1956 Atlantic Hurricane Database Reanalysis – Sandy Delgado and Chris Landsea

Red indicates wind changes of 15 kt or greater
Yellow indicates a deletion
Green indicates a new entry
Blue indicates lat/lon changes greater than 1°

"Minor" intensity changes are less than 20 kt
"Minor" position changes are less than 2 degrees

Unnamed Tropical Storm 1 [June 12-15, 1956] – AL011956

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39285 06/12/1956 M= 4  1 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*208 915  30    0*216 915  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    0*
            *** ***          *** ***  **                      *** ***  **
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 1001*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), Navy reconnaissance book (ATSR), 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 with 1011 mb at Grand Isle, LA at 1315Z (MWR/SWO). 41 kt SSE with 1008 mb at 15Z at Burrwood, LA (SWO). 1004 mb with 19 kt SSW winds at New Orleans-Airport Station at 2025Z (MWR/SWO). 1004 mb with 18 kt SSE winds at New Orleans-Naval Air Station at 2200Z (SWO). 40 kt at Golden Meadow, LA (no time given) (CONNOR). Aircraft highlights: 40 kt maximum wind and 1009 mb minimum pressure and "no circulation" (ATSR); 35 kt SE with 1012 mb at 19Z at 27.2N 88.8W (micro); 35 kt SSE with 1013 mb at 27.5N 87.3W at 1830Z (micro). "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 Airport, New Orleans, and at McComb, Miss. The highest measured tide was 4.7 feet above mean sea level at Biloxi, Miss… 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 with 15 kt NE at McComb, MS at 0128Z (SWO/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.

This system 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 reported 20 kt E and 1009 mb, therefore, the 1009 mb at 12Z has been removed. 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. 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. 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. (Around the time of landfall, a reconnaissance mission was underway. They found peak winds of 40 kt and minimum pressure of 1009 mb and "no circulation", but did not sample the northern semicircle as the center was over land.) The tropical storm passed at about 30 miles west of New Orleans where the pressure dropped to 1004 mb at the airport with SSW 19 kt winds at 2025Z. Also McComb, MS also reported 1004 mb with NE 15 kt winds at 0128Z on the 14th. Therefore, this suggests that the central pressure of the system was around 1001 mb at 00Z on the 14th. The central pressure at landfall may have been around 998-1001 mb, but is not certain enough to include into 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] – AL021956

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39315 07/25/1956 M= 3  2 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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Landfall:
7/26 – 21Z – 21.7N 97.5W – 75 kt – Mexico

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 this has significant uncertain as there is no data from the core between 15Z and landfall around 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. Unfortunately, the original observations from Tampico are not available from any source. The intensity of 75 kt is based upon the reports from Tampico along with assumed continued quick intensification of the system (as observed earlier on the 26th) up until landfall. 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] – AL031956

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39780 08/09/1956 M=12  3 SNBR= 866 BETSY       XING=0 SSS=0
39780 08/09/1956 M=13  3 SNBR= 866 BETSY       XING=0 SSS=0
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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  55    0*139 502  60    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  65    0*141 530  70    0*143 545  80    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*
                     **      *** ***  **      *** ***  **  ***     ***

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*
           ***       **     **** ***  **      **** ***  **      **** ***  **
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(September 21st is new to HURDAT)
39843 08/21E420 320 25   0E420 310 25   0E420 300 25   0* 0   0   0   0*
          **** *** **   **** *** **   **** *** **

39845 HR

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), Colon - 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 33°W. 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 course 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 00Z on the 10th, six hours earlier than originally shown in HURDAT. HURDAT indicated an unrealistic increase in intensity from 60 kt at 00Z on the 10th to 105 kt at 06Z. There are no observations to indicate such a dramatic intensity increase, though the system did become a Category 2 hurricane later in the day. A rapid intensification is still indicated between 06 and 18Z on the 10th, but with a more realistic trend. Major intensity changes are at 06Z with 70 kt and at 12Z with 80 kt (both originally 105 kt). 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 – each of which would suggest a moderate increase over the standard pressure-wind relationship, 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. In addition, NHRP conducted a research mission from roughly 15Z to 22Z. It is unknown 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 12Z on the 21st becoming absorbed by the larger and intense extratropical cyclone to the northeast.

Tropical Storm Carla [September 7-16, 1956] – AL041956

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39850 09/05/1956 M= 7  4 SNBR= 867 CARLA       XING=0 SSS=0
39850 09/07/1956 M=10  4 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  35 1003*314 720  35 1002*320 708  40 1000*325 692  50    0*
           *** ***  ** **** ***  ***     **** ***  ***  ** **** ***  ***  **

39880 09/10*338 670  35  998*347 642  35    0*360 612  35  996*377 587  35    0*
39880 09/10*332 670  50    0E343 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. Aircraft highlights: Investigation mission found no low pressures or strong winds (ATSR/micro). "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 in 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. 32.5° N., Long. 70° 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. It is noted that Carla did not develop strong inner core (resembling more of a subtropical cyclone appearance) and thus the pressure-wind relationships may somewhat overstate the maximum wind for a given central pressure. An intensity of 35 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 35 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 40 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 16Z, a ship reported SSW 40 kt winds with 996 mb. A peripheral pressure of 996 mb supports at least 50 kt from the north of 25N Brown et al. pressure-wind relationship. At 18Z, another ship located at 32.3N, 70.0W reported 50 kt N and 1000 mb. An intensity of 50 kt has been selected for 18Z on the 9th, up from 35 kt originally in HURDAT. 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.) A central pressure of 998 mb is present in HURDAT at 00Z on the 10th, but it does not appears reasonable given the ship observations available and is removed.

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 06Z 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. 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 is made to the in intensity to HURDAT on this date. 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] – AL051956

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39895 09/10/1956 M= 3   5 SNBR= 868 DORA        XING=0 SSS=0
39895 09/10/1956 M= 4   5 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*
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

Landfall:

9/12/18Z - 20.9N 97.3W - 50 kt - 1000 mb - Mexico
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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 northeasterly 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 and 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. (It is of note that the text storm report on one of the 1200 UTC 12 September microfilm maps states that while the “eye” was 8 n mi wide and clear, the wall cloud was poorly defined and existed only in the eastern quadrant. This suggest the system had an exposed center rather than a true eye.) Mainly due to estimated 50 kt surface winds, the intensity is analyzed 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.

Tropical Storm Ethel [September 11-14, 1956] – AL061956

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39920 09/11/1956 M= 4  6 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*
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           *** ***          *** ***  **      *** ***          *** ***  **
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*
           *** ***  **      *** ***  **
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39945 TS

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 peculiar 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). Aircraft highlights: 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. It is of note that the HWM 500 mb charts suggest a cold trough was over the cyclone as it develops on 11-12 September. It is possible that the system could have been considered a subtropical cyclone on these dates instead of a tropical cyclone if satellite imagery were available.

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39950 09/21/1956 M=10  7 SNBR= 870 FLOSSY      XING=1 SSS=2
39950 09/20/1956 M=14  7 SNBR= 870 FLOSSY      XING=1 SSS=1
                   **                                  *

(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  75  980*299 876  80    0*
            *** ***  **  *** *** ***         * *** ***  **  *** *** ***  **

39975 09/25*304 864  65  980*307 856  45    0*312 844  40    0E320 830  35    0*
39975 09/25*304 864  80  974*308 854  50    0*312 844  40    0E319 832  35  998*
                     **  *** *** ***  **                       *** ***      ***

39980 09/26E328 816  35    0E336 801  35    0E344 789  30    0E348 784  30    0*
39980 09/26E326 818  40  999E334 803  45  999E341 791  45 1001E345 784  45 1001*
            *** ***  **  *** *** ***  **  *** *** ***  ** **** ***      **  ****

39985 09/27E350 780  30    0E351 776  30    0E353 772  35    0E358 765  35    0*
39985 09/27E348 780  50 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 LA1AFL1
           *
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U.S. Hurricane
Sep 24th – 10Z – 29.1N 89.4W – 75 kt – Category 1 – 980 mb – 1010 mb OCI – 300 nm ROCI
Sep 25th – 00Z – 30.4N 86.4W – 75 kt – Category 1 – 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), Richter and DiLoreto (1956), Graham and Hudson (1960), Surface Weather Observations, Monthly Weather Review, Mexican synoptic maps, Climatological Data National Summary, 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). 994 mb central pressure at 26.3N 90.2W at 0650Z ("SS Tasculus" – micro). 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: 60 kt SSE and 982 mb at 29.5N, 87.2W at 00Z (micro), 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). 980 mb ("passed within the eye") at 15Z, no location (Graham and Hudson), 974 mb ("a dredge within the eye") at Destin at 2325Z (Graham and Hudson). Land highlights: 72 kt, gusts to 82 kt at an Oil Rig at 29.1N, 90.5W at 0505Z (CONNOR/MWR). 78 kt (estimated) NW, gusts to 85 kt, 989 mb at Grande Isle, LA at 09Z (CDNS/CONNOR). 983 mb at Burrwood, LA at 1010Z (CDNS/CONNOR – CDNS indicates 1100Z). 983 mb at Venice, LA (calm between 0950Z-1155Z) (CONNOR). 78 kt (estimated) NW at Burrwood, LA at 1228Z (CDNS/CONNOR – CDNS indicates 1205Z). 984 mb with 50 kt NE (max wind) at Pensacola (airport), FL at 2010Z (CDNS). 980 mb with 30 kt N at Pensacola NAS at 2030Z, 56 kt max wind (no time)(CDNS/SWO). 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." ATSR: "Flossy entered the Mississippi Delta 10 miles north of Burrwood, 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." "The central pressure early on the morning of the 24th, at the time the hurricane center crossed the Mississippi Delta, as computed to be near 28.80 in. [975 mb]...Radius of maximum winds – 22 nm" (Graham and Hudson).

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). 37 kt SW (max wind) at Savannah, GA at 0454Z (CDNS). 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). 45 kt NE (max wind) at Hatteras, NC at 0743Z (CDNS). 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." Extratropical transition occurred between 00Z 25th and 00Z 26th (Richter and DiLoreto).

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). 49 kt NE (max wind) at Norfolk, VA at 0130Z (CDNS). 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 in comparison with numerous nearby ships, 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. Landfall occurred between the towns of Burrwood and Venice, with both registering a

pressure of 983 mb. Venice reported calm conditions between 0950Z and 1150Z. The central pressure is analyzed at 980 mb, slightly less deep than the 975 mb estimated by Graham and Hudson. A central pressure of 983 mb was present in HURDAT at 06Z on the 24th and has been moved to 12Z with a value of 980 mb. This central pressure suggests 73 kt from the north of 25N pressure-wind relationship and 76 kt from the intensifying subset. Grand Isle and Burrwood had estimated sustained winds of 78 kt. Given the near average speed (14 kt), and slightly low environmental pressure (1010 mb outer closed isobar), 75 kt is analyzed as the maximum sustained wind. This makes Flossy a Category 1 at landfall in Louisiana, which is a downgrade from the original Category 2 analyzed by Hebert and Taylor.

Flossy continued to deepen after leaving Louisiana 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. The eye passed just south of Pensacola and made landfall near Destin, where a 974 mb observation was taken in the eye. 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 15 nm south of the city. A central pressure of 974 mb suggests maximum surface winds of 80 kt from the north of 25N pressure-wind relationship and 83 kt from the intensifying subset. The 30 nm diameter eye suggests an RMW of about 22 nm, compared with 23 nm for climatology at that central pressure and latitude (Vickery et al.) Flossy had a near average forward speed (12 kt) and a slightly lower than average environmental pressure (OCI of 1010 mb). An intensity of 80 kt is thus selected at 18Z on the 24th and 00Z on the 25th. The original HURDAT shows 80 kt and 65 kt, respectively 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 80 kt. This also makes Flossy a high end Category 1 hurricane, same as that originally in HURDAT.

80 kt is also the peak intensity for the lifetime of Flossy, same as that shown originally in HURDAT. 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 Kaplan and DeMaria model was run for 06Z, 12Z and 18Z on the 25th, yielding 53 kt, 39 kt and 30 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. The hurricane weakened to tropical storm intensity at 06Z on the 25th, same as in 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. Also Hatteras, NC reported 45 kt NE at 0743Z. An intensity of 40 kt is selected for 00Z, 45 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, while Norfolk, VA observed a peak winds of 49 kt NE at 0130Z on the 27th. 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.

Hurricane Greta [October 31 - November 7, 1956] – AL081956

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40010 10/30/1956 M= 9  8 SNBR= 871 GRETA       XING=0 SSS=0
40010 10/31/1956 M= 8  8 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*
                           *   *   *        *   *   *        *   *   *

40020 10/31*182 749  25    0*192 747  25    0*204 745  25    0*217 744  25    0*
40020 10/31*200 747  25    0*204 748  25    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*
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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     0*293 558  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*
            ***  ***  **      ***  ***  **
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40060 HR

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). 10 kt NNE and 989 mb at 26.4N 72.4W at 15Z (micro); 30 kt SE and 987 mb at 25.5N 71.2W at 18Z (micro); 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). 45 kt WSW and 977 at 22.4N 67.6W

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). 45 kt NE and 977 mb at 26.6N 61.5W at 12Z (HWM); 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 with a 10 nm diameter "diffuse" eye 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 (MWR, ATSR, this may have been an NHRP research mission).

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. 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 00Z on October 31st just north of eastern Cuba. Genesis is delayed 18 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. 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. Winds of hurricane intensity were reported by ships on the 4th, including 80 kt at 15Z and 70 kt at 21Z. Because of the increase in forward speed and the subsequent hurricane force winds later in the day, an intensity of 65 kt is selected at 00Z on the 4th, bringing Greta to hurricane intensity.

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 this was likely from an NHRP research mission (but for which no additional information is available). 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 on the 5th. 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. A 10 nm diameter eye was reported, which would suggest a quite small RMW. However, the eye was also described as “diffuse”, placing doubt as to whether a 5-10 nm RMW is appropriate. 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 12Z on the 6th, 12 hours earlier than originally shown in HURDAT. Data analysis at 12Z on the 6th (perhaps as early as 06Z) 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. 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. Late on the 6th and early on the 7th, Greta continued northeastward becoming embedded within a frontal boundary. After 12Z on the 7th, the circulation had become absorbed within a larger extratropical system to its northeast. Thus the last point is now 12Z on the 7th (six hours later than HURDAT).

It is of interest to compare the sizes of Greta versus Sandy of 2012. The largest 34 kt wind radii of Hurricane Sandy, analyzed at 00Z on October 28, 2012, reached 480 nm. For Greta, the 34 kt wind radii at 12Z on the 4th is analyzed to have been about 550 nm to the northwest. The ROCI of Hurricane Sandy on October 28th at 18Z was estimated to be 500 nm, which is the same as that for Greta at 12Z on the 5th.

New Storm [June 7-10, 1956] – AL091956

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37265 06/07/1956 M= 4  9 SNBR= 820 UNNAMED       XING=0 SSS=0

37265 06/07*0   0    0     0*340 751  35    0*337 756  35 1002*333 760  35    0*
37265 06/08*326 762  35    0*316 763  40    0*312 762  40    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 30 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 35 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 40 kt is selected for 06Z and 12Z on the 8th. 40 kt is also the peak intensity for the lifetime of this tropical cyclone, as the system appeared to lack an inner core. It is of note that this system has some hybrid characteristics, including some cool and dry air advection northwest of the system (especially overland) on the 7th and 8th as well as a trough developing northeast of the system on the 8th, especially as depicted at 06 and 12Z. However, the inner core of the system remained warm and moist with no frontal boundary detected over or near the system on the 7th to late on the 9th. 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 on the 9th and 10th. By 12Z on the 10th, the system was becoming quite disorganized, though a center may still have existed near 37N 66.5W while moving toward the east-northeast. At 18Z, a center was no longer present along the frontal boundary. By 00Z on the 11th, a center from a new extratropical cyclone formed near 40N 63W. This new extratropical cyclone then lasted a couple more days until dissipation. Since the original center of the tropical storm dissipated, the extratropical cyclone that formed by 00Z on the 11th is a separate feature and not included within the HURDAT for this system. It is of note that an examination of the 500 mb charts in the HWM suggests that this new tropical storm formed under a rather cold upper-level trough (temperatures of -10C to -13C). This plus the lack of evidence of an inner wind core, suggests the system was more subtropical than tropical. However, such a formal designation is not available until the advent of routine satellite imagery in the mid-1960s.

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37265 10/09/1956 M=4 9 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: 25 kt NNE and 1006 mb at 18Z at 11N 41W (micro).

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: 10 kt N and 989 mb at 15.4N 46.6W at 00Z (micro); 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 and the ship appears to have no significant pressure bias in comparison of its several observations on the 8th and 9th versus other ships. 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. It is of note that the reanalysis did not rely upon the 989 mb pressure reading, as it is uncertain as to the reliability of the measurement. Instead, the two independent measurements of 40 kt and 1004 mb from the Del Sol (as well as a 10 mb drop in 21 hours from aboard the ship) are sufficient to establish tropical storm intensity for this system. It is unknown why forecasters in 1956 did not "name" the system and initiate advisories, nor why Cry et al. did not include the system into the 1959 track book. Perhaps its non-inclusion was due to its somewhat weak and short-lived nature.

New Storm [October 14-18, 1956] – AL111956

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37265 10/14/1956 M= 6 10 SNBR= 820 UNNAMED       XING=0 SSS=0
37265 10/14*  0   0   0    0*  0   0   0    0*226 798  35    0*229 800  45    0*
37265 10/15*232 801  50    0*237 802  50    0*242 803  50    0*248 805  50    0*
37265 10/16*256 806  55    0*269 807  55    0*282 807  50  999*292 806  50    0*
37265 10/17*301 803  50  997*311 798  50  996*323 789  50    0E337 779  50    0*
37265 10/18E352 770  45    0E364 759  45  999E375 745  45    0E385 720  45    0*
37265 10/19E392 680  45    0*  0   0   0    0*  0   0   0    0*  0   0   0    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 1014 mb at 25.5N, 79.5W at 12Z (micro – the observation is plotted in the wrong location and appears to actually be at 30.5N 79.5W). 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: 55 kt NNW at 23.2N 81.1W at 00Z (micro); 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: 55 kt NE at 30.7N 75.3W at 00Z (COADS); 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 based upon a 35 kt ship report within the circulation of the 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. 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 and intensities of 45 kt at 18Z on the 14th and 50 kt at 00Z on the 15th are assessed. 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. (It is also of note that a strong pressure gradient was present to the north of the tropical cyclone on the 15th, generating gale-force winds over 300 nm from the center, which was not directly due to this system. However, the assessed intensity of the system does not take into account these indirect gale force winds.)

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 55 kt at this time. 50 kt is also the peak intensity for this tropical cyclone from 00Z to 06Z on the 16th. 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 and minimum pressure of 1001 mb, suggesting a central pressure of 999 mb, which has been added to HURDAT at 12Z. 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. A ship near the center reported 50 kt S at 15Z on the 17th. It is analyzed that at 18Z on October 17th, the tropical cyclone became an extratropical cyclone. 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 00Z on October 19. The development and characteristics of this cyclone bear similarities to Tropical Storm Leslie in 2000 and Tropical Storm Nicole in 2010.

New Storm [November 19-21, 1956] – AL121956

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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*
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. (This ship was compared for four days against neighboring ships and the pressures do not appear to be biased. Additionally, the ship showed a 9 mb 24 hour pressure drop (1011 to 1002 mb) and a 14 mb 48 hour pressure drop (1016 to 1002 mb).) 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. (This ship was compared against other neighboring ships for four days and the winds from it have no apparent bias.) 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 $100,000 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. The disturbance was listed 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 Atlantic Hurricane Database Reanalysis – Sandy Delgado and Chris Landsea

Green indicates wind changes of 15 kt or greater
Blue indicates lat/long changes greater than 1°
Red indicates a new entry
Yellow indicates a deletion

Unnamed Tropical Storm 1 [June 8-15, 1957] – AL011957

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40065 06/08/1957 M= 8  1 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 1000*323 782  45    0*
                     ** ****            **** ***        **** ***

40080 06/10*331 761  55    0E332 742  60    0E330 726  60    0E325 714  60    0*
40080 06/10*324 761  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

Significant Revisions:

1. Initial intensity significantly increased on the 8th based upon a ship report.

2. Tropical storm intensity thus indicated to occur 6 hours earlier.

3. Significant changes introduced to the track of the system (while extratropical) on the 11th, 12th, and 15th based upon ship reports.

4. Dissipation delayed by 12 hours based upon ship reports.

Daily Metadata:

June 7:

1. Maps and old HURDAT:

- HWM analyzes a spot low pressure at 23.5N, 93.2W at 12Z.
- HURDAT does not list an organized storm on this date.
- Microfilm does not show an organized system on this date.

2. Discussion:

a. 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."

b. Reanalysis: 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.

June 8:

1. Maps and old HURDAT:

- 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.

2. 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).

3. Land highlights:

- 5 kt NNE and 1005 mb at Panama City, FL at 21Z (micro).

4. Discussion:

a. 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."

b. Reanalysis: 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 (but perhaps 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. 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.

June 9:

1. Maps and old HURDAT:

- 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.

2. 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).

3. 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 (minimum pressure) with SW 10 kt at Savannah, GA at 0957Z (CLIMO, SWO).
- 1005 mb (minimum pressure) with NE 12 kt at Charleston, SC at 1159Z (CLIMO, SWO).

4. Discussion:

a. MWR: "The storm weakened as it moved inland but set off an active frontal wave after moving off the Georgia coast on the 9th."

b. Reanalysis: 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. Observations at 10Z from Savannah support a central pressure of about 1000 mb, which is added to HURDAT at 12Z. 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.

June 10:

1. Maps and old HURDAT:

- 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.

2. 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).

3. Discussion:

a. MWR: "Late on the 9th when the storm became extratropical off the Atlantic coast, ship reports indicated winds up to 65 knots."

b. Reanalysis: 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. At the same time, the system deepened and the intensity increased, suggesting that tropical processes were still at work while the cyclone moved over the warm Gulf Stream. The intensity at 00Z on the 10th is analyzed at 55 kt, same as HURDAT, and is the peak intensity of the system as a tropical cyclone. It is analyzed that the tropical storm became a hurricane-force extratropical cyclone around 06Z on June 10th, the same time as that originally shown in HURDAT. 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.

June 11:

1. Maps and old HURDAT:

- 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.

2. 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).

3. Discussion/Reanalysis: 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.

June 12:

1. Maps and old HURDAT:

- 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.

2. 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:

1. Maps and old HURDAT:

- 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.

2. 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).

3. Discussion/Reanalysis: On June 13th, the extratropical cyclone passed just south of Bermuda while moving northeast as a frontal boundary exited the United States.

June 14:

1. Maps and old HURDAT:

- 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.

2. Ship highlights:

- 40 kt SW and 1012 mb at 34.2N, 56.6W at 18Z (COADS).

June 15:

1. Maps and old HURDAT:

- 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.

2. Ship highlights:

- 35 kt SSE and 1008 mb at 35.0N, 57.9W at 06Z (COADS).

3. Discussion/Reanalysis: 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 is 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.

June 16:

1. Maps and old HURDAT:

- 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.

2. Ship highlights: No gales or low pressures.

Sources: NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Mexican synoptic maps, Surface Weather Observations and Monthly Weather Review.

Hurricane Audrey [June 24-29, 1957]- AL021957

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40115 06/25/1957 M= 5  2 SNBR= 873 AUDREY      XING=1 SSS=4
40115 06/24/1957 M= 6  2 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*239 936  80    0*248 937  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*266 937  90    0*280 938 100    0*293 938 110  946*306 935  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  35    0*
                     **    **    ***         **** ***         *         **

40140 06/29E394 809  40    0E437 771  50    0*  0   0   0    0*  0   0   0    0*
40140 06/29E394 809  40    0*  0   0   0    0*  0   0   0    0*  0   0   0    0*
                           *   *   *   *

40145 HRCTX4LA4
40145 HRCTX2LA3
         ******

U.S. Hurricane:
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June 27th – 1330Z – 29.8N 93.7W – 110 kt – Category 3 – 946 mb – 1003 mb OCI – 200 nm ROCI – 15 nm RMW

Significant Revisions:

1. Genesis: Started system 18 hours earlier based on ship reports on 24 June showing a closed circulation.

2. Tropical storm status 12 hours earlier based on 25 June ship report.

3. Maximum winds reduced on 25 June based on reported aircraft pressures, eye diameter, and motion. This delays hurricane status by six hours.

4. Modified HURDAT pressures on 25-26 June based on aircraft pressure data.

5. Intensities on 27 June significantly reduced, including the landfall intensities. Landfall status reduced from Category 4 to Category 3.

6. Landfall pressure modified by analysis of surface obs.

7. Intensities on 27-28 June after landfall modified based on Kaplan-DeMaria model.

8. Extratropical transition delayed 18 hours based on surface map data.

9. Dissipation moved up six hours based on surface map data.

Daily Metadata:

June 21:

1. Maps and old HURDAT:

- HWM analyzes a closed low pressure of at most 1010 mb at 16.5N, 85.5W at 12Z.
- HURDAT, microfilm, and ships show nothing of significance.

June 22:

1. Maps and old HURDAT:

- HWM analyzes a spot low pressure at 18.0N, 89.0W at 12Z.
- HURDAT, microfilm, and ships show nothing of significance.

June 23:

1. Maps and old HURDAT:

- HWM analyzes a spot low pressure at 20.0N, 94.0W at 12Z.
- HURDAT, microfilm, and ships show nothing of significance.

June 24:

1. Maps and old HURDAT:

- HWM analyzes a tropical storm of at most 1005 mb at 21.8N, 93.8W at 12Z
- HURDAT: No system on this date.
- Microfilm shows a closed low pressure of at most 1011 mb at 20.0N, 93.0W at 12Z.

2. 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)

3. Discussion:

a. MWR: "Hurricane 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."

b. Reanalysis: 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. 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.

June 25:

1. Maps and old HURDAT:

- 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.

2. 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).

3. 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).

4. Discussion:

a. 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."

b. 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."

c. Re-Analysis: 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 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.

June 26:

1. Maps and old HURDAT:

- 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.

2. 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).

3. 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).

4. Discussion:

a. Re-Analysis: A final center fix was made on the 25th at 2348Z measuring a central pressure of 979 mb with estimated 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. 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 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.

June 27:

1. Maps and old HURDAT:

- 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.

2. 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).
- 130 kt ("Sharp"), 126 kt ("Craig"), 126 kt ("Bates"), and 104 kt ("Reading") peak gusts (NHRP).

3. 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 or 1415Z to 1615Z (MWR, CDNS).
- 90 kt SW at Sabine, TX at 15Z (NHRP).
- 50 kt NNW and 973 mb at Port Arthur, TX at 15Z (SWO).
- 60 kt SE (gusts to 84 kt) at Lake Charles, LA at 1530Z (SWO).
- 60 kt SSW and 972 mb (min pressure) at Lake Charles, LA at 18Z (SWO).

4. 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).

5. Previous landfall data:

- "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)

6. Discussion:

a. MWR: "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… At 1530 GMT on the 27th…the town [of Orange, Tx] was now in the dead calm associated with the eye of the storm … An oil rig reported winds up to 180 m.p.h. and a pressure of 925 mb."

b. 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."'

c. NHRP: "The smoothed track of the hurricane center is shown in figure 15-1. Over the Gulf of Mexico, hourly positions of the storm center along the track were determined largely from aircraft reconnaissance reports and land-based radar reports. Over land, the hourly positions were determined from reports of calms and from radar eye reports. Reports of minimum pressure and wind shifts were also used in positioning the track … The lowest observed pressure in the hurricane, 28.30 in. at Hackberry, La., 12 n. mi. from the pressure center, was used as the inner most point of the visually-fitted profile when computing the exponential curve. The minimum observed pressure at Port Arthur, Tex., 28.52 in., 17 n. mi. from the pressure center, also fell on the exponential curve…A 70 percent confidence interval about the central pressure as extrapolated from the pressure observation nearest the pressure center … indicates that … the true

central pressure in hurricane Audrey lies between 27.15 in. [919 mb] and 28.35 in. [960 mb] … A radius of maximum winds of 19 n. mi. was computed using formula (1-1). This value is supported by observed data. Neither Lake Charles, La., nor Port Arthur, Tex., which lay approximately 19 n. mi. to the right and left of the track of the storm center, respectively, reported a lull in the wind as the center passed closest to the station. Their peak winds occurred about the time the center passed closes to the station. This would indicate that they lay at our outside of the radius of maximum winds … Central pressure (in.), 27.95* [946 mb] * - Computed with the exponential formula … Radius of maximum wind (n. mi.), Computed 19* * - Computed with the exponential formula, Observed 16-19# # - Estimated from miscellaneous wind observations … Four oil barge tenders from Continental Oil Co. – the Sharp, Bates, Reading, and Craig – provided peak gust measurements. The tenders were equipped with Bendix-Friez selsyn type anemometers located 65 feet above the water."

d. Re-Analysis: Hurricane Audrey made landfall around 1330Z near 29.8N, 93.7W, just east of the Louisiana-Texas border. The lowest pressure (not a central pressure) of 958 mb was recorded at Hackberry, LA at an unknown time but likely around 15Z on the 27th. A 925 mb ship pressure noted in the 1957 Monthly Weather Review writeup was notably not included in the subsequent 1960 NHRP report, suggesting that this observation was erroneous.

Ho et al. analyzed that the RMW of Audrey at landfall was 20 nm, while Jarvinen estimated a much larger 52 nm RMW. The track of Audrey, based upon a combination of radar imagery and station observations, suggests that it passed about 15 nm east of Port Arthur (966 mb minimum pressure at 1523Z) and about 25 nm west of Lake Charles (972 mb minimum pressure at 1740Z). With no lull reported at either location, but a definitive "dead calm" at Orange (5-10 nm from the center at 1530Z), an RMW of 15 nm is analyzed. Observations at both Lake Charles and Port Arthur are not consistent with an RMW of 50-55 nm as suggested by Jarvinen, as no peak in winds occurred at either location at that distance from Audrey's center (around 13Z at Lake Charles and around 11Z at Port Arthur). Wind records for Lake Charles do indicate a distinct secondary peak in the winds around 1530Z. (Actually the values for the secondary peak and the peak winds at time of lowest pressure were the same - 60 kt.) This occurred about 2 ½ hours before the time of lowest pressure and peak winds at a radius of about 30 nm. Comparison with the radar imagery suggests that there may have been a concentric eye structure, though interpretation of the imagery is difficult as attenuation and radar tilt affect the ability to determine the structure with more certainty. Thus it appears that Audrey had a double wind maximum of radius 15 and 30 nm at landfall.

The center of Audrey passed about 15 nm to the west of Hackberry, LA, and the environmental pressure was 1004 mb. The Schloemer equation suggests a central pressure of 931 mb. Varying the RMW and radius of the 958 mb peripheral pressure measurement to 18 nm and 12 nm, respectively, gives 945 mb from the Scholemer equation. Varying the RMW and 958 mb peripheral pressure radius to 12 nm and 18 nm,

respectively gives 909 mb. A 972 mb pressure at 00Z on the 28th (possibly a central pressure – see discussion on the 28th) suggests a landfall central pressure of 940 mb from the Gulf Coast Ho et al. inland pressure decay model. (If the 972 mb is instead a peripheral pressure reading, then the inland decay model would suggest even lower than 940 mb.) 946 mb central pressure at landfall was calculated in the NHRP report (with a 70% confidence range from 919 mb to 960 mb), which was apparently incorporated into HURDAT as the 12Z value. This is the same value that Ho et al. arrived at as well. Finally, Jarvinen concluded a high end value of 955 mb central pressure.

Given the range of plausible central pressure values (931, 940, 946, 946, and 955 mb), the 946 mb already included in HURDAT is retained. A central pressure of 946 mb suggests maximum sustained winds of 114 kt from the intensifying subset of north of 25N pressure-wind relationship. Highest sustained winds were 90 kt SW at the Sabine, TX U.S. Coast Guard Station at 15Z. Audrey at landfall had quite low environmental pressures (1004 mb OCI), a slightly smaller than typical RMW (climatology suggests about 20 nm), and moderate forward speed (14 kt). Another consideration is that with the double wind maxima structure that this could indicate weaker peak winds than a single wind maximum hurricane. An intensity of 110 kt is selected for 12Z and at landfall at 14Z on June 26th, down from 125 kt, a major intensity change to HURDAT. 110 kt is also 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 95 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 77 kt, 50 kt and 35 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.

June 28:

1. Maps and old HURDAT:

- 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.

2. 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).

3. Land highlights:

- 972 mb at Winnfield, LA at 00Z (climo).
- 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).

4. Discussion/Reanalysis: 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 based upon the observation at Winnfield. The center did make a close approach to the town, though it is not known what the wind conditions were at the time of minimum pressure. The 972 mb is retained as a central pressure. 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.

June 29:

1. Maps and old HURDAT:

- 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.

2. Ship highlights: No gales or low pressures.

3. Land highlights:

- 15 kt SSE and 994 mb at Pittsburgh, PA at 00Z (micro).

4. Aircraft highlights:

- Radar center fix at 32.9N, 92.2W at 02Z (ATSR).

5. Discussion:

a. MWR: "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."

b. Reanalysis: Audrey 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.

Sources: 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, Navy reconnaissance book (ATSR), National Weather Office in Lake Charles, LA (NWSLC), the National Hurricane Research Project report #39 (1960), Schwardt et al. (1979), Ho et al. (1987), Jarrell et al. (1992) and Jarvinen (2006).

Tropical Storm Bertha [August 8-11, 1957] – AL031957

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40150 08/08/1957 M= 4  3 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  50    0*283 913  45    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  55  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

U.S. Tropical Storm Landfall
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08/10 06Z 29.7N 93.9W 55 kt TX
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Significant Revisions:

1. Genesis indicated to be 18 hours earlier based upon ship reports.

2. Tropical storm intensity reached 6 hours earlier based upon ship reports.

3. Significant increase in intensity shown early on the 9th based upon aircraft observations.

4. Tropical storm intensity retained 6 hours later based upon landfall a few hours later.

5. Dissipation indicated to be 12 hours earlier due to station observations.

Daily Metadata:

August 6:

1. Maps and old HURDAT:

- HWM analyzes weakening frontal boundary over the northern Gulf of Mexico at 12Z.
- HURDAT does not list an organized storm on this date.

2. Discussion:

a. MWR: "A weak extra-tropical Low entered the northeastern Gulf of Mexico on August 6 and drifted slowly westward for the next 2 days."

b. Reanalysis: "A frontal boundary entered the northern Gulf of Mexico on August 6th and a low pressure system developed soon thereafter."

August 7:

1. Maps and old HURDAT:

- 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.

2. Discussion:

a. 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."

b. Reanalysis: The disturbance became better organized on the 7th based on ship reports while the frontal boundary dissipated.

August 8:

1. Maps and old HURDAT:

- 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 position).
- Microfilm shows a closed low pressure of at most 1011 mb at 27.5N, 89.0W at 12Z.

2. 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).

3. 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).

4. Discussion:
   a. MWR: "It developed into a tropical storm about 100 miles south of the mouth of the Mississippi River on August 8."

   b. 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."

   c. Reanalysis: 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.

August 9:

1. Maps and old HURDAT:
   - 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.

2. 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).

3. 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).

4. Discussion:
   a: MWR: "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."

   b: ATSR: "Of interest during [the 8th] is that night a 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."

   C: Reanalysis: 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. At 00Z on the 9th, Bertha is analyzed to have reached an intensity of 55 kt based on various ships reporting winds up to 55 kt. A minor intensity change to the original HURDAT and 55 kt is the peak intensity of Bertha (though this was also achieved on the 10th). 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.

August 10:

1. Maps and old HURDAT:
   - 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.

2. Ship highlights:
   - 40 kt NE and 1012 mb at 28.6N, 95.1W at 00Z (micro).

3. 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).

4. Discussion/Reanalysis: The tropical cyclone approached landfall early on August 10th and is analyzed to have crossed the coast near the Texas-Louisiana 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 55 kt is analyzed at 06Z on the 10th, a minor change to HURDAT. Note that the original HURDAT indicated an earlier landfall and an intensity of 60 kt. 55 kt is also the peak intensity of Bertha (along with a peak of 55 kt that also occurred on the 9th). 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.

August 11:

1. Maps and old HURDAT:
   - 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.

2. Discussion:

a. 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."

b. Reanalysis: Early on August 11th, Bertha turned to the north over eastern Texas dissipating after 06Z, 12 hours earlier than originally shown in HURDAT.

August 12:

1. Maps and old HURDAT:

- HWM, HURDAT and micro do not analyze an organized tropical cyclone on this date.

Sources: NHC microfilm maps, Historical Weather Maps series, COADS ship database, Monthly Weather Review, the Local Climatological Data and Navy reconnaissance book (ATSR).

Hurricane Carrie [September 2-25, 1957] – AL041957

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40180 09/02/1957 M=23  4 SNBR= 875 CARRIE      XING=0 SSS=0
40180 09/02/1957 M=24  4 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*
           ***                                    ***

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    0*
                         ***     *** ***      *** *** ***    *     *** ***

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*
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            *** *** ***      *** *** ***      ***      **    * *** ***  **  ***

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  90  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  90  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  85    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  85    0*343 492  90    0*342 477  95    0*342 460  95    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  90    0*345 420  90    0*347 400  85    0*350 380  80    0*
            ***      **      *** ***  **          ***  **    *          **

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*
            *** ***          *** ***              ***          *** ***
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(September 25th is new to HURDAT)

40297 09/25E512 094 40   0E510 080 35   0E505 070 35   0E500 060 35   0*

40300 HR

Significant Revisions:

1. Multiple new central pressures added from the 8th through the 18th from aircraft observations.
2. Large downward changes to the intensity from the 8th through the 10th based upon aircraft observations.
3. Peak intensity adjusted downward from 135 to 120 kt on the 8th.
4. Large downward changes to the intensity on the 14th and 15th based upon aircraft observations.
5. Large increase in intensity indicated from late on the 19th through the 21st based upon ship observations.
6. Large southwestward adjustment to the hurricane's position on the 22nd based upon ship reports.
7. Large west-northwestward adjustments to the extratropical cyclone's positions on the 23rd and 24th based upon ship reports.
8. Dissipation delayed by 24 hours based upon ship and coastal observations.

Daily Metadata:

September 1:

1. Maps and old HURDAT:

- HWM is not available on this date (system is south of 20°N).
- HURDAT and microfilm do not indicate any system on this date.

September 2:

1. Maps and old HURDAT:

- 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.

2. Discussion:

a. 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."

b. 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."

c. Reanalysis: 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.

September 3:

1. Maps and old HURDAT:

- 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.

2. Discussion/Reanalysis: 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.

September 4:

1. Maps and old HURDAT:

- 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.

September 5:

1. Maps and old HURDAT:

- 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.

2. Discussion/reanalysis: 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.

September 6:

1. Maps and old HURDAT:

- 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.

2. 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).

3. Discussion:

a. 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."

b. 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."

c. Reanalysis: 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.

September 7:

1. Maps and old HURDAT:

- 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.

2. Aircraft highlights:

- Penetration center fix measured a central pressure of 945 mb, estimated maximum flight-level winds of 120 kt at 700 mb, and an eye diameter of 20 nm at 17.2N, 42.5W at 2148Z (micro).

3. Discussion:

a. 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."

b. 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."

c. Reanalysis: 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. Weighting the intensifying subset of the pressure-wind relationship more (as the system was likely intensifying given its location in the eastern Atlantic), an intensity of 120 kt 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.

September 8:

1. Maps and old HURDAT:

- 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.

2. Ship highlights:

- 35 kt NE and 1013 mb at 19.2N, 49.7W at 15Z (micro).

3. Aircraft highlights:

- Penetration center fix at 18.0N, 45.1W at 1930Z (ATSR).

4. Discussion/Reanalysis: 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 appeared in HURDAT at 12Z on the 8th and has been removed since the reconnaissance aircraft did not report a central pressure on the afternoon flight. 120 kt is maintained throughout the day, based upon the central pressure reported by aircraft late on the 7th. 120 kt, which is also

the peak intensity for this hurricane, is down from 135 kt originally in HURDAT at 18Z, a major intensity change.

September 9:

1. Maps and old HURDAT:

- 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.

2. 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 150 kt at 700 mb and an eye diameter of 10 nm at 19.4N, 49.6W at 2021Z (micro).

3. Discussion:

a. ATSR: "Due to the extreme range, only one aircraft fix per day was available on CARRIE."

b. Reanalysis: The next reconnaissance aircraft reached Carrie at 2021Z on September 9th measuring a central pressure of 975 mb, estimating flight level winds of 150 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.

September 10:

1. Maps and old HURDAT:

- 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.

2. 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 (ATSF).

- 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 (ATSR).
- Penetration center fix maximum winds of 65 kt at 700 mb, and an eye diameter of 20 nm at 20.7N, 52.1W at 1930Z (micro).

3. Discussion:

a. ATSR: "... until 10 September when two or more fixes per day were available ..."

b. Reanalysis: 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. At the 1930Z fix, a 700 mb height of 9880 ft/3011 m produces a range of central pressures of 1003-982 mb using today's extrapolations formula. An intensity of 65 kt is analyzed at 18Z on the 10th, a major intensity change from the 85 kt originally in HURDAT.

September 11:

1. Maps and old HURDAT:

- 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.

2. 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).

3. 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 surface winds of 60 kt, and an eye diameter of 25 nm at 20.9N, 52.2W at 20Z (micro).

4. Discussion:

a. 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."

b. Reanalysis: 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 position 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 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 978 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.

September 12:

1. Maps and old HURDAT:

- 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.

2. 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).

3. 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).

4. Discussion:

a. 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."

b. Reanalysis: 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.

September 13:

1. Maps and old HURDAT:

- 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.

2. 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).

3. 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).

4. Discussion/Reanalysis: 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.

September 14:

1. Maps and old HURDAT:

- 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.

2. 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).

3. 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).

4. Discussion/Reanalysis: 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.

September 15:

1. Maps and old HURDAT:

- 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.

2. 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).

3. 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 30N, 58W 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 30N, 58W around 22Z (NHRP).

4. Discussion/Reanalysis: 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 on the 15th down from 110 kt originally in HURDAT, a major intensity change. 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.

September 16:

1. Maps and old HURDAT:

- 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.

2. Ship highlights:

- 35 kt NE and 1021 mb at 35.5N, 57.8W at 00Z (micro).

3. 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).

4. Discussion:

a. 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."

b. Reanalysis: 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. It is of note that the comment in MWR regarding the well-organized hurricane seen by the NHRP observers appears inconsistent with other accounts of how disorganized the cyclone was on that date.

September 17:

1. Maps and old HURDAT:

- 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.

2. 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).

3. 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 35N, 64W around 18Z (NHRP).

4. Discussion/Reanalysis: 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.

September 18:

1. Maps and old HURDAT:

- 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.

2. 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).

3. 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).

4. Discussion/Reanalysis: 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.

September 19:

1. Maps and old HURDAT:

- 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.

2. 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).

3. 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).

4. Discussion:

a. ATSR: "...until after 19 September when range again restricted fixes to one per day."

b. Reanalysis: 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 84 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 19th, up from 70 kt originally in HURDAT, a minor intensity change.

September 20:

1. Maps and old HURDAT:

- 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.

2. 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).
- > 105 kt NE and 970 mb at 34.7N 46.2W at 1515Z (MWL).
- 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).

3. Aircraft highlights:

- Penetration center fix at 34.4N, 45.6W at 20Z (ATSR).

4. Discussion/Reanalysis: The ship San Veronico reported 970 mb and "over" 105 kt NE at 1515Z. The peripheral pressure suggests intensity of at least 84 kt from the north of 25N and 82 kt north of 35N pressure-wind relationships. An intensity of 95 kt is analyzed at 12 and 18Z, up significantly from 80 kt, though the system may have been a major hurricane.

September 21:

1. Maps and old HURDAT:

- 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.

2. 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).

3. Aircraft highlights:

- Penetration center fix at 35.1N, 36.9W at 1930Z (ATSR).

4. Discussion/Reanalysis: A central pressure of 972 mb is present in HURDAT at 12Z on the 21st but the only reconnaissance mission occurred at 1930Z which did not report a central pressure. Thus the 972 mb has been removed from HURDAT. Late on the 21st, a warm front started developing northeast of the circulation but the hurricane remained tropical. A ship at 18Z on the 21st appears to be reporting 90 kt SSW on microfilm but the report may be biased slightly high. An intensity of 80 kt is selected for 18Z on the 21th, up from 70 kt originally in HURDAT, a minor intensity change.

September 22:

1. Maps and old HURDAT:

- 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.

2. 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).

3. 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).

4. Discussion:

a. 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."

b. Reanalysis: Carrie turned to the northeast and increased in forward speed on September 22nd passing over the central Azores as a 75 kt hurricane around 15Z. The highest winds on microfilm at the Azores were 45 kt and lowest pressure was 983 mb.

September 23:

1. Maps and old HURDAT:

- 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.

2. 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).

3. Discussion/Reanalysis: 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.

September 24:

1. Maps and old HURDAT:

- 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.

2. 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).

3. Land highlights:

- 25 kt SE and 997 mb at Dingle, Ireland at 12Z (HWM).

4. Discussion:

a. 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."

b. Reanalysis: Further weakening occurred on September 24th as Carrie turned eastward and slowed its forward speed.

September 25:

1. Maps and old HURDAT:

- 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.

2. 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).

3. Land highlights:

- 15 kt SW and 1004 mb at Isles of Scilly, England at 12Z (HWM).

4. Discussion/Reanalysis: 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.

September 26:

1. Maps and old HURDAT:

- 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.

Sources: NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Monthly Weather Review, Navy reconnaissance book (ATSR), and the National Hurricane Research Project (NHRP)(Shea and Gray, 1973).

Tropical Storm Debbie [September 7-9, 1957] – AL051957

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40305 09/07/1957 M= 3  5 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    0*297 870  35 1003*304 860  35    0*
           *** ***          *** ***          *** ***     **** ***

40320 09/09*319 851  30    0*325 844  30    0*  0   0   0    0*  0   0   0    0*
40320 09/09*316 851  30    0*331 844  25    0*  0   0   0    0*  0   0   0    0*
           ***              ***       **

40325 TS
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U.S. Landfall:
9/8th – 17Z – 30.3N, 86.1W – 35 kt – FL

Significant Revision:

1. None.

September 5:

1. Maps and old HURDAT:

- 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.

2. Discussion:

a. 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."

September 6:

1. Maps and old HURDAT:

- 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.

September 7:

1. Maps and old HURDAT:

- 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.

2. Ship highlights:

- 35 kt SW and 1015 mb at 25.7N, 86.0W at 00Z (COADS).

3. Discussion:

a. MWR: "This wave was apparently the trigger which set off a weak circulation in the central Gulf on September 7."

b. Reanalysis: 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 25°N 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. 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.

September 8:

1. Maps and old HURDAT:

- 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.

2. 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).

3. 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).
- 17 kt SE and 1005 mb at Hurlburt Field at 11Z (SWO).
- 10 kt SW and 1006 mb at Hurlburt Field at 12Z (SWO).
- 5 kt N and 1005 mb at Hurlburt Field at 16Z (SWO).
- Calm and 1005 mb at Hurlburt Field at 17Z (SWO).
- 8 kt SW and 1005 mb at Hurlburt Field at 18Z (SWO).
- 9 kt ESE and 1006 mb at Eglin AFB at 12Z (SWO).
- 18 kt NW and 1005 mb at Eglin AFB at 13Z (SWO).
- 6 kt NE and 1006 mb at Eglin AFB at 18Z (SWO).
- 7 kt S and 1005 mb at Eglin AFB at 19Z (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).

4. Discussion:

a. 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."

b. 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...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...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...No reconnaissance flights were flown into Tropical Storm Debbie."

c. Reanalysis: 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. Station observations – especially from Hurlburt Field and Eglin Air Force Base - and the 06Z microfilm map indicate that a weak low existed ahead of Debbie, riding along the frontal boundary with the front/weak low moving southward from 06Z to 12Z. Ship and land observations at 12Z on the 8th show that Debbie had begun extratropical transition as dry air entered the center of the

cyclone, indicated by the dew point gradient across the storm. However, as significant cooler or drier air did not advect into the Florida Panhandle in the wake of Debbie, the cyclone apparently did not complete an extratropical transition. 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 tropical storm 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 very 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. However, without more comprehensive observations being available, removal of the system from HURDAT is not justified.

September 9:

1. Maps and old HURDAT:

- HWM and microfilm analyze a stationary front over the southeast of the United States.
- HURDAT lists a 30 kt tropical depression at 32.5N, 84.4W at 06Z (last position).

2. Discussion/Reanalysis: 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.

Sources: NHC microfilm maps, Historical Weather Maps series, COADS ship database, Monthly Weather Review, Local Climatological Data, Surface Weather Observations, Navy reconnaissance book (ATSR), and Mexican synoptic maps.

Tropical Storm Esther [September 16-19, 1957] – AL061957

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40330 09/16/1957 M= 4  6 SNBR= 877 ESTHER      XING=1 SSS=0
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*304 907  50    0*
           *** ***          *** ***  ** ****          **    *     ***  **
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40350 09/19*315 905  35    0*325 905  25    0*335 910  25    0*  0   0   0    0*
40350 09/19*315 907  35 1002*325 909  25    0*335 910  25    0*  0   0   0    0*
               ***     ****     ***

40355 TS

U.S. Tropical Storm Landfall
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09/18 12Z 29.2N 90.9W 55 kt LA
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Significant Revisions

1. Genesis is indicated 18 hours earlier based upon ship observations.

2. Intensification to a tropical storm is indicated to be 18 hours earlier based upon ship reports.

3. A significant south-southwestward adjustment was made to the system's position on the 17th based upon aircraft reconnaissance.

Daily Metadata:

September 14:

1. Maps and old HURDAT:
   - 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.

September 15:

1. Maps and old HURDAT:
   - 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.

2. Discussion:
   a. 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:

1. Maps and old HURDAT:
   - 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.

2. 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).

3. 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).

4. Discussion:
   a. 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 92°W. 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."

   b. Reanalysis: 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. 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.

September 17:

1. Maps and old HURDAT:
   - 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.

2. 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).

3. 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).

4. Discussion:

a. 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."

b. 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."

c. Reanalysis: A couple of gales up to 40 kt were reported on the 17th, both in the northeastern quadrant where the pressure gradient was the strongest, but a couple hundred miles from the center. It is possible that these were not directly associated with the storm. A 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 aircraft 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.

September 18:

1. Maps and old HURDAT:
   - 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.

2. 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).

3. 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).

4. 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).

5. Discussion:
a. 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.”

b. 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."

c. Reanalysis: 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 this 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 based upon a ship report of 50 kt at 12Z, the large area of 50 kt winds reported by the reconnaissance aircraft with a peak surface estimate of 68 kt (overly specific), and a couple of land observations of winds between 40 and 45 kt, all on the eastern quadrant of the storm.

September 19:

1. Maps and old HURDAT:
   - 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.

2. Ship highlights:
   - 35 kt SE and 1008 mb at 29.9N, 88.2W at 00Z (COADS).

3. Land highlights:
   - 10 kt S and 1004 mb at Liberty, MS at 00Z (micro).

4. Discussion/reanalysis: 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.

Sources: 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 (ATSR), and Mexican synoptic maps.

Hurricane Frieda [September 20-27, 1957] – AL071957

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40360 09/20/1957 M= 8  7 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    0*
                ***             ***  ** **** *** ***  **    * *** ***  **

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 1004*280 722  45    0*
            *** ***  **      *** ***          *** ***     **** ***

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  50    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 09/26*388 608  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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Significant Revisions:

1. Multiple central pressures were added from ship reports and several aircraft reconnaissance missions.

2. System upgraded to hurricane intensity 6 hours earlier based upon aircraft reconnaissance.

3. Extratropical transition indicated to be 6 hours earlier based upon observations from ships.

4. Intensity increased substantially on the 27th as extratropical due to ship reports.

5. Position adjusted substantially on the 27th toward the west-southwest as extratropical due to ship reports.

Daily Metadata:

September 18:

1. Maps and old HURDAT:
   - 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.

2. Discussion/Reanalysis: 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.

September 19:

1. Maps and old HURDAT:
   - 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.

2. Discussion/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:

1. Maps and old HURDAT:
   - 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.

2. Discussion:
   a. 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."

b. Reanalysis: 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.

September 21:

1. Maps and old HURDAT:
   - 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.

2. 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).

3. Discussion:
   a. MWR: "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."

   b. Reanalysis: 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.

September 22:

1. Maps and old HURDAT:
   - 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.

2. 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).

3. 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).

4. Discussion:

   a. 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."

   b. Reanalysis: 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, 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.

September 23:

1. Maps and old HURDAT:
   - 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.

2. 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).

3. Aircraft highlights:
   - Penetration center fix measured a central pressure of 1004 mb, estimated maximum surface winds of 50 kt and an eye diameter of 35 nm at 27.2N, 71.8W at 14Z (ATSR, micro).
   - Penetration center fix estimated maximum surface winds of 45 kt at 27.5N, 71.5W at 1945Z (micro).

4. Discussion:
   a. 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."

   b. Reanalysis: 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 1004 mb. A central pressure of 1004 mb suggests maximum sustained winds of 36 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.

September 24:

1. Maps and old HURDAT:

- 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.

2. 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).
   - 30 kt SE and 1004 mb at 32.2N, 69.5W at 18Z (micro).

3. 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).

4. Discussion:

   a. 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."

   b. 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."

   c. Reanalysis: 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. It is possible that the poor location of the aircraft center could be due to the nature of the

cyclone, bad navigation, or both. However, the 1002 mb central pressure at 1130Z from the aircraft is consistent with the subsequent 30 kt SE/1004 mb ship at 18Z and thus is included as a central pressure at the 12Z best track point.

September 25:

1. Maps and old HURDAT:
   - 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.

2. 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).

3. Discussion:

   a. 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."

   b. 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."

1. c. Reanalysis: 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. 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. 75 kt is also the peak intensity for this tropical cyclone, up from 70 kt originally in HURDAT, a minor intensity change.

September 26:

2. Maps and old HURDAT:
   - 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.

3. 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).

4. Discussion/Reanalysis: The timing of the extratropical transition is ambiguous because of the lack of observations on the west side of the system at 18Z 25th and 00Z 26th. However, the microfilm frontal analysis is likely incorrect at 06Z on the 26th, as a ship just northwest of the center has a temperature of 68F, with 77F from another ship just northeast of the center. Extratropical transition is indicated to be 06Z on the 26th – six hours earlier than HURDAT – but the exact timing remains uncertain. 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.

September 27:

1. Maps and old HURDAT:
   - 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.

2. 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).

3. Land highlights:
   - 15 kt W and 993 mb at St. John's, Newfoundland, Canada at 12Z (micro).

4. Discussion:

   a. MWR: "After becoming extratropical, Frieda continued rapidly northeastward, with gradually decreasing intensity, and passed across Newfoundland on the night of the 26th."

   b. Reanalysis: 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.

September 28:

1. Maps and old HURDAT:
   - 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:

1. Maps and old HURDAT:

- 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:

1. Maps and old HURDAT:
   - 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.

Sources: NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Navy reconnaissance book (ATSR), and Monthly Weather Review.

Unnamed Tropical Storm #8 [October 23-27, 1957] – AL081957

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40410 10/23/1957 M= 5  8 SNBR= 879 NOT NAMED   XING=0 SSS=0                    L
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    0*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  45    0*254 650  45    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    0*282 654  50  991*292 648  50    0*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*
            *** ***  **      *** ***  **      *** ***  **      *** ***  **

40435 10/27E370 553  30    0E376 519  25    0E383 485  25    0E388 446  25    0*
40435 10/27*375 540  40    0*379 505  35    0*383 475  30    0*388 446  25    0*
            **** ***  **     **** ***  **     *    ***  **     *

40440 TS
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Significant Revisions:

1. Substantial northward change on the 23rd and 26th and substantial eastward change on the 27th based upon ship reports.

2. Substantial increase in intensity on the 25th due to ship and Bermuda observations.

3. Removal of four central pressures, which were likely estimates.

4. Removal of the extratropical stage.

Daily Metadata:

October 22:

1. Maps and old HURDAT:
   - 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.

October 23:

1. Maps and old HURDAT:
   - 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.

2. 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).

3. Discussion:

   a. 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."

   b. Reanalysis: 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. 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 appeared in HURDAT at 12Z on the 23rd. As there was no reconnaissance aircraft investigating the tropical cyclone on this date nor ship observations near the center, this value is removed from HURDAT. The intensity is boosted slightly on this day based upon ship observations available early on the 24th.

October 24:

1. Maps and old HURDAT:

- 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.

2. 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).
   - 30 kt W and 999 mb at 23.1N, 64.3W at 12Z (micro).
   - 25 kt NNW and 1000 mb at 25.1N, 66.9W at 18Z (COADS).

3. 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 1000 mb and a center diameter of 100 nm at 25.8N, 63.7W at 1430Z (micro).

4. Discussion:

   a. 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."

   b. Reanalysis: 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. As there were no reconnaissance aircraft investigating the cyclone at this time nor ship observations near the center, the central pressure is

removed from HURDAT. 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 1000 mb and an eye diameter of about 100 nm. This reported pressure is not believed to be a central pressure as one ship observed 30 kt W with 999 mb and another reported 35 kt NNW with 1002 mb. Thus, the 1000 mb aircraft measurement is 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.

October 25:

1. Maps and old HURDAT:
   - 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.

2. 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).
   - 20 kt WSW and 997 mb at 29.7N, 63.5W at 18Z (micro).

3. 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).

4. Aircraft highlights:
   - 25 kt WSW and 999 mb at 30.0N, 67.0W at 1930Z (micro).
   - 40 kt S at 30.0N, 60.5W at 2030Z (micro).

5. Discussion:

   a. MWR: "The lowest surface pressure reported was 993 mb by a ship near 28N, 65W at 0600 GMT on the 25th."

   b. Reanalysis: 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. Central pressure of 993 mb appears in HURDAT at 00Z and 12Z on the 25th. These appears to be estimates and are removed. 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. 50 kt is the peak intensity for this system (unchanged) and is indicated from 18Z on the 24th (same as original) through 18Z on the 15th (originally the system dropped below 50 kt by 00Z on the 25th). Late in the day a frontal boundary approached the tropical cyclone from the west and 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. An aircraft reconnaissance mission investigated the cyclone as indicated by a few observations plotted on the 18Z microfilm, but no mission summary could be located.

October 26:

1. Maps and old HURDAT:
   - 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.

2. 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).

3. Land highlights:
   - 10 kt N and 1004 mb at Bermuda at 00Z (micro).

4. Discussion/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:

1. Maps and old HURDAT:
   - 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.

2. Ship highlights:
   - 35 kt W and 1010 mb at 36.1N, 54.4W at 00Z (COADS).

3. Discussion/Reanalysis: Late on the 26th, the circulation of the tropical cyclone began to become less organized as the frontal boundary started to absorb it. The timing of its dissipation is ambiguous and thus the last position is retained at 18Z on the 26th, though dissipation may have occurred 6-18 hours earlier. Furthermore, it is analyzed that the tropical cyclone did not become extratropical before being absorbed as originally shown in HURDAT, a major change.

Sources: NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Air Force aircraft reconnaissance, and Monthly Weather Review.

1957 Additional Notes:

1) April 30-May 4: The Historical Weather Map series, Microfilm, COADS ship database and Surface Weather Observations provide evidence for a subtropical cyclone that may have become a subtropical storm. Its development of this off-season 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 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 cyclone 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 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 cyclone, thus it is likely that this system may have been subtropical. The system initially moved slowly to the west and later turned to the northeast on May 1st. A ship at 12Z on the 1st 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. Around 14Z on the 1st, the system made landfall in southern Louisiana. 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. A ship near the coast

reported 30 kt W and 1003 mb at 00Z on the 2nd. At the same time, LaFayette, LA reported 15 kt E and 1003 mb, this suggests a central pressure of 1000 mb. At 06Z on the 2nd, LaFayette, LA reported 15 kt W and 1002 mb, this suggests a central pressure of 999 mb. At 12Z on the 2nd, Baton Rouge, LA reported 15 kt SW and 1003 mb, this suggests a central pressure of 1000 mb. Late on the 2nd, the system 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. Early on the 3rd, the system started to accelerate to the east-northeast and the structure broadens, becoming elongated E-W, with weak winds near it. At 0528Z on the 3nd, McComb, MS reported 10 kt NW and 1003 mb, this suggests a central pressure of 1001 mb. At 12Z on the 3nd, Meridian, MS reported 10 kt S and 1003 mb, suggesting a central pressure of 1001 mb. Late on the 3rd, the system 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. At 00Z on the 4nd, Dothan, AL reported 10 kt S and 1001 mb, this suggests a central pressure of 999 mb. At 06Z on the 4th, observations indicate that the system became an extratropical cyclone over southeast Alabama. 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. While the system was probably a hybrid (subtropical) cyclone, the evidence that it had gale-force winds is a bit thin due to only one observation of such winds. The low pressures that might suggest it was of tropical storm strength are also suspect due to the broad nature of the system. A secondary consideration is that this cyclone seems to have had little or no impact on the Gulf Coast other than from rain and tornadoes. There is no mention of any significant wind in the severe storm data in the Climatological Data National Summary or any of the state climatological data publications. While not conclusive, this also suggests the cyclone was not very strong.

Day	LAT	LONG	STATUS
April 30	29N	92W	Subtropical Depression?
May 1	30N	93W	Subtropical Storm?
May 2	30N	92W	Subtropical Depression?
May 3	31N	89W	Subtropical Depression?
May 4	32N	84W	Extratropical

2) July 16-19: Microfilm shows a tropical wave over the central Atlantic on July 16th that became convectively active as it approached the Lesser Antilles. The disturbance was investigated by a reconnaissance aircraft on July 18th and found winds below tropical storm intensity, pressures above 1011 mb and no closed circulation. The system continued westward and lost intensity the next day as it interacted with northeastern South America. Therefore, since the disturbance did not have a well-defined center, nor gale-force winds, it is not added to HURDAT. This disturbance was in the MWR's Weather Notes, July 1957, Pg. 251-253.

Day	LAT	LONG	STATUS
July 16	8N-16N	49W	Tropical Wave
July 17	8N-16N	51W	Tropical Wave
July 18	8N-16N	55W	Tropical Wave
July 19	8N-16N	61W	Tropical Wave

3) 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

4) November 3-7: Sources from the Historical Weather Map series, Microfilm, COADS ship database, and David Roth's suspect list indicated that a tropical storm (or subtropical storm) may have formed in early November over the northeastern Caribbean and moved northeastward over the open Atlantic. 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 around 12Z on November 3rd and the system may have been a tropical depression at this time. The 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. A ship reported 30 kt northeast of the center 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. 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. The ship "Seattle" located on the southeast quadrant reported 45 kt SW at 12Z on the 5th, however, the ship is about 200 nm from the center and no time series from ship is available to determine its accuracy. Weakening started on November 6th as a frontal boundary approached from the west. Later on the 7th, ship observations indicate that the cyclone became less organized and either dissipated over the north Atlantic or was absorbed by the approaching frontal boundary.

Day	LAT	LONG	STATUS
November 3	18N	64W	Tropical Depression?
November 4	21N	62W	Tropical Depression?
November 5	24N	58W	Tropical Depression/Tropical Storm?
November 6	29N	52W	Tropical Depression/Tropical Storm?
November 7	32N	44W	Tropical Depression?

5) 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 Atlantic Hurricane Database Reanalysis – Sandy Delgado and Chris Landsea

Green indicates wind changes of 15 kt or greater
Yellow indicates lat/long changes greater than 1°
Red indicates a new entry
Blue indicates a deletion

"Minor" intensity changes are less than 20 kt
"Minor" position changes are less than 2 degrees

Tropical Storm Alma [June 14-16, 1958] – AL011958

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40445 06/14/1958 M= 3  1 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*211 945  30    0*217 950  40    0*225 956  50    0*
                                                                  **

40455 06/15*235 964  40  997*245 973  35 1006*256 981  35    0*267 990  30    0*
40455 06/15*235 964  55    0*245 973  55    0*256 981  45    0*267 990  30    0*
                     **    *          **    *          **

40460 06/16*2791001  25    0*2911010  20    0*3031017  15    0*3141025  15    0*
40460 06/16*2791001  25    0*2911010  20    0*  0   0   0    0*  0   0   0    0*
                                               *   *   *        *   *   *

40465 TS
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Tropical Storm Landfall

06/15 08Z 24.9N 97.6W 55 kt Mexico

Significant Revisions:

- Large intensity increases on the 15th based on ship observations
- 12 hours removed from the end of Alma's lifecycle based upon land observations

Daily Metadata:

June 12:

1. Maps and old HURDAT:

- 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.

2. Land highlights: 5 kt ENE and 1005 mb at Campeche, Mexico at 18Z (micro).

3. Discussion/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:

1. Maps and old HURDAT:

- 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.

2. 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).

3. Discussion:

a. MWR: "On succeeding maps, a weak circulation was observed and heavy rains continued over the northwestern Caribbean and eventually spread into Central America. The weak circulation moved westward into the Yucatan Peninsula-Guatemala area on the 12th and into the Gulf of Campeche on the 13th."

b. ATSR: "A low cell on the ITC was located over northern Guatemala causing intensive rainfall on June 13th."

c. Reanalysis: 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.

June 14:

1. Maps and old HURDAT:

- 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.

2. Ship highlights:

- 40 kt SSE and 997 mb at 22.8N, 95.6W at 21Z (MWR).

3. Land highlights:

- 1005 mb at Campeche, Mexico at 00Z (micro).
- 15 kt WNW and 1004 mb at Tampico, Mexico at 18Z (micro).

4. Discussion:

a. 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."

b. 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."

c. Reanalysis: 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. 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 55 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.

June 15:

1. Maps and Old HURDAT:

- 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.

2. Ship highlights:

- 35 kt SW and 1006 mb at 20.2N, 93.0W at 05Z (MWR/micro).

3. Land highlights:

- 15 kt W and 1004 mb at Tampico, Mexico at 00Z (micro).
- 35 kt, gusts to 40 kt at South Padre Island, TX at 16Z (WALLETS).
- 8 kt SW and 1004 mb (min pressure) at Laredo, TX at 2258Z (SWO).
- 20 kt SE and 1004 mb (max wind) at Del Rio, TX at 2359Z (SWO).

4. Aircraft highlights:

- Coast Guard aircraft measured 50 kt (likely visually estimated surface winds) near 25.3N, 97.2W at 14Z (MWR).

5. Discussion:

a. 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."

b. 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... 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."

c. Reanalysis: 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. 55 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 55 kt for 06Z on the 15th, 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 08Z. Alma crossed the coast near 24.9N, 97.6W, east of San Fernando, Tamaulipas, Mexico. 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. Weakening to a tropical depression is analyzed at 18Z on the 15th, no change from the original HURDAT.

June 16:

1. Maps and old HURDAT:

- 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.

2. Land highlights:

- 16 kt SE with 1004 mb (min pressure) at Del Rio, TX at 0058Z (SWO).

3. Discussion/Reanalysis: Observations from Texas – Laredo and Del Rio in particular - indicate that Alma continued on a northwestward course into the Rio Grande Valley as shown by HURDAT. Dissipation is analyzed by 12Z on the 16th over western Texas, twelve hours earlier than the original HURDAT.

June 17:

1. Maps and old HURDAT:

- HWM analyzes a cold front across Texas at 12Z.
- HURDAT does not list an organized storm on this date.

Sources: 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.

Tropical Storm Becky [August 8-17, 1958] – AL021958

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40470 08/08/1958 M=10  2 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*  0   0   0    0*  0   0   0    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*
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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  45    0*185 529  45 1006*
                ***  **      ***  ***       ***  ***  **      ***  ***  **  ****

40500 08/13*188 546  50    0*191 563  50    0*195 579  50    0*201 598  50    0*
40500 08/13*188 550  45    0*192 567  45    0*198 584  45    0*204 604  40    0*
                ***  **      ***  ***  **      ***  ***  **      ***  ***  **

40505 08/14*209 619  50    0*219 646  50    0*230 672  50    0*239 691  50    0*
40505 08/14*213 624  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  45    0*
            ****  ***  **      *     ***  **      ****  ***  **  *****     ***  **

40520 08/17E369 696  25    0E392 669  25    0E415 628  25    0E432 578  25    0*
40520 08/17*363 690  50    0*392 655  55    0*425 623  60    0*  0    0    0    0*
            ****  ***  **      *     ***  **      ****  ***  **          *    *    *
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40525 TS

Significant revisions:

- Significant shift to the track east-northeast on the 8th to the 10th based on ship and coastal observations
- Significant increases to the intensity on 9th to 11th based on ships and coastal stations
- No extratropical transition is now indicated
- Significant increases in intensity on the 16th and 17th based on ship observations
- Significant track revision to the east on the 17th based on ship observations
- Dissipation indicated six hours earlier on the 17th based on ship observations

Daily Metadata:

August 7:

1. Maps and old HURDAT:

- HWM is not available on this date (system south of 20°N).
- HURDAT does not list an organized storm on this date.
- Microfilm does not show an organized system at 12Z.

2. Discussion/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:

1. Maps and old HURDAT:
   - HWM is not available on this date (system south of 20°N).
   - 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.

2. Discussion:

   a. MWR: "Reports on August 7 and 8 from the Cape Verde Islands had indicated a westward-moving tropical depression."

   b. Reanalysis: 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 by 12Z on the 8th, though it is possible that the system may have formed as early as 00Z on the 8th but there are not enough observations to confirm this.

August 9:

1. Maps and old HURDAT:
   - HWM is not available on this date (system south of 20°N).
   - 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.

2. 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).

3. Discussion:

   a. MWR: "A continued westward movement with some intensification was confirmed on August 9 by reports from the ship Tatra."

   b. Reanalysis: The tropical depression moved westward passing just north of the Cape Verde Islands early on the 9th. A ship reported 45 kt ENE and 1004 mb at 18Z. This pressure suggests maximum winds of at least 39 kt from the Brown et al. south of 25N north pressure-wind relationship. An intensity of 45 kt analyzed at that time. 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. The intensity during these days is kept at 45 kt but ship observations were sparse.

August 10:

1. Maps and old HURDAT:
   - HWM is not available on this date (system south of 20°N).
   - HURDAT lists a 25 knot tropical depression at 17.0N, 35.5W at 12Z.
   - Microfilm does not show an organized system at 12Z.

August 11:

1. Maps and old HURDAT:
   - HWM is not available on this date (system south of 20°N).
   - 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.

2. Ship highlights:
- 30 kt NE and 1009 mb at 18.8N, 44.7W at 15Z (micro).
- 35 kt E and 1008 mb at 19.1N 45.3W at 21Z (micro).

3. Discussion:
   a. 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."
   b. 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:

1. Maps and old HURDAT:
- HWM is not available on this date (system south of 20°N).
- HURDAT lists a 50 kt 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.

2. 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).

3. 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).

4. Discussion:
   a. 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."
   b. 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."

c. Reanalysis: On August 12th, Becky crossed 50°W 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. Given that the MWR and Navy recon book were published well after the Storm Wallet report, the 1006 mb value is the accepted value. A central pressure of 1006 mb is added to 18Z on the 12th. A central pressure of 1006 mb suggests maximum sustained winds of 35 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 45 kt is selected for 18Z on the 12th, same as the original HURDAT. 45 kt is also the peak intensity for this tropical cyclone (from 18Z on the 9th through 12Z on the 13th), reduced from 50 kt in the original HURDAT.

August 13:

1. Maps and old HURDAT:

- HWM is not available on this date (system south of 20°N).
- HURDAT lists a 50 kt tropical storm at 19.5N, 57.9W at 12Z.
- Microfilm shows a trough at 15N-23N, 59W at 12Z.

2. 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).

3. 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).

4. Discussion/Reanalysis: 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 near 21.0N. 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.

August 14:

1. Maps and old HURDAT:

- 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.

2. 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).

3. Aircraft highlights:

- Radar center fix at 21.6N, 68.8W at 1151Z (ATSR).

August 15:

1. Maps and old HURDAT:

- 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.

2. 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).

3. Discussion:

a. 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."

b. Reanalysis: 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.

August 16:

1. Maps and old HURDAT:

- 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.

2. 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).

3. Discussion:
    a. 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."
    b. Reanalysis: 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 major 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.

August 17:

1. Maps and old HURDAT:

- 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.

2. 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).

3. Discussion/Reanalysis: On this date, Becky moved into the the warm sector of a developing extratropical cyclone to its northwest. While doing so, Becky intensified some more, perhaps through a combination of convective and baroclinic processes. A 50 kt ship at 00Z is the basis for 50 kt intensity at that time. At 12Z, a ship reported 45 kt W wind with 982 mb pressure. This peripheral pressure suggests an intensity of at least 71 kt from the Landsea et al. north of 35N pressure-wind relationship. Because the system was undergoing extratropical transition and had a very low (~1000 mb) outer closed isobar, an intensity of 60 kt is analyzed at that time, though Becky may have been a hurricane. The upward intensity revisions on the 17th were major changes. By 18Z, Becky's circulation became absorbed within the larger extratropical cyclone. Thus 12Z is the last position in HURDAT for the system, six hours earlier than the original HURDAT.

August 18:

1. Maps and old HURDAT:

- 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.

2. Discussion/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 … 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."

Sources: 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.

Hurricane Cleo [August 11-22, 1958] – AL031958

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40530 08/11/1958 M=12  3 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*159 490 110    0*167 494 115  951*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*198 499 115  953*213 504 115  956*227 510 110  954*241 516 100    0*
            *** *** ***  *** *** ***      *** *** ***      *** *** *** ***    *

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*
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                  ***  **    * *** ***  **  *** *** ***  **  *** *** ***  **  ***

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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Significant Changes:

- Multiple revisions to central pressures based upon aircraft reconnaissance
- Removal of multiple central pressures (not based upon observations)
- Large intensity reductions made on 14th to the 18th based on aircraft reconnaissance
- Extratropical transition indicated to be six hours earlier based on ship observations
- Track adjusted significantly to west-northwest on the 21st and 22nd based upon ship observations
- Lifetime extended by 18 hours based on ship and coastal observations

Daily Metadata:

August 10:

1. Maps and old HURDAT:

- HWM is not available on this date (system south of 20°N).
- HURDAT does not list an organized system on this date.
- Microfilm does not show an organized system at 12Z.

2. Discussion/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:

1. Maps and old HURDAT:

- HWM is not available on this date (system south of 20°N).
- HURDAT lists a 35 knot tropical storm at 11.0N, 23.8W at 12Z.
- Microfilm does not show an organized system at 12Z.

2. Discussion:

    a. 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."

    b. 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."

    c. Reanalysis: 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.

August 12:

1. Maps and old HURDAT:

- HWM is not available on this date (system south of 20°N).
- 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.

2. Discussion:

    a. 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."

    b. Reanalysis: Intensification to a tropical storm is delayed 24 hours until 06Z on August 12th, indicating a gradual strengthening of the tropical 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.

August 13:

1. Maps and old HURDAT:

- HWM is not available on this date (system south of 20°N).
- 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.

2. Discussion/Reanalysis: 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.

August 14:

1. Maps and old HURDAT:

- HWM is not available on this date (system south of 20°N).
- HURDAT lists a 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.

2. 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).

3. 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).

4. Discussion:

   a. 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."

   b. 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."

   c. Reanalysis: 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.

August 15:

1. Maps and Old HURDAT:

- HWM is not available on this date (system south of 20°N).
- 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.

2. 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, MWL).

3. 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).

4. Discussion:

   a. 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."

   b. 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."

   c. Reanalysis: 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. The origins of these are unknown, but it is likely that they were estimated and not based upon actual observations. These have now been removed from HURDAT when there does not exist any corresponding observations.) A reconnaissance mission reached Cleo at 14Z on the 15th measuring a central pressure of 959 mb by dropsonde and estimating surface winds of 90 kt and an eye diameter of 10 nm. However, the reported 700 mb height and temperature would produce an extrapolated pressure of 951 mb using today's formulas. Also, the 700 mb height is 70 m lower than that reported on the previous fix, which was 960 mb. 951 mb central pressure is used based upon extrapolation with the likelihood that the dropsonde fell into the eyewall instead of the eye. A central pressure of 951 mb suggests maximum sustained winds of 112 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 11 nm. Since the hurricane has a smaller RMW, an intensity of 115 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 110 kt, consistent with aircraft reconnaissance.

August 16:

1. Maps and old HURDAT:

- HWM analyzes a hurricane with a central pressure of 953 mb at 22.5N, 51.0W at 12Z.
- HURDAT lists a 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.

2. 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).

3. Aircraft highlights:

- Penetration center fix estimated maximum surface winds of 75 kt, 956 mb central pressure, and an eye diameter of 28 nm at 21.5N, 50.4W at 08Z (ATSR, MWR).
- The Navy flew an aircraft mission early on 16 August that was problematic due to bad navigation and an inability to receive data from the eye dropsonde. However, while the plane was in the eye at 10Z, it reported a 700 mb height of 8860 ft/2700 m and a 700 mb temperature of +16C. This produces an extrapolated pressure of 954 mb using today's formulas (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).

4. Discussion:

    a. MWR: "On the 16th, the storm turned toward the north-northwest and gradually increased its forward speed. Recurvature south of latitude 20°N 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."

    b. Reanalysis: The observations from the ship Tahitien (details available from the Mariners Weather Log) at 2230Z on the 15th allow for a central pressure analysis of 953 mb at 00Z on the 16th. This suggests 108 kt intensity from the south of 25N pressure-wind relationship. 115 kt is analyzed at 00Z (based in part on the very small size reported earlier and subsequently), down from 140 kt originally. The peak for Cleo is now at 18Z on the 15th with 120 kt, down from 140 kt initially in HURDAT at 00Z 16th. 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 from the pressure-wind relationship. An eye diameter of 15 nm suggests an RMW of about 12 nm and climatology suggests about 18 nm. An intensity of 110 kt is selected for 12Z on the 16th, unchanged from in HURDAT. 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 10Z and 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 2052Z 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 100 kt is selected for 18Z on the 16th and 95 kt at 00Z on the 17th, down from 110 kt originally shown in HURDAT. Weakening below major hurricane status is now analyzed 30 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 removed. The 959 mb is not included into HURDAT, as it was between synoptic times while a rapid filling was occurring.

August 17:

1. Maps and old HURDAT:

- 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.

2. 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).

3. 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).

4. Discussion/Reanalysis: 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.

August 18:

1. Maps and old HURDAT:
- 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.

2. 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).

3. 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 flight-level winds (811 mb) of 86 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).

4. Discussion:
   a. 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."
   b. Reanalysis: 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.

August 19:

1. Maps and old HURDAT:

- 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.

2. 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).

3. 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).

4. Discussion:

   a. 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."

   b. Reanalysis: 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.

August 20:

1. Maps and old HURDAT:

- 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.

2. 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).

3. Discussion/Reanalysis: 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.

August 21:

1. Maps and old HURDAT:
- 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.

2. 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).

3. Discussion/Reanalysis: The intensity of the extratropical cyclone decreased steadily on the 21st

August 22:

1. Maps and old HURDAT:
- 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.

2. Discussion/Reanalysis: Dissipation is analyzed to have occurred after 18Z on the 22nd, 18 hours later than originally shown in HURDAT.

August 23:

1. Maps and old HURDAT:
- 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.

August 24:

1. Maps and old HURDAT:
- 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.

August 25:

1. Maps and old HURDAT:
- 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.

2. Discussion/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."

Sources: 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, 1976), La Seur and Hawkins (1963), and NHC Storm Wallets.

Hurricane Daisy [August 24-31, 1958] – AL041958

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40600 08/24/1958 M= 8  4 SNBR= 883 DAISY       XING=0 SSS=0
40600 08/24/1958 M= 9  4 SNBR= 883 DAISY       XING=0 SSS=0
                    *

(The 23rd is new to HURDAT.)
40605 08/23*  0   0   0    0*  0   0   0    0*  0   0   0    0*250 730  25    0*

40605 08/24*  0   0   0    0*  0   0   0    0*252 736  35    0*259 746  40    0*
40605 08/24*252 733  25    0*255 736  30    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*267 755  55  996*271 758  55  997*
            *** ***          *** ***  **      *** ***  **  *** *** ***  **  ***

40615 08/26*274 765  65  989*278 768  65  985*281 770  70  979*285 771  75  974*
40615 08/26*275 763  60  992*278 768  70    0*281 770  85  975*285 771  85  975*
            *** ***  **  ***         **  ***         **  ***         **  ***

40620 08/27*288 769  80  968*291 766  85  963*294 762  90  956*298 757  95  944*
40620 08/27*288 769  90  972*290 765 100    0*292 760 110  952*296 756 115  948*
                  **  *** *** *** ***  *** *** *** ***  *** *** *** *** ***

40625 08/28*304 751 105  935*315 746 110  938*330 742 110  946*346 741 110  955*
40625 08/28*303 750 115    0*315 746 110    0*331 742 100    0*347 741  95  965*
            *** *** ***    *                * ***     ***  *** ***     *** ***

40630 08/29*362 740 110  963*380 729 110  970*398 708 105  977*412 683  90  982*
40630 08/29*363 739  95  965*380 726  90  969*400 704  80    0E415 679  70  980*
            *** *** ***  ***     ***  **  *** *** ***  **  ******* ***  **  ***

40635 08/30E420 650  85  987E430 605  55    0E422 561  50    0E415 529  50    0*
40635 08/30E420 650  65    0E425 610  60    0E422 570  50    0E422 530  50    0*
                  **  *** *** ***  **          ***         *** ***

40640 08/31E410 496  45    0E410 459  40    0E410 422  35    0E417 389  30    0*
40640 08/31E422 490  50    0*  0   0   0    0*  0   0   0    0*  0   0   0    0*
            *** ***  **     *   *   *   *     *   *   *   *     *   *   *   *

40645 HR
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Significant Revisions:

- Genesis begun 18 hours earlier based upon ship and coastal observations
- Several revised central pressures based upon aircraft reconnaissance

- Several supposed central pressures removed, as these were not based upon observations
- Hurricane intensification delayed 18 hours to 06Z on the 26th
- Large upward changes in intensity from the 26th and the 27th based upon aircraft reconnaissance
- Large downward changes in intensity from the 28th through the 30th based upon aircraft reconnaissance
- Extratropical transition indicated six hours earlier based upon ship and coastal observations
- Dissipation indicated 18 hours earlier based upon ship observations

Daily Metadata:

August 22:

1. Maps and old HURDAT:
- 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.

2. Discussion:

    a. MWR: "Hurricane Daisy formed in a strong easterly wave which passed through the Lesser Antilles during August 20-21."

    b. Reanalysis: 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.

August 23:

1. Maps and old HURDAT:
- 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.

2. Discussion:

    a. 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."

    b. 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."

    c. Reanalysis: Genesis as a 25 kt tropical depression is begun at 18Z based upon ship and coastal observations. This is 18 hours earlier than originally shown in HURDAT.

August 24:

1. Maps and old HURDAT:
- 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.

2. 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).

3. Aircraft highlights:
- Penetration center fix measured a central pressure of 1002 mb and estimated surface winds of 45 kt at 2311Z (ATSR/MWR).

4. Discussion:

    a. 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."

    b. 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."

    c. Reanalysis: Transition to a 35 kt tropical storm is unchanged at 12Z, based upon 35 kt ship report at 16Z.

August 25:

1. Maps and old HURDAT:
- 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.

2. 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).

3. 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 at 27.2N 75.7W measured a central pressure of 997 mb at 1730Z (micro, Colon).
- Penetration center fix measured a central pressure of 997 mb and measured flight-level winds of 50 kt at 5000 ft at 2030Z (micro, NHRP).

4. Discussion:

    a. 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."

b. 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."

c. Reanalysis: 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 997 mb (value from NHRP report) and estimated 50 kt at 5000 feet of altitude at 2030Z. Due to the slow forward speed of about 5 kt but small size of the tropical cyclone, an intensity of 55 kt has been selected for 18Z on the 25th, down from 65 kt originally in HURDAT, a minor intensity change. A central pressure of 997 mb has been added to 18Z on the 25th, replacing the existing 994 mb in the original HURDAT.

August 26:

1. Maps and old HURDAT:

- 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.

2. 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).

3. Aircraft highlights:

- Penetration center fix with central pressure of 992 mb at 00Z (Colon).
- 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).
- Penetration center fix with central pressure of 975 mb at 13Z (Colon).

- Penetration center fix with central pressure of 975 mb at 19Z (Colon).
- Penetration center fix with central pressure of 972 mb at 22Z (Colon).

4. Discussion:

   a. MWR: "The hurricane recurved initially near latitude 28N on the 26th, and its forward speed accelerated."

   b. Reanalysis: A central pressure of 992 mb at 00Z was reported from a research aircraft mission. This suggests maximum winds of 59 kt from the north of 25N intensifying pressure-wind relationship. 60 kt is analyzed at 00Z, down slightly from 65 kt. Daisy experienced a period of rapid intensification as the eye diameter decreased from 20 nm to 12 nm between 1930Z on the 25th and 0944Z on the 26th according to reports from the reconnaissance aircrafts. At 13Z and 19Z central pressure of 975 mb was reported. This suggests an intensity of 82 mb from the north of 25N intensifying pressure-wind relationship. A few ships reported tropical storm force winds and there was a ship at 12Z near the center of the hurricane that registered 75 kt. Given the small RMW (~10 nm), the intensity is analyzed at 85 kt at 12 and 18Z. The revisions are upward for the whole day, with a large increase (70 to 85 kt) at 12Z.

August 27:

1. Maps and old HURDAT:

- 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.

2. 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).

3. 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 measured flight-level winds of 109 kt (637 mb), an RMW of 10 nm and measured a central pressure of 944 mb around 1630Z (NHRP). Note that Colon indicates this to be 950 mb.
- Penetration center fix measured flight-level winds of 104 kt (637 mb), an RMW of 12 nm and measured a central pressure of 940 mb around 19Z (NHRP). Note that Colon indicates this to be 948 mb.
- 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 Tracy 1966 in MWR) at 1945Z (ATSR).

4. Discussion/Reanalysis: A research aircraft measured 972 mb at 22Z on the 26th. This suggests maximum winds of 86 kt from the north of 25N

intensifying pressure-wind relationship. Given the preceeding and subsequent inner core, the intensity is analyzed to be 90 kt, up from 80 kt originaally. 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 06Z on the 27th, 18 hours earlier than originally in HURDAT. 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 (Shea and Gray). However, the report by Colon indicates 948 mb at 19Z, which agrees with what was published in MWR in 1966, as the lowest central pressure. A central pressure of 948 mb suggests maximum sustained winds of 112 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 20 nm. Due to a forward speed of about 8 kt and a small RMW, an intensity of 115 kt is selected for 18Z on the 27th, up from 95 kt originally in HURDAT, a major intensity change. 115 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.

August 28:

1. Maps and old HURDAT:

- HWM analyzes a hurricane of at most 990 mb at 33.1N, 74.5W with cold front to the west at 12Z.
- HURDAT lists a 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.

2. 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).

3. Land highlights:

- 25 NNW and 1000 mb at Cape Hatteras, NC at 21Z (micro).

4. 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 measured flight-level winds of 101 kt (637 mb), an RMW of 20 nm and measured a central pressure of 950 mb around 17Z (NHRP). Colon gives 965 mb central pressure for this fix.
- Penetration center fix estimated surface winds of 110 kt and measured a central pressure of 949 mb at 1933Z (ATSR). Colon gives 969 mb central pressure for this fix.

5. Discussion:

    a. 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."

    b. ATSR: "DAISY developed further and winds increased to values in excess of 100 knots."

    c. Reanalysis: 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. Another reconnaissance aircraft measured a central pressure of 949 mb at 1933Z. However, Colon does not show a central pressure around 14Z and instead has 965 mb at 18Z and 968 mb at 1933Z. Comparison of the surface pressure derived from the 1933Z dropsondes 700/850 mb heights and temperatures, suggests that the higher values are correct. Thus no central pressure is shown at 12Z and 965 mb is indicated at 18z. 965 mb central pressure suggests maximum sustained winds of 90 kt north of 25N from the Brown et al. pressure-wind relationship and 86 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 27 nm. Daisy was moving at about 16 kt and remained a small hurricane, thus an intensity of 95 kt is selected for 18Z on the 28th, reduced substantially down from 110 kt in original HURDAT. 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.

August 29:

1. Maps and old HURDAT:

- 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.

2. 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).

3. 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).

4. Aircraft highlights:
- Penetration center fix with 965 mb central pressure at 36.8N, 73.8W at 02Z (ATSR, Colon).
- Penetration center fix measured a central pressure of 967 mb at 37.7N, 72.9W at 0428Z (ATSR/micro).
- Penetration center fix with 969 mb central pressure at 06Z (Colon).
- 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 with 980 mb at 17Z (Colon).
- Penetration center fix with 985 mb at 41.8N, 67.2W at 1930Z (ATSR).

5. Discussion:
   a. 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."
   b. Reanalysis: Early on the 29th, Daisy made a sharp turn to the northeast increasing in forward speed ahead of a frontal boundary. A central pressure of 969 mb was reported at 06Z, which suggest maximum sustained winds of 83 kt from north of 35N 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. 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 18Z on the 29th, six hours earlier than originally shown in HURDAT (though it is possible that this occurred by 12Z). 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. A final reconnaissance measured 980 mb at 17Z as the system became extratropical. This suggests an intensity of 73 kt from the north of 35N pressure-wind relationship. 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.

August 30:

1. Maps and old HURDAT:

- 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.

2. 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).

3. Discussion/Reanalysis: 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.

August 31:

1. Maps and old HURDAT:

- 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.

2. 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).

3. Discussion/Reanalysis: 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.

September 1:

1. Maps and old HURDAT:

- 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.

2. 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).

Date	Original HURDAT htral Pres	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	Retained
Aug 25 12Z	997 mb	Penetration center fix: 996 mb at 1310Z	996 mb
Aug 25 18Z	994 mb	Penetration center fix: 997 mb at 2030Z	997 mb
Aug 26 00Z	989 mb	Penetration center fix: 992 mb at 00Z	992 mb
Aug 26 06Z	985 mb	No observations of central pressure were taken. This value likely represents an analysis	Removed
Aug 26 12Z	979 mb	Penetration center fix: 975 mb at 13Z	975 mb
Aug 26 18Z	974 mb	Penetration center fix: 975 mb at 19Z	975 mb
Aug 27 00Z	968 mb	Penetration center fix: 972 mb at 22Z on 26th	972 mb
Aug 27 06Z	963 mb	No observations of central pressure were taken. This value likely represents an analysis	Removed
Aug 27 12Z	956 mb	Penetration center fix: 952 mb at 14Z	952 mb
Aug 27 18Z	944 mb	Penetration center fix: 948 mb at 19Z	948 mb
Aug 28 00Z	935 mb	No observations of central pressure were taken. This value likely represents an analysis	Removed
Aug 28 06Z	938 mb	No observations of central pressure were taken. This value likely represents an analysis	Removed
Aug 28 12Z	946 mb	Penetration center fix: 947 mb at 14Z, but likely incorrect	Removed
Aug 28 18Z	955 mb	Penetration center fix: 965 mb at 18Z	965 mb
Aug 29 00Z	963 mb	Penetration center fix: 965 mb at 02Z	965 mb
Aug 29 06Z	970 mb	Penetration center fix: 969 mb at 06Z	969 mb
Aug 29 12Z	977 mb	No observations of central pressure were taken. This value likely represents an analysis	Removed
Aug 29 18Z	982 mb	Penetration center fix: 980 mb at 17Z	980 mb
Aug 30 00Z	987 mb	No observations of central pressure were taken. This value likely represents an analysis	Removed

Sources: NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Monthly Weather Review, Jack D. Tracy (MWR, 1966), Colon (NHRP Report #48), the NHRP atlas (Shea and Gray 1976), the Local Climatological Data, Surface Weather Observations, Mariners Weather Log, Navy reconnaissance book and NHC Storm Wallets.

Hurricane Ella [August 30 – September 7, 1958] – AL051958

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40650 08/30/1958 M= 8  5 SNBR= 884 ELLA        XING=1 SSS=0
40650 08/30/1958 M= 9  5 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*
                           *** ***          *** ***          *** ***
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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  65    0*163 690  70    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  70  995*
            *** ***  **  *** *** ***  **      *** ***          *** ***  **  ***
40670 09/02*200 763 100    0*206 772  70    0*210 780  60    0*214 791  45    0*
40670 09/02*200 762  70    0*207 774  55    0*211 782  50    0*213 792  45 1004*
                ***  **      *** ***  **      *** ***  **      *** ***     ****
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    0*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*
            *** ***  **      *** ***  **      *** ***  ** **** *** ***  **
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

Hurricane Landfall
------------------
09/01 12Z 18.2N 73.4W 95 kt Haiti
09/02 00Z 20.0N 76.2W 70 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
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Significant Changes:

- Large westward shift in initial position to provide for a more realisitic initial motion

- Large intensity decreases on the 31st through the 2nd based upon aircraft reconnaissance observations
- Several central pressure obsevations added into HURDAT
- Large east-southeastward adjustment in position on the 6th based upon land station observations
- Additional six hours added to the end of Ella's track based on land station observations

Daily Metadata:

August 29:

1. Maps and old HURDAT:

- HWM is not available on this date (system south of 20°N).
- HURDAT does not list an organized storm on this date.
- Microfilm shows a tropical wave extending along 10N-16N, 50-52W at 12Z.

2. Discussion/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:

1. Maps and old HURDAT:

- HWM is not available on this date (system south of 20°N).
- 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.

2. Discussion:
   a. 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."
   b. 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."
   c. Reanalysis: Hurricane Ella developed from a tropical wave just east of the Lesser Antilles during late August. The observations are somewhat sparse while Ella crossed the Lesser Antilles on the 30th and it is uncertain if the system had a closed circulation. Given that Ella already exists within HURDAT on the 30th and that it is ambiguous whether it had a closed circulation, the system is retained on the 30th. Genesis is analyzed at 06Z on August 30th as a 30 kt tropical depression, same as the original HURDAT. Intensification to a tropical storm is analyzed at 12Z on the 30th, same as the original HURDAT.

August 31:

1. Maps and old HURDAT:

- HWM is not available on this date (system south of 20°N).
- 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.

2. 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).
- 65 kt ENE and 1010 mb at 16.9N, 67.5W at 12Z (micro).
- 60 kt S at 16.3N, 69.5W at 20Z (micro).
- 40 kt S and 1006 mb at 16.3N, 69.5W at 21Z (micro).

3. 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).
- Central pressure of 1000 mb (from pressure altitude of 14,200 ft), no time (Colon). (Note that the determination of central pressure from a pressure altitude of 14,200 ft becomes very uncertain, so this value is not included.)

4. Discussion:

   a. 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 …"

   b. 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."

   c. Reanalysis: The tropical cyclone 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. Two ships passed close to the center of Ella at 12Z on the 31st reporting 56 kt E with 1000 mb and 65 kt ENE with 1010 mb, respectively.

September 1:

1. Maps and old HURDAT:

- HWM is not available on this date (system south of 20°N).
- 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.

2. Land highlights:

- 40 kt ENE and 1006 mb at Guantanamo Bay, Cuba at 21Z (micro).

3. 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). Note that the ATSR indicated 995 mb central pressure, which is consistent with the 850 mb height on the sonde.

4. Discussion:

   a. 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."

   b. 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."

   c. Reanalysis: 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. 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. (The track of Ella is based upon the available (and numerous) radar and center fixes from aircraft reconnaissance, which takes it across the southwest peninsula of Haiti. It is noted that the solution, despite what was written in MWR, is the same as what is currently in HURDAT. Indeed, even the track map for the 1958 seasonal summary in MWR shows Ella going across the Haitian peninsula.) Data from the reconnaissance aircraft at 20Z on the 1st indicates that the central pressure had increased to 995 mb (the 989 mb value is not likely correct as the 850 mb heights on the sonde are consisten with a 995 mb central pressure), 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 995 mb suggests maximum sustained winds of 56 kt according to the south of 25N 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 fast forward speed of about 15 kt and putting some weight on the estimated surface winds, an intensity of 70 kt is selected for 18Z on the 1st, down from 95 kt originally in HURDAT, a major intensity change. A central pressure of 995 mb has been added to 18Z on the 1st.

September 2:

1. Maps and old HURDAT:

- 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.

2. 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).

3. 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).

4. 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).
- Central pressure of 1004 mb (from pressure altitude of 8,200 ft), no time (Colon).

5. Discussion:
    a. 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."
    b. ATSR: "ELLA moved inland into Cuba and lost much of her "punch" during her journey over land for almost the entire length of Cuba."
    c. Reanalysis: 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 70 kt, based upon persistence from the center fix late on the 1st. 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. A central pressure of 1004 mb was reported from research aircraft (Colon) likely flying around 18Z, though no center fix nor time was available. 1004 mb central pressure suggests an intensity of 39 kt from the south of 25N pressure-wind relationship. A 45 kt intensity at 18Z is retained. Beginning on this day, 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.

September 3:

1. Maps and old HURDAT:

- 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.

2. 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).

3. 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).

4. 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).

5. Discussion:

   a. 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."

   b. Reanalysis: 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. Around that time, a couple of ships reported 50 kt, so an intensity of 60 kt already in HURDAT at 18Z is retained.

September 4:

1. Maps and old HURDAT:

- 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.

2. Ship highlights:

- 55 kt E and 1011 mb at 24.4N, 85.4W at 00Z (COADS/MWR).

- 15 kt NNE and 1003 mb at 22.2N, 86.5W at 00Z (COADS).
- 55 kt E and 1012 mb at 24.4N, 85.4W at 06Z (COADS).
- 50 kt SE and 1012 mb at 24.5N 85.4W at 09Z (micro).
- 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).

3. 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).

4. 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). (Note – may not have been a central pressure due to poor organization of the storm.)
- Central pressure of 1010 mb reported (6,400 ft pressure altitude), no location or time given (Colon). (Note – likely not to have been a central pressure due to poor organization of the storm.)

5. Discussion:
   a. 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."
   b. Reanalysis: 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 lowest pressure of 1003 mb and estimated surface winds of 60 kt at 1440Z on the 4th. The radar and penetration fixes from the reconnaissance aircraft 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. Additionally because of this, the central pressure may have been lower than the 1003 mb measured. Thus this value is not added into HURDAT.

September 5:

1. Maps and old HURDAT:
- 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.

2. 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).

3. Land highlights:
- 40 kt ESE and 1015 mb at Grande Isle, LA at 18Z (micro).

4. 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).

5. Discussion:
   a. 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."
   b. 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."
   c. Reanalysis: 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.

September 6:

1. Maps and old HURDAT:
- 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.

2. Ship highlights:
- 15 kt ENE and 1003 mb at 26.9N, 96.5W at 00Z (COADS).

3. 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).

4. Aircraft highlights: Radar center fix at 27.8N, 96.8W at 0624Z (ATSR).

5. Discussion/Reanalysis: 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 6th. 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.

September 7:

1. Maps and old HURDAT:

- 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.

2. Land highlights:

- 5 kt E and 1006 mb at Laredo, TX at 00Z (micro).

3. Discussion/Reanalysis: 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.

Sources: 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, Colon (1963), Perez et al. (2000), and NHC Storm Wallets.

Hurricane Fifi [September 4-11, 1958] – AL061958

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40700 09/04/1958 M= 9  6 SNBR= 885 FIFI        XING=0 SSS=0
40700 09/04/1958 M= 8  6 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  55    0*159 561  65    0*166 571  75    0*175 583  70    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  60 1004*195 609  60    0*205 621  60 1003*211 631  60 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  55 1003*221 644  55    0*226 649  55    0*229 654  55 1000*
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            *** ***  ** **** *** ***  **      *** ***  **      *** ***     ****

40730 09/09*233 658  50    0*235 659  50    0*236 660  50    0*238 662  50    0*
40730 09/09*232 658  50    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*
            ***      **                 **      *** ***  ** **** *** ***  ** ****

(The 12th is removed from HURDAT.)
40745 09/12*297 643  55    0*302 632  45    0*307 621  35    0*313 613  25    0*

40750 HR
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Significant Changes

- Major track alteration to the west-northwest on the 5th based upon aircraft reconnaissance
- Multiple new central pressures added to HURDAT based upon aircraft reconnaissance
- Large downward adjustments made to the intensity from the 7th and the 9th to the 11th based upon aircraft reconnaissance
- Dissipation indicated 24 hours earlier

Daily Metadata:

September 3:

1. Maps and old HURDAT:

- HWM is not available on this date (system south of 20°N).
- HURDAT does not list an organized storm on this date.
- Microfilm does not show an organized system at 12Z.

2. Discussion/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:

1. Maps and old HURDAT:

- HWM is not available on this date (system south of 20°N).
- 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.

2. Discussion:
    a. 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."

b. Reanalysis: 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. The tropical cyclone moved generally west-northwest at a fast forward speed on the 4th.

September 5:

1. Maps and old HURDAT:

- HWM is not available on this date (system south of 20°N).
- 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.

2. Aircraft highlights:

- 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).

3. Discussion:

a. 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."

b. 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."

c. Reanalysis: 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. The intensity was decreased only at 12Z on the 5th to provide a more reasonable intensification during the day. The original intensities were 25, 30, 45, and 45 kt at 00Z, 06Z,

12Z, and 18Z accordingly, while the revised intensities smooth out the jump between 06Z and 12Z by showing 30, 35, 40, and 45 kt.

September 6:

1. Maps and old HURDAT:

- HWM is not available on this date (system south of 20°N).
- 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.

2. 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).

3. Discussion:

a. 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."

b. 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."

c. Reanalysis: 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 retained at 75 kt in HURDAT. 75 kt is also the peak intensity for Fifi, down from 80 kt originally in HURDAT, a major intensity change.

September 7:

1. Maps and old HURDAT:

- 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.

2. Aircraft highlights:

- 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).

3. Discussion:
    a. MWR: "The storm slowed to around 12 mph and highest winds decreased to 75 mph on the 7th."
    b. Reanalysis: 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, small synoptic scale of the tropical cyclone, high environmental pressure and some weighting of the earlier surface wind estimates, an intensity of 60 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 60 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 60 kt is analyzed at 18Z 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.

September 8:

1. Maps and old HURDAT:

- 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.

2. 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).
- Penetration center fix measured a central pressure of 1011 mb (pressure altitude of 13,000 ft), unknown time, unknown location (Colon).

3. Discussion:
    a. 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."
    b. Reanalysis: 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 and the environmental pressure remained high, thus an intensity of 55 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 embedded within high pressure, an intensity of 55 kt is retained at 18Z on the 8th. A central pressure of 1000 mb is added to HURDAT at 18Z on the 8th. (Note that the 1011 mb central pressure from the NHRP flights [Colon] is not added in. Given the pressure altitude of 13,000 ft, extrapolation to the surface is uncertain and they may not have sampled the center of the system.)

September 9:

1. Maps and old HURDAT:

- 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.

2. Aircraft highlights:

- 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).

3. Discussion:

   a. 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."

   b. Reanalysis: 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. On this day, the environmental pressures also decreased around Fifi. 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. A central pressure of 1007 mb was measured on the by reconnaissance

aircraft at 1949Z on the 9th and has been added to HURDAT at 18Z on the 9th.

September 10:

1. Maps and old HURDAT:

- 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.

2. Ship highlights:

- 20 kt NNW and 1005 mb at 25.9N, 69.2W at 18Z (micro).

3. 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).

4. Discussion/Reanalysis: 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 1010 and 1009 mb were measured on the by the reconnaissance aircrafts at 1430Z and 1930Z on the 10th, respectively, and have been added to HURDAT at 12Z and 18Z on the 10th, respectively.

September 11:

1. Maps and old HURDAT:

- 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.

2. Aircraft highlights:

- 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).

3. Discussion:

   a. 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."
   b. 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."
   c. Reanalysis: 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 a developing extratropical system north of Fifi and and not likely attributable to relatively small Fifi a few hundred miles

away. Observations suggest that Fifi weakened into a surface trough on September 11th and was absorbed shortly thereafter.

September 12:

1. Maps and old HURDAT:

- 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.

September 13:

1. Maps and old HURDAT:

- 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.

Sources: NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Monthly Weather Review, Navy reconnaissance book, Colon (1963), and the NHC Storm Wallets.

Tropical Storm Gerda [September 14-22, 1958] – AL071958

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40755 09/13/1958 M= 3  7 SNBR= 886 GERDA       XING=0 SSS=0
40755 09/14/1958 M= 9  7 SNBR= 886 GERDA       XING=0 SSS=0
         **         *

(The 13th is removed from HURDAT.)
40760 09/13*  0   0   0    0*  0   0   0    0*151 620  25    0*159 642  35    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*174 675  40      175 694  45    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    0D183 734  40    0D185 759  35    0D187 786  35    0*
            ***      **     **** ***        **** ***        **** ***  **

(September 16th through 22nd is new to HURDAT)
40771 09/16D188 815  30    0D185 845  30    0D181 870  25    0D176 892  25    0*
40772 09/17D176 905  25    0D180 914  25    0D186 920  25    0D193 925  25    0*
40773 09/18D199 930  25    0D204 935  25    0D208 940  25    0D212 944  25    0*
40774 09/19D216 948  25    0D218 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

Tropical Storm Landfall
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09/14 21Z 18.0N 71.2W 50 kt Dominican Republic
09/20 08Z 24.5N 97.7W 40 kt Mexico
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Substantial Changes:

- Genesis delayed by 18 hours because of aircraft, ship, and coastal station observations
- Position adjusted considerably toward the west-southwest due to a combination of aircraft, ship, and coastal station observations
- Introduction of a second tropical cyclone stage on the 20th to the 22nd with Gerda becoming a tropical storm again on the 20th
- As part of the second tropical cyclone stage, Gerda is now shown to have made landfall in northeastern Mexico as a tropical storm
- Final dissipation delayed by seven days through a combination of aircraft, ship, and coastal station observations

Daily Metadata:

September 12:

1. Maps and old HURDAT:

- HWM is not available on this date (system south of 20°N).
- 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.

2. Discussion:
    a. 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."
    b. 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:

1. Maps and old HURDAT:

- HWM is not available on this date (system south of 20°N).
- 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.

2. Discussion:
    a. 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."
    b. 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."
    c. Reanalysis: 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.

September 14:

1. Maps and old HURDAT:

- HWM is not available on this date (system south of 20°N).
- 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.

2. 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).

3. 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).

4. Aircraft highlights:

- Radar center fix at 17.6N 67.5W at 0600Z with "max gusts to 65 knots" (micro).
- 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).

5. Discussion:

   a. 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."
   b. 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."
   c. Preliminary 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."
   d. Reanalysis: Genesis is delayed 18 hours until September 14th at 06Z as a 40 kt tropical storm based on reports from the reconnaissance aircraft and 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.

September 15:

1. Maps and old HURDAT:

- HWM is not available on this date (system south of 20°N).
- 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.

2. 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).

3. Land highlights:

- 40 kt at Port-au-Prince, Haiti at 06Z (WALLET).

4. Discussion:

   a. 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.”
   b. 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.”
   c. Reanalysis: The mountainous terrain of Hispaniola took its toll on Gerda and weakening to a disturbance is analyzed by 06Z 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 about 00Z on the 15th. Ships still reported gale-force winds late on September 15th and on that basis, the intensity of the disturbance 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.

September 16:

1. Maps and old HURDAT:
- HWM is not available on this date (system south of 20°N).
- 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.

2. Ship highlights:
- 35 kt E and 1017 mb at 23.1N, 74.4W at 00Z (COADS).

3. Discussion:
   a. ATSR: "Reconnaissance flights were continued for the next two days along the easterly wave but no further indications of tropical storm formation were observed."
   b. Reanalysis: The disturbance wave moved rapidly across the western Caribbean Sea on September 16th. Weakening below gale-force is analyzed at 00Z on the 16th.

September 17:

1. Maps and old HURDAT:
- HWM is not available on this date (system south of 20°N).
- HURDAT does not list an organized storm on this date.
- Microfilm shows a tropical wave along 18-23N, 92W at 12Z.

2. Discussion/Reanalysis: Around 12Z on September 17th, the disturbance entered the Bay of Campeche and its forward speed decreased.

September 18:

1. Maps and old HURDAT:
- HWM is not available on this date (system south of 20°N).
- 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.

September 19:

1. Maps and old HURDAT:
- 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.

2. Ship highlights:
- 1004 mb near 21.0N, 94.5W (report says "early on the 19th") (WALLET).

3. Aircraft highlights:
- 35 kt maximum surface winds, minimum pressure 1005 mb (not central pressure), but no fix (no time, likely around 12Z, Advisory)

4. Discussion:
   a. Advisory: 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."

b. Reanalysis: 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.

September 20:

1. Maps and old HURDAT:

- 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.

2. 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).

3. 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).

4. Discussion:

a. Advisory: 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."

b. Reanalysis: 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.

September 21:

1. Maps and old HURDAT:

- 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.

2. Discussion/Reanalysis: 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.

September 22:

1. Maps and old HURDAT:

- 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.

2. Discussion:
    a. 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."
    b. Reanalysis: 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.

Sources: 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.

Hurricane Helene [September 21 – October 4, 1958] – AL081958

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40780 09/21/1958 M=14  8 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  60  995*
           ***      **     * *** ***  **    * *** ***  **  *** *** ***  **  ***

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    0*283 735  70    0*288 739  70    0*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  70  981*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*
           *** *** ***      *** *** ***  ***     *** ***          *** ***    *

27th/09Z best track point (for peak intensity):
32.7N 78.6W 130 kt 930 mb

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*366 713 100  955*380 683 100    0*
           *** *** ***  *** *** ***          *** *** ***  ***         ***  ***

40825 09/29*390 659  85  959*417 619  70  963*457 590  65  966E490 566  65  968*
40825 09/29*400 650  95  957E430 625  85    0E465 602  75    0E495 560  70    0*
           *** ***  **  ******* ***  **      **** ***  **      *** ***  **

40830 09/30E520 524  60  972E539 488  60    0E550 450  60    0E562 411  55    0*
40830 09/30E515 515  65    0E535 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*
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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

U.S. Hurricane Impact (no landfall, time and date indicative of closest approach)
--------------------------------------------------------------------------------
(Helene had 120 kt intensity, 938 mb central pressure, and RMW of 20 nm)
09/27 18Z 33.9N 77.6W 110 kt North Carolina

U.S. Tropical Storm Impact
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09/27 15Z 33.4N 78.2W  60 kt South Carolina
09/28 03Z 35.1N 74.9W  40 kt Virginia
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Significant changes:

- Positions adjusted substantially farther south-southwest on the 21st based upon ship and aircraft observations
- Multiple central pressures either replaced or removed based primarily upon aircraft reconnaissance observations
- Large downward adjustment to intensity introduced on the 26th based upon aircraft reconnaissance
- Large upward adjustment to intensity introduced on the 27th based upon aircraft reconnaissance
- Peak intensity boosted from 115 kt to 130 kt
- Extratropical transition indicated to have occurred 12 hours earlier based on aircraft, coastal and ship observations
- Large north-northwestward change in position indicated on the 29th based upon aircraft, coastal, and ship observations
- Large upward intensity adjustment indicated on the 1st and 2nd based upon ship reports
- Large southwestward shift in positions shown late on the 1st to early on the 3rd
- Large west-northwestward adjustment made to the postions introduced late on the 3rd and early on the 4th

Daily Metadata:

September 20:

1. Maps and old HURDAT:

- HWM is not available on this date (system south of 20°N).
- HURDAT does not list an organized system on this date.
- Microfilm shows a tropical wave along longitude 47W, extending from 12N-20N at 12Z.

2. Discussion:

a. 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."
b. 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."
c. Reanalysis: 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.

September 21:

1. Maps and old HURDAT:

- HWM is not available on this date (system south of 20°N).
- 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.

2. Ship highlights:

- 40 kt SE and 1012 mb at 18.5N, 52.0W at 18Z (micro).

3. Aircraft highlights:

- Penetration center fix near 19N 54W, 35 kt maximum surface winds (no time, MWR).

4. Discussion:
   a. 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."
   b. Reanalysis: 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.

September 22:

1. Maps and old HURDAT:

- 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.

2. 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).

3. Discussion:
    a. 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."
    b. 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."
    c. Reanalysis: 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.)

September 23:

1. Maps and old HURDAT:

- 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.

2. 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).

3. 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).

4. Discussion:
    a. 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."
    b. 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."
    c. Reanalysis: 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.

September 24:

1. Maps and old HURDAT:

- 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.

2. 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).

3. 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).
- Penetration center fix measured a central pressure of 995 mb around 18Z (Colon).
- Radar center fix estimated an eye diameter of 10 nm at 27.2N, 72.9W at 19Z (ATSR).

4. Discussion:

   a. MWR: "Helene continued on a west-northwestward course at 12 to 15 mph through the 24th with slow intensification."

   b. Reanalysis: 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 from the north of 25N 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. An NHRP research flight reported 995 mb central pressure around 18Z. This suggests an intensity of about 52 kt from the north of 25N pressure-wind relationship. Because of the continued small size and fast forward speed, the intensity is assessed at 60 kt at 18Z, down from 65 kt originally. 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.

September 25:

1. Maps and old HURDAT:

- 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.

2. 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).

3. 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, measured flight-level winds of 76 kt (811 mb), and a flight-level 25 nm RMW at 29.0N, 74.0W around 1820Z (NHRP). (Note that Colon indicates a central pressure of 987 mb for this mission. However, the 982 mb from the Shea and Gray NHRP report is a better match to the value indicated by the Navy's reconnaissance mission.)

4. Discussion/Reanalysis: Intensification to a hurricane is analyzed at 00Z, 12 hours later than originally shown in HURDAT. A ship about 90 nm northeast of the center of Helene reported 65 kt. This supports an intensity of 70 kt at that time as well as the system to have become a hurricane earlier in the day. 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 25 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 near average (25 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.

September 26:

1. Maps and old HURDAT:

- 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.

2. 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).

3. 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 981 mb at 29.5N, 74.8W at 0230Z (ATSR). (Examination of the 986 mb pressure reported from a dropsonde suggests this value is in error. First, the aircraft reported a 700 mb height of 9600 ft/2926 m and a temperature of 14C. Using today's formulas, this extrapolates to a pressure of 981 mb. Second, the dropsonde that reports 986 mb has a 700 mb height of 9790 ft/2983 m, suggesting it was not released in the center of the eye. The 981 mb extrapolated value is used instead.)
- 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, measured flight-level winds of 99 kt (811 mb), and a 25 nm RMW at 30.0N, 76.0W around 1830Z (NHRP). (Shea and Gray report 948 mb, while Colon [NHRP report #72] indicates 942 mb. Using the flight level of 9800 ft and D-value of -1170 ft in Jordan's nomogram yields 952 mb. No additional information can be obtained to decipher these discrepancies. Given the the range of plausible answers, consistency with the Navy's central pressure value suggests 948 mb should be used.)
- 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, measured flight-level winds of 119 kt (577 mb), and a 15 nm RMW at 30.0N, 76.0W around 2030Z (NHRP).
- Radar center fix at 31.1N, 77.9W at 2307Z (ATSR).

4. Discussion:

   a. 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."

b. 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."
c. Reanalysis: Another penetration center fix at 0230Z on September 26th measured a central pressure of 981 mb, indicating no change in intensity early on this date from the 70 kt at 18Z on the 25th. This represents a major decrease in intensity from the 85 kt originally in HURDAT. 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.

September 27:

1. Maps and old HURDAT:

- 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.

2. 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).

3. 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).

4. 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 from the aircraft reported a minimum 700 mb height of 8310 ft/2533 m at 09Z (80 ft/24 m lower than that on the 932 mb sonde and 90 ft/27 m lower than that on the 933 mb sonde). These suggest that the central pressure at this time was about 930 mb (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).

5. Discussion:
   a. 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… 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."

b. Reanalysis: 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 08Z fix had a central pressure of 932 mb and the 700 mb flight level heights suggested that the central pressure bottomed out around 930 mb at 09Z. An asynoptic best track point is indicated at 09Z with 930 mb central pressure and 130 kt intensity. 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, as weakening had commenced. 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 detailed Surface Weather Observations available for Wilmington and Cape Hatteras – both about 25 nm from the center of Helene – were at or outside of the RMW, as no distinct lull was indicated that the time of lowest pressure. These are consistent with a 20 nm RMW estimate. 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. Therefore, Helene is analyzed as a category 3 hurricane impact for North Carolina. The same wind model suggests that South Carolina was impacted by about 90 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 about 80 kt. As peak observed winds in South Carolina were only about 50 kt in Charleston, so the model may be overestimating the impact there. A high end tropical storm (60 kt) impact for South Carolina is analyzed. Additionally, 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.

September 28:

1. Maps and old HURDAT:

- 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.

2. 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).

3. 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).
- 973 mb (minimum pressure) at Cape Hatteras, NC at 0220Z (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).

4. 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 955 mb, estimated surface winds of 90 kt and estimated an eye diameter of 24 nm at 36.9N, 70.0W at 14Z (ATSR). (The dropsonde surface pressure was 966 mb, but the surface pressure from 700 and 850 mb heights/temperatures were arout 955 mb. This is also was was provided in the vortex fix message.)
- Penetration center fix measured a central pressure of 957 mb and estimated surface winds of 105 kt at 38.7N, 66.9W at 2130Z (ATSR). (The 850/700 mb height/temperatures suggest about a 957 mb central pressure, compared with the 943 mb reported at the surface by the drop. 957 mb value accepted as central pressure.)
- Penetration center fix at 39.0N, 65.0W at 2230Z (ATSR).

5. Discussion/Reanalysis: 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 28th, 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 955 mb. This suggests an intensity of 93 kt from the north of 25N pressure-wind relationship. 100 kt intensity is analyzed, based upon continued very quick motion.

September 29:

1. Maps and old HURDAT:

- 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.

2. 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).
- 45 kt ENE and 961 mb at 43.3N, 61.9W at 06Z (COADS).
- 45 kt SE and 964 mb at 43.4N, 61.4W 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).

3. Land highlights:

- 50 kt N and 990 mb at Halifax, Canada at 06Z (micro).
- 30 kt SSE 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).

4. Discussion:

   a. 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."
   b. Reanalysis: The last reconnaissance aircraft to reach Helene measured a central pressure of 957 mb and estimated surface winds of 105 kt at 2130Z on the 28th. A central pressure of 957 mb suggests maximum surface winds of 92 kt north of 35N from the pressure-wind relationship. Since the hurricane was becoming extratropical but also moving very rapidly (~40 kt) towards the east-northeast, an intensity of 95 kt is selected at 00Z, up from 85 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 by 06Z. Extratropical transition is analyzed at that time, twelve hours earlier than originally shown in HURDAT. At 06Z, ship observations with a 45 kt ENE with 961 mb and 45 kt SE with 964 mb in particular indicate that Helene was about 80 nm NNW of the original HURDAT position. These along with a SSE wind at St. Paul Island at 12Z show that Helene's center made landfall over Nova Scotia around 10Z. Thus it is analyzed that Helene reached Canada as a powerful extratropical cyclone and not as a hurricane as originally shown in HURDAT. Later on the 29th, Helene moved northeast back over the North Atlantic.

September 30:

1. Maps and old HURDAT:

- 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.

2. 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).

3. Discussion/Reanalysis: Weakening below hurricane force occurred at 06Z on September 30th, six hours later than originally shown in HURDAT.

October 1:

1. Maps and old HURDAT:

- 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.

2. 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).

3. Discussion/Reanalysis: 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.

October 2:

1. Maps and old HURDAT:

- 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.

2. 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).

3. Discussion/Reanalysis: Late on the 2nd, the extratropical cyclone weakened again below hurricane force and kept a general eastward track.

October 3:

1. Maps and old HURDAT:
- 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.

2. 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).

3. Land highlights:
- 10 kt S and 988 mb at Kerry, Ireland at 12Z (HWM).

October 4:

1. Maps and old HURDAT:
- 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.

2. 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).

3. Discussion/Reanalysis: 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.

October 5:

1. Maps and old HURDAT:
- 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.

Date	Original RDAT ntral Pres	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	Penetration center fix: 995 mb ~18Z on Sep 24th	995 mb
Sep 25 00Z	993 mb	No observations available. Central pressure values are likely to be analyses.	Removed
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 Sep 28th and 955 mb at 08Z on Sep 28th	Retained
Sep 28 12Z	954 mb	Penetration center fix: 955 mb at 14Z on Sep 28th	955 mb
Sep 28 18Z	957 mb	No observations available. Central pressure value is likely to be an analysis.	Removed
Sep 29 00Z	959 mb	Penetration center fix: 957 mb at 2130Z on Sep 28th	957 mb
Sep 29 06Z	963 mb	No observations available. Central pressure values are likely to Be analyses.	Removed
Sep 29 12Z	966 mb		
Sep 29 18Z	968 mb		
Sep 30 00Z	972 mb		

Sources: NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Monthly Weather Review, Surface Weather Observations, Navy reconnaissance book, Mariners Weather Log, NHC Storm Wallets, and Colon (1964, NHRP #72).

Hurricane Ilsa [September 24-30, 1958] – AL091958

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40860 09/24/1958 M= 7  9 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  986*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  95  957*
              ***  **          ***  **  *** *** ***  **  *** ***      ***  ***

40880 09/27*214 612 115    0*219 613 110    0*223 613 105    0*232 612 100    0*
40880 09/27*204 613  90  966*209 613  70    0*219 611  65    0*232 610  65    0*
            *** *** ***  *** ***      ***      *** *** ***          ***  **

Asynoptic best track point added:
9/27/08Z  21.2N 61.2W  65 kt  990 mb

40885 09/28*245 611 100    0*262 615  95    0*280 619  90    0*295 616  90    0*
40885 09/28*245 611  65    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  978*350 580  80    0*374 549  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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Significant Changes

- Large intensity increase indicated on the 24th based upon ship and aircraft data
- Many new central pressures were added to HURDAT from aircraft reconnaissance missions
- Positions significantly adjusted westward late on the 25th and early on the 26th based upon aircraft observations
- Large intensity increase shown on the 26th based upon aircraft reconnaissance data
- Large intensity reduction indicated on the 27th and 28th based on aircraft observations
- Ilsa peaked at 95 kt Category 2 hurricane, originally 115 kt Category 4
- Extratropical transition occurred six hours earlier based upon ship observations

Daily Metadata:

September 23:

1. Maps and old HURDAT:

- HWM is not available on this date (system south of 20°N).
- HURDAT does not list an organized system on this date.
- Microfilm does not show an organized system at 12Z.

2. Ship highlights:

- 10 kt SW and 1012 mb at 10.3N 48.7W at 12Z (micro).
- 5 kt SW and 1011 mb at 10.4N 55.2W at 18Z (micro).

3. Discussion/MWR: "Ship reports on September 23 indicated that special aircraft reconnaissance into the area east of the Antilles was necessary."

September 24:

1. Maps and old HURDAT:

- HWM is not available on this date (system south of 20°N).
- 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.

2. 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).

3. 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, ATSR). Note that the ATSR indicates the fix occurred at 1728Z.

4. Discussion:

   a. 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."
   b. ATSR: "On 24 September a vortex was definitely confirmed by an Air Force reconnaissance aircraft at 241728Z in position 17.7N 54.0W."
   c. Reanalysis: 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.

September 25:

1. Maps and old HURDAT:

- HWM is not available on this date (system south of 20°N).
- 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.

2. 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).

3. 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 986 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).

4. Discussion/Reanalysis: 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 986 mb and estimated surface winds of 65 kt and an eye diameter of 30 nm. A central pressure of 986 mb suggests maximum winds of 70 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 986 mb is added to HURDAT at 12Z on the 25th. The same reconnaissance aircraft provided another center fix for 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.

September 26:

1. Maps and old HURDAT:

- 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.

2. 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).

3. 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 957 mb and an eye diameter of 30 nm at 20.1N, 61.3W at 20Z (ATSR/micro).

4. Discussion:
   a. 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."
   b. Reanalysis: 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 957 mb and estimating surface winds of 80 kt and an eye diameter of 30 nm. An intensity of 95 kt is thus also selected at 18Z on the 26th.

September 27:

1. Maps and old HURDAT:

- 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.

2. 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).

3. Aircraft highlight:

- Penetration center fix measured a central pressure of 966 mb with 80 kt maximum surface winds and comments - "eye became deformed, more diffuse and decreased in diam near end flt" at 20.7N 61.2W at 02Z (ATSR).
- Penetration center fix measured a central pressure of 990 mb and an eye diameter of 40 nm at 20.9N, 61.1W at 08Z (ATSR). (The surface pressure from the dropsonde was 949 mb, but this not corroborated by the 850/700 mb heights/temperatures. These instead indicate 990 mb.)
- Penetration center fix at 22.4N, 61.0W at 14Z (ATSR).
- Penetration center fix at 23.5N, 60.8W at 1930Z (ATSR).

4. Discussion:
    a. 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."
    b. Reanalysis: On September 27th, the track of Ilsa turned to the north slowly gaining in forward speed. The 932 mb central pressure for Ilsa reported in the Monthly Weather Review was a case of mistaken identity. Two separate recon flights were going on early on the 27th – one into Helene and one into Ilsa. The Helene flight did indeed measure 932 mb at 08Z. The ATSR report indicates an eye drop with 966 mb surface pressure, consistent with temperature/height at 850 mb information. 966 mb added as cental pressure at 02Z. This suggests an intensity of 92 kt from the south of 25N weakening pressure-wind relationship. An intensity of 90 kt is indicated at 00Z, a large decrease from the 115 kt in HURDAT originally. Ilsa's peak is thus revised to be a 95 kt Category 2 (at 12 and 18Z on the 26th) versus a 115 kt Category 4 (at 00Z on the 27th) originally. Further rapid weakening occurred on the 27th, as the central pressure filled to 990 mb at 08Z. This suggests 64 kt maximum winds from the south of 25N pressure-wind relationship. 65 kt intensity is analyzed at 08Z (asynoptic best track point) and 70 kt at 06Z. This is a large reduction from the 110 kt intensity originally in HURDAT. It is of note that most ships remained away from the circulation of Ilsa on the 27th but a few reported tropical storm force winds in the periphery.

September 28:

1. Maps and old HURDAT:

- 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.

2. 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).

3. Aircraft highlights:

- Radar center fix at 26.3N, 60.8W and an eye diameter of 45 nm at 02Z (ATSR).
- Penetration center fix measured a central pressure of 989 mb at 26.9N, 61.0W at 0340Z (ATSR).
- Penetration center fix estimated surface winds at 60 kt 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).

4. Discussion/Reanalysis: Ilsa remained relatively steady state on September 28th. A reconnaissance aircraft reached the hurricane early on the 28th 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. 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.

September 29:

1. Maps and old HURDAT:

- 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.

2. 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).

3. 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 978 mb at 31.9N, 59.4W at 0456Z (wallet).
- 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).

4. Discussion/Reanalysis: 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 measuring a central pressure of 980 mb. 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 at 00Z on the 29th as the hurricane was accelerating at more than 20 kt, down from 90 kt. The pressure dropped slightly to 978 mb at an 0456Z fix. This suggests 75 kt maximum winds from the north of 25N pressure-wind relationship. 80 kt intensity is also analyzed at this time.

September 30:

1. Maps and old HURDAT:

- 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.

2. 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).

3. Discussion/Reanalysis: Ship observations at 00Z suggest 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 that time, six 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.

Sources: NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Monthly Weather Review, and Navy reconnaissance book and NHC Storm Wallets.

Hurricane Janice [October 4-13, 1958] – AL101958

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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 10 SNBR= 889 JANICE      XING=0 SSS=0
         **        **

(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 1002*209 812  45    0*
            *** ***  ** **** *** ***          *** ***  ** ****     ***  **  ***
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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     0*233 788  55     0*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   987*272 756  65     0*283 751  70     0*289 748  70   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  70     0*300 742  70   986*307 738  70     0*314 733  70   988*
            ***      **     *           **  *** ***      **     * ***           ***

40930 10/09*320 726  70   987*321 719  65   985*322 710  65   983*327 697  65   977*
40930 10/09*318 728  70   984*320 721  70     0*322 709  70   982*327 696  75     0*
            *** ***      *** *** ***  **   ***      ***  **   ***      ***  **   ***

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     0*340 671  85   968*348 657  80   973*360 639  80     0*
                ***  **   *** *** ***  **       ***  ***       ***                ***

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     0*384 590  80     0*399 559  80   974*415 515  80     0*
            ***           *** ***           *** *** ***  **   *** *** ***  **

40945 10/12*433 461  65     0E449 422  50     0E462 382  50     0E472 335  50     0*
40945 10/12E433 470  70     0E450 430  60     0E462 382  50     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*
                             *   *    *    *
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40955 HR

Tropical Storm Landfall

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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
10/06 23Z 25.5N 76.8W 60 kt Bahamas
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Significant Changes:

- Genesis indicated to be 18 hours earlier based upon ship, coastal, and aircraft observations
- Several central pressures added and/or replaced based upon aircraft reconnaissance
- Large intensity increases on the 10th based upon aircraft observations
- Extratropical transition occurred six hours earlier based upon ship reports
- Dissipation indicated to be six hours earlier based upon ship reports

Daily Metadata:

October 1:

1. Maps and old HURDAT:

- HWM is not available on this date (system south of 20°N).

- HURDAT does not list an organized system on this date.
- Microfilm shows a tropical wave along 12N-20N, 66W-69W at 12Z.

2. Discussion/MWR: "A fairly active easterly wave passed through the Lesser Antilles on September 30 and into the Virgin Islands on October 1."

October 2:

1. Maps and old HURDAT:
- HWM is not available on this date (system south of 20°N).
- HURDAT does not list an organized system on this date.
- Microfilm shows a tropical wave along 13N-25N, 70W-72W at 12Z.

2. Ship highlights:
- 35 kt NE and 1013 mb at 19.6N, 74.8W at 03Z (COADS).
- 35 kt ESE and 1009 mb at 16.6N, 69.3W at 18Z (micro).
- 40 kt at 17N 71W at ~18Z (micro).

3. Discussion/Reanalysis: The last tropical cyclone of the 1958 Hurricane Season developed from a strong tropical wave that entered the Caribbean Sea in early October. The vigorous disturbance produced tropical storm force winds on October 2nd, 3rd and early on the 4th.

October 3:

1. Maps and old HURDAT:
- HWM is not available on this date (system south of 20°N).
- HURDAT does not list an organized system on this date.
- Microfilm shows a tropical wave along 15N-23N, 74W-77W at 12Z.

2. 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).

3. Aircraft highlights:
- No closed circulation, but with peak winds of 35 kt and lowest pressure of 1010 mb around 18Z (MWR).

4. Discussion/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:

1. Maps and old HURDAT:
- HWM is not available on this date (system south of 20°N).
- 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.

2. Ship highlights:

- 35 kt SE and 1014 mb at 17.1N, 75.6W at 00Z (COADS).

3. Land highlights:
- 40 kt E and 1011 mb at Kingston, Jamaica at 06Z (micro).

4. Aircraft highlights:
- Minimum pressure of 1008 mb with maximum surface winds of 20 kt (no center fix location, no time by likely ~18Z, MWR, note that the flight is not included in the ATSR, despite it being a Navy reconnaissance mission)

5. Discussion:
   a. 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."
   b. Reanalysis: 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. Observations confirming the well-defined center were from Grand Cayman, Swan Island, and a couple of ship reports. 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.

October 5:

1. Maps and old HURDAT:
- 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.

2. 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).

3. Land highlights:
- 5 kt WNW and 1006 mb at Grand Cayman at 00Z (micro).

4. Aircraft highlights:
- Penetration center fix estimated surface winds of 35 kt and measured a central pressure of 1002 mb at 1330Z (ATSR).
- Penetration center fix estimated flight level winds of 55 kt, measured a central pressure of 1009 mb at 1820Z (micro, Colon).

5. Discussion:
   a. 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."

b. 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."

c. Reanalysis: 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 1330Z 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 35 kt and 45 kt is selected for 12 and 18Z on the 5th, respectively, up from 30 and 35 kt originally in HURDAT. (A research mission around 18Z indicated a central pressure of 1009 mb from a 12,000' flight level. Given ship/coastal station observations below that, this value appears to be high biased.) Late on the 5th, the track of Janice turned to the northeast as it approached the southern coast of Cuba.

October 6:

1. Maps and old HURDAT:

- 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.

2. 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).

3. 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).
- N (no speed) and 1001 mb at Cienfuegos, 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).
- 14 kt ESE and 988 mb minimum pressure at 22Z, 9 kt WNW at 23Z at Harbour Island (WALLET).

4. 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 with 995 mb around 18Z from research aircraft (Colon).
- 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).

5. Discussion:
   a. 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."
   b. ATSR: "Hurricane force winds were first observed at 061800Z after the center had crossed Andros Island and was again out over water."
   c. Reanalysis: 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 around 08Z. 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 intensity at 12Z on the 6th is analyzed at 55 kt, 5 kt higher than 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.

October 7:

1. Maps and old HURDAT:

- 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.

2. 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).

3. 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).

4. 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 (note that the exact time of the 983 mb reading is uncertain - micro).

5. Discussion:
    a. MWR: "The hurricane decelerated in forward speed from 15-20 mph to 7 mph by afternoon of the 7th."
    b. Reanalysis: At 22Z on the 6th, Harbour Island experienced minimum pressure of 988 mb with ESE 14 kt winds, followed by WNW 9 kt winds at 23Z. This indicates a central pressure of about 987 mb, which is added into HURDAT at 00Z on the 7th. A central pressure of 987 mb suggests

maximum sustained winds of 66 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) along with an observed 65 kt from a ship, an intensity of 65 kt is selected for 00Z on the 7th, 5 kt higher than original HURDAT. Intensification to a hurricane is analyzed at 00Z on the 7th, six hours earlier than as 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 and another observation of 65 kt from a ship, an intensity of 70 kt is selected at 18Z on the 7th, 10 kt less than originally shown in HURDAT, a minor intensity change. The aircraft fixes were due north from 0530Z to 1930Z then due east from 1930Z to 02Z on the 8th. The best track has been adjusted toward the fix locations, but not all the way as such an exact track is not realistic.

October 8:

1. Maps and old HURDAT:

- 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.

2. 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).

3. 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 with central pressure of 988 mb around 18Z (Colon).
- Penetration center fix at 31.2N, 73.0W at 2007Z (ATSR).

4. Discussion/Reanalysis: 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 70 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.

October 9:

1. Maps and old HURDAT:

- 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.

2. 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).

3. 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 with 982 mb central pressure at 32.0N, 70.2W at 1345Z (ATSR, Wallet).
- Radar center fix at 32.9N, 69.3W at 1908Z (ATSR).
- Penetration center fix at 33.1N, 68.5W at 2340Z (ATSR).

4. Discussion:

   a. MWR: "The hurricane drifted slowly north-northeastward to northeastward then began accelerating northeastward to east-northeastward on the 9th."

   b. Reanalysis: A reconnaissance aircraft reached Janice on October 9th at 1345Z and measured a central pressure of 982 mb. A central pressure of 982 mb suggests maximum sustained winds of 70 kt from the north of 25N pressure-wind relationship. 70 kt intensity is analyzed at 12Z, up from 65 kt previously. 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.

October 10:

1. Maps and old HURDAT:

- 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.

2. 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).

3. Aircraft highlights:

- Penetration center fix with a eye diameter of 50 nm (at 500 mb) 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 measured a central pressure of 973 mb at 34.9N, 65.5W at 13Z (ATSR, wallet).
- Penetration center fix at 36.1N, 63.3W at 1930Z (ATSR).

4. Discussion:
   a. 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."
   b. Reanalysis: 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. An earlier fix suggested an eye diameter of 50 nm, which usually equates to about 35-40 nm RMW. Given the high altitude of the fix, the surface RMW may have been about 25-30 nm. The climatologial RMW for this latitude and central pressure is 27 nm. Due to a near average RMW, an intensity of 85 kt is selected for 06Z on the 10th, up from 75 kt originally in HURDAT, a minor intensity change. 85 kt is also the peak intensity for this hurricane, 5 kt higher than originally.

October 11:

1. Maps and old HURDAT:

- 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.

2. 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).

3. 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).

4. Discussion:
   a. 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."
   b. Reanalysis: 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, but rapidly accelerating, and with a couple of 75 kt ship reports, an intensity of 80 kt is selected at 12Z on the 11th, 5 kt higher than originally shown in HURDAT.

October 12:

1. Maps and old HURDAT:

- 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.

2. 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).

3. Discussion/Reanalysis: 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.

October 13:

1. Maps and old HURDAT:

- 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.

2. 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).

3. Discussion/Reanalysis: 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 Pres	Evidence	Changes
Oct 5 00Z		Grand Cayman: 5 kt WNW and 1006 mb at 00Z on Oct 5th	1005 mb
Oct 5 12Z		Penetration center fix: 1002 mb at 1330Z on Oct 5th	1002 mb
Oct 5 18Z	999 mb	No observations available, value likely to be estimate	Removed
Oct 6 00Z	999 mb	Ship: 45 kt NE and 999 mb at 21Z on Oct 5th	Removed
Oct 6 06Z	999 mb	No observations available, values likely to be estimates	Removed

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	Harbour Island: 14 kt ESE and 988 mb at 22Z on Oct 6th	987 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	Penetration center fix: 988 mb at ~18Z on Oct 8th	988 mb
Oct 9 00Z	987 mb	Penetration center fix: 984 mb at 0144Z on Oct 9th	984 mb
Oct 9 06Z	985 mb	No observations available, values likely to be estimates	Removed
Oct 9 12Z	983 mb	Penetration center fix: 982 mb at 1345Z on Oct 9th	982 mb
Oct 9 18Z	977 mb	No observations available, values likely to be estimates	Removed
Oct 10 00Z	970 mb	No observations available, values likely to be estimates	Removed
Oct 10 06Z	968 mb	Penetration center fix: 968 mb at 0735Z on Oct 10th	Retained
Oct 10 12Z	970 mb	Penetration center fix: 973 mb at 13Z on Oct 10th	973 mb
Oct 10 18Z	970 mb	No observations available, values likely to be estimates	Removed
Oct 11 00Z	968 mb	No observations available, values likely to be estimates	
Oct 11 06Z	972 mb		
Oct 11 12Z		Penetration center fix: 974 mb at 1035Z on Oct 11th	974 mb

Sources: NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Monthly Weather Review, Surface Weather Observations, Navy reconnaissance book, Mariners Weather Log, Colon (NHRP #65), Perez et al. (2000) and NHC Storm Wallets.

New Storm [May 24-29, 1958] – AL111958

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37265 05/25/1958 M= 5 11 SNBR= 820 UNNAMED       XING=0 SSS=0
37265 05/25*250 805  25 1003*260 793  25 1003*270 790  30 1003*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
```

Significant Revisions:

A new tropical storm has been added to HURDAT, not previously shown in McAdie et al. (2009).

Daily Metadata:

May 21:

1. Maps:

- HWM is not available on this date (system south of 20°N).
- Microfilm shows a closed low pressure of at most 1008 near 16.0N, 82.0W at 12Z.

2. Discussion/Reanalysis: A broad area of low pressure developed over the southwestern Caribbean Sea around May 21st and slowly moved northwestward.

May 22:

1. Maps:

- HWM is not available on this date (system south of 20°N).
- Microfilm shows a closed low pressure of at most 1008 near 16.0N, 84.0W at 12Z.

May 23:

1. Maps:

- 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.

May 24:

1. Maps:

- 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.

2. Land highlights: 10 kt NE and 1005 mb at Cabo San Antonio, Cuba at 00Z (micro).

3. Discussion/Reanalysis: The large disturbance developed into a broad area of low pressure on the 24th.

May 25:

1. Maps:

- 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.

2. 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).

3. 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).

4. Discussion/Reanalysis: The system developed a well-defined center around 00Z on the 25th near Florida Keys and genesis as a tropical depression is indicated at that time. 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. 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. (It is possible that the system might be better considered a subtropical cyclone, given its large size. However, without satellite imagery to confirm the convective structure, the system is considered a tropical cyclone.) Freeport, Bahamas reported 5 kt SW and 1005 mb at 12Z on the 25th, suggesting a central pressure of 1004 mb. (The 00Z, 06Z, and 12Z central pressures are all analyzed to be 1003 mb to account for noise in the measurements, errors in the estimation of the central pressure, and to provide a smoother consistent analysis.) 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.

May 26:

1. Maps:

- 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.

2. 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).

3. Discussion/Reanalysis: 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 based upon comparison versus other nearby ships at this and other observation times. 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.

May 27:

1. Maps:

- 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.

2. 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).

3. Discussion:

- Clark and French: "During the period May 18-28, 1958 a subtropical depression formed in the Caribbean Sea and moved north-northeastward parallel to the east coast of the United States. The Low becamse extra-tropical and continued northward west of Greenland…It had all the prospects of becoming a full scale hurricane but the winds never even reached storm speed (greater than 38 m.p.h.) until after the depression became extra-tropical…Track of the depression including the track beyond the position when it became extra-tropical at 0000 GMT, May 27, 1958."
- Reanalysis: 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, which is 18 hours after that suggested by Clark and French.

May 28:

1. Maps:

- 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.

2. 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).

3. 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).

4. Discussion/Reanalysis: The extratropical cyclone produced gale force winds on Nantucket Shoals, MA and Georges Shoal, MA on May 28th.

May 29:

1. Maps:

- 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.

2. 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).

3. Land highlights:

- 25 kt S and 998 mb at Halifax, Canada at 06Z (micro).

4. Discussion/Reanalysis: On May 29th, the extratropical cyclone moved over the Atlantic provinces of Canada where it merged with another extratropical cyclone. As the merger took place around 12Z, the last position for the system is analyzed to be 06Z on the 29th.

May 30:

1. Maps:

- 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.

Sources: Historical Weather Map series, Microfilm, Monthly Weather Review (including a paper by Clark and French (1958)), COADS ship database, Surface Weather Observations, Mariners Weather Log and Jack Beven's and David Roth's suspect list.

New Storm [October 15-18, 1958] – AL121958

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37265 10/15/1958 M= 4  12 SNBR= 820 UNNAMED       XING=0 SSS=0
37265 10/15*  0   0   0    0*  0   0   0    0*  0   0   0    0*213 687  30    0*
37265 10/16*227 685  30    0*240 675  35    0*250 672  40    0*255 668  40    0*
37265 10/17*265 660  40    0*285 650  45    0E310 635  50    0E335 620  55    0*
37265 10/18E355 600  60    0E375 580  60    0E410 555  60    0E450 530  60    0*
37265 TS
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Significant Revisions:

A new tropical storm has been added to HURDAT, not previously shown in McAdie et al. (2009).

Daily Metadata:

October 15:

1. Maps:
   - HWM indicates a stationary front running along 24N.
   - Microfilm shows an open low pressure near 21N, 69W with a frontal boundary extending ENE to W of the low at 12Z.

2. Ship highlights:
   - 10 kt SW and 1004 mb at 25.7N 68.7W at 18Z (COADS).

3. Discussion/Reanalysis: A closed low pressure developed along a decaying frontal boundary around 18Z. Analysis of available ship and station observations indicate, however, that the front had dissipated by this time. Thus the system is begun as a 30 kt tropical depression.

October 16:

1. Maps:
   - HWM indicates a low pressure of at most 1010 mb near 25N 67W at 12Z with a warm front extending east and a cold front extending west-southwest.
   - Microflim shows a low pressure of at most 1008 mb near 26N 67W at 12Z with a warm front extending east and a cold front extending west-southwest.
   - MWL Tracks of Centers of Cyclones shows a center at 24N 68W at 12Z.

2. Ship highlights:
   - 38 kt ENE and 1010 mb at 26.6N 68.4W at 12Z (COADS/MWL).

3. Aircraft highlights:

- 30 kt maximum surface winds ~21Z, no center fix, "extratropical wave" (ATSR).

4. Discussion/Reanalysis: The cyclone moved northeastward at 15 kt initially, but slowed by the end of the day. The first observed gale was 38 kt ENE at 12Z. (Two other gales were reported at that time as well.) The system is analyzed to have become a 35 kt tropical storm at 06Z.

October 17:

1. Maps:
   - HWM indicates a low pressure of at most 1005 mb near 29N 66W with a warm front extending east and a cold front extending south-southwest.
   - Microfilm indicates a low pressure of at most 1008 mb near 31N 63W with a warm front extending east and a cold front extending south-southwest.
   - MWL Tracks of Centers of Cyclones shows a center at 31N 63W at 12Z.
2. Ship highlights:
   - 45 kt E and 1012 mb at 31.3N 65.5W at 06Z (micro).
   - 35 kt S and 1007 mb at 30.3N 62.0W at 12Z (COADS).
   - 55 kt NE and 1005 mb at 34.7N 61.4W at 18Z (COADS).
3. Aircraft highlights:
   - 40 kt maximum surface winds with lowest pressure of 1010 mb ~12Z, no center fix, "cold front" (ATSR).
4. Discussion/Reanalysis: The cyclone accelerated off toward the north-northeast during the day. Intensification also was occurring, as indicated by a 45 kt ship at 06Z and a 55 kt ship at 18Z. However, cyclone developed frontal characteristics with significant baroclinicity around 12Z. Thus extratropical transition is indicated at that time. The peak intensity of the system while it was a tropical cyclone is 45 kt at 06Z, just before extratropical transition.

October 18:

1. Maps:
   - HWM indicates an occluding low of at most 1000 mb centered near 42N 56W with an occluded front extending east of the low. A large extratropical system is to the northwest of the low near 47N 62W.
   - Microfilm indicates a low of at most 999 mb centered near 41N 55W witn a frontal boundary extending south of the low. An extratropical system is to the northwest of the low near 47N 62W.
   - MWL Tracks of Centers of Cyclones shows a center at 41N 56W.
2. Ship highlights:
   - 60 kt SW and 1000 mb at 34.9N 60.1W at 00Z (MWL/micro/COADS).
   - 50 kt WNW and 1008 mb at 35.1N 56.7W at 06Z (MWL/micro/COADS).
   - 35 kt NNE and 999 mb at 42.7N 56.5W at 12Z (MWL/micro/COADS).
   - 45 kt S and 1012 mb at 38.1N 51.5W at 12Z (MWL/micro/COADS).
   - 60 kt W and 995 mb at 43.1N 53.2W at 18Z (MWL/micro/COADS).
3. Discussion/Reanalysis: As the extratropical cyclone continued accelerating toward the northeast during the day, it also further intensified with six reports of 50 kt or greater with 60 kt observed at both 00 and 18Z. It is of note that the 00Z 60 kt report was about 40 nm from the center of the system, suggesting that it still retained some tropical characteristics. Peak intensity of the system as an extratropical cyclone is indicated to be 60 kt, though it may have reached hurricane-force while extratropical.

October 19:

1. Maps:
   - HWM
   - Microfilm indicates an extratropical cyclone (not the original cyclone) with at most 978 mb near 56N 50W with a frontal boundary extending south of the system.
   - MWL Tracks of Centers of Cyclones dissipated the system before 12Z, with last position near 53N 52W.
2. Ship highlights:
   - 40 kt S with 998 mb at 47.6N 47.7W at 00Z (micro/COADS).
3. Discussion/Reanalysis: By 00Z, the original system merged with a larger extratropical cyclone approaching from the west. Thus the system is indicated to have a last position at 18Z on the 18th.

Sources: NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Monthly Weather Review, Navy reconnaissance book, and Mariners Weather Log.

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 f
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 Depressi
May 28	26N	50W	Tropical Storm?
May 29	26N	49W	Tropical Storm?
May 30	30N	48W	Tropical Storm?
May 31	34N	50W	Tropical Depressi
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 Depressi
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 Depressi
September 9	8N	52W	Tropical Depressi
September 10	12N	55W	Tropical Depressi

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 Depressi
October 5	25N	58W	Tropical Depressi
October 6	28N	56W	Tropical Depressi
October 7	35N	45W	Absorbed

6) 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 Octbober 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 Atlantic Hurricane Database Reanalysis - Sandy Delgado and Chris Landsea

Green indicates wind changes of 15 kt or greater
Yellow indicates lat/long changes greater than 1°
Red indicates a new entry
Blue indicates a deletion

Tropical Storm Arlene [May 28 - June 1, 1959] - AL011959

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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*233 865  25    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  40    0*274 901  45 1000*277 912  45 1002*
           *** ***                  **          ***  ** **** *** ***     ****
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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*280 919  45  999*285 919  50  996*292 918  55  993*
                ***          ***          *** *** ***      *** *** ***  **  ***

40980 05/31*299 917  30    0*304 915  25    0*310 912  25    0*317 909  25    0*
40980 05/31*298 916  55    0*304 914  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*324 899  25    0*326 891  25    0*327 883  25    0*
            *** ***         ***            ***            ***  ***

40990 06/02*334 874  25    0*336 853  25    0*338 833  25    0*342 807  25    0*
40990 06/02*328 872  20    0*329 850  20    0*335 827  20    0*344 800  20    0*
            *** ***  **      *** ***  **      *** ***  **      *** ***  **

40995 TS

U.S. Tropical Storm Landfall
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05/30 22Z 29.6N 91.6W 55 kt LA
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Significant Revisions:

- Three new central pressures were added based upon ship and aircraft reconnaissance observations
- Large intensity increases introduced late on the 30th and early on the 31st based upon aircraft reconnaissance
- Landfall in Louisiana analyzed to be at high end tropical storm (55 kt) compared with 40 kt originally

Daily Metadata:

May 25:

1. Maps and old HURDAT:

- 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.

2. Discussion:

- 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:

1. Maps and old HURDAT:

- 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.

2. Land highlights:
- 35 kt ESE and 1017 mb at Dry Tortugas, FL at 12Z (micro).

May 27:

1. Maps and old HURDAT:
- 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.

2. 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).

3. Discussion/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:

1. Maps and Old HURDAT:
- 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.

2. Ship highlights:
- 35 kt E and 1012 mb at 25.2N, 84.6W at 00Z (COADS);
- 20 kt W and 1012 mb at 23.8N 87.2W at 12Z (COADS).

3. Discussion:
- 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."
- Reanalysis: 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. Because of the 20 kt W wind at 12Z, it is analyzed that genesis occurred around 06Z, six hours earlier than the original HURDAT.

May 29:

1. Maps and old HURDAT:
- 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.

2. 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).

3. Aircraft highlights:
- Penetration center fix measured a central pressure of 1000 mb, estimated maximum surface winds of 45 kt and an eye diameter of 40 nm at 12Z (ATSR). (The text message in the ATSR for the 1200 UTC fix [coded Navy Seven] says that the minimum observed pressure was 1008 mb. However, the text coding sheet and the plotted map shows a pressure of 1000 mb (ob #8) at 1230 UTC. The lower pressure is supported by the subsequent ob #9, which appears to show a 1005 mb pressure and estimated winds of 45 kt. Thus 1000 mb is analyzed as the central pressure from this fix.)
- Penetration center fix measured a central pressure of 1002 mb and estimated maximum surface winds of 45 kt at 1854Z (ATSR).

4. Discussion:
- 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."
- Reanalysis: 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 1000 mb. This central pressure suggests 44 kt from the Brown et al. pressure-wind relationship. 45 kt is analyzed as the intensity at this time, up from 40 kt in HURDAT originally. A central pressure of 1002 mb is added to HURDAT at 18Z on the 29th, based upon the next center fix at 1854Z.

May 30:

1. Maps and old HURDAT:
- 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.

2. Ship highlights:
- 45 kt N at 28.0N, 92.0W at 00Z (micro).
- 40 kt E and 1005 mb at 29.0N 91.5W at 06Z (oil platform).

- 20 kt W and 998 mb at 28.6N, 92.4W at 12Z (micro).
- 44 kt S and 1003 mb at 29.0N, 91.5W at 12Z (oil platform).
- 55 kt S and 1005 mb at 28.7N 91.4W at 14Z (oil platform).
- 40 kt SSW and 1003 mb at 29.0N 91.5W at 18Z (oil platform).

3. 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).

4. 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. (Note that the remainder of the aircraft information suggests that this observations was actually taken around 21Z on the 29th. The 1000 mb surface pressure agrees well with calculations fro 700 and 850 mb temperatures and heights.)
- Penetration center fix measured 850 mb minimum height of 4600 ft, indicating a central pressure of around 999 mb at 0710Z.
- 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.

5. Disussion:
- 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."
- Louisiana Climatic Data: "Wind damage was confined to a small area near the center, main in Franklin, St. Mary Parish, where treeds were uprooted bringing power and phone lines down, shingles were blown from some roofs and TV antennas were bent or broken…Franklin: Calm 6:30-6:30 p.m./30; east beroe, west after calm; highest wind from west"
- Reanalysis: The next reconnaissance aircraft reached Arlene late on the 29th 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. (Of note is that the center fix location from the drop does not match well with the other reported center positions. Less weight is thus placed on this for the 00Z 30th position.) A 999 mb central pressure roughly estimated from 850 mb minimum height at 0710Z fix replaces the 1000 mb already in HURDAT at 06Z. 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 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. 55 kt S (unknown anemometer height) and 1005 mb was observed at 14Z from a Phillips Petroleum oil platform. 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. 55 kt is assessed as the intensity at 18Z, which is 15 kt more than originally shown in HURDAT, a major intensity change. A central pressure of 993 mb is added to HURDAT at 18Z on the 30th. Landfall occurred around 22Z near 29.6N, 91.6W in south-central Louisiana 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.

May 31:

1. Maps and old HURDAT:

- 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.

2. 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).

3. Discussion:

- Reanalysis: 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. Arlene is the earlier tropical storm on record to make landfall in Louisiana.

June 1:

1. Maps and old HURDAT:

- 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.

June 2:

1. Maps and old HURDAT:

- 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.

2. Discussion:

- Reanalysis: Arlene moved east-northeastward over the southeast United States on the 1st and 2nd, while gradually weakening. Dissipation is analyzed after 18Z on the 2nd, same as originally shown in HURDAT. Arlene's remnants were absorbed by a frontal boundary after that time.

June 3:

1. Maps and old HURDAT:

- 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.

2. 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:

1. Maps and old HURDAT:

- 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.

Sources: NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, oil platform observations from NCDC, Monthly Weather Review, Navy reconnaissance book, Surface Weather Observations, State Climatological Data, Mariners Weather Log and NHC Storm Wallets.

Tropical Storm Beulah [June 15-19, 1959] – AL021959

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41000 06/15/1959 M= 4  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*
41005 06/15*  0   0   0    0*  0   0   0    0*  0   0   0    0*211 947  35    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  40    0*221 957  50    0*225 961  55    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  985*230 967  50  992*229 969  50  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  45  997*223 971  40    0*221 972  35 1001*210 973  35 1001*
           *** ***  **  *** *** ***  **      ***         **** *** ***  ** ****
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(June 19th is new to HURDAT)
41023 06/19*218 974 30   0*214 976 25   0* 0   0   0   0* 0   0   0   0*

41025 TS

Significant Revisions:

- Intensity significantly raised at 00Z on the 16th based upon ship observations
- Several new central pressures were added based upon aircraft reconnaissance observations
- A major change is to indicate that Beulah made landfall as a tropical depression in Mexico
- Twelve hours added to the end of the track before dissipation based upon land and ship observations

Daily Metadata:

June 13:

1. Old maps and HURDAT:

- 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.

2. Discussion:

- 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."
- Reanalysis: 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.

June 14:

1. Old Maps and HURDAT:

- 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.

2. Discussion:

- Reanalysis: 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.

June 15:

1. Old Maps and HURDAT:

- 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.

2. Station highlights:
- 20 kt W and 1005 mb at Tampico at 12Z (HWM);

3. Discussion:
- 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."
- Reanalysis: 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 and may have occurred earlier given the 20 kt W wind with 1005 mb at Tampico at 12Z. However, given the lack of observations near the supposed center at 12Z, genesis is retained at 18Z.

June 16:

1. Old Maps and HURDAT:
- 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.

2. 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).

3. Land highlights:
- 20 kt W and 1004 mb at Tampico, Mexico at 12Z (HWM).

4. 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).

5. Discussion:
- 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."

- Reanalysis: The ship SS HONDO reported 50 kt NE and 997 mb at 09Z on June 16th. Intensity is boosted from 40 to 50 kt at 06Z. This necessitates revisions at 00Z (from 25 to 40 kt – a major change) and at 18Z on the 15th (from 25 to 35 kt). 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. 60 kt is also the peak intensity for this tropical cyclone, same as the original HURDAT, but 12-24 hours earlier.

June 17:

1. Old Maps and HURDAT:

- 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.

2. 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).

3. 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).

4. 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 985 mb, estimated maximum surface winds of 50 kt and an eye diameter of 18 nm at 22.9N, 96.4W at 06Z (ATSR). (Note that the vortex message indicated 987 mb, but that a dropsonde gave 985 mb which is used here.)
- 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).

5. Discussion:

- MWR: "Highest winds were estimated by reconnaissance aircraft at 61 kt with lowest pressure 987 mb."
- Reanalysis: The next aircraft to reach Beulah occurred at 06Z on the 17th and measured a central pressure of 985 mb, estimated surface winds of 50 kt and an eye diameter of 18 nm. A central pressure of 985 mb suggests maximum surface winds of 71 kt south of 25N from pressure-wind relationship. An eye diameter of 18 nm suggests an RMW of about 15 nm and climatology is 18 nm.

Since Beulah was of near average size but nearly stationary and embedded in low environmental pressure (1008 mb outer closed isobar), an intensity of 60 kt is assessed at 06Z on the 17th, slightly higher than that originally shown in HURDAT. A central pressure of 985 mb is added to HURDAT at 06Z on the 17th. 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, a near average RMW, and low environmental pressure, an intensity of 50 kt is selected at 12Z on the 17th, slightly lower than that originally 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. A central pressure of 987 mb was present in HURDAT at 18Z on the 17th and has been replaced with 992 mb.

June 18:

1. Old Maps and HURDAT:

- 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.

2. 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).

3. 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).

4. Discussion:

- 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.”
- Reanalysis: 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 and low environmental pressure, an intensity of 45 kt is selected at 00Z on the 18th, 10 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 35 kt is selected at 12Z and 18Z on the 18th, same as 35 kt at 12Z and up from 30 kt at 18Z in HURDAT, minor intensity changes. A central pressure of 1001 mb is added to HURDAT at 12Z and 18Z on the 18th.

June 19:

1. Old Maps and HURDAT:

- 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.

2. Discussion:

- Reanalysis: 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 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 30 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 00Z on the 19th just before landfall and six hours later than originally shown in HURDAT. Dissipation occurred shortly after 06Z on the 19th.

Sources: 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.

Unnamed Tropical Storm #3 [June 18-22, 1959] – AL031959

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41030 06/18/1959 M= 4  3 SNBR= 892 NOT NAMED   XING=0 SSS=0
41030 06/18/1959 M= 5  3 SNBR= 892 NOT NAMED   XING=1 SSS=0
                    *                           *

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*288 805  40    0*304 775  45    0*
           *** ***  **              **  ****    ***  **          ***  **

41040 06/19*322 751  50  993*350 705  60    0*384 653  65  974E412 621  70    0*
41040 06/19*320 740  55    0*345 700  65    0*384 650  75  974E412 625  75    0*
           *** ***  **    * *** ***  **          ***  **          ***  **

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
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U.S. Tropical Storm Landfall

06/18 08Z 28.0N 82.8W 40 kt FL

Significant Revisions:

- The track is significantly adjusted westward on the 21st based upon ship and coastal observations
- Dissipation is analyzed to have occurred 18 hours later

June 15:

1. Old Maps and HURDAT:
- HWM analyzes a stationary cold front over the northern Gulf of Mexico at 12Z.
- HURDAT does not list an organized system on this date.

2. Discussion:
- 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:

1. Old Maps and HURDAT:
- 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.

2. 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).

3. Discussion:
- MWR: "This wave moved northwestward into the central Gulf on the 16th."
- Reanalysis: 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.

June 17:

1. Old Maps and HURDAT:
- 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.

2. 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).

3. Discussion:

- MWR: "A weak closed circulation appeared in the east-central Gulf on the 17th. It began moving northeastward."

June 18:

1. Old Maps and HURDAT:

- 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.

2. 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).

3. 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).

4. Discussion:

- MWR: "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...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."
- Reanalysis: Genesis is retained at 00Z on the 18th, based upon ship observations. The tropical cyclone exhibited some subtropical characteristics from the beginning, including the large size of the circulation and the strongest winds being present about 100-200 nm away from the center in the eastern semicircle. The system is begun as a tropical storm 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 and an elevated report of 40 kt from Dry Tortugas Light. 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 Clearwater at 28.0N, 82.8W. 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 maps at 06Z and 12Z 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. As the tropical storm was moving over the peninsula, the center apparently passed over or just south of McCoy Air Force Base around 10-11Z with the wind going from east to calm to north along with a minimum of pressure around 1003 mb. The tropical storm rapidly crossed Florida, entering the Atlantic between 11-12Z on the 18th.

June 19:

1. Old Maps and HURDAT:

- 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.

2. 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).
- 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).
- 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).

3. Discussion:

- 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.”
- Reanalysis: The tropical cyclone rapidly began to intensify over the Atlantic Ocean late on the 18th as it began to acquire extratropical characteristics. 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 system reached hurricane intensity at 06Z, six hours earlier than 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 given the hurricane-force ship reports, although it is only mentioned in the Monthly Weather Review and does not appear in any of the other available sources. 974 mb central pressure suggests an intensity of 79 kt from the Landsea et al. pressure-wind relationship. Given that the system was undergoing extratropial transition, the intensity is analyzed to be 75 kt at 12Z, up from 65 kt originally. 75 kt is also the peak intensity for the system as a tropical cyclone, up from 65 kt originally. The synoptic maps on the 19th show gradual development of extratropical features and the time of extratropical transition is somewhat ambiguous. The two 65 kt ship reports at 12Z suggest that the cyclone had not fully lost its tropical characteristics at that time. Thus, transition to an extratropical cyclone is analyzed at 18Z

on June 19th, same as originally shown in HURDAT. The system 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.

June 20:

1. Old Maps and HURDAT:

- 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.

2. 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).

3. 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).

4. Discussion:

- 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."
- Reanalysis: 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.

June 21:

1. Old Maps and HURDAT:

- 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.

2. 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).

3. Discussion:

- Reanalysis: 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.

June 22:

1. Old Maps and HURDAT:

- 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.

2. Ship highlights: 35 kt W and 1011 mb at 42.2N, 50.5W at 00Z (COADS).

3. Discussion:

- Reanalysis: 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.

June 23:

1. Old Maps and HURDAT:

- 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.

Sources: the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Monthly Weather Review, Surface Weather Observations, and Mariners Weather Log.

Hurricane Cindy [July 4-12, 1959] – AL041959

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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=1
         **         *

(July 4th is new to HURDAT)
41063 07/04*  0   0   0    0*  0   0   0    0*315 790  25    0*310 790  25    0*
                                             **** ***  **     **** ***  **

41065 07/05*  0   0   0    0*  0   0   0    0*296 785  25    0*298 783  25    0*
41065 07/05*305 789  25    0*300 787  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  65  995*324 787  65    0*
           *** ***      *** *** ***         *** ***      *** *** ***

41085 07/09*324 793  65    0*330 798  50    0*337 802  35    0*341 803  30    0*
41085 07/09*326 793  65  995*332 798  50    0*337 801  35    0*341 803  30    0*
           ***          *** ***               ***
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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  30    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*395 727  50    0*417 707  50   998E443 677  45 1000*
            *** ***  **          ***  **      *** ***      *** ***      ** ****
41100 07/12E458 649  45    0E480 620  35    0E502 591  35    0E524 562  35    0*
41100 07/12E463 649  40    0E483 620  35    0E505 591  30    0E530 562  25    0*
            ***      **      ***              ***      **      ***      **
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41105 HR SC1

U.S. Landfall

07/09 04Z 33.0N 79.6W - 65 kt - 995 mb - 20 nm RMW - 1017 OCI - SC1
07/11 12Z 41.7N 70.7W - 50 kt - MA

Significant Revisions:

- Genesis 24 hours earlier based upon ship and coastal observations.
- A few additional central pressures were added, primarily from aircraft reconnaissance.

Daily Metadata:

July 3:

1. Old Maps and HURDAT:

- 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.

2. Discussion:

- Reanalysis: 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.

July 4:

1. Old Maps and HURDAT:

- 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.

2. Discussion:

- 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."
- Reanalysis: Genesis is analyzed at 12Z on July 4th as a 25 kt tropical depression. System is started as a tropical cyclone based on surface observations indicating the dissipation of the frontal features and a more uniform and tropical airmass around the system. Note that the initial

development of Cindy may have been subtropical due to the influence of the large upper-level low, but without routine satellite imagery such a formal categorization is not possible.

July 5:

1. Old Maps and HURDAT:

- 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.

2. Discussion:

- 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."
- Reanalysis: The system initially moved slowly to the south, later turning to the east on July 5th.

July 6:

1. Old Maps and HURDAT:

- 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.

2. Discussion:

- 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"
- Reanalysis: 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.

July 7:

1. Old Maps and HURDAT:

- 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.

2. 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).

3. 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).

4. Discussion:

- 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."
- Reanalysis: 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.

July 8:

1. Old Maps and HURDAT:

- 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.

2. 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).

3. 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).

4. 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).

5. Discussion:

- 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."
- Reanalysis: 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, an intensity of 65 kt is selected for 12Z on the 8th, same as HURDAT. 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. However, these were based upon flight-level extrapolations. An eye drop on the same flight at the 23Z fix indicated a central pressure of 995 mb, so it is likely that the 1002 and 1000 mb values are too high and thus not added into HURDAT.

July 9:

1. Old Maps and HURDAT:

- 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.

2. 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).

3. 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).

4. Radar highlights:
- Radar fix 32.5N 79.0W at 00Z from Cherry Point (wallets);
- Radar fix 33.0N 79.8W at 04Z from Charleston (wallets).

5. 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).

6. Discussion:
- Jarrell et al: "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."
- Reanalysis: At 23Z on the 8th, a penetration fix reported a central pressure from dropsonde of 995 mb. A central pressure of 995 mb suggests maximum sustained winds of 52 kt north of 25N from the pressure-wind relationship. 56 kt sustained winds were reported at McClellanville, as part of the Cooperative Hurricane Reporting Network or CHURN. The last reconnaissance mission just before landfall was conducting radar fixes and reported an eye diameter of 24 nm, suggesting an RMW of about 20 nm. This is smaller than climatology of 28 nm for this central pressure and landfall latitude. Given the smaller than average size, high environmental pressure (1017 mb OCI), and the observation at McClellanville, the intensity at 00Z and at landfall at 04Z on July 9th is analyzed at 65 kt, same as HURDAT. A central pressure of 995 mb is added to HURDAT at 00Z on the 9th. 65 kt is also the peak intensity of Cindy, same as in HURDAT. Landfall occurred around 04Z on the 9th as a Category 1 65 kt hurricane near 33.0N, 79.6W or about 25 nm northeast of Charleston, SC. However, it is noted that the intensity late on the 8th until landfall is uncertain and could be sub-hurricane force (55-60 kt), given the available observations. 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.

July 10:

1. Old Maps and HURDAT:
- 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.

2. Ship highlights:

- 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).

3. Land highlights:

- 42 kt NW (gusts to 52 kt) at Charlotte, NC at 2105Z (SWO).

4. Discussion:

- Reanalysis: A ship near the North Carolina coast reported 35 kt SE at 06Z. However, this appears to be high relative to its neighbors and is not reliable. (Note that examination of the Charlotte, NC SWO indicates that the 42 kt wind on 10 July was in a severe thunderstorm and appears to be unrepresentative of the strength of the tropical cyclone. The winds outside of the thunderstorm were less than 15 kt.) 40 and 45 kt ship reports that do appear to be more reliable were observed late on the 10th. It is estimated that Cindy regained tropical storm intensity at 12Z (six hours earlier than HURDAT), while still overland but approaching the coast.

July 11:

1. Old Maps and HURDAT:

- 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.

2. 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).

3. 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).

4. Discussion:

- 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."
- Reanalysis: Cindy moved back over the Atlantic Ocean late on the 10th and continued to gain strength. A ship at 06Z on the 11th reported operationally 65 kt S and 1003 mb according to the microfilm, COADS and

MWR. However the Mariners Weather Log post-storm analysis 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 at 12Z at 41.7N 70.7W along Buzzards Bay east of New Bedford with an intensity of 50 kt. This location is based upon hourly observations from East Boston, South Weymouth, Otis, Martha's Vineyard, Nantucket, and Barnstable. Nantucket Shoals, MA reported 25 kt SSW and 1001 mb at 1155Z, suggesting a central pressure of 998 mb, 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.

July 12:

1. Old Maps and HURDAT:

- 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.

2. Ship highlights:

- 40 kt SW and 1014 mb at 44.4N, 63.4W at 00Z (COADS).

3. Discussion:

- Reanalysis: 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.

July 13:

1. Old Maps and HURDAT:

- 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.

July 14:

1. Old Maps and HURDAT:

- HWM analyzes an extratropical cyclone of at most 1005 mb at 62.0N, 27.0W at 12Z.
- Microfilm is not available on this date.

July 15:

1. Old Maps and HURDAT:

- HWM analyzes an extratropical cyclone of at most 995 mb at 60.0N, 22.0W at 12Z.

July 16:

1. Old Maps and HURDAT:

- HWM analyzes an extratropical cyclone of at most 990 mb at 62.0N, 22.0W at 12Z.

July 17:

1. Old Maps and HURDAT:

- HWM analyzes an extratropical cyclone of at most 995 mb at 64.0N, 18.0W at 12Z.

July 18:

1. Old Maps and HURDAT:

- HWM analyzes an extratropical cyclone of at most 995 mb at 69.0N, 14.0W at 12Z.

July 19:

1. Old Maps and HURDAT:

- HWM analyzes an extratropical cyclone of at most 1005 mb at 70.0N, 22.0W at 12Z.

Sources: 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.

Hurricane Debra [July 22-27, 1959] – AL051959

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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  30    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  50    0*283 950  65    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*292 952  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*
                    **                                                  **
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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

U.S. Hurricane Landfall

July 25th – 05Z – 29.1N 95.2W – 75 kt – Category 1 – 980 mb – 1012 mb Outer Closed Isobar – 150 nm ROCI – 20 nm RMW

Signficant Revisions:

- Genesis is indicated six hours earlier based upon ship and coastal observations
- A few additional central pressure values are added in based upon aircraft reconnaissance missions
- Dissipation is indicated to be twelve hours earlier based upon station observations

Daily Metadata:

July 20:

1. Old Maps and HURDAT:
- HWM and microfilm do not analyze an organized system at 12Z.
- HURDAT does not list an organized system on this date.
2. Discussion:
- 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."
- Reanalysis: A disturbance developed over the northeastern Gulf of Mexico around July 20th.

July 21:

1. Old Maps and HURDAT:
- 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.

2. Discussion:
- 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:

1. Old Maps and HURDAT:

- 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.

2. Discussion:
- Reanalysis: 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.

July 23:

1. Old Maps and HURDAT:
- 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.

2. Discussion:
- 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."
- Reanalysis: No gale force winds or equivalent low pressures on July 23rd were observed, despite substantial ship observations being available.

July 24:

1. Old Maps and HURDAT:
- 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.

2. 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).

3. Aircraft 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).
- Radar center fix with an eye diameter of 30 nm at 28.7N 95.1W at 2215Z (ATSR).

4. Radar highlights:
- 28.8N 95.0W at 2330Z from Freeport (wallet).

5. Discussion:
- 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."
- Reanalysis: The tropical depression moved slowly to the west-northwest and became a tropical storm at 00Z on the 24th, twelve hours later than originally shown in HURDAT. 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 12Z on the 24th same as in HURDAT originally, based in part on the radar imagery indicating that an eye had developed. 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.

July 25:

1. Old Maps and HURDAT:

- 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.

2. 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).

3. Land highlights:

- 35 kt N (gusts to 59 kt) and 999 mb at Brazos River Floodgate, Texas at 00Z (SWO).
- 987 mb at Coast Guard Station, Freeport, Texas at 0430Z (WALLET – min pressure).
- 989 mb with 48 kt W (with gusts to 57 kt) at Brazos River Floodgates, Freeport, Texas at ~04Z (SWO and Wallet – min pressure)
- 70 kt W with 994 mb (gusts to 90 kt) at Brazos River Floodgate, Freeport, Texas at 05Z (SWO – fastest mile).
- 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).

4. Aircraft 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).

5. Radar highlights:

- 29.3N 95.3W at 05Z from Freeport (wallet).
- 29.5N 95.2W at 1315Z from Freeport (wallet).

6. Discussion:

- Jarrell et al.: "Jul – TX1 – Cat 1N – 984 mb".
- 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.l… 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."
- Reanalysis: 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 05Z on the 25th near 29.0N 95.2W or about 15 nm northeast of Freeport, Texas, as a 75 kt hurricane. A

central pressure of 986 mb was measured at Dickinson, Texas, at 1145Z on the 25th. 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. Using the 987 mb at the Freeport Coast Guard Station (~12 nm from the center) and assuming an RMW of 20 nm, a central pressure of 981 mb is obtained from the Schloemer equation. Using an RMW of 15 nm, a central pressure of 977 mb is obtained. These support a 980 mb central pressure at landfall, which is 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. The Galveston aiport and city office stations were about 25 nm from the center and remained outside of the RMW (no lull reported at time of lowest pressure). Hourly observations from the Brazos River Floodgates, Freeport (about 15 nm from the center) indicate that this station was inside the RMW with a distinct lull at the time of lowest pressure. This indicates an RMW of about 20 nm, about the same as climatology of 23 nm for this latitude and central pressure. This RMW is also consistent with the last reported eye diameter from aircraft reconnaissance (30 nm diameter at 2215Z on the 24th). Based on both the pressure-wind relationship and surface winds of 73 kt measured at Coast Guard station, 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.

July 26:

1. Old Maps and HURDAT:

- 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.

2. Discussion:

- Reanalysis: Weakening to a tropical depression occurred at 06Z on the 26th over eastern Texas, same as the original HURDAT.

July 27:

1. Old Maps and HURDAT:

- 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.

2. Discussion:

- Reanalysis: The track of the tropical depression veered to the northwest on July 27th while over Oklahoma.

July 28:

1. Old Maps and HURDAT:

- 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).

2. 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.

Sources: 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.

Tropical Storm Edith [August 18-19, 1959] – AL061959

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41150 08/17/1959 M= 3  6 SNBR= 895 EDITH       XING=0 SSS=0
41150 08/18/1959 M= 2  6 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  35 1007*149 599  40    0*155 618  50    0*161 637  40    0*
                       **** *** ***          *** ***          *** ***

41165 08/19*172 648  35    0*172 679  35    0*172 711  30    0*  0   0   0    0*
41165 08/19*167 655  35    0*  0   0   0    0*  0   0   0    0*  0   0   0    0*
           *** ***           *   *   *        *   *   *

41170 TS

Tropical Storm Landfall
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08/18 10Z 15.3N 61.3W 50 kt Dominica
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Significant Revisions:

- Track significantly shifted west-southwestward on the 18th based upon station, ship, and aircraft observations.
- Dissipation indicated to be twelve hours earlier based upon ship and station observations

Daily Metadata:

August 15:

1. Old Maps and HURDAT:

- HWM and microfilm do not show an organized system at 12Z.
- HURDAT does not list an organized system on this date.

2. Discussion:

- 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:

1. Old Maps and HURDAT:

- 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.

August 17:

1. Old Maps and HURDAT:

- 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.

2. 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).

3. Discussion:

- 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.”

- Reanalysis: A tropical wave 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 35 kt tropical storm, same as 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.

August 18:

1. Old Maps and HURDAT:

- 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.

2. 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).

3. Land highlights:
- 34 kt S at Raizet Airport, Guadeloupe at 1310Z (WALLET).

4. Aircraft:
- Estimated surface winds of 50 kt near 16.7N, 61.2W at 13Z (ATSR).

5. Discussion:

- 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."

- Reanalysis: Intensification to a tropical storm is analyzed at 00Z on the 18th, same as 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. The track is significantly shifted west-southwestward on the 18th based upon station, ship, and aircraft observations. 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. The 50 kt originally in HURDAT at 12Z is retained, which also is the peak intensity. Landfall on the island of Dominica occurred near 10Z as a 50 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.

August 19:

1. Old Maps and HURDAT:
- 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.

2. Discussion:

- 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."
- Reanalysis: 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 as a 35 kt tropical storm, 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.

August 20:

1. Old Maps and HURDAT:

- 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.

2. Ship highlights:

- 35 kt E and 1010 mb at 21.6N, 72.9W at 06Z (COADS).

August 21:

1. Old Maps and HURDAT:

- HWM and microfilm do not analyze an organized system at 12Z.

August 22:

1. Old Maps and HURDAT:

- 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.

Sources: 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.

Hurricane Flora [September 9-12, 1959] – AL071959

41175 09/09/1959 M= 6 7 SNBR= 896 FLORA XING=0 SSS=0

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41175 09/09/1959 M= 5   7 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*
41185 09/10*208 465  30    0*220 460  35    0*231 454  40    0*243 448  45 1008*
                           *                                      ***     ****

41190 09/11*256 439  50    0*271 427  55    0*287 413  65    0*303 398  65  994*
41190 09/11*255 442  55    0*269 436  60    0*285 426  65    0*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    0E368 281  50  994*
           *** ***  **      *** ***  **      *** ***  **      *** ***  ** ****

41200 09/13E387 241  55    0E418 229  50    0E450 229  50    0E465 241  45    0*
41200 09/13E387 241  50    0*  0   0   0    0*  0   0   0    0*  0   0   0    0*
                    **     **** ***  **     **** ***  **     **** ***  **
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(September 14th has been removed from HURDAT)

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41205 09/14E470 263  45    0E484 288  45    0*  0   0   0    0*  0   0   0    0*
41210 HR
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Asynoptic best track point:

11/15Z 29.2N 41.6W – 65 kt – 994 mb

Significant Revisions:

- Large westward track shift on the 11th based ship observations
- Four central pressures were added based upon aircraft reconnaissance
- Large reduction in intensity on the 12th based upon aircraft and ship observations
- Dissipation indicated to be 30 hours earlier

Daily Metadata:

September 8:

1. Old Maps and HURDAT:

- 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.

2. Discussion:

- 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."
- Reanalysis: Ships with WNW winds/1008 mb and WSW winds were reported at 12 and 18Z between 40W and 45W. These suggest the possibility a tropical cyclone existed on that day in the tropical north Atlantic.

September 9:

1. Old Maps and HURDAT:

- 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.

2. Discussion:

- 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."
- Reanalysis: 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 earlier.

September 10:

1. Old Maps and HURDAT:

- 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.

2. 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).

3. 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).

4. Discussion:

- 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."

- Reanalysis: 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. 1008 mb is added as a central pressure into HURDAT at 18Z.

September 11:

1. Old Maps and HURDAT:

- 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.

2. 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).

3. 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).

4. Discussion:

- 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."

- Reanalysis: 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 15Z on the 11th, as an asynoptic best track point. 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.

September 12:

1. Old Maps and HURDAT:

- 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.

2. 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).

3. 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).

4. Discussion:

- 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."

- Reanalysis: 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.

September 13:

1. Old Maps and HURDAT:

- 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.

2. Discussion: Ship and surface observations from the Azores Islands indicate that Flora had already been absorbed by 06Z on September 13th by the larger extratropical cyclone to the north. A vort max was likely still present after than time, but observations indicate that the circulation was not

closed. Thus, the last position is analyzed at 00Z on the 11th, 30 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.

September 14:

1. Old Maps and HURDAT:

- 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.

September 15:

1. Old Maps and HURDAT:

- 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.

September 16:

1. Old Maps and HURDAT:

- 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.
-

September 17:

1. Old Maps and HURDAT:

- 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.

Sources: 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.

Hurricane Gracie [September 20 – October 2, 1959] – AL081959

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41215 09/20/1959 M=13  8 SNBR= 897 GRACIE      XING=1 SSS=3
41215 09/20/1959 M=13  8 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*
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41230 09/22*218 741  35    0*222 736  45    0*226 732  55    0*232 730  65  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  65 1000*244 732  65 1002*249 735  65    0*254 740  60    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  65 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 1000*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*
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  60  997*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  981*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*306 791 115  951*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 SC4
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U.S. Hurricane Landfall

Sep 29th – 17Z – 32.5N 80.4W – 115 kt – Category 4 – 951 mb – 10 nm RMW – 1013 mb OCI – 300 nm ROCI

Significant Revisions:

- Several central pressures added based upon aircraft reconnaissance observations
- Large downward reductions in intensity for the 23rd through the 26th because of aircraft reconnaissance

- Intensity at US landfall assessed as 115 kt, down slightly from 120 kt. However, Saffir-Simpson Hurricane Wind Scale adjusted upward from Category 3 to 4
- Significant downward reduction in intensity on the 30th based upon land observations and the inland wind decay model

Daily Metadata:

September 18:

1. Old Maps and HURDAT:

- 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.

2. Discussion:

- 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."
- Reanalysis: 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.

September 19:

1. Old Maps and HURDAT:

- 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.

2. Discussion:
3. 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."

- Reanalysis: The disturbance moved westward and a reconnaissance aircraft investigated in the afternoon of September 19th but did not find a closed-low level circulation.

September 20:

1. Old Maps and HURDAT:

- 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.

2. 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).

3. Discussion:

- Reanalysis: 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. 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.

September 21:

1. Old Maps and HURDAT:

- 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.

2. 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).

3. Discussion:

- 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."

- Reanalysis: 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.

September 22:

1. Old Maps and HURDAT:

- 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.

2. Ship highlights:

- 40 kt ENE and 1017 mb at 22.6N, 73.2W at 00Z (COADS).

3. 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).

4. Discussion:

- 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."

- Reanalysis: 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 65 kt is selected for 18Z on the 22nd, same as HURDAT. A central pressure of 997 mb was present in the original HURDAT at 18Z on the 22nd and has been retained.

September 23:

1. Old Maps and HURDAT:

- 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 an 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.

2. 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).

3. Aircraft highlights:

- Penetration center fix measured a central pressure of 1000 mb and estimated eye diameter of 18 nm at 24.1N, 73.1W at 01Z (ATSR).
- Penetration center fix measured a central pressure of 1002 mb 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).

4. Discussion:

- 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."
- Reanalysis: On September 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 and weighting the aircraft estimated surface winds late on the 22nd as well as the hurricane-force ship later on the 23rd, an intensity of 65 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 65 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 possible that the ship had a high bias and that Gracie didn not obtain hurricane intensity on the 22nd and 23rd.

September 24:

1. Old Maps and HURDAT:

- 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.

2. 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).

3. 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).

4. Discussion:

- ATSR: "GRACIE followed a generally northwesterly track until 241000Z then moved on erratic courses at varying speeds for the next 96 hours."
- Reanalysis: The reconnaissance aircraft just before 00Z on the 24th 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.

September 25:

1. Old Maps and HURDAT:

- 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.

2. 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).

3. Aircraft highlights:

- Penetration center fix with 1000 mb cental pressure 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).

4. Discussion:
- 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."
- Reanalysis: 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.

September 26:

1. Old Maps and HURDAT:
- 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.

2. 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).

3. 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 997 mb, estimated surface winds of 85 kt and an eye diameter of 15 nm at 28.0N, 73.0W at 2330Z (ATSR). (Flight level extrapolation gave 992 mb, but drop provided 997 mb in eye consistent with 850 and 700 mb heights/temperatures.)

4. Discussion:
- 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."
- Reanalysis: 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.

September 27:

1. Old Maps and HURDAT:

- 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.

2. 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).

3. 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).

4. Discussion:

- 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."
- Reanalysis: Gracie gradually intensified on the 26th as indicated by a reconnaissance aircraft measuring a central pressure of 997 mb, estimating surface winds of 85 kt and an eye diameter of 15 nm at 2330Z. A central pressure of 997 mb suggests maximum surface winds of 49 kt from the north of 25N pressure-wind relationship. An eye diameter of 15 nm suggests an RMW of about 12 nm and the climatological value is 23 nm. Since the RMW was smaller than average and weighting the surface estimates some, an intensity of 60 kt is selected at 00Z on the 27th, slightly below that originally shown in HURDAT. A central pressure of 997 mb was added to HURDAT at 00Z on the 27th. Intensification to a hurricane is analyzed at 00Z on the 27th, 4.5 days later than originally shown in HURDAT. On September 27th, Gracie started to move to the west-northwest and continued to gain in strength.

September 28:

1. Old Maps and HURDAT:

- 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.

2. 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).

3. Aircraft highlights:

- Penetration center fix with extrapolated (from 850 mb) central pressure of 981 mb 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).

4. Discussion:

- Reanalysis: A reconnaissance aircraft reached the hurricane at 04Z on September 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.

September 29:

1. Old Maps and HURDAT:

- 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.

2. 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).

3. 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).

4. 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 950 mb and estimated eye diameter of 15 nm at 30.8N, 79.1W at 07Z (ATSR). (The reported pressure via dropsonde was 958 mb. However, the plane reported an 850 mb height in the eye of 3185 ft, which yields an extrapolated pressure of 950 mb. In addition, the plane reported a 700-mb height of 8780 ft and a temperature of 16C, which yields an extrapolated pressure of 951 mb. 951 mb used instead of 958 mb).
- Penetration center fix measured a central pressure of 951 mb at 32.5N, 80.2W at 1530Z (ATSR/WALLET).

5. Radar highlights:
- 0550Z – 30.6N 79.1W from Charleston, 30.5N 79.2W from Savannah (22 nm eye diameter) (wallet).
- 1150Z – 31.7N 79.7W from Charleston (18 nm eye diameter), 31.6N 79.7W from Savannah (20 nm eye diameter) (wallet).
- 1450Z – 32.1N 80.2W from Charleston (15 nm eye diameter) (wallet).
- 1700Z – 32.4N 80.5W from Charleston (wallet).

6. Discussion:
- Ho et al. (1987): "28.08" (950.9 mb) central pressure measured by RECON – RMW 26 nmi – 12 kt forward speed – landfall pt 32.5N, 80.4W".
- Jarrell et al. (1992): "Sep – SC3 – Cat 3 – 950 mb".
- Schwardt et al. (1979): "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".
- 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." [NOTE: 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. Thus the 950 mb report from Beaufort is erroneous.]

- 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."
- Reanalysis: 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 September 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 00Z on the 29th, 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 951 mb, which has 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 from the north of 25N and 109 kt north of 25N intensifying pressure-wind relationships. During the day the eye diameter monitored by coastal radar shrank (22 nm to 18-20 nm to 15 nm at the last size observation at 1450Z), consistent with the observed deepening. The 15 nm eye diameter suggests an RMW of about 12 nm (rounded to 10 nm), compared with climatology of 22 nm for this central pressure and the landfall latitude. An RMW of about 10 nm is also consistent with observations from Beaufort which was about 15 nm west of the hurricane center. Beaufort's observation indicated peak winds at time of lowest pressure, so that the RMW was 15 nm or smaller. Since the circulation remained small, the forward speed was about 13 kt, and a near average 1013 mb OCI, an intensity of 115 kt is selected at 06Z, 12Z, and 18Z on the 29th. HURDAT originally had 120, kt, 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. 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. However, peak observed sustained winds in Savanah – quite close to the South Carolina border – were well below hurricane force. Therefore, Gracie is analyzed as a high end (~55-60 kt) tropical storm impact for Georgia.

September 30:

1. Old Maps and HURDAT:

- 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.

2. Ship highlights:

- 50 kt SSW (likely too high) and 999 mb at 31.8N, 80.5W at 00Z (micro).
- 35 kt SE and 1016 mb at 33.3N 76.0W at 12Z (COADS).

3. 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).
- 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).

4. Discussion:

- Reanalysis: 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, 35 kt and 35 kt, respectively. An intensity of 60 kt is selected for 00Z, 45 kt at 06Z and 35 kt at 12Z on the 30th (same 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 00Z on the 30th, same as 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.

October 1:

1. Old Maps and HURDAT:

- 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.

2. Discussion:

- Reanalysis: The extratropical depression increased in forward speed on October 1st over the Northeast of the United States and turned to the east.

October 2:

1. Old Maps and HURDAT:

- 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.

2. Discussion:

- Reanalysis: 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.

Sources: 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.

Hurricane Hannah [September 27 – October 8, 1959] – AL091959

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41290 09/27/1959 M=12  9 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*305 681 100  967*316 690 100  963*
               ***              ***  ***    * ***     ***  ***  ***  ***  ***  ***
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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  85    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*
            *** ***      *** *** **  ***      **      *** *** **

41355 HR
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Significant Revisions:

- Intensity significantly reduced downward on the 28th based upon ship and aircraft reconnaissance observations;
- Positions adjusted significantly east-northeastward on the 29th based upon ship and aircraft observations;
- Several central pressures added in based upon aircraft observations;
- Several central pressures originally in HURDAT but not based upon observations were removed from the 1st to the 3rd;
- Intensity significantly reduced downward on the 2nd and the 3rd based upon aircraft observations;
- Positions adjusted substantially northward from late on the 6th through early on the 8th based upon aircraft and ship measurements;
- Extratropical transition indicated to be 30 hour earlier based upon ship observations;
- Intensity significantly adjusted upward on the 8th based upon ship observations;
- Position significantly adjusted southward late on the 8th based upon ship observations.

Daily Metadata:

September 25:

1. Old Maps and HURDAT:

- HWM and microfilm do not analyze an organized system at 12Z.
- HURDAT does not list an organized system on this date.

September 26:

1. Old Maps and HURDAT:

- 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.

September 27:

1. Old Maps and HURDAT:

- 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.

2. Discussion:

- 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."

- Reanalysis: 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 as the observations were quite sparse.

September 28:

1. Old Maps and HURDAT:

- 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.

2. Ship highlights:

- 35 kt E and 1008 mb at 28.5N, 53.5W at 18Z (micro).

3. 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).

4. Discussion:

- 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."
- Reanalysis: 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.

September 29:

1. Old Maps and HURDAT:

- 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.

2. 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).

3. 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).

4. Discussion:

- Reanalysis: 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.

September 30:

1. Old Maps and HURDAT:

- 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.

2. 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).

3. 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).

4. Discussion:

- Reanalysis: 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.

October 1:

1. Old Maps and HURDAT:

- 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.

2. 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).

3. 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). (Note that it is possible that this 1750Z ATSR based fix and the 1740Z NHRP based fix were at the same time from the same aircraft.)

4. Discussion:

- 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."

- Reanalysis: 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 and consideration for subsequent continuity, an intensity of 100 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. 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.

October 2:

1. Old Maps and HURDAT:

- 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.

2. 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).

3. 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 measured a central pressure of 961 mb at 34.4N, 67.5W at 18Z (ATSR).
- Penetration center fix at 34.7N, 67.0W at 21Z (ATSR).

4. Discussion:

- 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 …".

- Reanalysis: 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.

October 3:

1. Old Maps and HURDAT:

- 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.

2. 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).

3. 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).

4. Discussion:

- Reanalysis: 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.

October 4:

1. Old Maps and HURDAT:

- 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.

2. 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).

3. 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).

4. Discussion:

- 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."
- Reanalysis: 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.

October 5:

1. Old Maps and HURDAT:

- 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.

2. 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).

3. 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:

1. Old Maps and HURDAT:

- 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.

2. 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).

3. 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).

4. Discussion:

- 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."
- Reanalysis: 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.

October 7:

1. Old Maps and HURDAT:

- 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.

2. 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).

3. 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).

4. Aircraft highlights:

- Radar center fix at 38.0N, 28.9W at 0330Z (ATSR).

5. Discussion:

- ATSR: "…and finally appeared to merge with a second cold front in the vicinity of the Azores."
- Reanalysis: 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.

October 8:

1. Old Maps and HURDAT:

- 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.

2. 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).

3. Discussion:
- Reanalysis: 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.

October 9:

1. Old Maps and HURDAT:
- 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.

2. 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	967 mb

		Oct 1st	
Oct 1 18Z	959 mb	Penetration center fix: 963 mb at 1750Z on Oct 1st	963 mb
Oct 2 00Z Oct 2 06Z Oct 2 12Z	959 mb	No central pressure were reported around these times by penetration center fixes or ships	Removed
Oct 2 18Z	959 mb	Penetration center fix: 961 mb at 1603Z on Oct 2nd	961 mb
Oct 3 00Z Oct 3 06Z	959 mb	No central pressure were reported around these times by penetration center fixes or ships	Removed
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

Source: 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.

Tropical Storm Irene [October 6-9, 1959] – AL101959

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41360 10/06/1959 M= 4 10 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  35 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

U.S. Tropical Storm Landfall
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10/08 10Z 30.3N 87.6W 40 kt AL
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Signficant Revisions:

- Several central pressures were added based upon aircraft reconnaissance;

Daily Metadata:

October 4:

1. Old Maps and HURDAT:

- HWM does not analyze an organized system at 12Z.
- HURDAT does not list an organized system on this date.

2. Discussion:

- 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:

1. Old Maps and HURDAT:

- 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.

2. Discussion:

- 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."
- Reanalysis: Tropical Storm Irene developed from a tropical wave that reached the Gulf of Mexico on October 5th.

October 6:

1. Old Maps and HURDAT:

- 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.

2. Discussion:

- 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."
- Reanalysis: 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.

October 7:

1. Old Maps and HURDAT:

- 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.

2. 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).

3. Land highlights:
- 10 kt SE and 1004 mb at Burrwood, LA at 2055Z (SWO).

4. 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).

5. Discussion:

- 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."

- Reanalysis: The first reconnaissance aircraft to reach the system measured a central pressure of 1003 mb and estimated surface winds of 35 kt at 14Z on the 7th. 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 and some weighting of the surface wind estimates, an intensity of 35 kt is selected at 12Z on October 7th, slightly higher than 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.

October 8:

1. Old Maps and HURDAT:
- 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.

2. 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).

3. 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).
- (Note that in the Storm Wallet, there is an account of Irene that stated the pressure in Mobile, Alabama fell to 999.5 mb at 2:58 LST 8 October. This does not match what is in the SWO, which shows a pressure of 1003.7 mb. It is likely that the wallet account is a station pressure instead of a sea level pressure. Thus this pressure is not be used for the re-analysis.)

4. 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).

5. Radar highlights:

- 29.4N 87.5W at 0630Z from Apalachicola (wallet).
- 29.9N 87.0W at 09Z from Apalachicola (wallet).

6. Discussion:

- 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."
- Reanalysis: 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.

October 9:

1. Old Maps and HURDAT:

- 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.

2. Discussion:

- Reanalysis: 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.

Sources: the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, oil rig observations from NCDC, Monthly Weather Review, Navy reconnaissance book, Surface Weather Observations, Mariners Weather Log, and NHC Storm Wallets.

Hurricane Judith [October 17-22, 1959] – AL111959

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41390 10/17/1959 M= 5 11 SNBR= 900 JUDITH      XING=1 SSS=0                    L
41390 10/14/1959 M= 9 11 SNBR= 900 JUDITH      XING=1 SSS=0
                    *

(The 14th to the 16th are new to HURDAT.)
37265 10/14*  0   0   0    0*140 735  30    0*140 753  35    0*140 770  40    0*
37265 10/15*141 785  40    0*143 797  35    0*146 807  30    0*150 815  25    0*
37265 10/16D156 822  25    0D164 829  25    0D174 836  25    0D186 843  25    0*

41395 10/17*  0   0   0    0*  0   0   0    0*212 851  40    0*231 850  55    0*
41395 10/17D198 848  25    0D210 851  25    0*223 851  30    0*238 845  40    0*
           **** ***  **     **** ***  **      ***      **      *** ***  **
41400 10/18*247 840  65    0*259 833  55    0*267 824  45  999*270 804  40    0*
41400 10/18*250 840  55    0*260 834  55    0*267 825  55  998*270 805  45 1001*
           ***      **      *** ***              ***  **  ***     ***  ** ****
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*
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41420 HR

U.S. Tropical Storm Landfall

10/18 14Z 26.7N 82.3W 55 kt FL

Significant Revisions:

- Genesis and new tropical storm stage introduced three days earlier, based upon ship and aircraft observations;
- Position adjusted significantly northward on the 17th, based upon ship and aircraft observations;
- Large reduction to the intensity late on the 17th, based upon ship and aircraft observations;
- Moderate upward revisions made to the intensity on the 19th based upon aircraft reconnaissance observations;
- Several central pressures were added based upon station and aircraft observations;
- A significant eastward revision to the position is introduced on the 20th based upon aircraft and ship observations;
- A significant west-southwestward revision to the position is introduced on the 21st based upon aircraft and ship observations;
- Dissipation is indicated to be twelve hours later based upon ship observations.

Daily Metadata:

October 12:

1. Old Maps and HURDAT:

- 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.

2. Discussion:

- 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."
- Reanalysis: A strong tropical wave entered the Caribbean Sea on October 12th.

October 13:

1. Old Maps and HURDAT:

- 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.

October 14:

1. Old Maps and HURDAT:

- 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.

2. 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).

3. Aircraft highlights:

- Lowest pressure of 1004 mb and peak estimated surface winds of 50 kt at collocated at 14.5N, 77.5W around 20Z (micro).

4. Discussion:

- Reanalysis: 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 appears that the system developed a closed low-level circulation around 06Z on the 14th. The ship Holland reported 40 kt at both 03 and 06Z. Based upon this, the initial intensity at genesis is 40 kt. Late on the 14th, a reconnaissance aircraft investigated the disturbance finding a pressure of 1004 mb collocated with surface winds of 50 kt, as shown on microfilm. This suggests a central pressure of 1000 mb or lower. A central pressure of 1000 mb or less would indicate a maximum surface wind of at least 49 kt from the Brown et al. south of 25N pressure-wind relationship. An intensity of 40 kt is assessed at 18Z on the 14th and 00Z on the 15th, though this could be slightly low.

- October 15:

1. Old Maps and HURDAT:

- 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.

2. Ship highlights:

- 15 kt SW and 1005 mb at 18.0N, 78.2W at 00Z (micro).

3. Station highlights:

- 10 kt ENE and 1005 mb at Puerto Cabezas, Nicaragua at 00Z (micro).
- 5 kt E and 1007 mb at Puerto Cabezas, Nicaragua at 12Z (micro).
- Calm and 1006 mb at San Andres Island at 12Z (micro).
- Calm and 1006 mb at Puerto Cabezas, Nicaragua at 18Z (micro).

4. Aircraft highlights:

- 15 kt SSE and 1006 mb (lowest pressure observed) at 14.5N 78.0W at ~12Z (micro).

5. Discussion:

- 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."
- Reanalysis: The tropical cyclone apparently weakened as quickly as it developed. While there were few observations near the center at 00 and

06Z, an aircraft reconnaissance found only weak winds at lowest pressure of 1006 mb around 12Z. It is analyzed that the system dropped to a tropical depression around 12Z and then dissipated as a tropical cyclone after 18Z. Based upon rawindsonde obserations throughout the Caribbean, it appears that the system may have weakened due to substantial dry air near the system at low to mid levels. (Note that at both 00Z and 12Z there were ship reports of 35-40 kt south of Hispaniola. However, it appears that these may have only been indirectly related to the tropical cyclone as they were over 350 nm from its center. They may have been more related to the large pressure gradient induced by a strong Bermuda high off toward the northeast.)

October 16:

1. Old Maps and HURDAT:

- 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.

2. Station highlights:

- Calm and 1006 mb at Puerto Cabezas, Nicaragua at 00Z (micro).
- Calm and 1005 mb at Cabo Gracias a Dios, Honduras at 00Z (micro).
- 5 kt E and 1005 mb at Guanaja, Honduras at 12Z (micro).
- Calm and 1006 mb at Guanaja, Honduras at 18Z (micro).

3. Discussion:

- 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 moderate 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."
- Reanalysis: The system continued as a trough, which moved generally northwestward on this date.

October 17:

1. Old Maps and HURDAT:

- 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.

2. 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).

3. Land highlights:

- 40 kt SE and 1008 mb at Dry Tortugas Light, FL at 21Z (micro).

4. 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).

5. Discussion:

- 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."
- Reanalysis: By 12Z, the trough had reorganized into a 30 kt tropical cyclone near the west end of Cuba. A reconnaissance aircraft reached the disturbance at 1345Z on October 17th estimating peak surface winds of 35 kt and measuring a central pressure of 1007 mb. However, these peak surface winds were a couple hundred nm north of the center reported by the aircraft and the winds were light and variable within 100 nm of the center. Moreover, a fix with five hours late was 150 nm northeast of the first fix, suggesting that the system redeveloped farther north at 18Z. By the time of the 1840Z fix within the Gulf of Mexico southwest of the Dry Tortugas, the circulation had become well-defined and the system is indicated to have reached tropical storm intensity with 40 kt based upon ship and reconnaissance observations. This is a large intensity reduction from 55 kt at 18Z in HURDAT originally.

October 18:

1. Old Maps and HURDAT:

- 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.

2. 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).

3. Land highlights:

- 40 kt SSW and 1007 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).
- 1001 mb pressure measured in the broad center of Judith at Okeechobee, Florida near 1730Z (WALLET).

4. 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).

5. Radar highlights:

- 25.0N 83.8W at 02Z at Naples (wallet).

6. Discussion:

- 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 wind 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."
- Reanalysis: 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. Unfortunately, it cannot be determined which ship reported the 65 kt observation. The only observation nearby (~30 nm) was Fort Jefferson with 40 kt SSW and 1007 mb. (There was a closer ship from COADS, but it

appears that its longitude was provided five degrees too far west and thus was not actually in the vicinity of the hurricane-force ship.) This single 65 kt ship was the reason for Judith being considered a hurricane both operationally and in HURDAT. No other observation at sea or at landfall 15 hours later reported anything more than 55 kt winds (Carysfort Reef Light at 12Z – elevated anemometer) with a lowest pressure of 998 mb (12Z aircraft fix). Because of the uncertainty of the quality of this single observation and lack of corroboration with any other measurements, the peak intensity in the Gulf of Mexico is analyzed to be 55 kt. Thus no intensification to a hurricane in the Gulf of Mexico is analyzed. Early on the 18th, reconnaissance data suggested that Judith had a small eye of about 9 nm in diameter. 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. (Note that the reconnaissance mission that reported the 998 mb central pressure in their vortex message also had three dropsondes that were launched. Two gave 1003 and 1004 mb, respectfully, but were in the periphery and not in the center. A third one reported 994 mb surface pressure with 850 and 700 mb heights/temperatures that are consistent with this value. However, this drop was taken way in the periphery of Judith and is not consistent with the extrapolated surface pressure provided in the fix message or with the 999 mb observed at landfall. Thus this 994 mb reading is discarded as being erroneous.) 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 (elevated anemometer) 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. Observations suggest an elongation of the vortex southwest-northeastward around 12Z-18Z, but not a separate vortex forming east of Florida. A 1001 mb pressure was measured in the broad center of Judith at Okeechobee, Florida near 1730Z. This value is added as a central pressure at 18Z. The center of the storm made oceanfall in the Atlantic Ocean around 19Z on the 18th after just five hours overland.

October 19:

1. Old Maps and HURDAT:

- 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.

2. 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).

3. Aircraft highlights:

- Penetration center fix with a central pressure of 1003 mb (extrapolated from 850 mb) 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).

4. Discussion:

- ATSR: "…developed to hurricane intensity on the 19th of October."
- Reanalysis: 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.

October 20:

1. Old Maps and HURDAT:

- 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.

2. Aircraft highlights:

- Radar center fix at 31.0N, 62.5W at 0030Z (ATSR).
- Penetration center fix with maximum surface wind estimate of 70 kt at 31.3N, 56.2W at 1903Z (ATSR).

3. Discussion:

- Reanalysis: 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.

October 21:

1. Old Maps and HURDAT:

- 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.

2. Ship highlights:

- 35 kt S and 1001 mb at 31.7N, 54.7W at 12Z (COADS).

3. 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).

4. Discussion:

- Reanalysis: Judith weakened rapidly on October 21st. Weakening below hurricane force is analyzed at 00Z on the 21st, same as originally shown in HURDAT.

October 22:

1. Old Maps and HURDAT:

- 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.

2. Discussion:

- 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 22nd of October after becoming involved with a cold front."
- Reanalysis: It does not appear that the system became associated with a significant baroclinic zone on the 21st and 22nd despite the frontal analyses shown in HWM and the microfilm maps, as the temperatures remained relatively isothermal across the Judith on these dates. Thus it would appear that showing dissipation with no extratropical stage is most appropriate. 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.

October 23:

1. Old Maps and HURDAT:

- 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.

Sources: 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.

New Storm [August 2-6, 1959] – AL121959

37265 08/02/1959 M= 5 6 SNBR= 820 UNNAMED XING=0 SSS=0

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37265 08/02*350 765  30    0*348 758  40    0*347 746  60    0*352 730  60    0*
37265 08/03*363 707  60    0*372 683  55    0*379 662  55    0*387 642  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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Signficant Revisions:

- A new tropical storm has been added to HURDAT

Daily Metadata:

August 1:

1. Old Maps:

- 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.

August 2:

1. Old Maps:

- 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.

2. 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).

3. Discussion:

- 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 34°N, 74°W."
- Reanalysis: A non-frontal disturbance developed along the southeast coast of the United States and rapidly intensified as it moved to the northeast. Coastal and ship observations at 00Z on August 2nd indicated that a well-defined low pressure system had formed along the North Carolina. Genesis is analyzed at 00Z on the 2nd as a 30 kt tropical depression. At 06Z 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. 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.

August 3:

1. Old Maps:

- 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.

2. 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).

3. Discussion:

- Reanalysis: 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.

August 4:

1. Old Maps:

- 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.

2. 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).

3. Discussion:

- Reanalysis: At 00Z on the 4th, the tropical storm is analyzed to have transitioned into an extratropical cyclone. However, the timing is uncertain to within about 12 hours. 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.

August 5:

1. Old Maps:

- 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.

2. 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:

1. Old Maps:

- 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.

2. 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).

3. Discussion:

- Reanalysis: 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.

Sources: the Historical Weather Map series, Microfilm, COADS ship database, Mariners Weather Log and Jack Beven's and David Roth's suspect list.

New Storm [August 28 – September 4, 1959] – AL131959

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37265 08/28/1959 M= 8  8 SNBR= 820 UNNAMED       XING=0 SSS=0
37265 08/28*  0   0   0    0*337 544  40    0*342 548  40    0*347 552  40    0*
37265 08/29*354 556  40    0*362 559  40    0*366 560  40    0*366 557  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  50    0*380 470  55    0*380 466  55    0*382 461  55    0*
37265 09/01*388 454  55    0*395 450  55    0*396 448  55    0*397 448  55    0*
37265 09/02*399 444  55    0*401 439  55    0*404 427  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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Significant Revision:

- A new tropical storm has been added to HURDAT

Daily Metadata:

August 26:

1. Old Maps:

- 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.

2. Discussion:

- Reanalysis: A low pressure developed along the tail-end of a frontal boundary over the central Atlantic on August 26th.

August 27:

1. Old Maps:

- 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.

2. 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).

3. Discussion:
- Reanalysis: 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.

August 28:

1. Old Maps:
- 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.

2. 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).

3. Discussion:
- Reanalysis: An Air Force invest mission was investigating the system late on the 27th and early on the 28th. At this time, there were multiple observations of "wind variable 10 kt" spread out over a 120-180 n mi wide area near the center. Thus the system had not yet obtained a well-defined center. Genesis is analyzed at 06Z on August 28th as a 40 kt tropical storm. 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. The 500 mb HWM maps that there was an upper-level low over the system on the 28th and 29th, providing some evidence that system may have had some subtropical cyclone characteristics.

August 29:

1. Old Maps:
- 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.

2. 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).

3. Discussion:

- Reanalysis: 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 from the north of 35N 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.

August 30:

1. Old Maps:

- 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.

2. 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).

3. Discussion:

- Reanalysis: 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.

August 31:

1. Old Maps:

- 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.

2. 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).

3. Discussion:

- Reanalysis: 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 suggests sustained maximum winds great than 55 kt from the north of 35N pressure-wind relationship. At this time, the forward speed of the cyclone had decreased to about 3 kt, thus an intensity of 55 kt is selected starting at 06Z on the 31st. 55 kt is the peak intensity of this storm as a tropical cyclone. On August 31st and September 1st, the tropical storm moved very slowly while located about halfway between Newfoundland and the Azores.

September 1:

1. Old Maps:

- 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.

2. 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:

1. Old Maps:

- 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.

2. 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).

3. Discussion:

- Reanalysis: 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 and continued through the 2nd. 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 symmetric.

September 3:

1. Old Maps:

- 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.

2. 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).

3. Discussion:

- Reanalysis: 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. It is noted the time of extratropical transition of this system is highly uncertain and could have occurred

earlier. The circulation became somewhat elongated on 1 September, and the track changes that day could be consistent with the merging of the cyclone with an upper-level low. Subsequently, the surface observations on 2 September do not suggest surface fronts. It may be that the system had an aborted transition on 1 September and then recovered some of its tropical characteristics.

September 4:

1. Old Maps:

- 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.

2. 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).

3. Discussion:

- 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 extratropical 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.

Sources: the Historical Weather Map series, Microfilm, COADS ship database, Mariners Weather Log and David Roth's suspect list.

New Storm [September 7-14, 1959] – AL141959

```
37265 09/09/1959 M= 6  9 SNBR= 820 UNNAMED       XING=0 SSS=0                  L
37265 09/09*323 675  25    0*325 675  25 1007*330 672  30    0*336 670  30    0*
37265 09/10*341 672  30    0*345 680  30    0*350 695  35    0*360 700  35 1006*
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
```

Significant Revisions:

- A new tropical storm has been added to HURDAT

Daily Metadata:

September 6:

1. Old Maps:

- 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.

2. Discussion:

- Reanalysis: A broad area of low pressure developed between the Bahamas and Bermuda on September 6th.

September 7:

1. Old Maps:

- 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.

2. Discussion:

- Reanalysis: The disturbance moved slowly northward becoming a broad low on this date. Historical Weather Maps show a stationary front just north of the broad low on the 7th but microfilm indicates that the boundary was not present, which appears correct based on the synoptic data. The system remained nearly stationary during the next two days with little change in intensity or structure.

September 8:

1. Old Maps:

- 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.

September 9:

1. Old Maps:

- 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.

2. Ship highlights:

- 15 kt NNE with 1008 mb at 31.3N 68.8W at 06Z (COADS).

3. Discussion:

- Reanalysis: Based upon increased wind circulation, development into a tropical cyclone is analyzed to have occurred around 00Z on the 9th. 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 15 kt NNE ship with 1008 mb suggests a central pressure of about 1007 mb at 06Z, which has been added into HURDAT.

September 10:

1. Old Maps:

- 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.

2. Ship highlights:

- 35 kt NE and 1015 mb at 36.9N, 71.1W at 12Z (COADS).
- 35 kt E (30 kt in HWM) and 1009 mb at 37.1N, 68.0W at 18Z (COADS).
- 20 kt E and 1008 mb at 36.7N 69.7W at 18Z (COADS).

3. Discussion:

- Reanalysis: The tropical cyclone 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. This ship and another to the southwest reporting 20 kt E and 1008 mb suggest a central pressure of 1006 mb, which has been added into HURDAT. The tropical storm retained a large circulation embedded within a moist environment. Unfortunately, the 500 mb pattern in HWM has no observations over or near the system, so it is difficult to determine if it had an upper level low/trough associated with it. However, the lack of an inner wind core (i.e., large 100-200 nm RMW) would support that the system may have been a subtropical cyclone. Thus it is likely that it was a subtropical cyclone during its lifetime, but this cannot be confirmed without satellite imagery.

September 11:

1. Old Maps:

- 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.

2. 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).

3. 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).

4. Discussion:

- Reanalysis: 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 from the north of 35N Landsea et al. pressure-wind relationship. Due to the large circulation of the tropical storm and that the system was undergoing extratropical transition, 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.

September 12:

1. Old Maps:

- 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.

2. 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).

3. Discussion:
- Reanalysis: The extratropical cyclone continued to gain in forward speed on September 12th as it passed south of Nova Scotia, Canada. Ships reported storm-force winds up to 55 kt on the 12th.

September 13:
1. Old Maps:
- 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.

2. 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).

3. Discussion:
- Reanalysis: 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.

September 14:
1. Old Maps:
- 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.

2. 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).

3. Discussion:
- Reanalysis: 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.

Sources: 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.

1959 Additional Notes

1) May 29 – June 2: Historical Weather Maps shows 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 circulation 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 diffused 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. While the apparent lack of impact of this system suggests it was not a tropical storm, the central pressure of 1004 mb and the high pressures to the east suggest at least the possibility of 35 kt winds. 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	Western Gulf of Mexico		Tropical Depression
August 25	Western Gulf of Mexico		Tropical Depression
August 26	Western Gulf of Mexico		Tropical Depression
August 27			Dissipated

3) October 21-24: Historical Weather Maps shows 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 before dissipating 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 shows 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. 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 northward 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 tropical storm force winds based on the ship observations, 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 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 Atlantic Hurricane Database Reanalysis – Sandy Delgado and Chris Landsea

Green indicates wind changes of 15 kt or greater
Blue indicates lat/long changes greater than 1°
Red indicates a new entry
Yellow indicates a deletion

Unnamed Tropical Storm One [June 22-28, 1960] – AL011960

```
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  30    0*235 958  35    0*247 963  40    0*255 967  45    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  50    0*272 975  45 1000*282 979  35 1002*290 982  30 1003*
                ***  **      ***  ***  ** ****  ***  ***  ** ****  ***  ***    ****

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 1004*287 985  25 1005*283 984  25 1006*287 982  25 1006*
                ***      **** ***  ***     ****             **** ***  ***    ****

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 1005*300 972  25 1006*311 969  25 1007*323 965  25 1008*
            *** ***  ** **** ***  ***  ** ****  ***  ***  ** ****  ***  ***  ** ****

41455 06/27*330 956  15    0*344 945  15    0*357 933  15    0*366 923  15    0*
41455 06/27*334 961  20 1008*347 950  20 1009*360 938  20 1010*371 927  20 1011*
            *** ***  ** **** ***  ***  ** ****  ***  ***  ** ****  ***  ***  ** ****

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 1011*380 905 20 1012*385 890 20 1013* 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*

41470 TS

U.S. Tropical Storm Landfall

06/24 04Z 26.9N 97.4W 50 kt TX

Significant Revisions:

- Several central pressures added after landfall based upon station observations.
- Two central pressures in HURDAT were removed, as these were periperhal and not central pressures.
- Dissipation indicated to be 12 hours earlier.

Daily Metadata:

June 21:

1. HURDAT and Old Maps:

- 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.

2. Discussion - Reanalysis: A tropical wave reached the Bay of Campeche on June 20th and gradually became better organized.

June 22:

1. HURDAT and Old Maps:

- 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.

2. Discussion:

- 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."

- Reanalysis: Although the data is scarce, coastal and ship observations indicate that the disturbance did not have a well-defined low level circulation until early on June 22nd. Genesis is analyzed at 06Z on June 22nd as a tropical depression, same as originally shown in HURDAT. The tropical depression is initialized with an intensity of 25 kt, up from 15 kt originally in HURDAT, a minor intensity change. The daily routine surveillance 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.

June 23:

1. HURDAT and Old Maps:

- 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.

2. Aircraft highlights:

- 15 kt S and 1006 mb at 25.0N 96.0W at 2320Z (micro).

3. Discussion:

- 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."
- Reanalysis: 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 06Z on June 23rd, six hours earlier than originally shown in HURDAT. A central pressure of 1006 mb is present in HURDAT at 12Z on the 23rd. While 1006 mb was measured by an aircraft reconnaissance late on the 23rd, this was not a central pressure. Thus the 1006 mb is removed. The small tropical storm approached the coast of southern Texas late on the 23rd and early on the 24th.

June 24:

1. HURDAT and Old Maps:

- 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.

2. 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 Corpus Christi 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).

3. Discussion:

- 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."

- Reanalysis: 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 50 kt is analyzed at 00Z on August 24th, up from 40 kt originally in HURDAT, a minor intensity change. 50 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 50 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.

June 25:

1. HURDAT and Old Maps:
- 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.

2. Land highlights:
- 15 kt S and 1004 kt (min pressure) at Beeville, TX at 2058Z (SWO).

3. Radar highlights:
- Center fix at 28.8N 98.2W at 12Z from Victoria (wallet).
4. Discussion:
- 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."
- Reanalysis: 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.

June 26:

1. HURDAT and Old Maps:
- 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.
2. Radar highlights:
- Center fix at 28.1N 98.1W at 00Z from Kelly Air Force Base (wallet).
- Center fix at 28.6N 97.5W at 0020Z from Victoria (wallet).
- Center fix at 29.7N 97.3W at 04Z from Victoria (wallet).
3. Discussion - Reanalysis: 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.

June 27:

1. HURDAT and Old Maps:
- 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.

2. Discussion - Reanalysis: The intensities are boosted systematically on the 27th and 28th from 15 to 20 kt, 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.

June 28:

1. HURDAT and Old Maps:

- 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.

2. Discussion - Reanalysis: 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.

June 29:

1. HURDAT and Old Maps:

- HWM and microfilm analyzes a cold front moving across the Midwest at 12Z.
- HURDAT does not list an organized system on this date.

Sources: 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, the Climatological Data National Summary, and NHC Storm Wallets.

Hurricane Abby [July 9-17, 1960] – AL021960

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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
         **         *
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(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*139 609  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*
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41500 07/14*147 795  45 1004*151 810  50    0*156 825  55    0*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*186 953  30    0*194 966  30    0*205 980  30    0*  0   0   0   0    0*
            *** ***  **      *** ***  **      *** ***  **

41515 HR

Tropical Storm Landfall
-----------------------
07/10 12Z 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
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Significant Revisions:

- Genesis indicated 12 hours earlier.
- Significant west-northwestward position change on the 10th based upon ship and station observations.
- Large increase in intensity early on the 10th based upon ship and subsequent aircraft and station observations.
- Large reductions in intensity from late on the 10th through early on the 13th based upon aircraft reconnaissance.
- Several central pressures were added based upon aircraft reconnaissance data.
- Track extended 18 hours before dissipation late on the 17th.

Daily Metadata:

July 7:

1. HURDAT and Old Maps:

- HWM and microfilm do not show an organized system at 12Z.
- HURDAT does not list an organized system on this date.

2. Discussion - 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:

1. HURDAT and Old Maps:

- HWM and microfilm do not show an organized system at 12Z.
- HURDAT does not list an organized system on this date.

July 9:

1. HURDAT and Old Maps:

- 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).

2. Ship highlights:

- 40 kt ESE and 1013 mb at 13.2N, 56.2W at 10Z (micro).

3. Discussion:

- MWR: "The first indication of the disturbance which finally grew into hurricane Abby was received from a ship about 3.5° 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."
- Reanalysis: 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. Note that that the positions on 9 July are more uncertain than normal because of the lack of inner core observations. The first position is analyzed twelve hours earlier than originally shown in HURDAT.

July 10:

1. HURDAT and Old Maps:

- 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.

2. Ship highlights:

- 40 kt ENE and 1007 mb at 13.8N, 59.8W at 06Z (micro).

3. 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).
- 1009 mb (min pressure) at St. Lucia (WALLET).

4. 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).

5. Discussion

- MWR: "At 0100 est on the 10th, a report received from the SS Del Oro, located at 13.8°N., 59.7°W., 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."
- Reanalysis: 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. A major change in positon is made at 00Z and 06Z, two degrees to the west-northwest based on ship and station observations. 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 12Z 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.

July 11:

1. HURDAT and Old Maps:

- 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.

2. 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).

3. 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).

4. Discussion:

- 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."

- Reanalysis: 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. (This central pressure based a dropsonde has odd data, with 850 mb heights/temps suggesting 1013 mb and the surface coding of 1004 mb. 1004 mb, which was reported in the vortex fix, does fit in well with previous and subsequent aircraft reports and is thus used here.) 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.

July 12:

1. HURDAT and Old Maps:

- 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.

2. Ship highlights:
- 47 kt E and 1014 mb at 16.5N, 67.7W at 00Z (MWL).

3. 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).

4. Discussion:

- ATSR: "At 120100Z, the maximum wind speed diminished to 65 knots then increased to 75 knots at 121600Z."

- Reanalysis: 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.

July 13:

1. HURDAT and Old Maps:
- 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.

2. 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).

3. 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).

4. Discussion:

- 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."

- Reanalysis: 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 13th, 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 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.

July 14:

1. HURDAT and Old Maps:
- 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.

2. 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).

3. 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).

4. Discussion:

- 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."
- Reanalysis: 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. The 1008 mb reported pressure at 07Z was from a dropsonde that "may have been slightly N of center", according to the vortex message from the aircraft. Thus this value is not used here. 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.

July 15:

1. HURDAT and Old Maps:

- 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.

2. Ship highlights:

- 35 kt SE and 1008 mb at 16.4N, 87.4W at 12Z (COADS).

3. Land highlights:

- 45 kt NE at Guanaja Island, Honduras at 02Z (WALLET).

4. 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).

5. Discussion:

- 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."

- Reanalysis: 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, which is consistent with the system being a hurricane on this date.

July 16:

1. HURDAT and Old Maps:

- 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).

2. Ship highlights:

- 40 kt and 1004 mb at 16.3N, 87.5W at 00Z (WALLET).

3. Land highlights:

- 10 kt NE and 1005 mb at Villahermosa, Mexico at 12Z (micro).

4. Discussion:

- 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.”
- Reanalysis: 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.

July 17:

1. HURDAT and Old Maps:

- 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.

2. Discussion:

- 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."
- 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.

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

Sources: 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.

Tropical Storm Brenda [July 27-31, 1960] – AL031960

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41520 07/28/1960 M= 5  3 SNBR= 903 BRENDA      XING=1 SSS=0
41520 07/27/1960 M=12  3 SNBR= 903 BRENDA      XING=1 SSS=0
         **        **
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(July 27th is new to HURDAT)

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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  55 1000*328 797  60  993*
           *** ***  **      *** ***  **          ***  ** **** ***       **  ***
41535 07/30*346 780  50    0*370 763  45    0*395 748  45    0*416 730  45    0*
41535 07/30*346 779  55  994*370 765  50  993*387 753  50  992*405 738  50  991*
              ***  **  ***     ***  **  *** *** ***  **  *** *** ***  **  ***
41540 07/31*439 711  40    0E470 698  35    0E505 690  30    0E541 690  30    0*
41540 07/31*430 715  40  991E460 693  35  992E500 686  35  990E540 683  35  986*
           *** ***      *** *** ***      *** *** ***  **  *** *** ***  **  ***
41545 08/01E578 689  30    0*  0   0   0    0*  0   0   0    0*  0   0   0    0*
41545 08/01E580 689  40  977E605 695  45  976E610 715  45  976E615 750  40  980*
           ***      **  ******* ***  **  ******* ***  **  ******* ***  **  ***
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(The 2nd through the 7th are new to HURDAT.)

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41547 08/02E605 775  35  982E580 795  35  983E560 800  35  983E555 760  30  984*
41547 08/03E555 710  30  984E557 680  30  984E560 670  30  984E564 660  30  985*
41547 08/04E567 660  30  986E570 660  30  986E572 660  30  987E575 660  25  989*
41547 08/05E580 660  25  992E590 680  25  995E595 705  20  998E598 710  20 1000*
41547 08/06E595 720  20 1003E590 735  20 1005E582 720  20 1006E578 690  20 1006*
41547 08/07E575 660  20 1007E570 640  20 1007E562 620  20 1006E560 600  20 1005*
41550 TS
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U.S. Tropical Storm Landfall

07/29 06Z 29.7N 83.5W 35 kt FL
07/29 21Z 33.9N 78.2W 60 kt NC

Significant Revisions

- Genesis is indicated to be 24 hours earlier based upon ship and coastal observations.
- Several central pressures were added based upon aircraft and station observations from the 29th through the 31st.
- Large intensity boost indicated at 18Z on the 29th and at North Carolina landfall based upon ship observations.
- Dissipation is indicated to have occurred seven days later based upon Canadian and ship observations.

Daily Metadata

July 26:

1. HURDAT and Old Maps:

- 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.

2. Discussion:

- 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."

- Reanalysis: 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.

July 27:

1. HURDAT and Old Maps:

- 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.

2. Ship highlights:

- 50 kt SW at 27.3N 83.0W at 18Z (micro – observation appears to be erroneous).

3. Discussion:

- 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."
- Reanalysis: 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 about 100-200 nm from the center. Additionally, the HWM 500 mb map indicates an upper-low co-located over Brenda's center. The large RMW and upper-low suggest that the system may have been a subtropical cyclone, but without satellite images to confirm the convective structure, this classification is not formally used.

July 28:

1. HURDAT and Old Maps:

- 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).

2. Ship highlights:

- 35 kt SW at 26.5N, 83.2W at 18Z (micro).

3. 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).

4. Discussion/Reanalysis: On July 28th at 12Z, 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.

July 29:

1. HURDAT and Old Maps:

- 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.

2. 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).

3. 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).

4. 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).

5. Discussion:

- 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."

- Reanalysis: 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 60 kt is selected at 18Z on the 29th based upon the two 55 kt ship observations, up from 45 kt originally in HURDAT, a major intensity change. 60 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. 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 60 kt tropical storm.

July 30:

1. HURDAT and Old Maps:

- 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.

2. 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).

3. 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).

4. Aircraft highlights:

- Penetration center fix at 34.6N, 77.7W at 00Z (ATSR).

5. Discussion:

- 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."
- Reanalysis: Synoptic data early on the 30th indicates that Brenda was beginning to acquire extratropical characteristics with an elongated circulation on the northeast side. Observations from several stations from Maryland to Massachusetts show that the dewpoints near the center dropped from the upper 60's/low 70's F to the lower 60's F shortly after the center passed. However, in every case, the dewpoints increased again a few hours later. This suggests that although a small tongue of cooler and drier air was near the center, Brenda did not develop the well-defined frontal systems characteristic of an extratropical low on this day. Also 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 tropical storm 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.

July 31:

1. HURDAT and Old Maps:

- 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).

2. 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).

3. 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).

4. Discussion/Reanalysis: Early on July 31st, the system became an extratropical cyclone and this transition at 06Z is unchanged from that originally in HURDAT. On this date, the extratropical Brenda began to interact with another extratropical cyclone over eastern Canada and synoptic data suggests that the two had merged by 12Z. The series of microfilm maps suggest that Brenda was the dominant system in the merger with the extratropical low, and this is supported by analyses in the North American map series.

August 1:

1. HURDAT and Old Maps:
- 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.

2. Discussion/Reanalysis: The merged cyclone then prescribed a slow loop over the next several days over Canada. The extratropical system briefly reintensified to 45 kt on the 1st, followed by a very gradual weakening through the 7th. The last position is analyzed at 18Z on the 7th, seven days later than originally shown in HURDAT.

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

Sources: 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.

Hurricane Cleo [August 17-21, 1960] – AL041960

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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*
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41575 08/20*377 678   80    0*400 668  80    0*422 654  60    0*436 634  55    0*
41575 08/20*377 678   70  997*400 668  70    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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Significant Revisions:

- Significant north-northeastward shift in position late on the 17th based on ship and coastal observations.
- A few central pressures added from aircraft reconnaissance observations.
- Dissipation indicated to be 6 hours earlier based on ship and coastal observations.

Daily Metadata:

August 16:

1. HURDAT and Old Maps:

- 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.

2. Discussion/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."

August 17:

1. HURDAT and Old Maps:

- 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.

2. Discussion:

- 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."
- Reanalysis: 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 organization 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.

August 18:

1. HURDAT and Old Maps:

- 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.

2. 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).

3. 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).

4. Discussion:

- 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."

- Reanalysis: 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.

August 19:

1. HURDAT and Old Maps:

- 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.

2. 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).

3. Aircraft highlights:
- Penetration center fix estimated an eye diameter of 14 nm at 29.3N, 71.1W at 00Z (ATSR). (An 850 mb height of 4800 ft was measured on this mission – possibly in the center of Cleo - which would yield a surface pressure of 1006 mb. However, this seems to be at odds with other measured pressures near that time and is thus discarded.)
- 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).

4. Discussion:

- 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 estimated 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."

- Reanalysis: 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.

August 20:

1. HURDAT and Old Maps:

- 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.

2. 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).

3. Aircraft highlights:

- Penetration center fix estimated flight level winds of 100 kt at 700 mb at 38.4N, 67.5W at 0132Z (ATSR). 700 mb height in the eye of 10050 ft along with a temperature of 13C yields a central pressure of 997 mb.
- Radar center fix at 40.0N, 66.6W at 06Z (ATSR).

4. Discussion:

- 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."

- Storm Wallet: "One disturbing feature of the hurricane was that there was never a good correlation between reported winds and central pressures, except during the early and late stages of the storm. Wind reports from aircraft were consistently higher compared with winds calculated from SLP obtained by aircraft penetrations. Some compromise has been made and this accounts for the est central SLP noted in the official storm track."

- Reanalysis: 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 and a central pressure of 997 mb can be estimated from the height/temperature. This central pressure suggests an intensity of 53 kt from the Landsea et al. pressure-wind relationship. Cleo continued moving very quickly - ~25 kt – and it appears that it maintained its very small size. An intensity of 70 kt is analyzed at this time, down from 80 kt originally. The peak intensity of Cleo is now indicated to be 75 kt from 06Z to 18Z on the 19th, compared with 80 kt at 00 and 06Z on the 20th. Late 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.

August 21:

1. HURDAT and Old Maps:

- 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.

2. Discussion:

- ATSR: "It finally dissipated south of Newfoundland. The final warning on CLEO was issued at 210400Z."
- Reanalysis: 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.

Sources: 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.

Hurricane Donna [August 31 – September 14, 1960] – AL051960

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39675 08/29/1960 M=17  5 SNBR= 869 DONNA       XING=1 SSS=4
39680 08/29*  0   0   0    0*  0   0   0    0*  0   0   0    0*102 215  25    0*
39680 08/29*  0   0   0    0*  0   0   0    0*  0   0   0    0*102 228  25    0*
                                                              ***

39685 08/30*101 242  25    0*102 255  30    0*103 269  35    0*105 284  35    0*
39685 08/30*101 242  25    0*102 255  25    0*103 269  25    0*105 284  25    0*
                                  **                **                **

39690 08/31*108 300  35    0*109 316  35    0*110 331  35    0*114 346  35    0*
39690 08/31*107 300  30    0*109 316  30    0*111 331  35    0*114 346  35    0*
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            ***      **              **      ***

39695 09/01*118 362  40    0*120 378  50    0*122 394  65  990*126 411  80    0*
39695 09/01*117 362  40    0*120 378  50    0*123 394  55    0*126 411  65    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  70    0*133 443  75    0*136 458  85    0*139 476  95  973*
                     **              ***              ***  ***         ***

39705 09/03*143 494 125    0*147 512 130    0*152 529 130  965*156 546 135  947*
39705 09/03*143 494 100    0*147 512 105    0*153 531 105  962*159 550 105    0*
                    ***             ***      ***  ***  ***  ***  ***  ***  ***    *

39710 09/04*160 563 135    0*164 580 140    0*168 595 140  952*172 608 135    0*
39710 09/04*164 566 110    0*166 582 110    0*169 597 110  958*174 609 110    0*
            ***  ***  ***     ***  ***  ***     ***  ***  ***  ***  ***  ***  ***

39715 09/05*177 620 130    0*184 634 120    0*191 647 115  958*197 657 110    0*
39715 09/05*178 621 110  956*183 634 110    0*191 648 110  958*197 658 110  956*
            ***  ***  ***  ***  ***     ***          ***  ***          ***      ***

39720 09/06*203 665 110    0*208 673 110    0*212 681 110  940*215 689 115    0*
39720 09/06*201 665 115  941*206 675 115    0*212 683 120  940*215 689 120  940*
            ***      ***  ***  ***  ***  ***          ***  ***               ***  ***

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*220 705 120    0*221 713 110  948*221 723 110    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  945*222 743 105  947*223 753 100  951*224 761 105  945*
              ***  ***  ***  ***     ***  ***          ***  ***          ***  ***

39735 09/09*224 769 130  948*227 778 130  940*232 787 130  934*237 794 125  939*
39735 09/09*226 769 110  939*229 778 110  942*232 787 110  942*237 794 110  944*
            ***      ***  ***  ***     ***  ***          ***  ***          ***  ***

39740 09/10*242 801 120  932*247 807 115  932*253 813 120  938*262 817 115  950*
39740 09/10*242 801 115  938*247 808 125  930*253 813 115  939*263 818 105  945*
                    ***  ***      ***  ***  ***          ***  ***  ***  ***  ***  ***

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*283 817  65  964*297 810  75  968*311 799  80  970*
                    ***  ***  ***      **  ***  ***  ***  **  ***  ***  ***  **  ***

39750 09/12*331 780  95  958*350 769  90    0*373 748  95  965*400 731  90    0*
39750 09/12*330 783  90  958*351 767  85  960*373 748  85    0*401 733  85  959*
            ***  ***  **      ***  ***  **  ***          **  ***  ***  ***  **  ***

39755 09/13*431 712  75    0E466 689  60    0E500 660  55    0E531 625  45    0*
39755 09/13*428 712  60  969E468 686  60    0E500 660  60    0E531 625  60    0*
            ***      **  ***  ***  ***                    **                 **

39760 09/14E560 582  35    0*  0   0   0    0*  0   0   0    0*  0   0   0    0*
39760 09/14E560 582  45    0E585 540  40    0E610 500  40    0*  0   0   0    0*
                     **     ****  ***  **     ****  ***  **

39765 HRBFL4    DFL2 NC3     NY3 CT2 RI1 MA1 NH1 ME1
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39765 HRBFL4CFL4DFL1 NC2 VA1 NY2 CT1 RI1 MA1
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Significant Revisions

- Position adjusted westward at 18Z on the 29th to provide a reasonable initial motion.
- Intensity significantly reduced from the 1st to the 5th and the 7th to the 11th based upon aircraft reconnaissance data
- Several central pressure added based primarily upon aircraft reconnaissance flights
- A few central pressures were removed as they were not based upon actual observations
- Southeast Florida added as Category 4 impact
- Northeast Florida impact reduced from Category 2 to 1
- North Carolina landfall reduced from Category 3 to 2
- New York landfall reduced from Category 3 to 2
- Connecticut landfall reduced from Category 2 to 1
- Virginia added as Category 1 impact
- New Hampshire and Maine impact reduced from Category 1 to tropical storm
- Intensity significantly reduced early on the 13th based upon ship and coastal observations and the New England inland wind decay model
- Intensity significantly boosted late on the 13th based on ship and coastal observations
- Dissipation delayed by 12 hours

Landfalls:

4/22Z: 17.7N 61.8W – Barbuda – 110 kt

5/04Z: 18.1N 63.0W – Sint Maarten – 952 mb - 110 kt

8/06Z: 22.2N 74.3W – Crooked Island, Bahamas – 947 mb – 105 kt

8/16Z: 22.4N 75.8W – Racoon Cay, Bahamas – 945 mb – 105 kt

10/07Z: 24.8N 80.9W – Conch Key, FL - 930 mb - 125 kt - 20 nmi RMW – 1009 mb OCI – 250 nmi ROCI - BFL4,CFL4

10/16Z: 25.9N 81.6W – Marco Island, FL - 942 mb - 105 kt – 20 nmi RMW – 1009 mb OCI – 300 nmi ROCI

12/04Z: 34.6N 77.3W – Sneeds Ferry, NC - 958 mb - 90 kt - 50 nmi RMW – 1008 mb OCI – 350 nmi ROCI - NC2,VA1

12/19Z: 40.7N 72.9W – Brookhaven, NY - 959 mb - 85 kt - 50 nmi RMW – 1004 mb OCI – 350 nmi ROCI - NY2

12/20Z: 41.3N 72.4W – Old Saybrook, CT - 962 mb - 80 kt - 50 nmi RMW – 1004 mb OCI – 350 nmi ROCI - CT1, RI1, MA1

Daily Metadata:

August 29

1. HURDAT and Old Maps:

- HWM indicates a low near 10.5N, 19.5W.
- HURDAT begins the system at 18Z at 10.2N 21.5W as a tropical depression.

2. Discussion:

- MWR: "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 ".
- Reanalysis: Genesis is retained at 18 UTC, though the evidence that the Donna existed as a tropical cyclone is sparse on the 29th and 30th. The initial motion showed a large, unrealistic discontinuity. The position adjusted westward at 18 UTC for reasonable initial motion.

August 30

1. HURDAT and Old Maps:

- HWM indicates a closed low of at most 1010 mb near 9.0N, 27.0W.
- HURDAT lists this as a Tropical Storm with 35 kt winds at 10.3N, 26.9W at 12 UTC.

2. Discussion/MWR: "An aircraft reported indication of a tropical disturbance near 10.0N, 24.0W".

August 31

1. HURDAT and Old Maps:

- HWM indicates a storm with at most 1010 mb near 11.0N, 32.8W.
- HURDAT lists this as a Tropical Storm with 35 kt winds at 11.0N, 33.1W at 12 UTC.

September 1

1. HURDAT and Old Maps:

- HWM indicates a storm with at most 1005 mb near 11.5N, 39.1W.
- HURDAT lists this as a Category 1 hurricane with 65 kt winds and a pressure of 990 mb at 12.2N, 39.4W at 12 UTC.

2. Discussion/Reanalysis: (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. The ones that were not based upon an observation, but instead were likely estimated, have been removed. However, central pressures mentioned in HURDAT with no explicit documentation of a measured value yet aircraft were present are not removed. See the table at the end of the writeup for details about all central pressures.) Original intensities showed a dramatic jump from 50 to 80 kt between 06 and 18 UTC. However, this rapid intensification had no available inner core observations. Intensities adjusted downward at 12 and 18 UTC based upon subsequent aircraft observations on the 2nd.

September 2

1. HURDAT and Old Maps:

- HWM indicates a storm with at most 1000 mb near 13.4N, 46.1W.
- HURDAT lists this as a Category 4 hurricane with 115kt winds and a pressure of 980 mb at 13.6N, 45.8W at 12 UTC.

2. Ship highlight:

- 45 kt with pressure of 1004 mb at 14.2N, 48.6W at 1600 UTC (COADS).

3. Aircraft highlight:

- Central Pressure of 973 mb with 120 kt surface winds and 22 nmi diameter eye at 14.2N, 48.4W at 2001 UTC (ATSR).

4. Discussion:

- MWR: "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 120 kt and there was a well-developed eye with a central pressure of 973 mb".

- Reanalysis: 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 (suggesting an RMW of about 15 nmi) at 2001 UTC. The 973 mb pressure suggests maximum winds of 87 kt from the intensifying subset of the Brown et al. south of 25N pressure-wind relationship. 95 kt (down from 120 kt) are chosen, weighting some the surface wind estimate, a fast – 17 kt - forward motion, and a near average RMW (which is 12 nmi for this central pressure and latitude - Vickery et al. 2000).

September 3

1. HURDAT and Old Maps:

- HWM indicates a storm with at most 1000mb near 14.9N, 53.2W.
- HURDAT lists this as a Category 4 hurricane with 130 kt winds and a pressure of 965 mb at 15.2N, 52.9W at 12 UTC.

2. Aircraft highlight:

- Central pressure of 962 mb with 110 kt surface winds, 120 kt flight level winds (below 850 mb), and 18 nmi eye diameter eye at 15.3N, 53.2W at 1255 UTC (ATSR).
- Radar fix at 15.8N 54.7W at 1639 UTC (ATSR).

3. Discussion/Reanalysis: The next aircraft found that the central pressure dropped to 962 mb with an 18 nmi eye (suggesting RMW of about 15 nmi) at 1255 UTC on the 3rd. This pressure gives 98 kt maximum winds from the pressure-wind relationship. With a near average RMW (12 nmi climatologically), weighting the surface wind estimate slightly, and accounting for a fast – 17 kt – forward motion, 105 kt is chosen for 12 UTC on the 3rd down from 130 kt originally.

September 4

1. HURDAT and Old Maps:

- HWM indicates a storm with at most 995 mb near 16.4N, 59.6W.
- HURDAT lists this as a Category 5 hurricane with 140 kt winds and a pressure of 952 mb at 16.8N, 59.5W at 12 UTC.

2. Station highlights:

- "lull for 15-20 minutes" about 2100 UTC at Barbuda (17.1N 61.8W) (CLIMDAT)

3. Aircraft highlight:

- Radar fix at 16.6N 56.6W at 0000 UTC (ATSR).
- Radar fix at 16.3N 58.0W at 0600 UTC (ATSR).
- Central pressure of 958 mb with 140 kt surface winds, 150 kt flight-level winds at 1000 ft, and a 20 nmi eye diameter at 17.0N, 60.0W at 1317 UTC (ATSR). (The initial vortex message indicated at first a 952 mb central pressure from a dropsonde, but then changed it to 942 mb in the final vortex message – apparently a typo. However, the surface pressure of 952 mb from the dropsonde does not match the 850 mb heights/temperatures (958 mb) or the 700 H/T (960 mb). 958 mb used as central pressure instead, which does match values early on the 5th.)
- Radar fix at 17.5N 61.0W at 1850 UTC (ATSR).

4. Discussion:

- MWR: "Donna continued toward the west-northwest on approximately the climatological track, but at a slightly faster-than-average rate of about 17 kt. 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".

- Reanalysis: The 1317 UTC 958 mb central pressure from reconnaissance suggests maximum wind of 103 kt from the pressure-wind relationship. A 15 nmi RMW estimated from the eye diameter is about the same as the 13 nmi from climatology. Weighting the surface estimate moderately and having a near average – 11 kt – forward speed, an intensity of 110 kt is selected at 12 UTC, down from 140 kt originally.

September 5

1. HURDAT and Old Maps:

- HWM indicates a storm with at most 995 mb near 18.3N, 64.9W.
- HURDAT lists this as a Category 4 hurricane with 115 kt winds and a pressure of 958 mb at 19.1N, 64.7W at 12 UTC.

2. Station highlight:

- 110 kt (no time given), 952 mb (no time given, likely central pressure) at Sint Maarten (18.0N, 63.0W) (MWR, Note – report from San Juan Office in Storm Wallet indicates "(eye)" in connection with this 952 mb report.)
- "In eye 35-45 minutes" with lowest pressure of 987 mb, no time given at Anguilla (18.2N 63.0W) (CLIMDAT, WALLET). (Note that this pressure looks too high given that the station was in the eye and in comparison with other data.)

3. Ship highlight:

- 10 kt with 992 mb at 20.5N, 72.8W at 2300 UTC (COADS).

4. Aircraft highlight:

- Central pressure of 956 mb with 34 nmi eye diameter at 18.1N, 62.3W at 0100 UTC (ATSR).
- Central pressure of 962 mb (from 9168 ft 700 mb height with 18.1C) at 18.5N 63.7W at 07 UTC (ATSR).
- Central pressure of 958 mb with 25 nmi eye diameter and 110 kt maximum surface winds at 19.2N 64.9W at 1245 UTC (ATSR).
- Extrapolated central pressure of 956 mb with 18 nmi eye diameter at 19.8N 66.1W at 1943 UTC (NHRP).

5. Discussion:

- MWR: "The maximum sustained wind observed at Sint Maarten was 110 kt and the lowest barometer reading 952 mb, compared to earlier reports from reconnaissance of 140 kt winds and dropsonde measurements of 947 mb … Only minor damage was reported at St. Thomas, Virgin Islands, with the wind reaching a gust speed of 52 kt 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".
- CLIMDATA: "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".
- Reanalysis: Donna's central pressure dropped from 956 mb from aircraft at 01 UTC on the 5th to 952 mb at landfall in Sint Maarten around 04 UTC. Some filling occurred with 962 mb from aircraft at 07 UTC with a resumption of some deepening the remainder of the day with 958 mb from aircraft at 1245 UTC to 956 mb from aircraft at 1943 UTC. A central pressure of 952 mb

suggests an intensity of 109 kt from the pressure-wind relationship. This along with observed sustained winds of 110 kt from Sint Maarten justify a 110 kt intensity in HURDAT at 04 UTC. 962 mb is not included as a central pressure at 06 UTC, because of the rather rapid filling that apparently occurred between landfall in Sint Maarten at 04 UTC until the 07 UTC aircraft fix. Winds during the remainder of the 5th with pressures slightly higher are analyzed to be 110 kt, consistent with values late on the 4th. The revised intensities were large reductions at 00 UTC, but diminished to no change by 18 UTC.

September 6

1. HURDAT and Old Maps:

- HWM indicates a storm with at most 995 mb near 21.0N, 68.2W.
- HURDAT lists this as a Category 3 hurricane with 110 kt winds and a pressure of 940 mb at 21.2N, 68.1W at 12 UTC.

2. Ship highlight:

- 35 kt SE with 1016 mb at 23.2N, 64.87W at 0600 UTC (COADS).

3. Aircraft highlight:

- Central pressure of 941 mb "by drop" with 21 nmi eye diameter at 20.3N 66.9W at 0130 UTC (ATSR). (One dropsonde was transmitted with 960 mb surface pressure, which matches the 700 mb heights/temperature, but was likely outside of the eye. It appears that there was a second drop – not transmitted – which obtained the 941 mb, which is consistent with the central pressures obtained several hours subsequently.)
- Radar fix at 20.8N 67.5W at 0600 UTC (20 nmi eye diameter at 0500 UTC) (ATSR).
- Central pressure of 940 mb with 70 kt surface winds and 10 nmi eye diameter at 21.3N 68.4W at 1306 UTC (AF).
- Central pressure of 940 mb with 110 kt surface winds at 14 nmi eye diameter at 21.7N 69.1W at 1835 UTC (AF). (Aircraft extratpolated 932 mb, but then reported 940 mb from dropsonde, which is used here.)
- Central pressure of 935 mb (from 700 mb heigh of 8300 ft and 16.8C at 671 mb) with 120 kt surface winds and concentric eyewalls 13 and 50 nmi diameters at 21.7N, 69.1W at 2230 UTC (ATSR).

4. Discussion:

- CLIMDAT: "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 12 kt and later to 7-9 kt with a concurrent drop of central pressure to near 941 mb and an increase in maximum surface winds to around 122 kt and later to 130 kt".
- Reanalysis: Donna intensified down to 941 mb was observed by aircraft at 0130 UTC and then remained about steady state the remainder of the day. The 941 mb pressure suggests maximum winds of 118 kt from the pressure-wind relationship. As the 21 nmi eye suggests an RMW about the same as climatology (15 nmi versus 12 nmi) but with a slow – 8 kt – forward speed, the reanalyzed winds were set to 115 kt, up from 110 kt originally at 00 UTC on the 6th. The eye contracted down to 10-14 nmi during the remainder of the 6th. An intensity of 120 kt is thus analyzed at 12 and 18 UTC, up from 110 and 115 kt originally.

September 7

1. HURDAT and Old Maps:

- HWM indicates a storm with at most 990 mb near 21.3N, 71.4W.
- HURDAT lists this as a Category 4 hurricane with 125 kt winds and a pressure of 945 mb at 22.1N, 71.3W at 12 UTC.

2. Station highlight:

- 50 kt N at Mayaguana (22.3N 73.0W) at 1800 UTC (micro).
- 45-50 kt at Turks Island (21.5N, 71.2W) no time given (MWR).

3. Ship highlight:

- 55 kt W at 21.5N, 71.0W at 0600 UTC (micro).
- 50 kt W with 985 mb at 21.4N, 71.0W at 0900 UTC (micro);
- 35 kt SE with 1013 mb at 20.3N, 66.7W at 1200 UTC (COADS).

4. Aircraft highlight:

- Radar fix at 21.9N 69.8W at 0000 UTC (ATSR).
- Central pressure of 948 mb with 120 kt surface winds and 25 nm diameter eye at 21.9N 71.3W at 1045 UTC (ATSR).
- Penetration at 8200' provides D-value supporting 946 mb at location of 40-50 kt flight-level winds. (Central pressure would be lower than this by some unspecified amount.)
- Radar fix at 22.0N 72.4W with a 20 nmi eye diameter at 1818 UTC (RFF).

5. Discussion:

- MWR: "The central pressure given by dropsonde was 940 mb on the 6th and 944 mb on the 7th".
- CLIMDAT: "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 … As Donna approached the southeastern Bahamas, maximum winds were estimated up to 150 m.p.h. Mayaguana was buffeted for 13 hours by winds of hurricane force which reached over 100 m.p.h., at times. Heavy rain continued to accompany the storm in the Bahamas".
- Reanalysis: The 2230 UTC fix on the 6th indicated that Donna was beginning a concentric eyewall cycle with eye diameters of 13 and 50 nmi reported but with the central pressure reaching a minimum at 935 mb. (This "double eye" was documented in Jordan and Schatzle (1961), MWR.) This central pressure suggests a maximum wind of 128 kt from the south of 25N intensifying pressure-wind relationship. The 13 nmi eye suggests an RMW of about 10 nmi, near climatology (13 nmi), though Donna was still moving somewhat slowly (~8 kt). 125 kt the intensity analyzed at 00 UTC (up from 120 kt originally) and is also the revised peak intensity for Donna, which originally was 140 kt on the 4th. Another center fix at 1045 UTC showed substantial weakening with a 948 mb central pressure and estimated maximum surface winds of 120 kt at 1045 UTC. This pressure suggests an intensity of 108 kt from the weakening subset of the south of 25N pressure-wind relationship. The eye diameter suggests an RMW of about 15-20 nmi which is close to climatology. Thus the intensity is set at 110 kt at 12 UTC, down substantially from the 125 kt originally in HURDAT.

September 8

1. HURDAT and Old Maps:

- HWM indicates a storm with at most 995 mb near 22N, 75.2W.
- HURDAT lists this as a Category 4 hurricane with 130 kt winds and a pressure of 948 mb at 22.3N, 75.3W at 12 UTC.

2. Station highlight:

- 50 kt N at Acklins/Crooked Island (22.6N 74.5W) at 0000 UTC (micro).
- 50 kt ENE with 1000 mb at Long Island (23.0N 75.0W) at 0600 UTC (micro).
- 981 mb (min pressure) with 120 kt (likely a gust) at Long Cay (22.6N 74.4W) at 0800 UTC (wallet).

- 70 kt ENE at The Exumas (23.4N, 75.6W) at 1200 UTC (micro).
- 945 mb in eye at Ragged Key (22.2N, 75.7W) at 1540 UTC (wallet).

3. Ship highlight:
- 35 kt NE with 1011 mb at 25.0N 74.0W at 0000 UTC (COADS).
- 35 kt ESE with 1013 mb at 25.0N 72.3W at 0600 UTC (COADS).
- 35 kt S with pressure of 1007mb at 19.5N, 75.1W at 1200 UTC (COADS).

4. Aircraft highlight:
- Central pressure of 945 mb with 26 nm eye diameter at 22.2N 73.5W at 0100 UTC (ATSR);
- Central pressure of 947 mb (from 700 mb height of 8593 ft and 14C temperature) at 22.2N 74.8W at 0700 UTC (ATSR);
- Central pressure of 951 mb with elliptical eye 20 nmi/15 nmi at 22.2N, 75.5W at 1300 UTC (AF);
- Radar fix at 22.4N 76.2W at 1830 UTC (WALLET).

5. Discussion:
- MWR: "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 … At 0700 EST on September 8, when the hurricane was located only 380 miles southeast of Miami and moving westward at about 10 kt the Miami wind at 500 mb was still blowing from the west" (MWR).
- Reanalysis: Donna's pressure remained relatively steady state through early on the 8th. By 13 UTC on the 8th, aircraft reported that the central pressure had risen some to 951 mb with an eliptical eye with axes of 20 and 15 nmi while slowing its forward speed to about 8 kt. 951 mb suggests maximum winds of 107 kt from the weakening pressure-wind relationship. The eye size suggests an RMW of 12-15 nmi, which is about the same as climatology (15 nmi). Winds are chosen at 12 UTC on the 8th to be 100 kt, down from 130 kt originally. A 945 mb pressure value – likely in the eye – was measured around 1540 UTC at Ragged Key. This value was added into HURDAT at 18 UTC.

September 9

1. HURDAT and Old Maps:
- HWM indicates a storm near 23N, 78.6W.
- HURDAT lists this as a Category 4 hurricane with 130 kt winds and a pressure of 934 mb at 23.2N, 78.7W at 12 UTC.

2. Station highlight:
- 50 kt ESE with 1006 mb at Andros (24.1N 77.5W) at 0000 UTC (micro).
- 70 kt SSE at Andros (24.1N 77.5W) at 0600 UTC (micro).
- 75 kt S with 1004 mb at Andros (24.1N, 77.5W) at 1200 UTC (micro).
- 50 kt SE at Andros (24.1N 77.5W) at 1800 UTC (micro).

3. Ship highlight:
- 45 kt ENE with 1009 mb at 25.2N 80.0W at 1200 UTC (COADS).
- 100 kt NNW at 24.0N, 80.0W at 1800 UTC (micro).

4. Aircraft highlight:
- Central pressure of 939 mb ("by drop") with 21 nmi eye diameter at 22.6N 77.0W at 0030 UTC (ATSR). (One dropsonde was transmitted with 946 mb surface pressure, which matches the 700 mb heights/temperature, was likely a peripheral pressure value. It appears that there was a second drop – not transmitted – which obtained the 939 mb, which is consistent with the central pressures obtained a few hours subsequently.)

- Central pressure of 942 mb with 25 nmi eye diameter at 22.9N 77.9W at 0700 UTC (ATSR). (Value from flight level heights and temperatures. A drop gave 946 mb pressure, which appears to be too high compared to previous and subsequent pressures.)
- Central pressure of 942 mb from dropsonde with 100 kt surface winds and 30 nmi eye diameter at 23.4N 78.9W at 1300 UTC (ATSR).
- Central pressure of 944 mb from dropsonde with 110 kt surface winds and 25 nmi eye diameter at 23.9N 79.8W at 1900 UTC (ATSR).

5. Radar highlight:
- Center fix at 23.3N 78.8W at 1200 UTC from Key West (WALLET);
- Center fix at 23.6N 79.6W at 1815 UTC from Miami (WALLET);

6. Discussion:
- MWR: "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".
- CLIMDAT: "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 … 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".
- Reanalysis: During the 9th, Donna was nearly steady state with 939 mb central pressure at 0030 UTC, 942 mb at 07 UTC, 942 mb at 13 UTC, and 944 mb at 19 UTC were measured by aircraft reconnaissance. The 939 mb suggests maximum winds of 122 kt from the pressure-wind relationship. With the RMW (20-25 nmi) larger than climatological (14 nmi) and Donna still moving slowly (8 kt), winds are set at 110 kt at 00 UTC on the 9th - which is reduced from 130 kt originally in HURDAT. This intensity value of 110 kt is maintained for all of the 9th.

September 10

1. HURDAT and Old Maps:
- HWM indicates a storm with at most 990 mb near 25N, 81W.
- HURDAT lists this as a Category 4 hurricane with 120 kt winds and a pressure of 938 mb at 25.3N, 81.3W at 12 UTC.

2. Station highlight:
- 38 kt ENE with 1004 mb at Miami (25.8N 80.2W) at 2355 UTC (9th) (SWO).
- 933 mb at Conch Key (24.8N, 80.9W) no time given (CLIMDAT);
- 111 kt NW (fastest mile) at Sombrero Key (24.6N, 81.1W) at 0630 UTC (CLIMDAT).
- 104 kt at Tavernier (25.0N 80.5W) – "Wind instrument at maximum reading for 4 hours" (CLIMDAT – no specific time given).
- 937 mb at Duck Key (24.8N 80.9W) at 0645 UTC and eye from 0605-0725 UTC (CLIMDAT).
- 945 mb at Flamingo (25.1N 80.9W) at 0845 UTC (CLIMDAT).
- 75 kt with 996 mb at Key Largo (25.1N 80.4W) at 1200 UTC (micro).
- 953 mb at Everglades City (25.9N 81.4W) at 1415 UTC (CLIMDAT).
- 950 mb at Naples (26.1N 81.8W) at 1720 UTC "not completely calm. No sun. Thinner overcast" (CLIMDAT and wallet).
- 80 kt (max 1 min) NE at Ft. Myers (26.6N 81.9W) at 1831 UTC (CLIMDAT).
- 950 mb at Ft. Myers (26.6N 81.9W) at 1927 UTC, in eye from 1920-2031 UTC (CLIMDAT). ("Private aneroid read 27.75 ["], believed correct" – wallet).

- 113 kt fastest mile at Punta Gorda (26.9N 82.0W) at 20 UTC (wallet).
- 954 mb pressure at 2100 UTC, "eye overhead" at 2200 UTC in Punta Gorda (26.9N 82.0) (CLIMDAT).

3. Ship highlight:
- 35 kt E with 1009 mb at 25.8N 77.0W at 0000 UTC (COADS).

4. Aircraft highlight:
- Central pressure of 938 mb with 20 nmi eye diameter at 24.2N 80.1W at 0050 UTC (ATSR – Note that the drop location given for this central pressure is well outside of the eye. This reported location is likely in error).
- Radar fix with 27 nmi eye diameter at 24.8N, 80.4W at 0530 UTC (ATSR).
- Central pressure of 939 mb with 130 kt with ellipitical eye 27 nmi/17 nmi at 25.3N 81.2W at 1129 UTC (ATSR). (Note 944 mb pressure from dropsonde was with a 700 mb height about 90 ft higher than the lowest in the eye. Thus the pressure value may not have been in the center of the eye. 700 mb extrapolation used instead.)
- Penetration fix at 26.1N 81.8W at 1600 UTC (ATSR). (Note that a 953 mb pressure was obtained, but the pressure could be wrong due to the eye making landfall. Thus this is not considered to be a central pressure.)
- Radar fix at 26.2N 81.8W with 16 nmi eye diameter at 1800 UTC (ATSR).
- Radar fix at 27.0N 81.8W at 2230 UTC (ATSR).

5. Radar highlight:
- Center fix at 24.1N 80.1W at 0030 UTC from Miami (WALLET);
- Center fix at 24.6N 80.8W at 0600 UTC from Miami (WALLET);
- Center fix at 25.4N 81.3W at 1230 UTC from Miami (WALLET);
- Center fix at 26.2N 81.8W at 1800 UTC from Miami (WALLET);

6. Discussion:
- MWR: "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".
- CLIMDAT: "On the Keys, the central eye extended from just north and east of Marathon shores to Lignumvitae Key … 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 120 mph, 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 … The lowest atmospheric pressure measured by a calibrated aneroid barometer was 27.55 inches in Conch Key as the eye passed … 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".
- Jarrell et al: "FL-SW4, FL-NE2 – 930 mb central pressure at landfall"
- Schwerdt et al: "1008 mb peripheral pressure, 114 kt max sustained 1 min wind (Gulf)"
- Ho et al: "Gulf – 930 mb central pressure, 18 nmi RMW, landfall at 24.8N 80.9W, speed – 9 kt; Florida Atlantic coast (exit) – 970 mb central pressure, 24 nmi RMW, oceanfall at 29.5N 81.1W, speed – 16 kt"

- Dunion et al: Keys landfall 06Z September 10th – 932 mb – 117 kt, 18 nmi RMW; Naples landfall – 98 kt, 18 nmi RMW.
- Reanalysis: The hurricane intensified slightly again on the 10th as it made landfall in the Florida Keys. Aircraft central pressure was 938 mb at 0050 UTC and 942 mb at 0530 UTC. Donna made landfall over the middle Florida Keys at 24.8N 80.9W around 07 UTC on the 10th. A pressure of 933 mb observed from a calibrated barometer on Conch Key is the basis for the estimated 930 mb central pressure at landfall, assuming that this single instrument may not have measured the exact central pressure of Donna. 930 mb central pressure was also that assessed by Ho et al. and Jarrell et al. 930 mb suggests maximum winds of 132 kt from intensifying subset of south of 25N and 129 kt from the intensifying subset of north of 25N pressure-wind relationships. The peak observed winds were the 111 kt fastest mile wind at the Sombrero Key Lighthouse and the 104 kt (for at least 45 minutes) at Taverneir. The 111 kt fastest mile converts roughly to a peak 1 minute wind of 106 kt. The NOAA technical catalog of station metadata indicates "Unknown" for the anemometer height for both the Sombrero Key Lighthouse station and the Tavernier cooperative station. It is possible that the Sombrero Key (and the Tavernier) anemometer observations were above the standard 10 m above ground/water. The 27 nmi eye from aircraft reconnaissance suggests an RMW of about 20 nmi, which is nearly the same as that estimated by Ho et al. and Dunion et al. The 20 nmi RMW arrived at from the aircraft reconnaissance eye diameter (and also arrived at by Ho et al. and Dunion et al.) can be compared with the peak winds from Sombrero Key Light and Tavernier. A 20 nmi RMW would place Sombrero Key Light nearly at the RMW and Tavernier just outside of the RMW at the times of closest approach. Thus these observations are consistent with a 20 nmi RMW. The RMW of 20 nmi is close to 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). Together, these factors suggest a somewhat lower value than the average of the two pressure wind relationships, so 125 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 slightly higher than the Schwerdt et al. and Dunion et al. estimates as well as the 115 kt in HURDAT at the 06 UTC slot. 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 also estimated to be Category 4 based upon the size and landfall location of Donna. After passing the Keys, Donna briefly entered the Gulf of Mexico. One final aircraft reconnaissance fix indicated some filling had occurred, as the central pressure went up to 939 mb just before 12 UTC. The intensity is lowered slightly to 115 kt. Donna then made landfall just east of Marco Island around 16 UTC on the 10th at 25.9N 81.6W. A pressure of 950 mb observed at Naples at 17 UTC, but the center of the hurricane passed to the east of the city, so this is a peripheral pressure value. Runs of the Schloemer model give a central pressure of about 945 mb, assuming that the distance from Naples to the center of the eye was 5-10 nm. Given that some filling occurred after landfall until the Naples observation was taken, central pressure at landfall near Marco Island is analyzed to be 942 mb, which is consistent with some filling measured by aircraft a few hours earlier. This pressure suggests maximum winds of 108 kt from the weakening subset of the north of 25N pressure-wind relationship. The forward speed of Donna had increased to about 12 kt but the outer closed isobar remained low (1009 mb). Intensity at this landfall is thus analyzed to be 105 kt. Note that there was a 113 kt fastest mile report (reduces to 108 kt peak 1 min wind) from Punta Gorda at 20 UTC, though it is unclear if this was observed or was visually estimated.

September 11

1. HURDAT and Old Maps:

- HWM indicates a storm near 30.0N, 80.2W.
- HURDAT lists this as a Category 2 hurricane with 90 kt winds and a pressure of 970 mb at 29.9N, 80.8W at 12 UTC.

2. Station highlight:

- 50 kt N at Tampa (27.5N 82.3W) at 0055 UTC (SWO).
- 962 mb at Wauchula (27.5N 81.8W) at 0200 UTC (CLIMDATA);
- 59 kt NE (max sustained wind) at Lakeland (28.0N, 81.9W) at 0235 UTC (CLIMDAT).
- "Lull from 03-04 UTC" at Bartow AFB (27.6N 81.5W) (CLIMDATA);
- 969 mb at 0355 UTC, "eye over city between 0230-0400 UTC" at Ft. Meade (27.8N 81.8W) (CLIMDATA).
- "Lull and wind shift from NE to SW from 0440-0530 UTC" in Lake Alfred (28.1N 81.7W) (CLIMDATA);
- "Lull 0600-0640 UTC. Wind shifted E to W" at Winter Haven (28.0N 81.7W) (CLIMDATA);
- 964 mb at 0645 UTC, "lull from 0655-0715 UTC" at Clermont (28.5N 81.8W) (CLIMDATA).
- 50 kt ESE with 984 mb at Daytona Beach (29.2N 81.0W) at 0659 UTC (SWO).
- "Lull 0740-0830 UTC" at Lisbon (28.9N 81.8W) (CLIMDATA);
- 64 kt at Ponce de Leon Inlet (29.1N 80.9W) at 0823 UTC (Wallet);
- "Lull from 09-10 UTC. Sky clear" at Alexander Springs (29.1N 81.6W) (CLIMDATA);
- "Dead calm for 50 minutes beginning at 0945 UTC" at 5 miles north of Daytona Beach station (~29.3N 81.0W) with lowest pressure of 958 mb (Wallet);
- "Eye passed 1010-1100 UTC" at Crescent (29.4N 81.5W) (CLIMDATA);
- "Calm began 1015 UTC, sky clear, lasted nearly 2 hours" at Flagler Beach (29.5N 81.1W) (CLIMDATA);
- 40 kt NE at Jacksonville (30.3N 81.7W) at 1054 UTC (SWO).
- Calm at Bunnell (29.5N 81.3W) at 1100-1230 UTC (CLIMDATA);
- 38 kt ENE with 989 mb at Wilmington, NC at 2259 UTC (SWO).

3. Ship highlight:

- 45 kt ESE with 1005 mb at 30.1N 80.5W at 0000 UTC (COADS);
- 50 kt SSW with 999 mb at 32.0N 76.0W at 0300 UTC (micro);
- 40 kt SE with 1004 mb at 27.0N 79.4W at 0600 UTC (COADS);
- 45 kt S with 1008 mb at 27.8N 77.3W at 1200 UTC (COADS);
- 60 kt SE with 988 mb at 30.5N 79.6W at 1500 UTC (COADS);
- 65 kt S with 997 mb at 30.2N 78.8W at 1800 UTC (COADS);
- 40 kt SE with 982 mb at 31.9N 79.6W at 1800 UTC (MWL);
- 64 kt E with 972 mb at 31.2N 80.4W at 1800 UTC (MWL);
- 105 kt at ~31.8N ~79.0W at ~1800 UTC (MWR);
- 65 kt WNW with 985 mb at 30.5N 79.5W at 2100 UTC (COADS).

4. Aircraft highlight:

- Central pressure of 968 mb with 65 kt surface winds and 50 nmi eye diameter at 30.7N, 80.6W at 1545 UTC (ATSR);
- Central pressure of 970 mb from dropsonde (850 mb heights/temperature suggests 974 mb) at 31.2N 80.2W at 1800 UTC (ATSR).

5. Radar highlight:

- Center fix at 28.3N 81.7W at 0600 UTC from Tampa (WALLET);

- Center fix at 29.7N 81.0W at 1200 UTC from Jacksonville (WALLET);

6. Discussion:

- MWR: "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 … Despite the trajectory over land and a filling of central pressure from 950 mb at Fort Myers to 970 mb on the east coast, the storm was still intense and well organized when it moved into the Atlantic again … Rapid intensification occurred over the ocean and when the center was about 80 miles southeast of Charleston, S.C., on the afternoon of September 11, the SS Mae reported winds of 105 kt and 20 to 30-foot seas".
- CLIMDAT: "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".
- Reanalysis: 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 inland wind decay model. Dunion et al. analyzed 78, 54, and 61 kt for 00, 06, and 12 (just offshore) UTC on the 11th, respectfully. However, that assumed a 98 kt intensity at landfall. Given that the intensity assessed here is higher (105 kt), the Kaplan-DeMaria inland decay model gives 82, 56, and 62 kt for 00, 06, and 12 (just offshore) UTC. Peak observed winds after landfall were 59 kt at 0235 UTC in Lakeland and 64 kt at 0823 UTC at Ponce de Leon Inlet lighthouse. Intensities in HURDAT are reanalyzed to be 85, 65, and 75 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 Category 1 hurricane winds for Northeast Florida. Thus this is reduced down from Category 2 hurricane status for the region originally. After passing back into the Atlantic, Donna began reintensifying. A Navy reconnaissance measured 970 mb mb and a 50 nmi diameter eye at 1830 UTC on the 11th. 970 mb central pressure suggests 84 kt from the pressure-wind relationship. Also around 18 UTC, a ship estimated winds of 105 kt. Accounting for the large eye diameter, the intensity is analyzed to be 80 kt (moderately lowered from HURDAT) at 18 UTC.

September 12

1. HURDAT and Old Maps:

- HWM indicates a storm of at most 975 mb near 37.7N, 74.5W.
- HURDAT lists this as a Category 2 hurricane with 95 kt and a pressure of 965 mb at 37.3N, 74.8W at 12 UTC.

2. Station highlight:

- 35 kt with 982 mb at Wilmington (34.1N 77.9W) at 2356 UTC (11th) (SWO);
- 966 mb "in eye 30 minute" at Holden Beach (33.9N 78.3W) at 0100 UTC (CLIMDAT);
- 965 mb "in eye 1 hour" at Oak Island (33.9N 78.2W) at 0200 UTC (CLIMDAT);
- 962 mb at Wilmington (34.1N 77.9W) at 0250 UTC (CLIMDAT);

- 961 mb “in eye 1 hour 30 minutes” at Sneeds Ferry (34.6N 77.4W) at 0300 UTC (CLIMDAT);
- 962 mb at New Topsail Beach (34.5N 77.5W) at 0320 UTC (CLIMDAT);
- 961 mb at Jacksonville (34.8N 77.4W) at 0450 UTC (CLIMDAT);
- 962 mb at Cherry Point (34.9N 76.9W) at 0540 UTC (CLIMDAT);
- 60 kt NW at Goldsboro (35.2N 77.6W) at 0555 UTC (SWO);
- 63 kt S (fastest mile) at Cape Hatteras at 0731 UTC (CLIMDAT);
- 958 mb “in eye 45 minutes” at Belhaven (35.5N, 76.6W) at 0700-0745 UTC (CLIMDAT);
- 963 mb “calm 09-10Z” at Elizabeth City (36.3N 76.3W) at 0900 UTC (CLIMDAT);
- 969 mb “calm between 1015-1047Z” at Cape Henry at 1030 UTC (CLIMDAT);
- 70 kt NW (fastest mile) at Cape Henry (36.9N 76.0W) at 1208 UTC (CLIMDAT);
- 967 mb at Atlantic City (39.7N 74.4W) at 1555 UTC (CLIMDAT);
- 967 mb at Long Branch, New Jersey (40.3N 74.0W) at 1720 UTC (CLIMDAT);
- 61 kt NE (fastest mile) at New York La Guardia (no time, likely around 1800 UTC) (CLIMDAT);
- 87 kt (unknown whether gust or sustained) at “several wind towers on Long Island” (unknown time, CLIMDAT-NY);
- 89 kt (unknown whether gust or sustained) at Montauk Point Lighthouse (41.1N 71.9W) (unknown time, CLIMDAT-NY);
- 961 mb at Brookhaven (40.8N 72.9W) at 1950 UTC (CLIMDAT);
- 965 mb with 23 kt W at Suffolk County AFB (40.8 72.6W) at 2045 UTC (SWO – time appears to be one hour late);
- 83 kt S (peak 1 min) at Block Island (41.2N 71.6W) at 2115 UTC (CLIMDAT);
- 968 mb (min p) at Noank, CT (41.3N 72.0W) (no time, CLIMDAT-NE);
- 969 mb “calm from 2145-2315Z” at Worcester (42.3N 71.8W) at 2230 UTC (CLIMDAT);
- 966 mb at 2246 UTC and 80 kt SSE (fastest mile) at 2132 UTC at Blue Hill Observatory (42.4N 71.1W) (CLIMDAT);

3. Ship highlight:
- 75 kt E with pressure of 991 mb at 32.3N, 79.2W at 0000 UTC (COADS – position appears to be incorrect);
- 60 kt SW with 1000 mb at 31.9N 73.9W at 0600 UTC (COADS);
- 85 kt SSE at 39.9N 71.6W at 1200 UTC (micro);
- 70 kt SSE with pressure of 974 mb at 39.7N, 72.0W at 1800 UTC (micro);

4. Aircraft highlight:
- Central pressure of 958 mb with 69 nmi eye diameter at 33.4N 78.0W at 0021 UTC (ATSR);
- Radar fix at 35.2N 77.0W at 0708 UTC (ATSR);
- Penetration fix at 37.5N 74.5W at 1240 UTC, possible eye diameter 103 nmi, 978 mb central pressure (likely erroneous), and 110 kt surface winds (reported at 1320Z fix) (ATSR);
- Radar fix at 40.6N 73.3W at 1748 UTC (ATSR);
- Radar fix at 41.5N 71.4W with possible eye diameter 50 nmi at 2030 UTC (ATSR).

5. Radar highlight:
- Center fix at 33.3N 78.0W at 0015 UTC from Cape Hatteras (WALLET);
- Center fix at 38.2N 74.3W at 1410 UTC from Washington (WALLET);
- Center fix at 40.3N 72.9W at 1738 UTC from Washington (WALLET).

6. Discussion:

- MWR: "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 967 mb and highest winds were in the 70-90kt bracket … When Donna again reached the ocean, it resumed its rapid movement with a forward speed of 30-35 kt, moving northeastward a short distance off the coast and crossing Long Island shortly after noon on September 12. Sustained winds reached about 90 kt at several points on Long Island and 50-60 kt on western Long Island and in New York City … 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".
- CLIMDAT: "The large eye (possibly the largest of record) was a continuing feature as Donna moved rapidly northeastward, paralleling the Middle Atlantic coast, at some 30-35 kt during the morning hours of the 12th … 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).
- Jarrell et al: "NC-3, CT-2, RI-2, MA-1, NH-1, ME-1"
- Schwerdt et al: "1008 mb peripheral pressure, 96 kt max sustained 1 min wind NC, 89 kt NY"
- Ho et al: "NC – 958 mb central pressure, 26 nmi RMW, landfall at 34.4N 77.6W, speed – 26 kt; NY – 959 mb central pressure, 48 nmi RMW, landfall at 40.6N 73.2W, speed – 32 kt, storm becoming extratropical"
- Boose et al: "Widespread F1 and one case of F2 structural damage in New York/New England. No changes recommended to HURDAT."
- Reanalysis: Aircraft reconnaissance reported 958 mb at 0100 UTC with a 69 nmi eye, suggesting an RMW of about 50 nmi. Donna had deepended considerably from the 11th, but the inner core had become much larger. 958 mb central pressure corresponds to 97 kt maximum wind from the north of 25N pressure-wind relationship. Because of the very large size but accounting for the fast (25 kt) forward speed, an intensity of 90 kt is analyzed at 00 UTC, slightly below HURDAT. Donna made a third landfall in the United States around 05 UTC on the 12th at 34.6N 77.3W in North Carolina just east of Sneeds Ferry. Lowest observed pressure was 958 mb in the eye at Bellhaven in eastern North Carolina a couple hours after landfall. However, the eye of Donna also passed over or very close to Wilmington, New Bern, and Cherry point before reaching Belhaven and all three of these stations reported minimum pressures near 962 mb. Thus it is likely that Belhaven's observation was biased slightly high. This along with the aircraft reconnaissance measurement three hours before landfall, the analyzed central pressure at landfall in North Carolina is around 958 mb. This pressure suggests maximum winds of 97 kt from the north of 25N pressure-wind relationship. Detailed observations from the Surface Weather Observations in Wilmington and Cape Henry allowed for explicit calculation of the RMW about 05 and 12 UTC, respectively. Both gave about a 60 nmi RMW in the western semicircle, which is substantially larger than the 26 nmi assessed by Ho. (Cape Hatteras was too far from the center and was outside of the RMW.) An RMW in the eastern semicircle is assessed to be 50 nmi, consistent with the eye diameter from the aircraft reconnaissance. Because of the very large RMW, relatively low (~1009 mb) environmental pressure, but fast forward speed (27 kt), 90 kt is analyzed as the maximum sustained winds at North Carolina landfall. This is slightly lower than the Schwerdt et al. assessment and 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 only drop from 95 kt to 90 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). A central pressure of 960 mb (up slightly from the measured Belhaven pressure) is added to HURDAT at the 06 UTC position and the 85 kt intensity is assessed (down slightly from 90 kt).

Donna went back out to sea for about nine more hours before making landfall in New York. A final aircraft reconnaissance mission indicated 110 kt estimated surface winds and 978 mb pressure from a drop around 12 UTC. Based upon previous and subsequent land-based readings, this value is way too high to be a central pressure and is likely erroneous. At the same time as the aircraft, a ship reported 85 kt. Donna made a fourth U.S. landfall in New York, just east of Brookhaven 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 maximum winds of 90 kt from the Landsea et al. north of 35N pressure-wind relationship. RMW was calculated explicitly from SWO observations from Suffolk County AFB, Block Island, and Providence, which were in the northern, eastern, and eastern semicircle of Donna, respectively. These cities' observations suggest 60, 55, and 40 nmi, respectively. An RMW of 50 nmi is estimated, which is consistent with Ho's analysis. Given the large size (climatology is 35 nmi for this central pressure and latitude), low (1004 mb) environmental pressure, but very fast (32 kt) forward speed, maximum sustained surface winds are estimated to be 85 kt at landfall. (Highest observed sustained winds were 83 kt from Block Island, RI. There were also reports of 87 kt from towers on Long Island and Montauk Point Lighthouse, but it is unknown whether these were gusts or sustained or how high above the ground the anemometers were.) 85 kt intensity at 18 UTC is also indicated, down from 90 kt originally.

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. Based upon the subsequent central pressure of 968 mb from Worcester at 2230 UTC and the earlier reading in Brookhaven, a central pressure at Connecticut landfall is analyzed to be 962 mb. Maximum 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.

September 13

1. HURDAT and Old Maps:

- 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.

2. Station highlight:

- 54 kt SE (fastest mile) at Portland (43.7N, 70.3W) at 0013 UTC (CLIMDAT);
- 969 mb at Haverhill (42.8N, 71.1W) at 0030 UTC (CLIMDAT);
- 978 mb at Caribou (46.9N 68.0W) at 0558 UTC (CLIMDAT).

3. Ship highlight:

- 55 kt SSE with 998 mb at 40.5N 67.9W at 0000 UTC (COADS);
- 30 kt SW with 983 mb at 41.6N 71.4W at 0000 UTC (COADS);

- 50 kt SSW with 1001 mb at 42.2N 68.7W at 0600 UTC (COADS);
- 20 kt S with 979 mb at 49.6N, 65.2W at 1200 UTC (COADS);
- 60 kt W at 47.7N, 59.3W at 1700 UTC (COADS).

4. Aircraft highlight:
- Radar fix at 0000 UTC withn 975 mb lowest pressure at 44.4N 70.0W (ATSR).

5. Discussion:
- MWR: "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".
- Reanalysis: A run of the Kaplan-DeMaria New England inland decay model suggests an intensity of 50 kt at 0000 UTC, after being overland for four hours. Given the observed 55 kt from a ship and 54 kt in Portland at that time, the intensity is analyzed to be 60 kt. This is a significant reduction from the original 75 kt in HURDAT at this time. New Hampshire and Maine likely 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 0600 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.

September 14

1. HURDAT and Old Maps:
- HWM indicates an occluding low of at most 990 mb near 59N 49W.
- The last position in HURDAT was 18 UTC on the 13th

2. Ship highlights:
- 40 kt SE with 994 mb at 56.5N 51.0W at 0000 UTC (COADS);
- 35 kt WSW with 995 mb at 56.5N 51.0W at 0600 UTC (COADS);
- 40 kt WSW with 1002 mb at 56.5N 51.0W at 1200 UTC (COADS).

3. Discussion/Reanalysis: 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.

Date	Original HURDAT Central Pressure	Evidence	Changes
September 1 12Z	990 mb	Estimate, not based on an observation	Removed
September 2 12Z	980 mb	Estimate, not based on an observation	Removed
September 2 18Z	973 mb	Aircraft: 973 mb at 2001Z	Retained
September 3 12Z	965 mb	Aircraft: 962 mb at 1255Z	962 mb
September 3 18Z	947 mb	Estimate, not based on an observation	Removed
September 4 12Z	952 mb	Aircraft: 958 mb at 1317Z	958 mb
September 5 00Z		Aircraft: 956 mb at 0100Z	956 mb
September 5 04Z		Station: 952 mb at Sint Maarten	952 mb
September 5 12Z	958 mb	Aircraft: 958 mb at 1245Z	Retained

September 5 18Z		Aircraft: 956 mb at 1943Z	956 mb
September 6 00Z		Aircraft: 941 mb at 0130Z	941 mb
September 6 12Z	940 mb	Aircraft: 940 mb at 1306Z	Retained
September 6 18Z		Aircraft: 940 mb at 1835Z	940 mb
September 7 00Z		Aircraft: 938 mb at 2230Z	938 mb
September 7 12Z	945 mb	Aircraft: 948 mb at 1045Z	948 mb
September 8 00Z		Aircraft: 945 mb at 0100Z	945 mb
September 8 06Z		Aircraft: 947 mb at 0400Z	947 mb
September 8 12Z	948 mb	Aircraft: 951 mb at 1300Z	951 mb
September 8 18Z	944 mb	Station: 945 mb at Ragged Island at 1540Z	945 mb
September 9 00Z	948 mb	Aircraft: 939 mb at 0030Z	939 mb
September 9 06Z	940 mb	Aircraft: 942 mb at 0700Z	942 mb
September 9 12Z	934 mb	Aircraft: 942 mb at 1300Z	942 mb
September 9 18Z	939 mb	Aircraft: 944 mb at 1900Z	944 mb
September 10 00Z	932 mb	Aircraft: 938 mb at 0050Z	938 mb
September 10 06Z	932 mb	Duck Key: 933 mb	930 mb
September 10 12Z	938 mb	Aircraft: 939 mb at 1129Z	939 mb
September 10 18Z	950 mb	Naples: 950 mb not in center of eye at 1720Z, 945 mb from Schloemer equation	945 mb
September 11 00Z	960 mb	Punta Gorda: 954 mb at 2100Z (10th) and Wauchula: 962 mb at 0200Z	957 mb
September 11 06Z	969 mb	Clermont: 964 mb at 0645 UTC	964 mb
September 11 12Z	970 mb	North of Daytona Beach: 968 mb at 0945-1035 UTC	968 mb
September 11 18Z	966 mb	Aircraft: 970 mb at 1830Z	970 mb
September 12 00Z	958 mb	Aircraft: 958 mb at 0100Z	Retained
September 12 06Z		Belhaven: 958 mb at 0700-0745Z, adjusted upward slightly as it appears to have low bias	960 mb
September 12 12Z	965 mb	Estimate, not based on an observation	Removed
September 12 18Z		Brookhaven: 961 mb at 1950Z	959 mb
September 13 00Z		Haverhill: 969 mb at 0030Z	969 mb

Sources: 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, Mariners Weather Log, Cry (1960), Jordan and Schatzle (1961), 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).

Hurricane Ethel [September 12-17, 1960] – AL061960

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41685 09/14/1960 M= 4  6 SNBR= 906 ETHEL       XING=1 SSS=1
41685 09/12/1960 M= 6  6 SNBR= 906 ETHEL       XING=1 SSS=1
         **         *

(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  974*
           *** ***  **      *** ***  **          ***  **          *** ***  ***

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  80  981*294 887  75  985*301 888  70  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 1010*
           *** ***  **      ***      **                ** ****     ***  ** ****

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 1011*349 880  20 1012*359 874  20 1013*368 866  20 1015*
              ***     **** ***       **** *** ***  ** ****     ***  ** ****

41710 HR MS1
41710 HR LA1MS1
         ***
U.S. Hurricane Landfall
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Sep 15th – 21Z – 30.4N 89.0W – 70 kt (80 kt impact in SE Louisiana about 12 hours before landfall) – Category 1 – 980 mb (at landfall) – 20 nm RMW - 1013 mb OCI – 150 nm ROCI

Substantial Revisions

- Genesis is indicated 42 hours earlier based upon ship observations
- Large upward adjustments in the intensity on the 14th based upon aircraft reconnaissance
- Large downward revision in the intensity on the 15th based upon aircraft reconnaissance
- Peak intensity reduced from 140 to 100 kt
- A few new central pressures were added primarily from aircraft reconnaissance over water and station observations over land

Daily Summary

September 12:

1. HURDAT and Old Maps:

- 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.

2. Discussion:

- 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."
- Reanalysis: 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. Evidence that this was a tropical cyclone at this point rather than a trough are the two ships in the southwestern Gulf of Mexico showing 25 kt winds out of the southeast north of the system and 20 kt winds out of the southwest south of the system. If the system were only a trough, then it is unlikely that there would be 25 kt SE winds present. A significant frontal boundary was present, but this was primarily affecting the northeastern Gulf.

September 13:

1. HURDAT and Old Maps:

- 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.

2. Discussion:

- 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."
- Reanalysis: 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.

September 14:

1. HURDAT and Old Maps:

- 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.

2. 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).

3. 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 974 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 975 mb at 26.6N, 89.3W at 2212Z (ATSR).

4. Discussion:

- 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." (It is noted that reports from the MAMOS buoy were the first time an automated weather buoy successfully transmitted observations from an Atlantic tropical cyclone - 1960 Mariners Weather Log, pages 191-194.)

- 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."

- Mariners Weather Log: "On September 14, 1960, for the first time in history, a marine automatic weather station (MAMOS) (Marine Automatic Meteorological Observating Station) anchored in the Gulf of Mexico at 25N 90W detected the existence of a tropical cyclone."

- Reanalysis: 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 974 mb, estimating surface winds of 130 kt and an eye diameter of 10 nm. A central pressure of 974 mb suggests maximum surface winds of 86 kt intensifying south of 25N and 83 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 974 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.

September 15:

1. HURDAT and Old Maps:

- 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.

2. 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).

3. 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).

4. Aircraft highlights:

- Penetration center fix at 27.1N, 89.2W at 00Z (ATSR). A 700 mb height of 9610 ft and temperature of 18C yields an extrapolated pressure of 976 mb.
- Penetration center fix with 981 mb central pressure 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).

5. Discussion:

- Ho et al: "979 mb measured at Gulfport, MS – RMW 22 nmi – 10 kt forward speed – landfall pt 30.3N, 89.3W"
- Jarrell et al: "Sep – MS1 – Cat 1 – 981 mb"
- Schwardt et al: "30.4N, 86.1W – 972 mb – 1015 mb Penv – RMW 18 nmi – speed 10 kt – 74 kt est max sustained 10m, 10-min wind"
- 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 eye 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."
- Reanalysis: Another reconnaissance aircraft reached Ethel at 2212Z on the 14th measuring a central pressure of 975 mb, estimating surface winds of 140 kt and an eye diameter of 10 nm. 976 mb was estimated at 00Z on the the 15th from heights/temperature. 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. It is noted that this 100-kt peak intensity value has greater than normal uncertainty. Ethel shares similarities with Hurricane Danny of 2015, which was a major hurricane with a central pressure near or above 970 mb. 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 984 mb and estimated surface winds of 60 kt. A central pressure of 984 mb suggests maximum surface winds of 65 kt weakening north of 25N from the pressure-wind relationship. At 1015Z, Venice, LA reported a peak sustained wind of 78 kt. Based primarily upon the observed winds in Venice, an intensity of 75 kt is selected at 12Z on the 15th, 5 kt less than HURDAT. 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 80 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 70 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.

September 16:

1. HURDAT and old maps:

- 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.

2. Land highlights: 8 kt NE and 1008 mb at Meridian, MS at 12Z (SWO).

3. Discussion/Reanalysis: 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.

September 17:

1. HURDAT and old maps:

- 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.

2. Discussion:

- MWR: “The remnants of the storm were located in central Tennessee on the morning of September 17.”

- Reanalysis: 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.

September 18:

1. HURDAT and old maps:

- 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.

Sources: 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.

Tropical Storm Florence [September 17-27, 1960] – AL071960

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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    0D236 816  25    0D234 826  25    0*
                             ***              ****             ****

41745 09/22*227 836  25    0*221 843  25    0*220 834  25    0*227 831  25    0*
41745 09/22D228 836  25    0D223 840  25    0D220 837  25    0D223 835  25    0*
          ****             ****  ***         *    ***         ****  ***

41750 09/23*236 827  25    0*244 822  25    0*251 816  25    0*259 811  25    0*
41750 09/23D230 832  25    0D240 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 1002*273 803  50    0*275 805  50    0*276 810  40    0*
                     ** ****          **                **                **

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  20    0*
                     **                **                **                **
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(The 27th is removed from HURDAT.)
41770 09/27*318 885 15   0*325 890 15   0* 0   0   0   0* 0   0   0   0*

41775 TS

Tropical Storm Landfall

09/19 09Z 21.1N 73.1W 35 kt Great Inagua, Bahamas

Significant Revisions:

- A few central pressures were added based upon aircraft reconnaissance and surface reports
- A tropical disturbance stage is added from the 21st to the 23rd
- Intensity is significantly raised on the 24th based upon ship observations
- Dissipation is indicated twelve hours earlier based upon station observations

Daily Summary:

September 16:

1. HURDAT and Old Maps:

- 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.

2. Discussion:

- 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."
- Reanalysis: 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.

September 17:

1. HURDAT and Old Maps:

- 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).

2. Discussion:

- 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 21°N, 66°W 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."
- Reanalysis: 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.

September 18:

1. HURDAT and Old Maps:

- 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.

2. Ship highlights:

- 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).

3. 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).

4. 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).

5. Discussion:

- 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 21°N, 69°W."

- 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."

- Reanalysis: 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.

September 19:

1. HURDAT and Old Maps:

- 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.

2. 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).

3. 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).

4. 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).

5. Discussion:

- ATSR: "Then dissipated on the 19th of September. The final warning was issued at 191600Z."

- Reanalysis: 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.

September 20:

1. HURDAT and Old Maps:

- 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.

2. Aircraft Highlights:

- "UABLE LCT ANY CLSED CRCLN CNTR…MAX OBSD SFC WND 12 KTS…MIN OBSD SLP 1011 MBS BY LOW LVL EXTRAPOLATION" between 12 and 15Z (ATSR).

3. Discussion:

- 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."
- Reanalysis: 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.

September 21:

1. HURDAT and Old Maps:

- 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.

2. Discussion/ Reanalysis: Synoptic observations by 12Z indicate that Florence degenerated into a sharp trough stretching from the northwest Caribbean to western Cuba to the northern Bahamas.

September 22:

1. HURDAT and Old Maps:

- 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.

2. Discussion:

- 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."
- Reanalysis: Synoptic observations indicate that Florence continued as 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.

September 23:

1. HURDAT and Old Maps:

- 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.

2. Land highlights:

- 35 kt ENE (gusts to 52 kt, max wind) and 1009 mb at Vero Beach, FL at 2359Z (SWO).

3. 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).

4. Discussion:

- 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."
- Reanalysis: 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.

September 24:

1. HURDAT and Old Maps:

- 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.

2. Station highlights:

- 11 kt N with 1004 mb at Clewiston at 00Z (micro, SWO).
- 35 kt ENE with 1009 mb at Vero Beach at 00Z (micro).
- 9 kt WSW with 1006 mb at Vero Beach at 2157Z (SWO – min P).

3. 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).

4. Discussion/Reanalysis: Clewiston's observations at 00Z allow for an analysis of 1002 mb central pressure at that time. 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.

September 25:

1. HURDAT and Old Maps:

- 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.

2. Discussion:

- 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."
- Reanalysis: 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. A few gales were reported by ships east of northeastern Florida, Georgia and the Carolinas, but these were primarily due to the synoptic-scale pressure gradient present and not directly from Florence.

September 26:

1. HURDAT and Old Maps:

- 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.

2. Discussion:

- 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."

- Reanalysis: The tropical depression continued northwestward on the 25th and 26th, making landfall as a 20 kt tropical depression in the western Panhandle of Florida.

September 27:

1. HURDAT and Old Maps:

- 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).

2. Discussion/Reanalysis: Dissipation is analyzed before 00Z on September 27th, twelve hours earlier than originally shown in HURDAT.

Sources: 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.

New Tropical Storm (September 1-3, 1960) – AL081960

41555 09/01/1960 M= 5 6 SNBR= 904 UNNAMED XING=0 SSS=0

41557 09/01*230 490 30 0*240 503 35 0*255 515 40 0*270 525 40 0*

41557 09/02*285 528 35 0*298 528 35 0*311 528 30 0*323 528 30 0*

41557 09/03*335 525 25 0* 0 0 0 0* 0 0 0 0* 0 0 0 0*

41585 TS

Substantial Revisions

- New tropical storm not previously included in HURDAT

Daily Summary

August 26:

1. Old Maps:

- HWM depicts an open low near 14N 24W.

August 27:

1. Old Maps:

- HWM depicts a closed low of at most 1010 mb near 12N 24W.

August 28:

1. Old Maps:

- HWM depicts a closed low of at most 1010 mb near 13N 30W.

August 29:

1. Old Maps:

- HWM depicts a closed low of at most 1010 mb near 14N 40W.

August 30:

1. Old Maps:

- HWM depicts an open low near 17N 47W.

2. Discussion/Reanalysis: Despite the HWM indicating a closed low moving west-northwestward across the eastern tropical North Atlantic from the 26th through the 30th, there is little evidence to substantiate such an analysis.

August 31:

1. Old Maps:

- HWM depicts an open low near 20N 49W.
- Microflim depicts a closed low of at most 1013 mb near 18N 48W.

2. Ship highlights:

- 30 kt E with 1016 mb at 25.5N 47.6W at 12Z (micro/COADS).
- 30 kt E with 1014 mb at 24.5N 49.5W at 18Z (micro).

3. Discussion/Reanalysis: Winds increased in magnitude and more curvature is noted in the wind circulation along a sharp trough near 48W between 18N and 26N. A routine aircraft mission late on the day did not uncover a closed circulation, but they may not have flown far enough north and/or east. The system may have been a tropical cyclone on this date, but the observations are inconclusive.

September 1:

1. Old Maps:

- HWM depicts a closed low of at most 1010 mb near 20N 56W.
- Microfilm depicts a closed low of at most 1011 mb near 26N 51W.

2. Ship highlights:

- 25 kt NE with 1010 mb at 00Z at 23.7N 49.6W (micro).
- 30 kt SSE with 1009 mb at 09Z at 23.2N 50.1W (micro).
- 40 kt SE with 1016 mb at 09Z at 28.2N 50.3W (micro).
- 35 kt E with 1016 mb at 12Z at 28.3N 50.7W (micro).
- 35 kt SE with 1014 mb at 15Z at 28.2N 48.9W (COADS/micro).

3. Aircraft highlights:

- 35 kt SE at 17Z at 26.5N 50.5W (micro).

4. Discussion/Reanalysis: At 00Z a 25 kt NE ship with 1010 mb pressure amidst high environmental pressure suggests that a closed low formed at that time. Genesis is indicated at 00Z. A 09Z 30 kt ship with 1009 mb suggests a central pressure of at most 1006 mb, supporting at least 35 kt maximum sustained winds from the south of 25N Brown pressure-wind relationship and at least 32 kt from north of 25N pressure-wind relationship. A separate ship at 09Z reported 40 kt SE wind. It is analyzed that the system became a tropical storm around 06Z and

reached 40 kt intensity from 12 to 18Z. 40 kt is the peak intensity for this weak, short-lived system. An aircraft reconnaissance mission measured at least 35 kt surface winds around 18Z, though the complete set of observations from this mission is unavailable.

September 2:

1. Old Maps:

• HWM depicts a closed low of at most 1010 mb at 21N 55W with a trough extending northward from the low.

• Microfilm depicts a closed low of at most 1011 mb at 30N 51W.

2. Discussion/Reanalysis: Highest observed winds on the 2nd were only 25 kt. It is analyzed that the system began weakening around 00Z and downgraded to a 30 kt depression by 12Z.

September 3:

1. Old Maps:

• HWM depicts a cold front extending from 40N 55W to 31N 80W.

• Microflim depicts an extratropical low near 40N 55W with a front extending west-southwestward.

2. Discussion/Reanalysis: A closed low was still present for the system at 00Z, but it appears that by 06Z the circulation for the system was absorbed by an approaching frontal boundary. The last position is indicated at 00Z.

Sources: the Historical Weather Map series, Monthly Weather Review, U.S. Weather Bureau six hourly maps available via microfilm at NHC, the COADS ship database, and Mariners Weather Log. This system was in Jack Beven's List of Suspects.

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. At 00Z on May 6th, a 55 kt/1000 mb ship report indicates that the system developed an inner core with strong winds but remained baroclinic with a 15F temperature gradient across the system north-south at that time. 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	Extratropical
May 6	29N	67W	Extratropical

May 7	28N	68W	Occluded
May 8	28N	68W	Occluded
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	36N	73W	Extratropical
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) 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

7) 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. The two ship reports of tropical-storm-force winds not far from the center at 1800 UTC 25 September suggest the possibility that the system had a tropical-cyclone-like

inner core. However, there are several other times where ships were near the center (notably 1200 UTC 25 September) and showed that no such feature existed. 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

8) 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

9) 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

10) 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