported gale-force winds on October 12th but the data over the eastern Atlantic is sparse. Therefore, because there is only one key piece of evidence, it is not added to HURDAT. This disturbance was in Ryan Truchelut's List of Suspects.

Day	Latitude	Longitude	Status
October 12	11N	22W	Tropical Storm?
October 13	13N	22W	Tropical Depression?
October 14	14N	22W	Tropical Depression?
October 15	16N	19W	Tropical Depression?
October 16			Dissipation

5. October 23-30: The Historical Weather Maps shows a trough of low pressure between Bermuda and Bahamas. The disturbance moved to the northeast and became embedded within a frontal boundary on the 25th. Gale-force winds were reported on October 26th. On October 30th, the disturbance was absorbed by another frontal boundary. Therefore, because it did not acquire tropical characteristics, it is not added to HURDAT.

Day	Latitude	Longitude	Status
October 23	28N	65W	Trough
October 24	32N	64W	Trough
October 25	32N	64W	Extratropical
October 26	34N	54W	Extratropical

October 27	36N	43W	Extratropical
October 28	38N	33W	Extratropical
October 29	42N	14W	Extratropical
October 30			Absorbed

6. November 3-8: The Historical Weather Maps indicates that an extratropical cyclone formed in the tail-end of a frontal boundary on November 5th. The extratropical cyclone moved eastward over the next couple of days before turning to the northeast on November 8th and becoming absorbed on November 9th. Therefore, because it did not acquire tropical characteristics, it is not added to HURDAT. This disturbance was in Jack Beven's List of Suspects.

Day	Latitude	Longitude	Status
November 3	Eastern Atlantic		Cold front
November 4	30N	40W	Trough
November 5	30N	35W	Extratropical
November 6	30N	31W	Extratropical
November 7	33N	25W	Extratropical
November 8	40N	15W	Extratropical
November 9			Absorbed