1961 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

Hurricane Anna [July 20-25, 1961]

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41780 07/20/1961 M= 5  1 SNBR= 908 ANNA        XING=0 SSS=0
41780 07/17/1961 M= 9  1 SNBR= 908 ANNA        XING=0 SSS=0
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(The 17th to the 19th are new to HURDAT.)
41785 07/17*  0   0   0    0*  0   0   0    0*  0   0   0    0*105 460  30    0*
41785 07/18*106 476  30    0*107 493  30    0*108 510  35    0*110 525  35    0*
41785 07/19*112 540  40    0*114 555  40    0*115 570  45    0*116 585  45    0*

41785 07/20*115 602  35    0*117 620  45 1002*119 638  60  999*124 657  70    0*
41785 07/20*117 602  50    0*118 620  55    0*119 638  60    0*124 656  65  999*
            ***      **      ***      **    *                *     ***  **  ***

41790 07/21*130 672  80 1002*132 695  90  992*134 715  95    0*137 733 100    0*
41790 07/21*129 675  65 1002*132 695  75  992*134 713  80  980*136 731  80  981*
            *** ***  **                **          ***  **  *** *** ***  **  ***

41795 07/22*137 747 100  984*140 766 100  982*145 782 100  976*152 797 100    0*
41795 07/22*137 748  80  984*140 765  80  983*145 782  90  976*151 799  85    0*
                ***  **          ***  **  ***         **      *** ***  **

41800 07/23*152 814 100  990*153 829  95    0*158 843  90  992*160 857  90    0*
41800 07/23*152 814  70  990*153 829  70    0*158 843  70  992*161 857  80  981*
                     **                **                **      ***      **  ***

41805 07/24*161 864  85  989*163 875  80    0*166 883  70    0*169 891  60    0*
41805 07/24*161 867  75  989*162 877  75    0*165 887  65    0*168 897  45    0*
                ***  **      *** ***  **      *** ***  **      *** ***  **

(July 25th is new to HURDAT)
41807 07/25*170 907  30    0*  0   0   0    0*  0   0   0    0*  0   0   0    0*
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41810 HR
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Hurricane Landfall

07/23 12Z 15.8N 84.3W 70 kt Honduras
07/24 01Z 16.1N 86.9W 75 kt Utila Island, Honduras
07/24 10Z 16.4N 88.5W 75 kt Belize

Significant Revisions:

1. Genesis is indicated to have occurred 54 hours earlier, based upon satellite and ship observations;
2. Intensity significantly boosted on the 20th based upon ship and aircraft observations later in the day;

3. Intensity significantly reduced on the 21st to the 23rd based upon aircraft reconnaissance;
4. Peak intensity reduced from Category 3 (100 kt on the 21st to the 23rd) to Category 2 (90 kt on the 22nd);
5. A few central pressures were added based upon aircraft reconnaissance observations;
6. Intensity significantly reduced on the 24th to show a more realistic weakening after landfall.

Daily Summary:

July 17:

1. Maps and old HURDAT:
   - HWM and microfilm do not show an organized system at 12Z.
   - HURDAT does not list an organized system on this date.
2. Satellite highlights:
   - Deep convection with some curved bands are evidence at 1440Z from TIROS-III (MWR).
3. Discussion:
   - ATSR: "An area of suspicion was noted well to the east of this position on July 17 when Navy reconnaissance aircraft reported a mass of strong radar echoes associated with an easterly wave between 14-16N and 50-54W."
   - Reanalysis: A tropical wave left the African coast around mid-July. The disturbance moved westward and on July 17th at 1440Z, a TIROS III satellite image (MWR 1962, pg. 109) indicated that the tropical wave was organizing with some banding features in the northern and southern quadrants. This satellite image appears to be a milestone in hurricane history as for the first time a satellite image is referenced in the Monthly Weather Review. The report of a west wind at 9.7N, 46.3W at 18Z on the 17th suggests that the low-level circulation was closed. Based upon this and the satellite imagery, genesis is begun at 18Z as a tropical depression. This also marks the first time that satellite imagery has been used for informing the position and intensity of a tropical cyclone in the best track.

July 18:

1. Maps and old HURDAT:
   - HWM and microfilm do not show an organized system at 12Z.
   - HURDAT does not list an organized system on this date.
2. Discussion/Reanalysis: A paper by Fritz (1962) indicates that the tropical wave continued to become better organized on July 18th as shown by a TIROS III satellite image at 1557Z (MWR 1962, pg. 511). Based upon satellite imagery as well as observations on the 20th, intensification to a tropical storm is analyzed to have occurred around 12Z.

July 19:

1. Maps and old 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: "ANNA, the first tropical storm of the 1961 hurricane season, developed just east of Windward Islands on the evening of July 19. During the 18th and 19th the Intertroical Convergence Zone shifted well north of its normal position and it appears that cyclogenesis began at its intersection with the easterly wave first noted by the Navy aircraft on the 17th. At 191200Z the vessel BENNEKON reported easterly winds of 20 knots and 7-foot seas near 15N 55W. About this time the Windward Islands began to show abnormal falls in pressure."
- Reanalysis: No observations nor satellite imagery were available, so gradual intensification is assumed based upon subsequent observations on the 20th.

July 20:

1. Maps and old HURDAT:
   - HWM analyzes a tropical storm of at most 1010 mb at 11.7N, 63.9W at 12Z.
   - HURDAT lists a 60 knot tropical storm at 11.9N, 63.8W at 12Z.
   - Microfilm shows a closed low pressure of at most 1011 mb at 12.0N, 63.8W at 12Z.
   - Navy reconnaissance book lists the best track position at 11.9N, 63.8W at 12Z.
2. Ship highlights:
   - 40 kt SE and 1010 mb at 13.1N, 62.8W at 12Z (COADS).
   - 50 kt SE and 1003 mb at 12.5N, 64.5W at 1550Z (micro).
   - 40 kt ESE at 12.6N, 64.0W at 18Z (micro).
3. Land highlights:
   - 1002 mb (min pressure) at Grenada at 05Z (WALLET/MWR/ATSR).
4. Aircraft highlights:
   - Penetration center fix estimated maximum surface winds of 55 kt at 11.8N, 63.8W at 1130Z (ATSR).
   - Penetration center fix measured a central pressure of 999 mb and estimated maximum surface winds of 85 kt at 12.2N, 65.5W at 1834Z (ATSR). (Note that the aircraft adjusted 850 mb heights yield a surface pressure of 992 mb, which appears to be erroneous given the other available measurements.)
5. Discussion:

- MWR: "Anna, the first tropical cyclone of the 1961 Atlantic hurricane season, developed a short distance east of the Windward Islands on the evening of July 19. An area of suspicion was first noted well to the east on July 17 as Navy reconnaissance reported an extensive area of strong radar echoes between 14-16N and 50-55W. Shipping in the area also reported numerous showers with winds generally light and variable. TIROS showed the principal concentration of weather near 12N, 43W. During the 18th and 19th the ITCs shifted well north of its normal position and cyclogenesis probably occurred at, its intersection with the easterly wave first noted by Navy aircraft on the 17th. Following reports from the island of Grenada, indicating heavy squalls with gusts to 50 mph and pressure of 1002 mb around

midnight local time on the 19th, reconnaissance aircraft located Anna in the extreme southeastern Caribbean some 75 miles north of the Venezuelan coast on the morning of July 20. By afternoon winds had increased to slightly over hurricane force. From its inception, Anna maintained a course slightly north of due west on its entire track through the Caribbean Sea with forward speed between 15 and 23 mph."

- ATSR: "At 200000Z the wind at Barbados had increased to 25 knots from 110 degrees, while St. Lucia reported 25 knots at 050 degrees. Coupled with considerable shower activity in the area, indications were that the easterly wave had passed Barbados and intensified. Intensification was confirmed when Granada at 200500Z reported heavy squalls with gusts to 45 knots and a 1002 mb pressure. At 201025Z a Navy reconnaissance aircraft reported a weak, diffuse eye near 12.7N 64.0W. The first official warning was issued at 201330Z. By afternoon, winds had increased to slightly over hurricane force. ANNA continued to intensify while moving through the Caribbean on a heading just north of west. Anna caused minor damage at Trinidad and Grenada but there were no casualties."
- Reanalysis: Data over the central Atlantic was sparse and the time of genesis is uncertain but likely occurred earlier than July 20th at 00Z as originally shown in HURDAT. The first position, not genesis, is analyzed at 00Z on July 20th as a 50 kt tropical storm. This intensity is based on a minimum pressure of 1002 mb measured at 05Z on the 20th on the island of Grenada as the center of Anna passed to the south. The barograph in the storm wallets indicates that the pressure dropped about 12 mb in 24 hours. A peripheral pressure of 1002 mb suggests maximum surface winds greater than 43 kt from the south of 25N Brown et al. pressure-wind relationship. Due to a forward speed of about 18 kt, an intensity of 50 kt is selected at 00Z and 55 kt at 06Z on the 20th, up from 35 kt and 45 kt, respectively, originally in HURDAT, minor intensity changes. A central pressure of 1002 mb originally in HURDAT at 06Z on the 20th has been removed since it was a not a central pressure. After entering the Caribbean Sea, Anna continued slightly north of due west at a fast forward speed. The first reconnaissance aircraft to reach the tropical storm measured a central pressure of 999 mb and estimated maximum surface winds of 85 kt at 1834Z on the 20th. A central pressure of 999 mb suggests maximum surface winds of 49 kt from the south of 25N pressure-wind relationship. Due to the forward speed of about 20 kt and slightly weighting the surface estimate, an intensity of 65 kt is selected at 18Z on the 20th, down from 70 kt originally in HURDAT, a minor intensity change. A central pressure of 999 mb was present in HURDAT at 12Z on the 20th and has been moved to 18Z. Intensification to a hurricane is analyzed at 18Z on the 20th, same as originally shown in HURDAT.

July 21:

1. Maps and old HURDAT:
   - HWM analyzes a tropical storm of at most 1000 mb at 13.1N, 71.2W at 12Z.
   - HURDAT lists a 95 knot hurricane at 13.4N, 71.5W at 12Z.
   - Microfilm shows a closed low pressure of at most 1005 mb at 13.5N, 71.5W at 12Z.

- Navy reconnaissance book lists the best track position at 13.4N, 71.5W at 12Z.

2. Ship highlights:
   - 50 kt NNE and 1000 mb at 13.4N, 68.2W (likely wrong location) at 06Z (micro).
   - 35 kt E at 15.3N, 68.4W at 10Z (micro).
   - 50 kt ENE and 1009 mb at 14.5N, 72.3W at 18Z (COADS).
   - 40 kt E and 1011 mb at 13.9N, 70.9W at 21Z (micro).
3. Land highlights:
   - 40 kt (max wind) at Aruba (time unknown)(WALLET).
4. Satellite highlights:
   - Well defined central dense overcast with possible eye in 1548Z TIROS-III image (MWR).
5. Aircraft highlights:
   - Penetration center fix measured a central pressure of 1002 mb and estimated an eye diameter of 13 nm at 13.1N, 67.7W at 01Z (ATSR).
   - Penetration center fix measured a central pressure of 992 mb, estimated maximum flight level winds of 90 kt and an eye diameter of 8 nm at 13.3N, 69.8W at 07Z (ATSR). (ATSR mentioned both 987 mb and 992 mb "by drop". The coded drop shows 992 mb surface pressure, which is consistent with the 700 mb temp/height. 987 mb may be an incorrect preliminary value.)
   - Penetration center fix with flight-level winds of 77 kt and a surface pressure of 980 mb based on D-values at 1407Z (NHRP).
   - Penetration center fix measured a central pressure of 983 mb, estimated maximum surface winds of 98 kt, 90 kt flight-level winds, and an RMW of 12 nm at 13.0N, 71.0W around 1730Z (NHRP) (Note that based upon D-values a central pressure of 976 mb could be estimated instead.)
   - Radar center fix at 13.4N, 71.7W at 1355Z (ATSR).
   - Penetration center fix measured a central pressure of 981 mb, estimated maximum surface winds of 110 kt and an eye diameter of 18 nm at 13.8N, 73.8W at 1910Z (ATSR).
6. Discussion/Reanalysis: Another penetration center fix occurred at 01Z on July 21st measuring a central pressure of 1002 mb and estimating an eye diameter of 13 nm. A central pressure of 1002 mb suggests maximum surface winds of 43 kt from the south of 25N pressure-wind relationship. An eye diameter of 13 nm suggests an RMW of about 10 nm and the climatological value is 12 nm. Due to the fast forward speed of about 21 kt, RMW slightly below the climatological value and data later in the day, an intensity of 65 kt is analyzed for 00Z on the 21st, down from 80 kt originally in HURDAT, a minor change. At 07Z on the 21st, the reconnaissance aircraft measured a central pressure of 992 mb, estimated flight level winds of 90 kt and an eye diameter of 8 nm. A central pressure of 992 mb suggests maximum surface winds of 61 kt from the south of 25N pressure-wind relationship. An eye diameter of 8 nm suggests an RMW of about 6 nm and the climatological value is 12 nm. Due to the fast forward speed of about 20 kt and RMW below the climatological value, an intensity of 75 kt is analyzed for 06Z on the 21st, down from 90 kt originally in HURDAT,

a minor change. Early on the 21st, Anna passed north of the ABC Islands where the strongest winds reported reached 40 kt. At 1548Z on the 21st, a TIROS III satellite image (MWR 1962, pg. 109) depicts a small, well-organized tropical cyclone with an organized CDO near or over the center, located just northwest of the Guajira Peninsula in Colombia. No eye is apparent in the satellite image. This was also a milestone as the first hurricane to appear in a satellite image. Another penetration fix occurred at 1910Z on the 21st measuring a central pressure of 981 mb, estimating surface winds of 110 kt and an eye diameter of 18 nm. A central pressure of 981 mb suggests maximum surface winds of 76 kt from the south of 25N pressure-wind relationship. An eye diameter of 18 nm suggests an RMW of about 14 nm and the climatological value is 13 nm. Due to a forward speed of 18 kt, RMW close to the climatological value and slightly weighting the surface estimate, an intensity of 80 kt is analyzed for 18Z on the 21st, down from 100 kt originally in HURDAT, a major intensity change. A central pressure of 981 mb has been added to HURDAT at 18Z on the 21st.

July 22:

1. Maps and old HURDAT:
   - HWM analyzes a tropical storm of at most 1000 mb at 14.3N, 78.1W at 12Z.
   - HURDAT lists a 100 knot hurricane at 14.5N, 78.2W at 12Z.
   - Microfilm shows a sharp trough or tropical wave over the southern Caribbean Sea along longitude 78W at 12Z.
   - Navy reconnaissance book lists the best track position at 14.5N, 78.2W at 12Z.
2. Ship highlights:
   - 35 kt E and 1012 mb at 16.3N, 76.0W at 06Z (micro).
   - 40 kt ENE and 1016 mb at 19.3N, 80.0W at 18Z (COADS).
   - 40 kt NE and 1007 mb at 15.6N, 81.6W at 21Z (micro).
3. Aircraft highlights:
   - Penetration center fix measured a central pressure of 984 mb and estimated an eye diameter of 25 nm at 13.6N, 74.9W at 01Z (ATSR).
   - Penetration center fix estimated maximum surface winds of 88 kt, an eye diameter of 21 nm, and a central pressure of 983 mb (from a 700 mb height of 2930 m and a temperature of 13C in the eye) at 14.1N, 76.6W at 07Z (ATSR).
   - Penetration center fix measured a central pressure of 976 mb and estimated an eye diameter of 18 nm at 14.5N, 77.8W at 1030Z (ATSR).
   - Penetration center fix at 15.1N, 80.0W at 1823Z (ATSR).
4. Satellite highlights:
   - TIROS III image at 15Z shows circular, well-defined central dense overcast (Figure 1 – Fett 1964).
5. Discussion:
   - MWR: "lowest pressure 976 mb (28.62 inches) on the 22nd."
   - ATSR: "After maximum winds increased to 110 knots early on the 22nd."
   - Reanalysis: On July 22nd, Anna moved away from South America and entered the western Caribbean on its way to Central America. At 07Z, an aircraft

reconnaissance estimated surface winds of 88 kt, an eye diameter of 21 nm, and a central pressure of 983 mb. This pressure suggests maximum surface winds of 74 kt from the south of 25N pressure-wind relationship. An eye diameter of 21 nm suggests an RMW of about 16 nm and the climatological value is 14 nm. Due to a forward speed of 18 kt and RMW close to the climatological value, an intensity of 80 kt is analyzed for 06Z on the 22nd, down from 100 kt originally in HURDAT, a major intensity change. Another penetration fix measured a central pressure of 976 mb and an eye diameter of 18 nm at 1030Z on the 22nd. A central pressure of 976 mb suggests maximum surface winds of 83 kt from the south of 25N pressure-wind relationship. An eye diameter of 18 nm suggests an RMW of about 14 nm and the climatological value is 14 nm. Due to a forward speed of 18 kt and RMW same as the climatological value, an intensity of 90 kt is analyzed for 12Z on the 22nd, down from 100 kt originally in HURDAT, a minor intensity change. 90 kt is also the peak intensity of hurricane Anna, down from 100 kt originally in HURDAT from 18Z on the 21st to 00Z on the 23rd. Hence, Anna is analyzed to have remained below major hurricane intensity during its lifetime.

July 23:

1. Maps and old HURDAT:
   - HWM analyzes a tropical storm of at most 995 mb at 15.8N, 84.1W at 12Z.
   - HURDAT lists a 90 knot hurricane at 15.8N, 84.3W at 12Z.
   - Microfilm shows a large closed low pressure of at most 1008 mb at 14.5N, 84.5W at 12Z.
   - Navy reconnaissance book lists the best track position at 15.8N, 84.3W at 12Z.
2. Aircraft highlights:
   - Penetration center fix measured a central pressure of 990 mb, estimated maximum surface winds of 55 kt (limited by darkness) and an eye diameter of 25 nm at 15.2N, 81.7W at 01Z (ATSR).
   - Radar center fix at 15.3N, 82.7W at 06Z (ATSR).
   - Penetration center fix measured a central pressure of 992 mb, estimated maximum surface winds of 90 kt and an eye diameter of 18 nm at 15.7N, 84.4W at 1230Z (ATSR).
   - Penetration center fix measured a central pressure of 981 mb, estimated maximum flight level winds of 50 kt and an eye diameter of 12 nm at 16.1N, 85.2W at 16Z (ATSR). (Note that extrapolating the pressure from 700 mb heights and temps in the drop gives 988 mb, while from 850 mb gives 982 mb. Given that the surface and 850 mb values are consistent, the 981 mb is used.)
   - Penetration center fix estimated maximum surface winds of 85 kt and an eye diameter of 14 nm at 16.1N, 86.3W at 2122Z (ATSR).
   - Penetration center fix measured a central pressure of 989 mb at 16.1N, 86.6W at 2352Z (ATSR).
3. Discussion:
   - MWR: "On the 23rd the center skirted the extreme northeastern coast of Honduras."

- ATSR: "…she grazed the northern coast of Honduras.…Considerable damage was reported along the extreme northern Honduras coast with several hundred buildings damaged or destroyed and many plantations suffering heavy damage to fruit trees. One death and a dozen casualties were reported from Trujillo, Honduras, and the Bay Islands, just north of Honduras. More than 5,000 coconut trees were blown down on Utila, a small island off the Honduras coast directly in the path of Anna."
- Reanalysis: On July 23rd at 01Z, a reconnaissance aircraft measured a central pressure of 990 mb, estimated surface winds of 55 kt (wind estimate limited by darkness) and an eye diameter of 25 nm. A central pressure of 990 mb suggests maximum surface winds of 64 kt from the south of 25N pressure-wind relationship. An eye diameter of 25 nm suggests an RMW of about 19 nm and the climatological value is 14 nm. Due to a forward speed of 15 kt and RMW larger than the climatological value, an intensity of 70 kt is analyzed for 00Z on the 23rd, down from 100 kt originally in HURDAT, a major intensity change. Anna continued west-northwest and made landfall around 12Z in northeastern Honduras as a 70 kt hurricane. At 1230Z, a penetration fix measured a central pressure of 992 mb, estimated surface winds of 90 kt and an eye diameter of 18 nm. A central pressure of 992 mb suggests maximum surface winds of 61 kt from the south of 25N pressure-wind relationship. An eye diameter of 18 nm suggests an RMW of about 14 nm and the climatological value is 14 nm. Due to a forward speed of 15 kt, RMW close to the climatological value and some weighting of the visual estimate, an intensity of 70 kt is analyzed for 12Z on the 23nd, down from 90 kt originally in HURDAT, a major intensity change. The center of Anna skirted the coast of Honduras for about four hours. Interaction with land apparently did not weaken Anna as a reconnaissance aircraft at 16Z measured a central pressure of 981 mb and an eye diameter of 12 nm. A central pressure of 981 mb suggests maximum surface winds of 76 kt from the south of 25N pressure-wind relationship. An eye diameter of 12 nm suggests an RMW of about 9 nm and the climatological value is 14 nm. Due to a forward speed of 14 kt and RMW smaller than the climatological value, an intensity of 80 kt is analyzed for 18Z on the 23nd, down from 90 kt originally in HURDAT, a minor intensity change. A central pressure of 981 mb has been added to HURDAT at 18Z on the 23rd. Note that proximity to land, given that the system was straddling the coast, could be contribute toward some discrepancies in the positions and central pressures from dropsonde/flight level.

July 24:

1. Maps and old HURDAT:
   - HWM analyzes a tropical storm of at most 1000 mb at 16.0N, 88.6W at 12Z.
   - HURDAT lists a 70 knot hurricane at 16.6N, 88.3W at 12Z.
   - Microfilm shows a closed low pressure of at most 1002 mb at 16.8N, 88.3W at 12Z.
   - Navy reconnaissance book lists the best track position at 16.6N, 88.3W at 12Z.
2. Ship highlights:

- 45 kt NW and 1004 mb at 16.1N, 86.4W at 00Z (micro).

3. Land highlights:
   - 35 kt ESE and 1008 mb at Guanaja Island, Honduras at 03Z (micro).
   - 10 kt S and 1005 mb at Tela, Honduras at 06Z (WALLET/micro).
   - 40 kt NE and 1009 mb at Belize City, British Honduras at 12Z (micro).
4. Discussion:
   - MWR: "then passed westward into the mountains of southern British Honduras the next morning."
   - ATSR: "…before passing inland on the 24th over British Honduras and dissipating. A total of 61 fixes on Anna was made by VW-4 in a maximum reconnaissance effort.…Unofficial reports from British Honduras indicated that damage was rather extensive at Punta Gorda [16.1N, 88.6W] in extreme southeastern British Honduras. The center of Anna moved inland over the British Honduras coast, a sparsely populated area, at approximately the same point that Abby entered in July 1960. The often observed succession of storms from the Caribbean into the Pacific did not occur on this occasion."
   - Reanalysis: The last penetration fix occurred at 2352Z on the 23rd measuring a central pressure of 989 mb. At 2122Z, another pass estimated surface winds of 85 kt and an eye diameter of 14 nm. A central pressure of 989 mb suggests maximum surface winds of 65 kt from the south of 25N pressure-wind relationship. An eye diameter of 14 nm suggests an RMW of about 11 nm and the climatological value is 14 nm. Due to a forward speed of 10 kt and RMW smaller than the climatological value, an intensity of 75 kt is analyzed for 00Z on the 24th, down from 85 kt originally in HURDAT, a minor intensity change. The hurricane continued west-northwest affecting the Bay Islands along its path. Landfall in the island of Utila, Honduras is analyzed at 01Z on the 24th as a 75 kt hurricane. The island was reported to have sustained heavy damages. Anna maintained a west-northwest course early on the 24th and impacted Belize near 16.4N, 88.5W or about 70 nm south of Belize City, at 10Z as a 75 kt hurricane. The landfall intensity in Belize is uncertain as there were no observations near the center of Anna during the last 10 hours before landfall or after landfall. The observations in Belize available in the Storm Wallets contradict the data available as the pressure values and time observed do not match the synoptic data in microfilm and HWM, nor are mentioned in the MWR. Thus, these observations have been disregarded. Anna is analyzed to have weakened to a tropical storm over Guatemala at 18Z, same as originally shown in HURDAT.

July 25:

1. Maps and old HURDAT:
   - HMW analyzes a spot low pressure at 16.5N, 94.0W at 12Z.
   - HURDAT does not list an organized storm on this day.
   - Microfilm shows a closed low pressure of at most 1008 mb at 16.5N, 93.5W at 12Z.
2. Discussion/Reanalysis: The weakening tropical cyclone kept moving west-northwest and dissipated over eastern Mexico early on July 25th. The last

position is analyzed at 00Z on the 25th, six hours later than originally shown in HURDAT. The last position in the original HURDAT had Anna as a 60 kt tropical storm and the last official advisory had Anna as a hurricane over Belize. Anna was a typical fast-moving hurricane in the Caribbean Sea during the month of July. The central pressures reported over the eastern Caribbean when the tropical cyclone was moving at its fastest were higher than typical from that expected of the Brown et al. pressure-wind relationship but this is not abnormal for the area. In 2002, Lili had a central pressure of 1004 mb and sustained winds of 60 kt over the eastern Caribbean Sea and Debby in 2000, reached hurricane intensity with only 1005 mb just north of the Leeward Islands. Both of these cyclones were also fast-moving storms.

Sources: the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Monthly Weather Review, Navy reconnaissance book, National Hurricane Research Project, Mexican synoptic maps, Mariners Weather Log, Fritz (1962), Fett (1964, MWR), and NHC Storm Wallets.

Hurricane Betsy [September 2–15, 1961]

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41815 09/02/1961 M=11  2 SNBR= 909 BETSY       XING=0 SSS=0
41815 09/02/1961 M=15  2 SNBR= 909 BETSY       XING=0 SSS=0
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41820 09/02*  0   0   0    0*133 417  40    0*138 428  40    0*143 436  40    0*
41820 09/02*  0   0   0    0*133 416  55    0*138 426  60    0*143 436  70    0*
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41825 09/03*148 445  45    0*152 456  50    0*159 467  65    0*170 481  80  973*
41825 09/03*148 446  80    0*153 456  85    0*159 467  90  973*170 479  85    0*
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41830 09/04*182 491  85  989*195 498  90    0*205 502  95  986*220 502 100  982*
41830 09/04*182 490  80  981*194 498  80    0*207 501  75  986*220 502  75  982*
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41835 09/05*232 506 105    0*245 514 110    0*256 523 115  957*269 529 120  952*
41835 09/05*232 506  85    0*244 514  95    0*256 521 105  957*270 529 110    0*
                     **      ***      **         *** ***      ***     ***    *

41840 09/06*285 541 120    0*299 551 120  950*309 561 120  945*324 568 115  954*
41840 09/06*285 540 115  952*299 550 115    0*311 561 115  945*323 569 105  954*
                ***  ***  ***     *** ***    * ***     ***      *** *** ***

41845 09/07*331 572 105    0*337 578 100    0*342 583  95  954*346 587  90    0*
41845 09/07*331 573 105    0*337 578 100    0*342 583  95  954*346 587  90    0*
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41850 09/08*350 590  90    0*353 597  90    0*356 600  90    0*359 599  90    0*
41850 09/08*350 592  90    0*353 596  85    0*355 599  85    0*359 598  75  974*
                ***               ***  **      *** ***  **          ***  **  ***

41855 09/09*361 596  90    0*362 593  90    0*366 586  90  978*376 579  90  976*
41855 09/09*360 596  75    0*363 592  75    0*366 587  75  978*372 575  80  976*
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41860 09/10*388 561  90    0*388 544  90    0*392 523  90  980*398 497  85  962*
41860 09/10*380 561  80    0*386 544  85    0*392 523  85    0*398 497  85  962*
                     **                **                ** *
41865 09/11*409 458  85    0*428 412  80    0*447 385  80  970*477 330  75    0*
41865 09/11E409 458  85    0E428 420  85    0E447 385  85    0E477 330  80    0*
           *                 **** ***  **     *          **    **         **
41870 09/12E508 265  70    0E548 205  60    0*  0   0   0    0*  0   0   0    0*
41870 09/12E508 265  75    0E540 226  70  956E565 210  70  952E580 200  70  949*
                     **          ***  **  ******* ***  **  ******* ***  **  ***
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(September 13rd through the 16th are new to HURDAT)

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41871 09/13E585 190  70  946E590 190  70  947E595 210  65  948E602 230  65  952*
41872 09/14E610 240  60  954E610 245  60  955E613 255  60  956E620 270  55  960*
41873 09/15E625 290  50  964E620 300  50  968E600 300  50  972E570 290  45  976*
41873 09/16E550 270  40  980E525 260  35  986E510 230  30  992*  0   0   0    0*
41875 HR
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Substantial revisions:

1. Intensity significantly increased on the 2nd and 3rd based upon ship and aircraft observations;
2. Intensity significantly reduced on the 4th and 5th based upon aircraft observations;
3. A few central pressures were removed, as these values were not based on observations;
4. Transition to extratropical 24 hours earlier;
5. Large west-southwestward adjustment in the position on the 12th based upon ship and coastal observations;
6. Four days added to its lifetime as an extratropical cyclone.

Daily Summary:

August 30:

1. Maps and old HURDAT:
   - HWM analyzes a spot low pressure at 10.0N, 36.0W at 12Z.
   - HURDAT does not list an organized storm on this day.

August 31:

1. Maps and old HURDAT:
   - HWM analyzes a spot low pressure at 11.5N, 36.5W at 12Z.
   - HURDAT does not list an organized storm on this day.

September 1:

1. Maps and old HURDAT:
   - HWM analyzes a closed low pressure of at most 1010 mb at 11.0N, 39.4W at 12Z.
   - HURDAT does not list an organized storm on this day.
   - Microfilm shows a closed low pressure of at most 1011 mb along the ITCZ near 12.5N, 44.4W at 12Z.
2. Discussion/Reanalysis: A strong tropical wave left the African coast during the last days of August. Ship observations over the eastern and central Atlantic are sparse, thus the time of genesis of Betsy is uncertain but may have occurred on August 31st or September 1st.

September 2:

1. Maps and old HURDAT:

- HWM analyzes a tropical storm of at most 1010 mb at 13.3N, 43.0W at 12Z.
- HURDAT lists a 40 kt tropical storm at 13.8N, 42.8W at 12Z.
- Microfilm does not show an organized storm at 12Z.

2. Ship highlights:
   - 998 mb at 13.6N, 42.2W at 08Z (MWR).
   - 40 kt N and 1004 mb at 15.6N, 45.2W at 15Z (MWR).
   - 40 kt NNE and 1002 mb at 15.4N, 44.7W at 23Z (micro).
3. Discussion:
   - MWR: "The formation of hurricane Betsy inaugurated one of the most active tropical cyclone periods in the history of the North Atlantic Ocean. No less than three other hurricanes made their appearance before Betsy dissipated. Betsy formed in the eastern tropical Atlantic apparently from a perturbation moving along the ITCZ. An observation from the SS Granheim at 0300 EST, September 2, located at 13.6N, 42.2W, with a barometer reading of "980" which is interpreted as 998.0 mb, was the first indication of Betsy. At 1000 EST the SS Charlotte Maersk at 15.6N, 45.2W, reported winds of 40 kt, and pressure of 1004 mb, steadily falling."
   - ATSR: "The second storm of the season, Hurricane Betsy, interrupted a lull of more than a month in tropical storm activity. This storm apparently formed at the intersection of an easterly wave and the Intertropical Convergence Zone. The easterly wave had been reported earlier by Fleet Weather Central, Port Lyautey, and subsequently tracked across the eastern Atlantic on weather charts by Fleet Weather Facility, Miami. An observation from the SS GRANHEIM, position near 13.5N 42.0W at 020800Z, gave a surface pressure of 1009 mb – the first unusual activity in the area. A Tiros satellite at 021137Z indicated possible cyclonic activity near 15N 45W. Shortly thereafter, a second vessel, the SS CHAROLETTE MAERSK, reporting from a position 15.5N 46W, gave a surface pressure of 1004.5 mb, steadily falling, and ENE to N winds up to 40 knots in squalls."
   - Reanalysis: The first ship to encounter the tropical cyclone reported a pressure of 998 mb at 08Z on September 2nd. Although no winds were reported with the pressure measurement, MWR does not indicate that it was a central pressure and it is analyzed as a peripheral pressure. A peripheral pressure of 998 mb suggests maximum sustained winds greater than 51 kt from the south of 25N Brown et al. pressure-wind relationship. The first position, not genesis, is analyzed at 06Z on the 2nd, same as the original HURDAT, as a 55 kt tropical storm, up from 40 kt originally in HURDAT, a minor intensity change.

September 3:

1. Maps and old HURDAT:
   - HWM analyzes a hurricane of at most 1000 mb at 15.5N, 46.8W at 12Z.
   - HURDAT lists a 65 kt hurricane at 15.9N, 46.7W at 12Z.
   - Microfilm shows a closed low pressure of at most 999 mb at 16.1N, 46.5W at 12Z.
2. Ship highlights:
   - 45 kt NE and 1001 mb at 15.6N, 44.3W at 01Z (micro).
   - 50 kt ESE and 1001 mb at 15.6N, 44.6W at 03Z (micro).
   - 50 kt SSE and 1003 mb at 15.9N, 44.3W at 06Z (micro).
   - 45 kt NNW and 1010 mb at 14.8N, 48.7W at 12Z (micro).
   - 40 kt E and 1009 mb at 19.0N, 46.3W at 18Z (COADS).
3. Aircraft highlights:

- Penetration center fix measured a central pressure of 973 mb, estimated surface winds of 90 kt and an eye diameter of 15 nm at 16.2N, 47.1W at 14Z (ATSR).

4. Discussion:
   - MWR: "The first advisory was issued by the San Juan Weather Bureau at 2300 EST, September 2, for a tropical storm. A reconnaissance aircraft was dispatched to the storm area September 3 and found surface winds of 90 kt, and a central pressure of 973 mb. The track and changes of intensity of Betsy can be associated nicely with fluctuations in the westerlies. Ridges near the east coast of the United States and in the eastern Atlantic Ocean with a trough near 50W were the main features of the upper-level flow pattern during the period of the storm. This trough not only steered Betsy into higher latitudes, but also later picked up Debbie and even temporarily pulled Esther northward before the trough finally filled."
   - ATSR: "The first warning was issued 030400Z for Tropical Storm Betsy. The disturbance came within reconnaissance range early on the 3rd and was investigated by a Navy aircraft. Maximum winds of 90 knots and a central surface pressure of 973 mb were found. Accordingly, Betsy was termed a hurricane on the 031600Z warning."
   - Reanalysis: The first aircraft to investigate Betsy arrived at 14Z on September 3rd. A penetration fix measured a central pressure of 973 mb, estimated surface winds of 90 kt and an eye diameter of 15 nm. A central pressure of 973 mb suggests maximum sustained winds of 86 kt from the south of 25N pressure-wind relationship. An eye diameter of 15 nm suggests an RMW of about 10 nm and the climatological value is 14 nm. Due to a forward speed of 18 kt and an RMW smaller than climatology, an intensity of 90 kt is selected at 12Z on the 3rd, up from 65 kt originally in HURDAT, a major intensity change. A central pressure of 973 mb was present in HURDAT at 18Z on the 3rd and based on the penetration fix at 14Z, it has been moved to 12Z on the 3rd. Intensification to a hurricane is analyzed at 18Z on the 2nd, 18 hours earlier than originally shown in HURDAT. Various ships reported tropical storm force winds on the 3rd, up to 50 kt.

September 4:

1. Maps and old HURDAT:
   - HWM analyzes a hurricane of at most 995 mb at 20.1N, 50.1W at 12Z.
   - HURDAT lists a 95 kt hurricane at 20.5N, 50.2W at 12Z.
   - Microfilm shows a closed low pressure of at most 1005 mb at 20.0N, 51.0W at 12Z.
2. Ship highlights:
   - 35 kt ESE and 1012 mb at 19.0N, 45.9W at 00Z (COADS).
   - 45 kt E and 1009 mb at 20.0N, 48.0W at 06Z (micro).
   - 45 kt ENE and 1009 mb at 19.7N, 48.2W at 1230Z (micro).
   - 45 kt SSW and 1004 mb at 19.6N, 49.8W at 15Z (micro).
   - 50 kt SE and 1011 mb at 22.0N, 48.0W at 18Z (micro).
3. Aircraft highlights:
   - Penetration center fix measured a central pressure of 981 mb and estimated an eye diameter of 15 nm at 18.5N, 49.2W at 01Z (ATSR). (Note

that the fix forms state that the pressure was 989 mb via a dropsonde, and they also state that the 700 mb height was 2988m. However, the fix form states that the maximum temperature in the eye was 19C, while the dropsonde reports 11C. The former would yield an extrapolated pressure of 981 mb - consistent with the previous and later pressure reports – and is used here.)

- Radar center fix at 21.8N, 50.0W at 13Z (ATSR).
- Penetration center fix measured a central pressure of 982 mb, estimated surface winds of 85 kt and an eye diameter of 20 nm at 22.3N, 50.3W at 2016Z (ATSR).

4. Discussion:
   - MWR: "A closed Low developed and intensified in the trough on September 4, weakening the ridge to the north of the storm and accordingly Betsy filled, with a central pressure rising to near 990 mb."
   - Reanalysis: Reconnaissance aircraft observations on September 4th indicate that Betsy weakened some as the central pressure filled slightly. A penetration fix at 01Z on the 4th measured a central pressure of 981 mb and an eye diameter of 15 nm. A central pressure of 981 mb suggests maximum sustained winds of 76 kt from the south of 25N pressure-wind relationship. An eye diameter of 15 nm suggests an RMW of about 10 nm and the climatological value is 15 nm. Due to a forward speed of 15 kt and an RMW smaller than climatology, an intensity of 80 kt is selected at 00Z on the 4th, down from 85 kt originally in HURDAT, a minor intensity change. A central pressure of 981 mb is added to HURDAT at 00Z on the 4th, replacing 989 mb. A central pressure of 986 mb was present in HURDAT at 12Z on the 4th and though it may have been from an Air Force mission, this could not be confirmed. As the value is somewhat consistent with earlier and later values, it is retained in HURDAT. A penetration fix occurred at 2016Z on the 4th measuring a central pressure of 982 mb, estimating surface winds of 85 kt and an eye diameter of 20 nm. A central pressure of 982 mb suggests maximum sustained winds of 75 kt from the south of 25N pressure-wind relationship. An eye diameter of 20 nm suggests an RMW of 15 nm and the climatological value is 16 nm. Due to a forward speed of 13 kt and an RMW close to climatology, an intensity of 75 kt is selected at 18Z on the 4th, down from 100 kt originally in HURDAT, a major intensity change. A central pressure of 982 mb was present in HURDAT at 18Z on the 4th and has been retained.

September 5:

1. Maps and old HURDAT:
   - HWM analyzes a hurricane of at most 995 mb at 25.1N, 52.3W at 12Z.
   - HURDAT lists a 115 kt hurricane at 25.6N, 52.3W at 12Z.
   - Microfilm shows a closed low pressure of at most 1005 mb at 25.5N, 52.3W at 12Z.
2. Ship highlights:
   - 40 kt ESE and 1004 mb at 24.8N, 52.4W at 00Z (micro).
   - 50 kt E and 1008 mb at 25.9N, 51.6W at 11Z (micro).
   - 50 kt S and 1008 mb at 25.0N, 51.6W at 12Z (COADS).
   - 45 kt SE and 1011 mb at 25.4N, 51.1W at 15Z (COADS).
   - 50 kt ESE and 1002 mb at 27.1N, 52.2W at 18Z (micro).
   - 50 kt SE and 1000 mb at 27.9N, 51.6W at 21Z (micro).
3. Aircraft highlights:
   - Penetration center fix measured a central pressure of 970 mb at 26.3N, 52.6W at 15Z (ATSR/WALLET).

- Penetration center fix measured a central pressure of 952 mb at 27.8N, 53.4W at 2138Z (ATSR/WALLET).

4. Discussion:
   - MWR: "On September 5, a short wave approached the trough and begun forcing the closed Low northeastward, resulting in height rises of the storm."
   - Reanalysis: On September 5th, Betsy continued on a northwest track over the central Atlantic and intensified. A central pressure of 957 mb was present in HURDAT at 12Z on the 5th and it appears to have been added in without actual observations. As it is a reasonable value, it is retained. Intensification to a major hurricane is analyzed at 12Z on the 5th, 18 hours later than originally shown in HURDAT. A penetration fix occurred at 2138Z on the 5th measuring a central pressure of 952 mb. A central pressure of 952 mb suggests maximum sustained winds of 108 kt from the south of 25N intensifying pressure-wind relationship. Due to a forward speed of 19 kt, an intensity of 115 kt is selected at 18Z on the 5th, down from 120 kt originally in HURDAT, a minor intensity change. A central pressure of 952 mb was present in HURDAT at 18Z on the 5th but it was measured closer to 00Z on September 6th, thus it has been moved to that time slot. A penetration fix at 15Z on the 5th in the Storm Wallets show a central pressure of 970 mb but this measurement has been discounted as it appears erroneous based on the reconnaissance aircraft report at 2138Z on the 5th. Various ships recorded gale-force winds on the 5th, including a couple of reports of 50 kt.

September 6:

1. Maps and old HURDAT:
   - HWM analyzes a hurricane of at most 995 mb at 30.6N, 56.4W with a weakening stationary front far to the northwest at 12Z.
   - HURDAT lists a 120 kt hurricane at 30.9N, 56.1W at 12Z.
   - Microfilm shows a closed low pressure of at most 1002 mb at 31.1N, 56.2W at 12Z.
2. Ship highlights:
   - 40 kt SE and 1006 mb at 28.0N, 50.3W at 00Z (COADS).
3. Aircraft highlights:
   - Penetration center fix measured a central pressure of 950 mb at 30.5N, 55.6W at 0912Z (ATSR/WALLET).
   - Penetration center fix measured a central pressure of 945 mb at 31.0N, 56.4W at 13Z (ATSR/WALLET).
   - Penetration center fix measured a central pressure of 954 mb at 32.9N, 56.9W at 19Z (ATSR/WALLET).
4. Discussion:
   - MWR: "In response, Betsy again intensified until September 6, when the central pressure reached its lowest value, 945 mb. Surface winds at this time were estimated near 120 kt. Betsy missed connection with the short wave on September 6, slowed almost to a standstill."
   - Reanalysis: On September 6th, Betsy remained on a northwestward course but began to slow its forward speed. A reconnaissance aircraft reached the hurricane at 0912Z on the 6th measuring a central pressure of 950 mb. The next penetration fix occurred at 13Z on the 6th measuring a central pressure of 945 mb. A central pressure of 945 mb suggests maximum surface winds of 115 kt from the north of 25N intensifying pressure-wind relationship. Based on a forward speed of 15 kt, an intensity of 115 kt is analyzed at 12Z on the 6th, down from 120 kt originally in HURDAT, a minor intensity change. 115 kt is also the peak intensity of Betsy, down from 120 kt originally in HURDAT from 18Z on the 5th to 12Z on the 6th. A

central pressure of 950 mb was present in HURDAT at 06Z on the 6th and has been removed as it was measured at 0912Z on the 6th, closer to the 12Z time slot than 06Z. A central pressure of 945 mb was present in HURDAT at 12Z on the 6th and has been retained. The last penetration fix on the 6th occurred at 19Z measuring a central pressure of 954 mb. A central pressure of 954 mb suggests maximum surface winds of 101 kt from the north of 25N and 97 kt from the weakening pressure-wind relationships. Based on a forward speed of 13 kt, an intensity of 105 kt is analyzed at 18Z on the 6th, down from 115 kt originally in HURDAT, a minor intensity change. A central pressure of 954 mb was present in HURDAT at 18Z on the 6th and has been retained.

September 7:

1. Maps and old HURDAT:
   - HWM analyzes a hurricane of at most 995 mb at 33.9N, 58.3W with a weakening front to the north at 12Z.
   - HURDAT lists a 95 kt hurricane at 34.2N, 58.3W at 12Z.
   - Microfilm shows a closed low pressure of at most 1005 mb at 34.5N, 58.6W with a frontal boundary to the north at 12Z.
2. Ship highlights:
   - 40 kt NNW and 1007 mb at 34.0N, 60.6W at 12Z (micro).
   - 40 kt NNW and 1007 mb at 34.0N, 60.8W at 15Z (micro).
   - 35 kt NW and 1011 mb at 33.2N, 60.4W at 18Z (micro).
   - 50 kt SSE and 1007 mb at 34.7N, 56.5W at 21Z (micro).
3. Aircraft highlights:
   - Penetration center fix estimated surface winds of at least 65 kt at 34.5N, 59.0W at 1245Z (ATSR/micro).
   - Penetration center fix at 34.4N, 58.5W at 1845Z (ATSR).
4. Discussion/Reanalysis: On September 7th, Betsy continued to slow its forward speed as a dissipating frontal boundary approached from the north. A central pressure of 954 mb was present in HURDAT at 12Z on the 7th and there was reconnaissance investigating the hurricane around that time, thus it has been retained. A central pressure of 954 mb suggests maximum surface winds of 101 kt from the north of 25N Brown et al. pressure wind-relationship and 94 kt from the north of 35N Landsea et al. pressure wind-relationship. Based on a forward speed of 6 kt, an intensity of 95 kt is analyzed at 12Z on the 7th, same as originally shown in HURDAT. Weakening below major hurricane is analyzed at 12Z on the 7th, same as originally shown in HURDAT. Various ships reported gale-force winds on the 7th, including 50 kt at 21Z.

September 8:

1. Maps and old HURDAT:
   - HWM analyzes a hurricane of at most 1000 mb at 35.1N, 60.0W with a warm front far to the northeast at 12Z.
   - HURDAT lists a 90 kt hurricane at 35.6N, 60.0W at 12Z.
   - Microfilm shows a closed low pressure of at most 1011 mb at 35.5N, 60.2W with a frontal boundary to the northeast at 12Z.
2. Ship highlights:
   - 55 kt S and 1012 mb at 34.3N, 56.0W at 00Z (COADS).
   - 45 kt S and 1012 mb at 34.0N, 56.2W at 03Z (COADS).
   - 35 kt S and 1012 mb at 33.8N, 56.5W at 06Z (COADS).
   - 35 kt S and 1013 mb at 33.4N, 58.0W at 12Z (COADS).
3. Satellite highlights:
   - Well defined central dense overcast with large convective bands in the northern and southern quadrants at 2015Z (MWR).
4. Aircraft highlights:

- Penetration center fix estimated surface winds of at least 60 kt at 35.5N, 60.1W at 12Z (ATSR/micro).
- Penetration center fix measured a central pressure of 974 mb at 35.5N, 59.7W at 1845Z (ATSR/micro).

5. Discussion:
   - ATSR: "Due to a long wave trough near 55W in the upper air flow, Betsy recurved into northerly latitudes quite early in her life cycle. She came almost to a standstill near 36N 60W on 8 September, before finally being caught in westerly flow on the same day."
   - Reanalysis: On September 8th, the westward progression of Betsy ended and the hurricane slowly turned to the northeast late in the day. A reconnaissance aircraft investigated Betsy at 19Z on the 8th measuring a central pressure of 974 mb. A central pressure of 974 mb suggests maximum surface winds of 79 kt from the north of 35N and 80 kt from the north of 25N pressure wind-relationships. Based on a forward speed of 3 kt, an intensity of 75 kt is analyzed at 18Z on the 8th, down from 90 kt originally in HURDAT, a minor intensity change. A central pressure of 974 mb is added to HURDAT at 18Z on the 8th. A TIROS III satellite image available on MWR 1962, pg. 110, shows hurricane Betsy at 2015Z on the 8th. The satellite image shows a well-organized cyclone with distinct banding to the north and south, CDO and cirrus clouds over the eastern and southern quadrants.

September 9:

1. Maps and old HURDAT:
   - HWM analyzes a hurricane of at most 1000 mb at 36.1N, 58.7W with a warm front far to the northeast at 12Z.
   - HURDAT lists a 90 kt hurricane at 36.6N, 58.6W at 12Z.
   - Microfilm shows a closed low pressure of at most 1014 mb at 36.5N, 58.5W at 12Z.
2. Ship highlights:
   - 40 kt W and 1010 mb at 33.7N, 60.5W at 00Z (COADS).
   - 35 kt W and 1011 mb at 33.9N, 61.0W at 03Z (micro).
   - 35 kt S and 1008 mb at 34.4N, 58.2W at 12Z (COADS).
   - 40 kt SW and 1011 mb at 35.5N, 55.5W at 18Z (micro).
3. Aircraft highlights:
   - Penetration center fix estimated maximum surface winds of at least 70 kt at 36.7N, 58.9W at 13Z (ATSR/micro).
   - Penetration center fix at 37.6N, 57.2W at 19Z (ATSR).
4. Discussion:
   - MWR: "...then was picked up by another minor trough on September 9."
   - Reanalysis: On September 9th, Betsy continued moving to the northeast and slowly gained in forward speed. Central pressures of 978 mb and 976 mb were present in HURDAT at 12Z and 18Z, respectively, on the 9th. Reconnaissance aircrafts investigated the hurricane around those times, thus the central pressures appear reasonable (but could not be confirmed) and have been retained. A central pressure of 978 mb suggests maximum surface winds of 75 kt from the north of 35N pressure-wind relationship. Due to a forward speed of 10 kt, an intensity of 75 kt is selected at 12Z on the 9th, down from 90 kt originally in HURDAT, a minor intensity change. Also, a central pressure of 976 mb suggests maximum surface winds of 77 kt from the north of 35N pressure-wind relationship. Due to a forward speed of 17 kt, an intensity of 80 kt is selected at 18Z on the 9th, down from 80 kt originally in HURDAT, a minor intensity change.

September 10:

1. Maps and old HURDAT:
   - HWM analyzes a hurricane of at most 995 mb at 39.0N, 52.5W with a warm front far to the northeast at 12Z.
   - HURDAT lists a 90 kt hurricane at 39.2N, 52.3W at 12Z.
   - Microfilm shows a closed low pressure of at most 1008 mb at 39.5N, 51.5W at 12Z.
2. Ship highlights:
   - 40 kt SSW and 1009 mb at 35.0N, 55.4W at 00Z (COADS).
   - 35 kt SW and 1013 mb at 35.2N, 53.5W at 06Z (COADS).
   - 45 kt SSE and 1007 mb at 37.4N, 50.0W at 10Z (COADS).
   - 50 kt S and 1006 mb at 37.4N, 51.1W at 12Z (COADS).
   - 45 kt S and 1004 mb at 37.9N, 48.1W at 18Z (COADS).
3. Aircraft highlights:
   - Penetration center fix at 39.3N, 51.5W at 1438Z (ATSR).
   - Radar center fix estimated maximum surface winds of at least 60 kt at 40.0N, 49.4W at 1850Z (ATSR/micro).
4. Discussion/Reanalysis: On September 10th, Betsy was moving quite rapidly to the northeast crossing 40°N late in the day. The environment around the system became less tropical with cool, dry air to the north and west and warm, moist air to the east and south. Reconnaissance aircrafts continued to investigate the tropical cyclone. Central pressures of 980 mb and 962 mb were present in HURDAT at 12Z and 18Z on the 10th, respectively. The central pressure of 980 mb has been removed as it appears erroneous based on the data available on the previous and subsequent days. The central pressure of 962 mb appears reasonable and has been retained. A central pressure of 962 mb suggests maximum surface winds of 88 kt from the north of 35N pressure-wind relationship. As the system was undergoing extratropical transition, so 85 kt is retained as the intensity at 18Z on the 10th, despite a fast forward speed of 34 kt.

September 11:

1. Maps and old HURDAT:
   - HWM analyzes a hurricane of at most 980 mb at 44.5N, 38.8W with a weakening warm front to the northeast and cold front to the southwest at 12Z.
   - HURDAT lists an 80 kt hurricane at 44.7N, 38.5W at 12Z.
   - Microfilm shows a closed low pressure of at most 990 mb at 46.0N, 36.0W with a frontal boundary extending to the south at 12Z.
2. Ship highlights:
   - 40 kt NE and 998 mb at 43.5N, 46.8W at 00Z (COADS).
   - 30 kt NE and 994 mb at 45.7N, 42.9W at 06Z (COADS).
   - 85 kt SW and 996 mb at 43.9N, 34.3W at 15Z (MWL).
   - 75 kt SW and 1006 mb at 43.8N, 34.4W at 18Z (COADS).
3. Aircraft highlights:
   - Penetration center fix estimated maximum surface winds of at least 55 kt at 45.5N, 36.9W at 1440Z (ATSR/micro).
   - Penetration center fix at 47.1N, 34.1W at 1720Z (ATSR).
4. Discussion:
   - MWR: “Thirty-five advisories were issued on this hurricane, the last by the Washington Weather Bureau at 1100 EST, September 11. Betsy remained over the ocean and apparently no damage was sustained by vessels along her path.”

- ATSR: "She then moved rapidly northeastward and became extratropical. The 35th and final warning was issued at 111600Z. Betsy remained entirely at sea and resulted in no known damage."
- Reanalysis: Synoptic observations on September 11th at 00Z indicate that Betsy had become an extratropical cyclone 24 hours earlier than originally shown in HURDAT. The data shows a temperature gradient across the circulation as frontogenesis had occurred. Betsy passed halfway between the Azores and Newfoundland on the 11th. A central pressure of 970 mb was present in HURDAT at 12Z on the 11th but was not based upon any observation and not consistent with subsequent observations. Thus it is removed. Ship observations indicate that Betsy was still a very powerful extratropical cyclone on the 11th. A ship reported 85 kt SW and 996 mb at 15Z and another reported 70 kt SW and 965 mb at 18Z.

September 12:

1. Maps and old HURDAT:
   - HWM analyzes a large extratropical cyclone of at most 950 mb at 56.5N, 21.2W at 12Z.
   - HURDAT lists a 60 kt extratropical cyclone at 54.8N, 20.5W at 06Z (last position).
   - Microfilm shows an extratropical cyclone of at most 969 mb at 56.7N, 25.0W at 12Z.
2. Ship highlights:
   - 70 kt NW and 963 mb at 50.5N, 27.8W at 00Z (COADS).
   - 70 kt SSW and 962 mb at 52.5N, 20.0W at 06Z (COADS).
   - 70 kt NW and 967 mb at 55.8N, 26.7W at 12Z (COADS).
   - 60 kt NNW and 978 mb at 56.7N, 28.4W at 18Z (COADS).

September 13:

1. Maps and old HURDAT:
   - HWM analyzes a large extratropical cyclone of at most 955 mb at 59.5N, 20.2W at 12Z.
   - HURDAT does not list an organized storm on this day.
   - Microfilm does not show an organized storm on this day (cyclone moving off the NE corner of the map).
2. Ship highlights:
   - 60 kt NNW and 981 mb at 56.9N, 29.9W at 00Z (COADS).
   - 60 kt NNW and 981 mb at 57.1N, 31.5W at 06Z (COADS).
   - 55 kt N and 986 mb at 57.4N, 33.5W at 12Z (COADS).
   - 60 kt E and 973 mb at 65.3N, 20.3W at 18Z (COADS).
3. Discussion/Reanalysis: On September 12th, Betsy began to slow its forward speed south of Iceland and on September 13th, turned to the west.

September 14:

1. Maps and old HURDAT:
   - HWM analyzes a large extratropical cyclone of at most 960 mb at 61.5N, 24.8W at 12Z.
2. Ship highlights:
   - 45 kt SE and 969 mb at 61.6N, 17.9W at 00Z (COADS).
   - 50 kt NE and 985 mb at 66.6N, 24.6W at 06Z (COADS).
   - 50 kt NE and 988 mb at 66.6N, 24.4W at 12Z (COADS).
   - 60 kt NNE and 988 mb at 62.4N, 40.5W at 18Z (COADS).
3. Discussion/Reanalysis: Weakening below hurricane intensity is analyzed at 00Z on September 14th, 42 hours later than originally shown in HURDAT. On the 14th, an extratropical cyclone developed along Betsy's cold front and the two extratropical systems began to rotate around each other.

September 15:

1. Maps and old HURDAT:
   - HWM analyzes two extratropical cyclones of at most 970 mb and 965 mb at 58.5N, 28.8W and 60.9N, 15.0W, respectively, at 12Z.
2. Ship highlights:
   - 60 kt SW and 967 mb at 55.2N, 15.0W at 00Z (COADS).
   - 45 kt NE and 990 mb at 66.3N, 24.0W at 06Z (COADS).
   - 50 kt NE and 992 mb at 66.3N, 24.0W at 09Z (COADS).
3. Discussion/Reanalysis: By September 15th at 06Z, it was clear that both centers had merged. As Betsy's vortex appeared to be the dominant one, the remaining cyclone is continued to be tracked.

September 16:

1. Maps and old HURDAT:
   - HWM analyzes an extratropical cyclone of at most 980 mb at 60.9N, 15.4W at 12Z.
2. Discussion/Reanalysis: By 18Z, the decaying extratropical low was absorbed by a larger cyclone (which was the extratropical low of Debbie) north of Great Britain.

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 Carla [September 3-16, 1961]

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40375 09/03/1961 M=14  3 SNBR= 885 CARLA       XING=1 SSS=4

40380 09/03*  0   0   0    0*  0   0   0    0*125 770  25    0*129 780  25    0*
40380 09/03*  0   0   0    0*  0   0   0    0*125 770  25    0*129 780  30    0*
                                                                        **

40385 09/04*133 788  25    0*137 795  25 1007*142 801  25 1006*149 807  25 1005*
40385 09/04*133 788  30    0*137 795  30 1007*142 800  30 1006*149 805  35 1004*
                     **                **          ***  **          ***  ** ****

40390 09/05*155 814  30 1002*159 821  30  999*163 827  40  997*169 831  45  993*
40390 09/05*155 812  40 1002*159 821  40  999*163 827  45  998*169 831  50  993*
                ***  **                **                **  ***          **

40395 09/06*174 836  50  990*181 843  55  987*188 851  65  984*191 856  70  981*
40395 09/06*174 836  55  990*181 843  65  987*187 851  75  982*191 856  75  981*
                     **                **      ***      **  ***          **

40400 09/07*195 859  75  978*202 860  80  975*209 860  85  973*217 863  95  970*
40400 09/07*195 858  75  978*202 859  75  982*210 859  80    0*217 863  85  975*
                ***               ***  **  *** *** ***  **  ***          **  ***

40405 09/08*223 873 100  968*228 878 105  966*231 883 110  965*234 892 110  962*
40405 09/08*222 871  90  972*228 878  95  966*232 884 100  961*234 890 100  961*
            *** *** ***  ***         ***      *** *** ***  ***     *** ***  ***

40410 09/09*237 898 110  959*240 902 110  956*246 910 110  953*249 918 110  948*
40410 09/09*237 897 105  954*241 903 105  955*246 909 105  954*251 917 110  947*
                *** ***  *** *** *** ***  ***     *** ***  *** *** ***      ***

40415 09/10*256 926 110  944*261 933 115  940*263 939 120  937*267 945 130  936*
40415 09/10*255 925 115  938*260 932 115  934*262 938 120  942*265 944 120  937*
            *** *** ***  *** *** ***      *** *** ***      *** *** *** ***  ***
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40420 09/11*270 950 140  936*272 957 150  936*276 962 145  935*280 964 125  931*
40420 09/11*269 950 120  936*272 957 125  927*276 960 125    0*281 963 125  931*
            ***     ***               ***  ***     ***  ***  *** ***  ***

40425 09/12*286 968 100  940*295 972  80  955*305 974  60  975*318 974  45  979*
40425 09/12*287 967 100  940*295 972  70  955*305 976  50  974*317 976  40  977*
            *** ***                  **          ***  **  *** ***  ***  **  ***

40430 09/13*328 972  40  980*335 970  35    0E343 968  30    0E362 940  30    0*
40430 09/13*329 974  35  980*343 970  35  985E355 953  35  988E365 935  35  991*
            *** ***  **      ***          *** *** ***  **  *** ***  ***  **  ***

40435 09/14E380 905  30    0E421 871  30    0E463 838  30    0E475 807  30    0*
40435 09/14E380 905  30  992E421 866  30  993E457 828  25  993E472 798  25  992*
                         ***     ***      *** *** ***  **  *** ***  ***  **  ***

40440 09/15E487 780  30    0E512 727  30    0E537 675  30    0E568 662  30    0*
40440 09/15E487 765  25  991E512 722  25  990E537 680  25  986E568 657  30  983*
                ***  **  ***     ***  **  ***     ***  **  ***     ***      ***

40445 09/16E600 650  30    0*  0   0   0    0*  0   0   0    0*  0   0   0    0*
40445 09/16E595 650  30  980E610 645  35  976E620 630  35  974E633 615  40  972*
            ***          ******* ***  **  ******* ***  **  ******* ***  **  ***
(The 17th and 18th are new to HURDAT.)
40445 09/17E650 600  40  974E664 603  35  976E670 595  30  980E675 580  25  984*
40445 09/18E680 540  20  988*  0   0   0    0*  0   0   0    0*  0   0   0    0*

40450 HRBTX4
40450 HRBTX4CTX3ATX1
            ********
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U.S. Landfall:
9/11 20Z 28.3N 96.4W – 20 nm RMW – 931 mb Central Pressure – 1007 mb outer closed isobar - 125 kt Intensity

Significant Revisions:

1. Transition to a tropical storm is indicated to be 18 hours earlier;
2. Intensity significantly reduced on the 11th based upon aircraft observations;
3. Peak intensity on the 11th reduced from 150 kt to 125 kt;
4. Position adjusted significantly northeastward on the 13th based upon surface observations;
5. Significant eastward adjustment to the position was added at 00Z on the 15th based on station observations;
6. Numerous central pressures were added during the extratropical phase based upon station observations;
7. The lifetime of the system is extended two days as an extratropical cyclone.

Daily Summary:

September 3:

1. Maps and old HURDAT:
   - HWM indicates a closed low near 12N, 76W.
   - HURDAT lists this as a Tropical Depression with 25kt winds at 12.5N, 77W at 12Z.
   - The MWR North Atlantic Tropical Cyclones chart showed a center at 12.5N, 77W (am) and at 14.5N, 78.9W (pm).

2. Discussion:
   - MWR: "Somewhat above normal shower activity was evident in the eastern Caribbean as early as September 1, apparently associated with a weak perturbation in the Intertropical Convergence Zone. The first indication of intensification and a closed circulation was noted on the 0700 EST September 3 surface chart and abnormal pressure and shower activity were mentioned in the tropical weather summary on that date".
   - Reanalysis: Observations in the southwestern Caribbean from microfilm and COADS indicate that a closed circulation developed around 12Z on the 3rd. No change is made to the timing of genesis.

September 4:

1. Maps and old HURDAT:
   - HWM indicates a closed low of at most 1005mb near 14N, 80W.
   - The MWR North Atlantic Tropical Cyclones chart showed a center at 14N, 80W (am) and at 15.5N, 81W (pm).
   - HURDAT indicated at 12Z a 30 kt tropical depression at 14.2N 80.1W
2. Ship highlights:
   - 20 kt SSW with 1006 mb at 13.9N 80.0W at 18Z (COA).
   - 15 kt NNW with 1004 mb at 14.8N, 81.7W at 22Z (COA).
3. Aircraft highlights:
   - Penetration fix with central pressure of 1004mb and max surface winds of 35 kt at 15.4N, 80.8W at 2125Z (storm wallets/ATSR)
4. Discussion:
   - MWR: "At 0700 EST on September 4 the circulation had increased to depression intensity (winds 32 to 38 mph) and the light north-northeast wind at San Andres Island the evening before had shifted to westerly 12 mph and the barometer, while still below normal, had risen slightly".
   - Reanalysis: Intensification to a tropical storm is now indicated to be around 18Z on the 4th, eighteen hours earlier. A 1004 mb central pressure at 18Z based upon ship observations suggests maximum winds of 39 kt from the south of 25N Brown et al. pressure-wind relationship. 35 kt indicated due to low environmental pressures. (Note that many central pressures for Carla are likely analysis pressures and not based upon specific observations. These have been removed. See table at end for details about central pressures.)

September 5:

1. Maps and old HURDAT:
   - HWM indicates a tropical storm with a pressure of at most 1000mb near 15N, 83W.
   - The MWR North Atlantic Tropical Cyclones chart showed a center at 16.2N, 82.5W (am) and at 17.5N, 84W (pm).
   - HURDAT indicated a 40 kt tropical storm at 16.3N 82.7W at 12Z.
2. Ship highlights:
   - 30 kt E with 1002 mb at 15.7N, 81.4W at 00Z (COA);

- 35 kt E with 1009 mb at 18.5N, 79.2W at 06Z (COA).

3. Station highlights:
   - 15 kt E with 1002 mb at Swan Island at 18Z (micro).
4. Aircraft highlights:
   - Penetration fix with central pressure of 1002 mb at ~00Z (MWR);
   - Penetration fix with central pressure of 998 mb and estimated max surface winds of 45 kt with a 15 nm diameter eye at 16.4N, 82.8W at 1312Z (storm wallets);
5. Discussion/Reanalysis: A central pressure of 1002 mb at ~00Z from an NHRP mission suggests an intensity of 43 kt from the south of 25N pressure-wind relationship. (A ship also reported 1002 mb with 30 kt E wind at 00Z, but the reliability of this observation is uncertain and not used for a central pressure calculation.) Again due to the low environmental pressure, an intensity of 40 kt is selected, which above the original intensity of 30 kt. The next reconnaissance fix at 1320Z observed 998 mb central pressure and estimated peak surface winds of 45 kt. This pressure suggests an intensity of 51 kt from the south of 25N pressure-wind relationship. An intensity of 45 kt analyzed at 12Z, up slightly from 40 kt.

September 6:

1. Maps and old HURDAT:
   - HWM indicates a hurricane with a pressure of at most 990mb near 18.5N, 85W.
   - The MWR North Atlantic Tropical Cyclones chart showed a center at 18.9N, 85.1W (am) and at 20N, 85.9W (pm).
   - HURDAT indicated a 65 kt hurricane at 18.8N 85.1W at 12Z.
2. Ship highlights:
   - 35 kt ENE with 999 mb at 19.3N 82.5W at 00Z (micro);
   - 45 kt E with 1006 mb at 20.8N 83.4W at 00Z (COA);
   - 40 kt ESE with 1004 mb at 20.9N 83.2W at 12Z (COA, micro);
   - 30 kt NW with 999 mb at 18.8N 86.9W at 12Z (COA, micro);
   - 35 kt SSE with 994 mb at 20.5N, 84.2W at 18Z (micro);
   - 40 kt SSW with 1009 mb at 18.0N 82.5W at 18Z (micro);
   - 45 kt NNW with 996 mb at 17.5N, 86.5W at 21Z (storm wallets).
3. Station highlights:
   - 30 kt N with 996 mb at Swan Island at 00Z (micro);
   - 25 kt SW with 998 mb at Swan Island at 06Z (micro);
   - 25 kt Sw with 999 mb at Swan Island at 12Z (micro).
4. Aircraft highlights:
   - Penetration fix with central pressure of 982 mb and peak estimated surface wind of 55 kt and 15 nm eye diameter at 19.0N 85.2W at 13Z (ATSR); (Note that vortex message transmitted discussed 988 mb extrapolated pressure, not the drop which shows 982 mb at surface and equivalent from 850 mb heights/temps.)

- Penetration center fix with 981 mb central pressure and 55 kt estimated surface winds with 10 nm eye diameter at 19.2N 85.8W at 1930Z (ATSR);
- Penetration center fix with 978 mb central pressure at 2130-2200Z (ATSR, MWR).

5. Discussion:
   - MWR: "During the next several days Carla continued a slow but remarkably steady intensification (fig. 9) reaching hurricane force on the morning of the 6th …" (MWR).
   - Reanalysis: While ships reported some tropical storm force winds and Carla passed just northeast of Swan Island, no observations of the inner core were available until the next reconnaissance at 13Z. This showed substantial deepening to 982 mb central pressure, which suggests an intensity of 75 kt. The eye diameter suggests an RMW of about 10 nm, which is smaller than climatology (16 nm) for this central pressure and latitude. As Carla was moving somewhat slow at 8 kt, an intensity of 75 kt is assessed at 12Z (up from 65 kt originally). Intensities are linearly adjusted from 12Z on the 5th until this time.

September 7:

1. Maps and old HURDAT:
   - HWM indicates a hurricane with a pressure of at most 985mb near 20.1N, 86W.
   - The MWR North Atlantic Tropical Cyclones chart showed a center at 21N, 85.5W (am) and at 22.5N, 87W (pm).
   - HURDAT indicated an 85 kt hurricane at 20.9N 86.0W at 12Z.
2. Ship highlights:
   - 40 kt W with 995 mb at 18.7N 86.5W at 00Z (COA);
   - 50 kt SSE with 998 mb at 20.5N 83.9W at 06Z (COA);
   - 60 kt SSW with 993 mb at 19.7N, 84.9W at 09Z (COA);
   - 60 kt SSW with 995 mb at 19.9N 84.9W at 12Z (micro);
   - 45 kt SSE with 1003 mb at 19.7N 83.3W at 18Z (COA).
3. Aircraft highlights:
   - Penetration fix with 982 mb at 20.3N 86.1W at 07Z (ATSR – drop reported 970 mb at surface and vortex message indicated 974 mb, but both 700 mb and 850 mb heights/temps indicate about 982 mb central pressure);
   - Radar fix with max estimated surface winds of 85 kt and a 20 nm diameter eye at 21.1N 85.9W at 1215Z (ATSR);
   - Penetration fix with 975 mb with max estimated surface winds of 95 kt and a 15 nm diameter eye at 21.8N 86.5W at 19Z (ATSR – vortex message reported 971 mb, but dropsonde indicates 975 mb from today's extrapolation formulas);
   - Penetration fix with 972 mb with 15 nm diameter eye at 22.2N 87.2W at 2230Z (ATSR – vortex message reported 967 mb, but dropsonde and flight-level data indicate 972 mb from today's extrapolation formulas).

4. Discussion/Reanalysis: Carla remained relatively steady state early on the 7th, but deepened slightly to 975 mb from the 19Z reconnaissance fix. This suggests an intensity of 85 kt from the south of 25N intensifying pressure-wind relationship. The 15 nm eye suggests an RMW of about 10-15 nm, which is smaller the the climatology of 17 nm. Due to the contrasting effects of smaller size but slow (8 kt) forward speed, the intensity is analyzed at 85 kt at 18Z, down slightly from 95 kt originally.

September 8:

1. Maps and old HURDAT:
   - HWM indicates a hurricane with a pressure of at most 975mb near 22.5N, 88W.
   - The MWR North Atlantic Tropical Cyclones chart showed a center at 23.1N, 88.1W (am) and at 23.9N, 89.5W.
   - HURDAT indicated a 110 kt major hurricane at 23.1N 88.3W at 12Z.
2. Ship highlights:
   - 50 kt ESE with 1008 mb at 25.7N 85.4W at 00Z (COA);
   - 50 kt E with 1008 mb at 25.1N 85.6W at 06Z (COA);
   - 50 kt NW with 977 mb at 22.9N, 88.8W at 12Z (COA);
   - 50 kt S with 995 mb at 22.3N 87.6W at 18Z (COA).
3. Aircraft highlights:
   - Radar fix at 22.7N 87.8W at 22.7N 87.7W at 0525Z (storm wallets);
   - Penetration fix with central pressure of 961 mb and max estimated surface winds of 110 kt with a 50 nm eye diameter at 23.3N, 88.5W at 13Z (storm wallets);
   - Penetration fix with central pressure of 964 mb, max flight level (859 mb) winds of 98 kt, and 32 nm RMW at ~23N ~88W at ~15Z (NHRP);
   - Radar fixat 23.2N 88.6W at 1746Z (ATSR);
   - Penetration fix with central pressure of 961 mb at 1805Z (NHRP);
   - Penetration fix with central pressure of 954 mb and estimated max surface winds of 100 kt with a 45 nm eye diameter at 23.5N 89.7W at 22Z (ATSR – the transmitted vortex message indicated 968 mb central pressure, but dropsonde had 954 mb at surface which was consistent with 700 mb and 850 mb heights/temps).
4. Discussion:
   - MWR: "High tides began affecting the upper Texas coast on September 8 and waves and tides continued to batter the Texas coast with ever increasing fury until the center moved inland three days later".
   - Reanalysis: A central pressure of 972 mb from 2230Z on the 7th suggests an intensity of 89 kt from the south of 25N intensifying pressure-wind relationship. This is the basis for 90 kt at 00Z on the 8th, down slightly from 100 kt originally. Carla deepened to 961 mb at 13Z, but with a large eye suggesting an RMW of about 35 nm. (This is a close match to the 964 mb at ~15Z with an explicit RMW observation of 32 nm from the NHRP flight.) A 961 mb central pressure gives an intensity of 101 kt from the south of 25N

intensifying pressure-wind relationship. An intensity of 100 kt is analyzed at 12Z, a minor reduction from the 110 kt in HURDAT.

September 9:

1. Maps and old HURDAT:
   - HWM indicates a hurricane with a pressure of at most 980mb near 24N, 91W.
   - The MWR North Atlantic Tropical Cyclones chart showed a center at 24.5N, 91W (am) and at 25.5N, 92.5W (pm).
   - HURDAT indicated a 110 kt major hurricane at 24.6N 90.9W at 12Z.
2. Ship highlights:
   - 55 kt NE with 1007 mb at 27.2N 91.5W at 00Z (COA);
   - 55 kt NW with 997 mb at 22.2N 92.0W at 06Z (micro);
   - 45 kt SW with 987mb at 23N, 90.9W at 12Z (COA);
   - 50 kt ENE with 996 mb at 26.7N 91.6W at 12Z (COA);
   - 60 kt E with 996 mb at 26.9N, 91.1W at 18Z (COA).
3. Aircraft highlights:
   - Penetration fix with 955 mb central pressure with 51 nm eye diameter at 24.1N 90.3W (ATSR);
   - Penetraion fix with 954 mb central pressure and estimated max surface winds of 110 kt with 45 nm eye diameter at 24.6N, 90.8W at 1130Z (storm wallets);
   - Penetration fix with 947 mb central pressure at 1838Z (NHRP);
   - Penetration fix with 948 mb central pressure, peak flight level (859 mb) winds of 111 kt, and RMW of 20 nm at ~24N ~91W at ~21Z (NHRP).
4. Discussion/Reanalysis: A 954 mb central pressure at 22Z on the 8th suggests an intensity of 109 kt from the south of 25N intensifying pressure-wind relationship. The eye remained large – RMW of 30-35 nm – and forward speed a slow 7 kt – is the reason for 105 kt intensity at 00Z on the 9th. This is a minor – 5 kt – reduction from 110 kt in HURDAT. Carla's central pressure and size remained about the same through 12Z. The hurricane deepened again and contracted in size late on the 9th, as the NHRP mission showed 947 mb central pressure witn an RMW (explicitly observed) of 20 nm. This pressure suggests and intensity of 116 kt from the south of 25N intensifying and 113 kt from the north of 25N intensifying pressure-wind relationships. As the inner core size of Carla is still slightly larger than climatology (16 nm) and is still moving less than 10 kt, an intensity of 110 kt is analyzed at 18Z, unchanged in HURDAT.

September 10:

1. Maps and old HURDAT:
   - HWM indicates a hurricane with a pressure of at most 980mb near 26N, 94W.
   - The MWR North Atlantic Tropical Cyclones chart showed a center at 26.5N, 93.9W (am) and at 27.1N, 95W (pm).
   - HURDAT indicated a 120 kt major hurricane at 26.3N 93.9W at 12Z.

2. Ship highlights:
   - 65 kt WNW with 992 mb at 23.7N 93.6W at 00Z (COA);
   - 55 kt NE with 997 mb at 28.4N 93.1W at 06Z (COA);
   - 70 kt WSW with 992 mb at 24.9N 93.5W at 12Z (COA);
   - 50 kt W with 984 mb at 25.1N, 95.1W at 18Z (COA);
   - 70 kt ESE with 990 mb at 28.4N, 93.3W at 18Z (COA).
3. Aircraft highlights:
   - Penetration fix with 938 mb central pressure at 25.6N 92.3W at 0030Z (storm wallet);
   - Penetration fix with 934 mb central pressure and 40 nm eye diameter at 26.2N, 93.4W at 06Z (ATSR);
   - Penetration fix with 942 mb central pressure and 40 nm eye diameter and 110 kt esimtated max surface winds at 1245Z (ATSR – vortex message reported 937 mb from extrapolation, but both dropsondes in mission reported 942 mb which were consistent with 700 mb heights/temps);
   - Penetration fix with 937 mb central pressure at 1837Z (NHRP);
   - Penetration fix with 936 mb central pressure with max estimated surface winds of 130 kt and 31 nm eye diameter at 27.0N, 94.1W at 19Z (storm wallets);
   - Penetration fix with 935 mb central pressure, max flight level (618 mb) winds of 96 kt, and 20 nm RMW at ~27N ~94W at ~21Z (MWR, NHRP – Note that in Gray and Shea the pressure is reported as 940 mb);
   - Penetration fix with 936 mb central pressure with max estimated surface winds of 130 kt and 29 nm eye diameter at 27.3N 94.5W at 23Z (storm wallets).
4. Radar highlights:
   - Radar fix at 25.8N 93.8W at 0718Z from Galveston (storm wallets);
   - Radar fix at 26.1N 93.9W with 50 nm eye diameter at 1110Z from Galveston (storm wallets);
   - Radar fix at 26.1N 94.0W at 1200Z from Galveston (storm wallets);
   - Radar fix at 26.6N 94.5W at 1800Z from Galveston (storm wallets).
5. Satellite highlights:
   - Large symmetric central dense overcast at 2230Z from TIROS-III (MWR).
6. Discussion/Reanalysis: A central pressure of 934 mb recorded by a Navy aircraft at 06Z suggests 126 kt intensity from the Brown et al. north of 25N intensifying pressure-wind relationship. The 40 nm eye diameter suggests an RMW of about 30 nm, which is much larger than 15 nm from climatology. The large size with slow (7 kt forward speed) is the basis for an intensity of 115 kt analyzed at 06Z, the same as HURDAT. Intensity brought up steadily from 12Z on the 9th to 06Z on the 10th.

September 11:

1. Maps and old HURDAT:
   - HWM indicates a hurricane with a pressure of at most 980mb near 27.5N, 96.2W.

- The MWR North Atlantic Tropical Cyclones chart showed a center at 27.8N, 96W (am) and at 29.9N, 96.8W (pm).
- HURDAT indicated a 145 kt major hurricane at 27.6N 96.2W at 12Z.

2. Station highlights:
   - 56 kt ENE (fastest mile) at 05Z at Freeport (TC Data);
   - 989 mb (min pressure) at 0835Z at Brownsville (TC Data);
   - 63 kt N (fastest mile) at 10Z with 975 mb (time unknown) at Aransas Pass-United Carbon (TC Data);
   - 973 mb (min pressure) at 1950Z at Port Aransas (TC Data);
   - ≤ 935mb at Port Lavaca (28.6N, 96.6W) at 2145Z (TC Data);
   - 126 kt NE (fastest mile) at Port Lavaca (no time given) (TC Data);
   - 126 kt NE (fastest mile) at Matagorda (no time given) (TC Data).
3. Ship highlights:
   - 75 kt ESE with 987 mb at 28.4N, 93.5W at 00Z (COA);
   - 95 kt SE with 991 mb at 28.5N, 93.6W at 06Z (COA);
   - 80 kt SE with 989 mb at 28.0N 93.6W at 12Z (COA);
   - 70 kt SSE with 993 mb at 28.5N 94.2W at 18Z (COA);
   - 931 mb at 28.4N 96.4W at 2015Z (wallet).
4. Radar highlights:
   - Radar fix at 27.2N 95.0W from Galveston, TX at 0000Z (wallet);
   - Radar fix at 27.2N 95.7W from Lake Charles, LA at 0530Z with 28 nm eye diameter (wallet);
   - Radar fix at 27.1N 95.6W from Galveston, TX at 0600Z (wallet);
   - Radar fix at 27.6N 96.3W from Galveston, TX at 1200Z (wallet);
   - Radar fix at 28.0N 96.3W from Galveston, TX at 1800Z (wallet).
5. Aircraft highlights:
   - Penetration fix with 927 mb central pressure at 07Z at 27.2N 95.7W (ATSR – no central pressure reported from aircraft, pressure obtained from 700 mb flight level temps/height);
   - Radar fix with 28 nm eye diameter at 1430Z at 27.5N 96.0W (ATSR);
   - Penetration fix with 941 mb central pressure, 120 kt max surface wind estimate, and 26 nm diameter eye at 1810Z at 28.2N 96.4W (ATSR).
   - Penetration fix with 940 mb central pressure, 102 kt peak flight level (618 mb) winds, and 17 nm RMW at ~28N ~96W at ~21Z (NHRP - The pressure derived from the D-values on this flight range from 933-938 mb. However, these fixes may have issues with the eye being over land, thus 940 mb from the NHRP report is accepted as the central pressure);
   - Radar fix at 23Z at 28.5N 96.6W (ATSR).
6. Discussion:
   - MWR: "The center of Carla was under surveillance for some 48 hours by three land-based radars located at Brownsville, Galveston, and Lake Charles. All radars showed a strong cycloidal track during the period preceding landfall. The New Orleans hurricane center described Carla as one of the largest, most intense and destructive hurricanes ever to strike the United States Gulf coast. Carla's center moved inland over the Port O'Conner-Port Lavaca area on the

central Texas coast during the afternoon of September 11 (fig.11). Sustained hurricane force winds were reported from Corpus Christi to Galveston and hurricane gusts were felt along almost the entire length of Texas coast…Highest tides were 16.6 ft MSL at Port Lavaca, 14.5 ft MSL at Port O'Connor, 15.2 ft MSL at Matagorda, and 14.8 ft MSL on the upper Houston ship channel…Peak gusts of 175 mph were estimated at Port Lavaca. A gust of 153 mph was observed on the anemometer of the Bauer Dredging Co. before the instrument failed. The lowest reported pressure at Port Lavaca was 27.62 in (935 mb) and it remained at that value from 1545 to 1735 CST. Available information indicates the needle was below the scale during that period…Its lowest central pressure (931 mb) on the afternoon of the 11th"

- N. Atlantic TC: "Early in the afternoon of the 11th the center moved over the northeastern tip of Matagorda Island and inland over the Port Lavaca – Port O'Conner area. Reconnaissance aircraft indicated a central pressure of 27.50 in [931 mb] just prior to its crossing the coast. The eye of the hurricane, approximately 30 miles in diameter, (fig 1) moved into the Port O'Conner area about 1400 CST of the 11th. The leading edge of the eye reached Port Lavaca at 1545 CST. Carla moved slowly, and was almost stationary at times as she approached the middle Texas Coast. From Port Lavaca, the storm followed a northwesterly course, that carried the center over Inez, Yoakum, and Waelder, No well defined "eye" was apparent after the storm moved out the Waelder area about 0100 CST on the 12th, and it began to weaken rapidly as it followed a more northerly course, passing near Austin, Waco, and Fort Worth…Gusts of hurricane force were reported for the Texas coast from Port Arthur to north of Brownsville, a distance of over 300 miles. The highest wind was reported at Port Lavaca with a peak gust estimated at 175 mph at Bauer Dredging Company on bay front. At 1414 CST at this location a wind gust of 153 mph was observed on the anemometer before the instrument failed. Matagorda reported a gust of 160mph and gusts of 150mph were estimated at Aransas Pass, Austwell, Edna, Port Aransas, and Victoria. Sustained winds (fastest mile) were reported as 145 at Matagorda and Port Lavaca. Aransas Pass and Victoria estimated fastest miles of 135 and 110, respectively. In Louisiana sustained winds were generally less than 50 mph. Peak gusts of 75, 60, and 58 mph were reported at Chauvin, Cameron, and Lake Charles, respectively…A low pressure of 27.62 in was reported by the Bauer Dredging Company at Port Lavaca from a recently calibrated barometer before the needle went below the scale. Other low pressures were 27.91 in at Victoria and 28.60 in at Matagorda. Austin, Fort Worth, and Waco reported their lowest pressures of record: 28.76, 28.94, and 28.91 in, respectively".
- Ho et al: Sept. 11, 1961, 931 mb central pressure at landfall based upon aircraft reconnaissance, 30 nm RMW, 6 kt forward speed, 28.3N 96.4W landfall location.
- Jarvinen and Wiggert: 931 mb central pressure at landfall (from MWR), 26 nm RMW, 1014 mb outer closed isobar.

- Reanalysis: Carla deepened to its lowest value on the 11th, as the central pressure dropped to 927 mb at 07Z. This suggests an intensity of 132 kt from the intensifying subset of the north of 25N pressure-wind relationship. Aircraft and radar reports near that time indicated an eye diameter of 30 nm and an RMW of about 22 nm. RMW climatology for that pressure and latitude is 15 nm, slightly smaller than Carla at that time. The hurricane was also moving a slow 7 kt. Thus an intensity of 125 kt is thus analyzed, down from 150 kt originally in HURDAT. One final Navy aircraft reconnaissance mission reported 941 mb from a dropsonde at 1810Z. Additionally, an NHRP mission indicated 940 mb around 21Z. However, given observations from the Texas coast significantly lower than this, it is possible that these measurement were not in the center of the eye. Carla made landfall around on September 11 around 20Z near 28.3N, 96.4W on the northeastern tip of Matagorda Island and inland over Port Lavaca - Port O'Conner area. Fastest mile winds of 126 kt were recorded at both Matagorda and Port Lavaca, which converts to a peak 1 minute wind of about 120 kt. (However, it is unknown the anemometer heights of either measurement.) A barge in Victoria Channel of Matagorda Bay at the point of landfall reported at 1815Z a 931 mb pressure, which was the central pressure used in Jarrell et al. (1992), Ho (1987), and Wiggert and Jarvinen (1986). It is of note that 931 mb appears to be converted from a rounded 27.5" value, which does introduce some uncertainty. This value is consistent with an inland pressure of 935 mb recorded at Port Lavaca almost two hours after landfall. The last couple of reports of eye diameter from the Navy reconnaissance indicated that Carla's eye had contracted some to 26 and 24 nm. Likewise, the NATC report indicated an eye diameter at landfall of about 25 nm, presumably based upon land-based radar. These all suggest an RMW of 15 to 20 nm. This is consistent with the 17 nm RMW explicity recorded by NHRP aircraft at the same time. On the other hand, Ho et al. suggested a 30 nm RMW (from "reconnaissance") while Wiggert and Jarvinen suggest about 25 nm (but do not indicate a source). Unfortunately, there are no surface observations that can assist with the landfall RMW determination. The RMW is thus assessed at 20 nm, which is about the same as climatology of 16 nm for this central pressure and latitude. The radius of outer closed isobar is about 1007 mb, somewhat lower than average. The forward speed at landfall was a somewhat slow 7 kt. 931 mb central pressure at landfall suggests maximum winds of 123 kt from the north of 25N pressure-wind relationship. The combination of the other factors – with significant consideration to the two observed 120 kt equivalent 1 min winds - gives an analyzed intensity of 125 kt at landfall which keeps it a Category 4 hurricane at landfall in central Texas. The landfall characterization – "BTX4" – of a Category 4 for the central Texas coast remains unchanged. A landfall characterization – "ATX1" – of a Category 1 for the southern Texas coast was added (winds of about 75kt) and a landfall characterization - "CTX3" – of a Category 3 hurricane for the northern Texas coast was also added

(winds of around 115kt). These estimates were derived from the Schwerdt et al. parametric wind model.

September 12:

1. Maps and old HURDAT:
   - HWM indicates a tropical storm with a pressure of at most 985mb near 30N, 97W.
   - The MWR North Atlantic Tropical Cyclones chart showed a center at 31N, 97W (am) and at 33N, 97W (pm).
   - HURDAT indicated a 60 kt tropical storm at 30.5N 97.4W at 12Z.
2. Station highlights:
   - 945 mb (min pressure) at Victoria (28.8N, 96.6W at 0047Z (TC Data);
   - 45 kt ESE (fastest mile) at Houston AP (30N, 95.4W) at 0258Z (TC Data);
   - 39 kt NE (fastest mile) at Austin (30.3N, 97.7W) at 0653Z (TC Data);
   - 974 mb (min pressure) at Austin (30.3N 97.7W) at 1120Z (TC Data);
3. Ship highlights:
   - 65 kt S with 994 mb at 28.2N, 94.2W at 00Z (COA);
   - 50 kt SE with 1004 mb at 27.7N 92.3W at 06Z (COA);
   - 40 kt SE with 1001 mb at 28.9N 93.9W at 12Z (COA);
   - 35 kt SE with 1006 mb at 28.5N 92.9W at 18Z (COA).
4. Radar highlights:
   - Radar fix at 28.8N 96.8W at Galveston, TX at 0030Z (wallet);
   - Radar fix at 29.5N 97.3W at Galveston, TX at 0600Z (wallet);
   - Radar fix at 30.7N 97.2W at Fort Worth, TX at 1417Z (wallet);
   - Radar fix at 31.7N 97.3W at Fort Worth, TX at 1838Z (wallet).
5. Discussion/Reanalysis: Runs of the Kaplan and DeMaria inland decay wind model (1995) suggests winds of 90 kt at 00Z on the 12th, 59 kt at 06Z, 41 kt at 12Z, and 30 kt at 18Z. Peak observed winds were 65, 50, 40 and 35 kt, respectively, though the reporting stations were not near the center of Carla during these times. (Note that the airport station at Victoria would have been ideal, but the anemometer broke at 2226Z on the 11th, just before hurricane winds occurred. The station meteorologist visually estimated that peak gusts reached 130 kt.) Winds were selected to be slightly higher than the model for HURDAT because Carla was a very large storm and large storms tend to weaken at a slower pace. Even though the winds were selected to be higher than the model, they were still lower than what was previously mentioned in HURDAT: 100 kt at 00Z (same as original), 70 kt at 06Z (originally 80 kt), 50 kt at 12Z (originally 60 kt), and 40 kt at 18Z (originally 45 kt).

September 13:

1. Maps and old HURDAT:
   - HWM indicates a tropical storm with a pressure of at most 995mb near 34.9N, 95.1W.

- The MWR North Atlantic Tropical Cyclones chart showed a center at 35N, 97W (am).
- HURDAT indicated a 30 kt extratropical depression at 34.3N 96.8W at 12Z.

2. Discussion:
   - N. Atlantic TC: "Increasing its forward movement it began a recurve northeastward and by the morning of the 13th, it became extratropical and was located over east-central Oklahoma. Continuing to pick up speed it moved northeastward toward the Great Lakes at about 35mph, reaching Lake Huron on the 14th. Extensive flooding from heavy rains was reported from areas along the storm's path".
   - Reanalysis: Transition into an extratropical cyclone at 12Z on the 13th is unchanced. Position adjusted significantly toward the northeast at 12Z based upon station observations.

September 14:

1. Maps and old HURDAT:
   - HURDAT indicated an extratropical depression of 30 kt at 46.3N 83.8W at 12Z.
   - HWM indicated an extratropical cyclone of at most 995 mb near 45N 83W.

September 15:

1. Maps and old HURDAT:
   - HURDAT indicated an extratropical depression of 30 kt at 53.7N 67.5W at 12Z.
   - HWM indicated an extratropical cyclone of at most 985 mb near 52N 69W. A second extratropial low near 61N 80W was approaching the post-Carla low.
2. Discussion/Reanalysis: Significant eastward adjustment to the position was added at 00Z. Significant westward adjustment was made at 12Z. Both were based upon station observations.

September 16:

1. Maps and old HURDAT:
   - HURDAT indicated an extratropical depression of 30 kt at 60N 65.0W at 00Z (last position).
   - HWM indicated a single extratropical low centered near 62N 63W.
2. Discussion/Reanalysis: The system briefly redeveloped gales as an extratropical cyclone early on the 16th. The system weakened below gale force around 12Z on the 17th and dissipation occurred after 00Z on the 18th.

Date	Original HURDAT Central Pressure	Evidence	Changes

Sep 4 06Z	1007 mb	Likely to be an analysis, but is a reasonable value	Retained
Sep 4 12Z	1006 mb	Likely to be an analysis, but is a reasonable value	Retained
Sep 4 18Z	1005 mb	1006 mb ship with 20 kt SW wind at 18Z	1004 mb
Sep 5 00Z	1002 mb	An Air Force penetration fix at 01Z likely is the source for this	Retained
Sep 5 06Z	999 mb	Likely to be an analysis, but is a reasonable value	Retained
Sep 5 12Z	997 mb	Reconn 998 mb at 1320Z	998 mb
Sep 5 18Z	993 mb	Likely to be an analysis, but is a reasonable value	Retained
Sep 6 00Z	990 mb	Likely to be an analysis, but is a reasonable value	Retained
Sep 6 06Z	987 mb	Likely to be an analysis, but is a reasonable value	Retained
Sep 6 12Z	984 mb	Reconn 982 mb at 13Z	982 mb
Sep 6 18Z	981 mb	Reconn 981 mb at 1930Z	Retained
Sep 7 00Z	978 mb	Reconn 978 mb at 2130-2200Z on the 6th	Retained
Sep 7 06Z	975 mb	Reconn 982 mb at 07Z	982 mb
Sep 7 12Z	973 mb	Likely to be an analysis and is not a reasonable value	Removed
Sep 7 18Z	970 mb	Reconn 975 mb at 19Z	975 mb
Sep 8 00Z	968 mb	Reconn 972 mb at 2230Z on the 7th	972 mb
Sep 8 06Z	966 mb	Likely to be an analysis, but is a reasonable value	966 mb
Sep 8 12Z	965 mb	Reconn 961 mb at 13Z	961 mb
Sep 8 18Z	962 mb	NHRP fix 961 at 1805Z	961 mb
Sep 9 00Z	959 mb	Reconn 954 mb at 22Z on the 8th	954 mb
Sep 9 06Z	956 mb	Reconn 955 mb at 07Z	955 mb
Sep 9 12Z	953 mb	Reconn 954 mb at 1130Z	954 mb
Sep 9 18Z	948 mb	NHRP fix 947 mb at 1838Z	947 mb
Sep 10 00Z	944 mb	Reconn 938 mb at 0030Z	938 mb
Sep 10 06Z	940 mb	Reconn 934 mb at 06Z	934 mb
Sep 10 12Z	937 mb	Reconn 942 mb at 1245Z	942 mb
Sep 10 18Z	936 mb	NHRP fix 937 mb at 1837Z	937 mb
Sep 11 00Z	936 mb	Reconn 936 mb at 23Z	Retained
Sep 11 06Z	936 mb	Reconn 927 mb at 07Z	927 mb
Sep 11 12Z	935 mb	Likely to be an analysis and is not a reasonable value	Removed
Sep 11 18Z	931 mb	Barge 931 mb at Victoria Channel, Matagorda Bay at 2015Z	Retained
Sep 12 00Z	940 mb	Victoria 945 mb at 0047Z	Retained
Sep 12 06Z	955 mb	Likely to be an analysis, but is a reasonable value	Retained
Sep 12 12Z	975 mb	Austin 974 mb at 1120Z	974 mb
Sep 12 18Z	979 mb	Interpolation from earlier and later times suggests 977 mb	977 mb

Sources: the Historical Weather Map series, the COADS ships database, the Monthly Weather Review, NHC Microfilm of synoptic weather maps, Annual Tropical Storm Reports, Storm Wallets, North Atlantic Tropical Cyclones

Report, Tropical Cyclone Data, Fett (1964, MWR), Jarrell et al. (1992), Schwerdt et al. (1979), Ho (1987), and Wiggert and Jarvinen (1986).

Hurricane Debbie [September 5–18, 1961]

```
40875 09/06/1961 M=11  4 SNBR= 894 DEBBIE      XING=0 SSS=0
40875 09/05/1961 M=14  4 SNBR= 894 DEBBIE      XING=0 SSS=0
         **        **
```

(September 5th is new to HURDAT)

```
40880 09/05*  0   0   0    0*  0   0   0    0*135 177  30    0*141 193  30    0*
                                  *** ***  **     *** ***  **
40880 09/06*  0   0   0    0*  0   0   0    0*  0   0   0    0*151 241  50    0*
40880 09/06*146 207  30    0*149 220  35    0*150 232  40    0*151 244  50    0*
            *** ***  **      *** ***  **      *** ***  **          ***
40885 09/07*152 254  65    0*154 267  70    0*157 281  70    0*161 294  70    0*
40885 09/07*152 256  65    0*154 268  70    0*157 281  70    0*161 294  70    0*
              ***             ***
40890 09/08*165 307  70    0*170 320  70    0*175 332  70    0*180 345  70    0*
40895 09/09*185 357  70    0*191 370  70    0*197 382  70    0*204 394  70    0*
40900 09/10*212 406  70    0*220 418  70    0*228 430  75    0*238 441  75    0*
40905 09/11*250 450  80    0*266 457  90    0*279 459 100  976*293 459 105    0*
40905 09/11*250 450  75    0*265 457  75    0*279 460  80    0*292 461  80  976*
                    **      ***      **                ** * *** ***  **  ***
40910 09/12*305 459 105    0*315 459 105    0*322 458 105  975*330 456 105    0*
40910 09/12*304 461  80    0*315 460  80    0*323 458  80  975*331 456  75    0*
            *** ***  **           ***  **                ** *** ***      **
40915 09/13*339 453 100    0*347 451  85  980*352 442  75    0*355 431  70    0*
40915 09/13*339 454  75    0*346 450  70  980*351 442  70    0*355 430  70    0*
              ***  **      *** ***  **      ***      **          ***
40920 09/14*359 411  70    0*362 389  70    0*366 365  70    0*370 341  70    0*
40920 09/14*359 413  70    0*362 394  70    0*365 370  70    0*370 344  70    0*
              ***             ***             *** ***             ***
40925 09/15*378 310  70    0*395 264  70    0*417 222  70    0*446 182  70    0*
40925 09/15E378 310  70    0E395 264  70    0E417 222  70    0E446 182  70    0*
          *                 *                 *                 *
40930 09/16*480 148  70    0*519 116  70  970*557  85  70    0*  0   0   0    0*
40930 09/16E480 148  70    0E517 116  75    0E560  85  75  961E605  58  75    0*
          *                 *         **      ****      **  *******  **  **
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(September 17th and 18th are new to HURDAT)

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40931 09/17E640  30  70    0E6603600  65    0E6703580  55    0E6753540  45    0*
40933 09/18E6803480  40    0E6853420  35    0E6903350  35    0E6953270  30    0*
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40935 HR

Tropical Storm Landfall

09/06 13Z 15.0N 23.4W 40 kt Santiago Island, Cape Verde Islands

Significant Revisions:

1. Genesis indicated 18 hours earlier based upon ship and coastal observations;
2. Intensity substantially decreased on the 11th to the 13th based upon aircraft observations;
3. Peak intensity on 11th and 12th reduced from 105 kt to 80 kt;
4. Extratropical transition introduced with ET stage on the 15th through the 18th;
5. Two additional days as an extratropical cyclone are added based upon ship and coastal observations.

Daily Summary:

September 5:

1. Maps and old HURDAT:
   - HWM analyzes a closed low pressure of at most 1010 mb at 13.0N, 17.5W at 12Z.
   - HURDAT does not list an organized storm on this day.
   - Microfilm shows a tropical wave near the Cape Verde Islands along longitude 24W at 12Z.
2. Discussion:
   - MWR: "Hurricane Debbie probably developed between the Cape Verde Islands and Africa. Pressures in that area fell to well below their normal values with evidence of cyclonic circulation during the first few days of September."
   - Reanalysis: A vigorous tropical wave developed over central Africa around September 1st. The disturbance moved westward and became better organized still over western Africa. A paper by Erickson (MWR 1963, pg. 61) details the early history of this tropical system and provides excellent data on its formation and development. Surface observations over western Africa indicate that the tropical wave developed a well-defined, low-level circulation while still over land. Genesis is analyzed at 12Z on September 5th as a 30 kt tropical depression, just off the African coast, 30 hours earlier than originally shown in HURDAT.

September 6:

1. Maps and old HURDAT:
   - HWM analyzes a closed low pressure of at most 1010 mb at 14.2N, 23.2W at 12Z.
   - HURDAT lists a 50 kt tropical storm at 15.1N, 24.1W at 18Z (first position).
   - Microfilm shows a closed low pressure of at most 1011 mb at 14.5N, 22.5W at 12Z.
2. Ship highlights:
   - 50 kt ENE and 994 mb (observation or location possibly erroneous) at 14.5N, 20.7W at 06Z (COADS).
   - 30 kt N and 1004 mb at 14.8N, 27.2W at 19Z (WALLET/ERICKSON).
3. Discussion:
   - ATSR: "Although below-normal surface pressures has been observed near the Cape Verde Islands since the beginning of September, it was not until the 6th that ship and land station reports indicated that Debbie had formed. A

Pan-American Airways report revealed an "active" tropical depression at 13N 23W at 061300Z."

- Reanalysis: The tropical depression moved westward on September 6th and gained strength. A ship reported 50 kt NE and 994 mb at 06Z on the 6th and although it is possible that the observation is correct, the position reported contradicts the other ship and coastal observations, thus it has been disregarded. Intensification to a tropical storm is analyzed at 06Z on the 6th based on data from the ship Charlotte Maersk later in the day and on September 7th. Originally HURDAT showed an initial intensity as a 50 kt tropical storm at 18Z on the 6th, also the original first position. Debbie made landfall in the island of Santiago, Cape Verde Islands, at 13Z on the 6th as a 40 kt tropical storm.

September 7:

1. Maps and old HURDAT:
   - HWM analyzes a hurricane of at most 1000 mb at 15.3N, 28.4W at 12Z.
   - HURDAT lists a 70 kt hurricane at 15.7N, 28.1W at 12Z.
   - Microfilm shows a closed low pressure of at most 1011 mb at 15.5N, 28.0W at 12Z.
2. Ship highlights:
   - 50 kt WNW and 995 mb at 14.8N, 26.3W at 01Z (micro/ERICKSON).
   - 45 kt WSW and 1001 mb at 14.8N, 25.6W at 03Z (micro/ERICKSON).
   - 45 kt S and 1004 mb at 14.8N, 25.0W at 06Z (micro/ERICKSON).
   - 35 kt S and 1008 mb at 14.2N, 23.5W at 09Z (micro/ERICKSON).
3. Discussion:
   - MWR: "Late on the 6th and early on the 7th, several reports from the SS C. Maersk indicated that a storm, probably already of hurricane intensity, existed near 15°N, 25°W. The storm moved west-northwestward for the next several days but there were no observations in the area and it was not possible to locate the center accurately."
   - ATSR: "…and at 070000Z the first warning on the disturbance was issued by Fleet Weather Central, Port Lyautey. On the initial warning, it was termed a tropical depression but unnamed. Early on the 7th the SS CHARLOTTE MAERSK, which had done yeoman service in sending initial reports on Betsy, radioed an observation from 15N 26W giving a west wind of 40 knots, 15 to 20 foot seas, and a surface pressure of 996 mb. Fleet Weather Facility, Miami assumed the forecast responsibility on the depression at 071600Z and at 072200Z the first regularly numbered, named warning was issued."
   - Reanalysis: Late on the 6th, the ship Charlotte Maersk was moving eastward near 15N, 27W and began to report lowering pressures and an increase in the winds. At 01Z on the 7th, the ship reported 50 kt WNW and 995 mb; the strongest winds experienced by the ship and also the lowest pressure. A peripheral pressure of 995 mb suggest maximum sustained winds greater than 56 kt from the Brown et al. pressure-wind relationship. Intensification to a hurricane is analyzed at 00Z on the 7th, same as originally shown in HURDAT. A TIROS III satellite image (MWR 1963, pg. 64) at 1913Z on the 7th shows hurricane Debbie in the southwest corner and an eye is apparent. It is possible that Debbie may have been stronger than analyzed (70 kt), but there is no other data to suggest increasing the winds from the values already in HURDAT, nor can an intensity assessment be made from the satellite image.

September 8:

1. Maps and old HURDAT:
   - HWM analyzes a hurricane of at most 995 mb at 18.3N, 33.3W at 12Z.
   - HURDAT lists a 70 kt hurricane at 18.0N, 34.5W at 12Z.

- Microfilm shows a weather bulletin over the location of the tropical cyclone at 12Z.

2. Discussion:
   - ATSR: "Late on the 7th Debbie was determined to be of tropical storm intensity. Beyond range of reconnaissance aircraft and with a lack of ship reports from the 7th to the 10th, no amplifying data on Debbie was available for three days. The positions and forecasts were based largely on climatology. The storm was positioned on a more westerly track then proved to be the case."
   - Reanalysis: Observations over the eastern Atlantic were very sparse as the hurricane moved away from the Cape Verde Islands. No ships passed near Debbie from September 8th through the 10th. No changes to the intensity or track were made from the 8th through the 10th.

September 9:

1. Maps and old HURDAT:
   - HWM analyzes a hurricane of at most 995 mb at 19.4N, 38.2W at 12Z.
   - HURDAT lists a 70 kt hurricane at 19.7N, 38.2W at 12Z.
   - Microfilm shows a weather bulletin over the location of the tropical cyclone at 12Z.

September 10:

1. Maps and old HURDAT:
   - HWM analyzes a hurricane of at most 995 mb at 22.3N, 43.3W at 12Z.
   - HURDAT lists a 75 kt hurricane at 22.8N, 43.0W at 12Z.
   - Microfilm shows a closed low pressure of at most 1011 mb at 26.5N, 40.9W at 12Z.
2. Satellite highlights:
   - Symmetric central dense overcast at 1907Z from TIROS-III (MWR).
3. Discussion:
   - MWR: "However, on September 10 TIROS photographs indicated that the center was near 25°N, 45°W. This estimate was less than 200 miles from the actual center."
   - ATSR: "The first indication that Debbie had taken a more northerly course than anticipated was at 101904Z when the Tiros satellite photographs placed the center much farther north."
   - Reanalysis: A TIROS III satellite image (MWR 1962, pg. 111) at 1907Z on the 10th shows hurricane Debbie in a better angle to judge its organization. The hurricane has a well-organized CDO but convection is restricted on the western and southern quadrants, it appears that southwesterly shear is affecting the storm. At 18Z on the 10th, HURDAT originally showed an intensity of 75 kt and this is retained.

September 11:

1. Maps and old HURDAT:
   - HWM analyzes a hurricane of at most 995 mb at 27.3N, 45.9W with a weakening front to the north at 12Z.
   - HURDAT lists a 100 kt hurricane at 27.9N, 45.9W at 12Z.
   - Microfilm shows a closed low pressure of at most 1002 mb at 28.5N, 47.0W at 12Z.
2. Ship highlights:
   - 50 kt NE and 1000 mb at 25.5N, 45.9W at 00Z (micro).
   - 55 kt NE and 1001 mb at 28.4N, 47.1W at 10Z (COADS).
   - 50 kt NE at 30.1N, 47.0W at 13Z (micro).
   - 60 kt NNW and 987 mb at 28.3N, 46.7W at 15Z (micro).
   - 60 kt WNW and 999 mb at 27.9N, 46.2W at 18Z (COADS).

3. Aircraft highlights:
   - Penetration center fix measured a central pressure of 976 mb, estimated surface winds of 100 kt and an eye diameter of 45 nm at 28.8N, 46.2W at 1615Z (ATSR). (Note that the dropsonde recorded 988 mb at the surface, but measured a 700 mb temp – 11C – 4C cooler than recorded on the aircraft. Thus it is suggested that the drop landed in the eyewall, rather than the eye.)
4. Discussion:
   - MWR: "From September 11 through 14 the center was within range of hurricane reconnaissance planes and during this time it moved northward."
   - ATSR: "Shortly thereafter, at 110000Z, a ship report from 25.5N 45.7W revealed for certain that Debbie's true position was further north and that she was proceeding on a northerly course. Early on the 11th a Navy reconnaissance aircraft discovered Debbie to be a full blown hurricane with maximum winds of 120 kt and a central pressure of 975 mb. The storm moved steadily northward under the influence of the same long wave trough that had steered Betsy."
   - Reanalysis: On September 11th, Debbie entered an area of heavier shipping traffic in the central Atlantic and gale-force winds were reported, including 60 kt at 15Z and 18Z. Also on the 11th, the hurricane turned to the north feeling the weakness left behind by the trough that picked up Betsy a couple of days before. The first reconnaissance aircraft reached the hurricane at 1615Z on the 11th measured a central pressure of 976 mb, estimated surface winds of 100 kt and an eye diameter of 45 nm. A central pressure of 976 mb suggests maximum sustained winds of 77 kt from the north of 25N pressure-wind relationship. An eye diameter of 45 nm suggests an RMW of 34 nm and the climatological value is 23 nm. Due to a forward speed of 14 kt, an RMW greater than the climatological value, and slightly weighting in the surface estimate, an intensity of 80 kt is selected at 18Z on the 11th, down from 105 kt originally in HURDAT, a major intensity change. A central pressure of 976 mb was present in HURDAT at 12Z on the 11th and based on the time of the penetration fix, it has been moved to the 18Z time slot on the 11th. 80 kt is also the peak intensity of this tropical cyclone, down from 105 kt originally in HURDAT, a major intensity change. It is analyzed that Debbie did not reach major hurricane intensity during its lifetime. Yet, it is possible that Debbie may have peaked in intensity earlier in its life and by the time the reconnaissance aircraft reached the hurricane, it had already weakened. An analog could be hurricane Julia in 2010 that peaked in intensity east of 35W and was a category 1 hurricane when it reached 45W.

September 12:

1. Maps and old HURDAT:
   - HWM analyzes a hurricane of at most 995 mb at 32.2N, 46.0W with a warm front far to the northeast at 12Z.
   - HURDAT lists a 105 kt hurricane at 32.2N, 45.8W at 12Z.
   - Microfilm shows a closed low pressure of at most 996 mb at 32.5N, 46.0W at 12Z.
2. Ship highlights:
   - 60 kt E and 1005 mb at 31.4N, 45.0W at 00Z (micro).
   - 45 kt N and 1002 mb at 32.4N, 47.4W at 06Z (COADS).
   - 75 kt E and 995 mb at 33.0N, 46.2W at 12Z (micro).
   - 45 kt WNW and 1000 mb at 32.4N, 46.3W at 18Z (micro).
3. Aircraft highlights:

- Penetration center fix measured a central pressure of 975 mb and estimated an eye diameter of 80 nm at 32.5N, 45.7W at 1315Z (ATSR).

4. Discussion:
   - MWR: "... This agrees well with earlier reconnaissance reports of 975 mb while the hurricane was in the central Atlantic."
   - Reanalysis: The next aircraft to investigate Debbie arrived at 1315Z on September 12th estimating a central pressure of 975 mb and an eye diameter of 80 nm. A central pressure of 975 mb suggests maximum sustained winds of 79 kt from the north of 25N pressure-wind relationship. An eye diameter of 80 nm suggests an RMW of 60 nm and the climatological value is 27 nm. Due to a forward speed of 8 kt and an RMW greater than the climatological value and weighting the 75 kt ship report, an intensity of 80 kt is selected at 12Z on the 12th, down from 105 kt originally in HURDAT, a major intensity change. A central pressure of 975 mb was present in HURDAT at 12Z on the 12th and it has been retained. Various ships reported gale-force winds on the 12th and a ship even reported hurricane-force winds, 75 kt E and 995 mb at 12Z.

September 13:

1. Maps and old HURDAT:
   - HWM analyzes a hurricane of at most 1000 mb at 35.1N, 44.2W with a cold 44.2W at 12Z.
   - Microfilm shows a closed low pressure of at most 1002 mb at 35.8N, 43.8W at 12Z.
2. Ship highlights:
   - 50 kt NNW and 1003 mb at 33.6N, 47.3W at 00Z (COADS).
   - 50 kt NW and 1004 mb at 33.9N, 47.1W at 06Z (COADS).
   - 50 kt NW and 1009 mb at 34.1N, 46.8W at 12Z (COADS).
   - 50 kt SSW and 1009 mb at 33.7N, 41.1W at 18Z (micro).
   - 60 kt SE and 1012 mb at 37.5N, 41.1W at 21Z (micro).
3. Aircraft highlights:
   - Penetration center fix at 34.9N, 44.9W at 0901Z (ATSR).
   - Penetration center fix at 35.2N, 44.0W at 13Z (ATSR).
4. Satellite highlight:
   - Central dense overcast with a possible eye shown at 1415Z from Project Mercury photograph (Fett 1964).
5. Discussion:
   - MWR: "... and turned sharply east-northeastward on the 13th."
   - ATSR: "On the 13th she turned sharply east-northeast."
   - Reanalysis: On September 13th, Debbie turned to the east-northeast. A central pressure of 980 mb is present in HURDAT at 06Z on the 13th and reconnaissance data shows that aircraft were present around this time, thus the central pressure has been retained even though it could not be confirmed. A central pressure of 980 mb suggests maximum sustained winds of 73 kt from the Brown et al. north of 35N south of 25N pressure-wind relationship and also 73 kt north of 25N from the Landsea et al. pressure-wind relationship. Due to a forward speed of 10 kt and a large RMW, an intensity of 70 kt is selected at 06Z on the 13th, down from 85 kt originally in HURDAT, a minor intensity change. Various ships reported tropical storm force winds, up to 60 kt. A great satellite image of hurricane Debbie made the cover of Mariners Weather Log, Volume 5, Number 6, November 1961. The satellite image was taken at 1416Z on the 13th by the Mercury spacecraft 12 minutes after launch at an altitude of 90 miles. In the satellite image, Debbie appears as a well-organized

hurricane with what seems to be a large eye surrounded by a symmetric CDO.

September 14:

1. Maps and old HURDAT:
   - HWM analyzes a hurricane of at most 990 mb at 36.5N, 36.8W with a weakening cold front to the northwest at 12Z.
   - HURDAT lists a 70 kt hurricane at 36.6N, 36.5W at 12Z.
   - Microfilm shows a closed low pressure of at most 996 mb at 37.0N, 37.0W at 12Z.
2. Ship highlights:
   - 50 kt SW and 1002 mb at 34.3N, 40.3W at 00Z (COADS).
   - 60 kt SSE and 1012 mb at 38.2N, 35.8W at 02Z (micro).
   - 50 kt SW and 1009 mb at 33.7N, 42.8W at 06Z (micro).
   - 45 kt SSW and 1010 mb at 34.0N, 35.9W at 09Z (micro).
   - 70 kt S and 1000 mb at 35.8N, 35.3W at 12Z (COADS).
   - 95 kt SW and 992 mb at 35.7N, 35.6W at 15Z (COADS).
   - 70 kt W and 1002 mb at 35.7N, 35.5W at 18Z (COADS).
3. Aircraft highlights:
   - Penetration center fix at 37.0N, 35.0W at 1653Z (ATSR).
4. Discussion/Reanalysis: On September 14th, the hurricane continued east-northeast gaining in forward speed with no appreciable changes in intensity. Many ships reported gale-force winds and a couple even recorded hurricane-force winds. A ship reported 95 kt at 15Z but this observation appears to be substantially high biased and was disregarded.

September 15:

1. Maps and old HURDAT:
   - HWM analyzes a hurricane of at most 985 mb at 41.5N, 22.5W with a warm front to the northeast and cold front to the south at 12Z.
   - HURDAT lists a 70 kt hurricane at 41.7N, 22.2W at 12Z.
   - Microfilm shows a trough along longitude 22W extending from a large extratropical cyclone of at most 981 mb at 57.5N, 27.0W to 33N at 12Z.
2. Ship highlights:
   - 45 kt SSW and 1010 mb at 35.4N, 29.9W at 00Z (COADS).
   - 55 kt SW and 1007 mb at 38.6N, 29.0W at 06Z (micro).
   - 35 kt SSW and 999 mb at 41.1N, 22.0W at 12Z (HWM).
   - 45 kt S and 985 mb at 45.3N, 16.3W at 18Z (COADS).
3. Discussion:
   - MWR: "... passing through the Azores during the night of September 14-15."
   - ATSR: "…raced through the Azores on the night of the 14th-15th."
   - Reanalysis: Late on the 14th, Debbie began to become extratropical as dry, cool air entered the circulation. Synoptic data at 00Z on September 15th indicate that Debbie became an extratropical cyclone as a temperature gradient was present between the eastern and western quadrants and frontogenesis had taken place. HURDAT did not show Debbie becoming an extratropical cyclone despite reaching 55°N. The strong extratropical cyclone crossed the Azores around 04Z as it raced to the northeast.

September 16:

1. Maps and old HURDAT:
   - HWM analyzes a hurricane of at most 960 mb at 55.5N, 10.0W with a warm front to the northeast and cold front to the east and southeast at 12Z.
   - HURDAT lists a 70 kt hurricane at 55.7N, 8.5W at 12Z (last position).

- Microfilm shows a closed low pressure of at most 990 mb at 54.5N, 13.0W at 12Z.

2. Ship highlights:
   - 50 kt S and 990 mb at 45.5N, 11.5W at 00Z (COADS).
   - 60 kt W and 976 mb at 50.6N, 13.7W at 05Z (MWL).
   - 45 kt NW and 983 mb at 50.2N, 13.2W at 06Z (COADS).
3. Land highlights:
   - 961 mb at Belmullet, Ireland around 11Z-12Z (Met Eirean).
   - 66 kt (10-min max wind) and gusts to 98 kt 10-min at Malin Head, Ireland at 13Z (Met Eirean/Hickey/Connolly-Johnson).
4. Discussion:
   - MWR: "It then accelerated and turned northward, passing along the western coasts of Ireland and Scotland on the 16th. The lowest available pressure was 970 mb reported by a ship a short distance from the center and offshore from Ireland. Gusts reached 106 mph at Ballykelly and 104 mph at Tiree and Snaefill. An Associated Press account of the hurricane from Longon follows: "The edge of Hurricane Debbie battered the British Isles Saturday night and left 11 or more dead and at least 50 injured. Flooding caused heavy damage in Ireland, Scotland, and Wales. Coastal areas of western Scotland were inundated by pounding surf whipped up by winds of 106 mph. Shipping and airplane traffic was disrupted. Coastal radio stations reported the airwaves were jammed with calls for help from small ships and fishing craft. Weathermen reported strong winds from northern Norway to the Bay of Biscay."
   - ATSR: "…and finally grazed the coasts of Ireland and Scotland on the 16th. In Ireland and Scotland, Debbie caused heavy damage to shipping and the coastal sections and claimed 11 lives."
   - Reanalysis: Early on September 16th, Debbie approached Ireland and the United Kingdom producing hurricane-force winds and damaging storm surge. A central pressure of 970 mb was present in HURDAT at 06Z on the 16th and has been removed as a ship near the center reported 25 kt SE and 963 mb at this time. Debbie made landfall in Ireland around 11Z and the lowest pressure recorded was 961 mb at Belmullet. This was likely a central pressure based on the track of the extratropical cyclone; thus, it has been added to HURDAT at 12Z on the 16th. The strongest winds recorded in Ireland were 66 kt 10-min (74 kt 1-min). An intensity of 75 kt is analyzed at 06Z and 12Z on the 16th, up from 70 kt originally in HURDAT, a minor intensity change.

September 17:

1. Maps and old HURDAT:
   - HWM analyzes a large extratropical cyclone of at most 975 mb at 67.5N, 3.0E at 12Z.
   - HURDAT does not list an organized storm on this day.
   - Microfilm does not show an organized storm on this day (cyclone moving off the NE corner of the map).

2. Ship highlights:
   - 55 kt SW and 979 mb at 58.8N, 3.7W at 00Z (COADS).
   - Land highlights: 45 kt SW and 991 mb at Rorvik, Norway at 12Z (HWM).

3. Discussion/Reanalysis: On September 17th, the extratropical cyclone turned to the northeast and east as it approached Norway. Weakening below hurricane intensity is analyzed at 12Z on the 17th. HWM indicates that gale-force winds affected Norway.

September 18:

1. Maps and old HURDAT:

- HWM analyzes a broad extratropical cyclone of at most 985 mb at 68.0N, 30.0E at 12Z.
- HURDAT does not list an organized storm on this day.
- Microfilm is not available on this date.

2. Discussion/Reanalysis: On September 18th, the system moved over northern Norway and northwestern Russia. Surface observations indicate that the extratropical cyclone weakened into an elongated trough and the last position is analyzed at 18Z on the 18th, 54 hours later than originally shown in HURDAT.

Sources: the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Monthly Weather Review, Navy reconnaissance book, Mariners Weather Log, Met Éireann (Irish National Meteorological Service), Erickson (1963), Fett (1964, MWR), Hickey and Connolly-Johnson (2012), and NHC Storm Wallets.

Hurricane Esther [September 10–27, 1961]

42025	09/10/1961	M=18	5	SNBR=	912	ESTHER			XING=1	SSS=0							
42030	09/10*	0	0	0	0*	0	0	0	0*	0	0	0	0*117	321	25	0*	
42030	09/10*	0	0	0	0*	0	0	0	0*	112	310	30	0*117	325	35	0*	
										***	***	**			***	**	
42035	09/11*124	339	25		0*135	353	25		0*144	367	35		0*152	381	40	0*	
42035	09/11*124	339	40		0*134	353	45		0*144	367	50		0*152	381	55	0*	
			**		***	***	**				**				**		
42040	09/12*160	394	50		0*168	408	65		0*176	420	65	975*184	431	70	967*		
42040	09/12*160	394	60		0*168	407	70		0*176	420	80	0*184	431	90	967*		
			**			***	**				**	*			**		
42045	09/13*191	442	75		0*196	453	90		969*198	464	105	970*200	474	110	983*		
42045	09/13*190	442	90		0*194	453	90		969*196	464	90	0*198	474	90	0*		
	***		**		***				***		**	* ***		**	*		
42050	09/14*201	484	110		0*202	494	110		0*203	505	110	975*205	513	110	966*		
42050	09/14*200	484	90		0*202	494	90		962*203	504	90	0*205	513	90	965*		
	***		**				**		***		***	**	*		**	***	
42055	09/15*207	521	110		965*211	534	110		965*216	547	110	966*218	561	110	961*		
42055	09/15*208	523	90		0*212	536	90		968*216	549	90	966*218	562	95	0*		
	***	***	**		*	***	***	**	***		***	**			***	**	*		
42060	09/16*220	574	110		960*223	587	105		956*227	600	105	949*233	613	105	944*		
42060	09/16*220	575	95		960*223	589	105		954*227	603	115	948*233	615	130	935*		
		***	**			***			***		***	***	***	***	***	***	
42065	09/17*238	626	105		939*241	639	110		934*244	652	110	930*248	662	115	927*		
42065	09/17*238	627	135		0*241	639	140		924*244	651	140	928*249	662	140	919*		
		***	***		*		***		***		***	***	***		***	***	
42070	09/18*254	669	120		928*261	678	120		932*270	686	125	938*280	694	125	944*		
42070	09/18*254	670	135		928*261	679	125		933*269	687	120	936*279	695	110	943*		
		***	***			***	***		***	***	***	***	***	***	***	***	

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42075 09/19*290 701 125  948*300 710 125  945*310 719 125  942*320 726 125  950*
42075 09/19*290 702 105  950*300 710 105  949*309 719 105  943*319 727 105  950*
                *** ***  ***         ***  *** ***     ***  *** *** *** ***

42080 09/20*330 731 120  947*340 734 120  957*350 733 120  949*363 730 120  955*
42080 09/20*329 731 105  952*339 732 105  956*350 733 105  948*363 730 100  953*
            ***     ***  *** *** *** ***  ***         ***  ***         ***  ***

42085 09/21*378 725 115  968*392 718 110  972*404 711 110  978*409 707 105    0*
42085 09/21*378 726  90  962*392 722  85  967*404 715  75  972*408 707  75    0*
                *** **   ***     ***  **  ***     ***  **  *** ***      **

42090 09/22*409 701  60    0*409 691  50    0*408 679  45  990*404 666  50    0*
42090 09/22*408 700  75    0*407 691  70    0*402 679  65  989*396 664  60    0*
            *** ***  **      ***      **      ***      **  *** *** *** **

42095 09/23*397 654  60  993*388 648  60    0*379 649  60    0*370 653  60    0*
42095 09/23*388 652  60  993*379 648  55    0*370 650  50    0*362 655  45    0*
            *** ***          ***      **      *** ***  **      *** *** **

42100 09/24*361 659  55    0*356 666  55    0*357 674  50    0*361 684  50    0*
42100 09/24*359 661  45  995*356 667  45    0*357 674  45    0*360 684  50    0*
            *** ***  **  ***     ***  **                 **      ***

42105 09/25*367 695  45    0*374 702  45  993*381 705  45    0*389 705  45    0*
42105 09/25*363 694  50  993*369 702  50    0*379 708  50  990*389 708  50  990*
            *** ***  **  *** ***      **    * *** ***  **  ***     ***  **  ***

42110 09/26*400 703  40  996*422 701  35    0*447 698  30 1002*466 692  30    0*
42110 09/26*400 705  50    0*417 702  50    0*440 698  35 1002*470 692  30    0*
                ***  **    * *** ***  **      ***      **      ***

42115 09/27E482 683  30    0E500 670  30    0*  0   0   0    0*  0   0   0    0*
42115 09/27E490 683  30    0E500 670  30    0*  0   0   0    0*  0   0   0    0*
            ***

42120 HR

U.S. Tropical Storm Landfall
----------------------------
09/26 05Z 41.3N 70.3W 50 kt MA
09/26 06Z 41.7N 70.2W 50 kt MA
09/26 11Z 43.8N 69.9W 35 kt ME

U.S. Tropical Storm Impact
--------------------------
09/21 08Z 39.6N 72.0W 40 kt New Jersey
09/21 12Z 40.4N 71.5W 60 kt New York
09/21 15Z 40.6N 71.1W 60 kt Rhode Island
09/21 15Z 40.6N 71.1W 50 kt Connecticut
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Significant Revisions:

1. Intensity substantially raised on the 11th based upon aircraft reconnaissance observations;

2. Intensity substantially reduced on the 12th through early on the 16th based upon aircraft reconnaissance observations;
3. Several central pressures were added or substantially adjusted based upon aircraft reconnaissance;
4. Several central pressures are removed, as they were likely analyses and not based upon observations;
5. Intensity substantially boosted from late on the 16th to early on the 18th based upon aircraft reconnaissance observations; Peak intensity now considered to be 140 kt on the 17th, was previously 125 kt on the 18th and 19th;
6. Intensity substantially reduced late on the 18th to the 21st based upon aircraft reconnaissance observations;
7. Intensity substantially increased on the 22nd based upon aircraft reconnaissance observations;
8. Intensity substantially reduced late on the 23rd based upon ship and coastal observations;
9. Intensity substantially increased on the 26th based upon ship and coastal observations.

Daily Summary:

September 9:

1. Maps and old HURDAT:
   - HWM analyzes a spot low pressure at 10.0N, 21.2W at 12Z.
   - HURDAT does not list an organized storm on this day.
   - Microfilm is not available on this date.
2. Discussion/Reanalysis: Hurricane Esther developed from a tropical wave that left the African coast around September 8th.

September 10:

1. Maps and old HURDAT:
   - HWM analyzes a closed low pressure of at most 1010 mb at 9.4N, 30.2W at 12Z.
   - HURDAT lists a 25 kt tropical depression at 11.7N, 32.1W at 18Z (first position).
   - Microfilm is not available on this date.
2. Satellite highlight:
   - Small convective core inside larger circulation seen at 1912Z from TIROS III (MWR).
3. Discussion:
   - ATSR: "Hurricane Esther formed in the eastern Atlantic and probably developed from a perturbation along the Intertropical Convergence Zone. Early indication of the existence of the tropical disturbance was provided by the weather satellite Tiros III at 1904Z on 10 September."
   - Reanalysis: The strong disturbance rapidly became better organized and based on a TIROS III satellite image on September 10th at 1912Z (MWR 1962, pg. 111), the system is begun as a tropical depression at 12Z and upgraded to a tropical storm at 18Z on the 10th, 18 hours earlier than originally shown in HURDAT. Genesis likely occurred on September 9th or early on the 10th, but the synoptic data is sparse over the eastern Atlantic. The first position in HURDAT was at 18Z on the 10th as a 25 kt tropical depression. The satellite image clearly indicates that the tropical cyclone had attained tropical storm intensity at this time and even our analysis of 35 kt may be conservative. The tropical storm initially moved northwestward under the influence of a mid-upper level trough which had steered Debbie to the north over the central Atlantic.

September 11:

1. Maps and old HURDAT:
   - HWM analyzes a tropical storm of at most 1005 mb at 13.3N, 37.8W at 12Z.
   - HURDAT lists a 35 kt tropical storm at 14.4N, 36.7W at 12Z.
   - Microfilm is not available on this date.
2. Discussion:
   - MWR: "On September 11, with Carla moving inland in Texas and Betsy and Debbie still threatening shipping in the Atlantic, evidence of a new disturbance began to appear. At 1330 EST on that date, pictures from the TIROS III satellite showed a vortex near 15°N, 38°W."
   - ATSR: "The following day, the Tiros III nephanalysis (111820Z) indicated a possible vortex."

September 12:

1. Maps and old HURDAT:
   - HWM analyzes a hurricane of at most 995 mb at 17.3N, 42.1W at 12Z.
   - HURDAT lists a 65 kt hurricane at 17.6N, 42.0W at 12Z.
   - Microfilm shows a spot low at 14.3N, 44.0W at 12Z.
2. Ship highlights:
   - 30 kt NW and 1000 mb at 18.2N, 45.2W at 21Z (micro).
3. Aircraft highlights:
   - Penetration center fix measured a central pressure of 967 mb, estimated surface winds of 110 kt and an eye diameter of 40 nm at 18.8N, 43.6W at 2010Z (ATSR).
4. Discussion:
   - MWR: "A reconnaissance flight was therefore dispatched to the area on September 12. It revealed that Esther had formed and was of full hurricane intensity with a central pressure of 967 mb. The first advisory at 1730 EST placed the center at 19°N, 44°W moving toward the northwest at 15 kt, accompanied by 110-kt winds. The intensity at this time suggests that Esther undoubtedly reached hurricane strength by September 11. In fact, a "possible" vortex near 11°N 30°W in the TIROS III nephanalysis for 1412 EST, September 10 may have represented near hurricane intensity."
   - ATSR: "A reconnaissance aircraft was dispatched on the morning of the 12th after estimating the position of the vortex to be within range of Roosevelt Roads, Puerto Rico. The aircraft located the eye near 18-45N 43-32W at 2010Z on 12 September and reported winds of 110 knots and a central pressure of 967 mb. The initial warning on Hurricane Esther was issued at 2230Z on 12 September."
   - Reanalysis: Conducive environmental conditions allowed the tropical storm to intensify and Esther is analyzed to have become a hurricane at 06Z on September 12th, same as originally shown in HURDAT. The first reconnaissance hurricane reached the hurricane at 2010Z on the 12th measuring a central pressure of 967 mb, estimating surface winds of 110 kt and an eye diameter of 40 nm. A central pressure of 967 mb suggests maximum sustained winds of 95 kt from the south of 25N intensifying subset of the Brown et al. pressure-wind relationship. An eye diameter of 40 nm suggests an RMW of 30 nm and climatology indicates 14 nm. Based on a forward speed of 13 kt and an RMW larger than climatology, an intensity of 90 kt is selected for 18Z on the 12th, up from 70 kt originally shown in HURDAT, a major intensity change. (Central pressures values for almost every 6 hour period were present in the original HURDAT between September 12th at 12Z and September 26th at 12Z. Some of these were obviously analyses that were added in, not based upon actual observations. Thus, based on proceeding and subsequent actual observations, some were

retained, others removed and new central pressure values added. Detailed information on these changes can be found in the table at the end.)

September 13:

1. Maps and old HURDAT:
   - HWM analyzes a hurricane of at most 995 mb at 19.2N, 46.4W at 12Z.
   - HURDAT lists a 105 kt hurricane at 19.8N, 46.4W at 12Z.
   - Microfilm shows a closed low pressure of at most 1002 mb at 19.7N, 46.5W at 12Z.
2. Ship highlights:
   - 80 kt WNW and 978 mb at 18.4N, 44.9W at 00Z (micro).
   - 60 kt NE and 1003 mb at 20.1N, 45.1W at 06Z (COADS).
   - 45 kt E and 1009 mb at 20.7N, 44.6W at 12Z (COADS).
   - 40 kt ESE and 1013 mb at 21.5N, 43.5W at 18Z (COADS).
3. Aircraft highlights:
   - Penetration center fix measured a central pressure of 969 mb, estimated surface winds of 100 kt and an eye diameter of 40 nm at 18.8N, 43.6W at 09Z (ATSR).
   - Radar center fix at 19.6N, 47.1W at 1810Z (ATSR).
4. Discussion:
   - MWR: "On the 13th and 14th surface pressure to the north of Esther began to rise as Debbie headed toward the Azores and a building anticyclone moved eastward from the vicinity of Bermuda. As a result, Esther was deflected to a west-northwestward course for the next few days. Also, as often happens under the influence of the increased gradient accompanying the passage of a High to the north of a hurricane, a gradual intensification began."
   - Reanalysis: By September 13th, an anticyclone was strengthening north of Esther causing the tropical cyclone to turn to the west-northwest while moving at a steady pace of about 12 kt. A ship at 00Z on September 13th reported 80 kt WNW and 978 mb. Reconnaissance aircraft on the 13th indicated that Esther had stopped intensifying as the central pressure remained steady near 970 mb. A penetration fix at 09Z on the 13th measured a central pressure of 969 mb, estimated surface winds of 100 kt and an eye diameter of 40 nm. A central pressure of 969 mb suggests maximum sustained winds of 91 kt south of 25N from the pressure-wind relationship. An eye diameter of 40 nm suggests an RMW of 30 nm and climatology indicates 15 nm. Based on a forward speed of 12 kt, an RMW larger than climatology but lightly weighing in the surface wind estimate, an intensity of 90 kt is selected for 06Z on the 13th, same as originally shown in HURDAT.

September 14:

1. Maps and old HURDAT:
   - HWM analyzes a hurricane of at most 995 mb at 20.2N, 50.6W at 12Z.
   - HURDAT lists a 110 kt hurricane at 20.3N, 50.5W at 12Z.
   - Microfilm shows a closed low pressure of at most 1008 mb at 20.5N, 50.6W at 12Z.
2. Ship highlights:
   - 35 kt W and 1008 mb at 18.7N, 52.2W at 19Z (micro).
3. Aircraft highlights:
   - Penetration center fix measured a central pressure of 962 mb and estimated an eye diameter of 40 nm at 20.3N, 49.8W at 07Z (ATSR).
   - Penetration center fix measured a central pressure of 965 mb at 20.4N, 51.1W at 2017Z (ATSR/micro).

4. Discussion/Reanalysis: On September 14th, the synoptic observations become sparse as ships avoided the hurricane. A reconnaissance aircraft measured a central pressure of 962 mb at 07Z. A central pressure of 962 mb suggests maximum sustained winds of 99 kt south of 25N and 100 kt intensifying from the pressure-wind relationship. An eye diameter of 40 nm suggests an RMW of 30 nm and climatology indicates 15 nm. Based on a forward speed of 10 kt and an RMW larger than climatology, an intensity of 90 kt is selected for 06Z on the 14th, down from 110 kt originally shown in HURDAT, a major intensity change. Another penetration fix at 2017Z on the 14th measured a central pressure of 965 mb suggesting maximum sustained winds of 96 kt south of 25N from the pressure-wind estimate. An intensity of 90 kt is selected for 18Z on the 14th, down from 110 kt originally in HURDAT, a major intensity change.

September 15:

1. Maps and old HURDAT:
   - HWM analyzes a hurricane of at most 995 mb at 21.4N, 54.5W at 12Z.
   - HURDAT lists a 110 kt hurricane at 21.6N, 54.7W at 12Z.
   - Microfilm does not provide an analysis in the area at 12Z.
2. Ship highlights:
   - 35 kt E and 1018 mb at 24.8N, 52.8W at 12Z (COADS).
   - 45 kt E and 1016 mb at 24.0N, 52.8W at 18Z (COADS).
3. Aircraft highlights:
   - Penetration center fix measured a central pressure of 968 mb at 21.3N, 54.0W at 07Z (ATSR).
   - Penetration center fix measured a central pressure of 966 mb, estimated maximum surface winds of 100 kt and an eye diameter of 30 nm at 21.6N, 55.0W at 13Z (ATSR).
   - Penetration center fix at 21.8N, 56.2W at 19Z (ATSR).
4. Discussion/Reanalysis: On September 15th, the intensity of Esther remained generally steady according to the reports from the reconnaissance aircrafts. Ships continued to avoid getting too close to the hurricane and remained in the periphery. A penetration fix measured a central pressure of 966 mb, estimated surface winds of 100 kt and an eye diameter of 30 nm at 13Z on the 15th. A central pressure of 966 mb suggests maximum sustained winds of 94 kt south of 25N from the pressure-wind relationship. An eye diameter of 30 nm suggests an RMW of 23 nm and climatology indicates 15 nm. Based on a forward speed of 13 kt and an RMW larger than climatology, an intensity of 90 kt is selected for 12Z on the 15th, down from 110 kt originally in HURDAT, a major intensity change.

September 16:

1. Maps and old HURDAT:
   - HWM analyzes a hurricane of at most 990 mb at 23.3N, 60.0W with a stationary front far to the northwest at 12Z.
   - HURDAT lists a 105 kt hurricane at 22.7N, 60.0W at 12Z.
   - Microfilm does not provide an analysis in the area at 12Z.
2. Aircraft highlights:
   - Penetration center fix measured a central pressure of 960 mb and estimated an eye diameter of 30 nm at 22.0N, 57.8W at 01Z (ATSR).
   - Penetration center fix with an extrapolated 954 mb from 700 mb flight level at 22.5N, 59.5W at 07Z (ATSR).
   - Penetration center fix measured a central pressure of 948 mb, estimated surface winds of 120 kt and an eye diameter of 20 nm at 22.8N, 60.5W at 1255Z (ATSR).

- Penetration center fix measured a central pressure of 935 mb, estimated surface winds of 128 kt and an RMW of 13 nm near ~23.0N, ~60.0W around 18Z (NHRP).
- Penetration center fix measured a central pressure of 936 mb, estimated surface winds of 100 kt and an eye diameter of 20 nm at 23.3N, 61.5W at 1830Z (ATSR).
- Penetration center fix at 23.6N, 62.6W at 2330Z (ATSR).

3. Satellite highlight:
   - Visible image showing northeast semicircle of Esther at 1711Z from TIROS III (Fett 1964).
4. Discussion/Reanalysis: On September 16th, Esther began to intensify rapidly as the central pressure decreased and eye diameter contracted. A reconnaissance aircraft measured a central pressure of 960 mb and an eye diameter of 30 nm at 01Z on the 16th. A central pressure of 960 mb suggests maximum sustained winds of 101 kt south of 25N from the pressure-wind relationship. An eye diameter of 30 nm suggests an RMW of 23 nm and climatology indicates 15 nm. Based on a forward speed of 15 kt and an RMW larger than climatology, an intensity of 95 kt is selected for 00Z on the 16th, down from 110 kt originally in HURDAT, a minor intensity change. Intensification to a major hurricane is analyzed at 06Z on the 16th, 66 hours later than originally shown in HURDAT. Another penetration fix measured a central pressure of 948 mb, estimated surface winds of 120 kt and an eye diameter of 20 nm at 1255Z on the 16th. A central pressure of 948 mb suggests maximum sustained winds of 115 kt intensifying south of 25N from the pressure-wind relationship. An eye diameter of 20 nm suggests an RMW of 15 nm, same as climatology. Based on a forward speed of 14 kt and an RMW same as climatology, an intensity of 115 kt is selected for 12Z on the 16th, up from 105 kt originally in HURDAT, a minor intensity change. A penetration fix around 18Z on the 16th measured a central pressure of 935 mb, estimated surface winds of 128 kt and an RMW of 13 nm. A central pressure of 935 mb suggests maximum sustained winds of 128 kt intensifying south of 25N from the pressure-wind relationship. Climatology indicates an RMW of 14 nm. Based on a forward speed of 13 kt and an RMW close to climatology, an intensity of 130 kt is selected for 18Z on the 16th, up from 105 kt originally in HURDAT, a major intensity change.

September 17:

1. Maps and old HURDAT:
   - HWM analyzes a hurricane of at most 990 mb at 24.2N, 65.3W with a frontal boundary far to the northwest at 12Z.
   - HURDAT lists a 110 kt hurricane at 24.4N, 65.2W at 12Z.
   - Microfilm shows a closed low pressure of at most 1002 mb at 24.5N, 66.0W at 12Z.
2. Ship highlights:
   - 40 kt SE and 1013 mb at 27.4N, 62.8W at 12Z (COADS).
   - 40 kt W and 1008 mb at 22.5N, 68.9W at 15Z (micro).
   - 45 kt W and 1004 mb at 22.8N, 68.1W at 18Z (COADS).
   - 45 kt W and 1001 mb at 23.0N, 68.1W at 21Z (MWL).
3. Aircraft highlights:
   - Penetration center fix with 924 mb extratpolated from flight-level with an eye diameter of 17 nm at 24.1N, 64.1W at 07Z (ATSR).
   - Penetration center fix measured a central pressure of 928 mb, estimated surface winds of 80 kt and an eye diameter of 18 nm at 24.5N, 65.5W at 1313Z (ATSR/micro).

- Penetration center fix measured a central pressure of 940 mb, estimated surface winds of 112 kt and an RMW of 10 nm at 24.0N, 65.0W around 1420Z (NHRP).
- Penetration center fix measured a central pressure of 927 mb, estimated surface winds of 120 kt and an eye diameter of 15 nm at 25.0N, 66.4W at 19Z (ATSR).
- Penetration center fix measured a pressure of 919 mb (from D-values not in center extrapolated from 811 mb) at 1914Z (NHRP).
- Radar center fix estimated an eye diameter of 17 nm at 25.4N, 66.9W at 2346Z (ATSR).

4. Discussion:
   - MWR: "By the 17th, the central pressure had dropped to 927 mb. According to the various formulae relating central pressure and maximum wind, this would support 150- to 175-kt squalls. Since the storm path was well to the north of the Virgin Islands, Puerto Rico, and the Bahamas, effects in these areas consisted mostly of increased surf and large swells."
   - ATSR: "Gradual intensification was indicated when, on the 17th, a reconnaissance aircraft reported a central pressure of 927 mb."
   - Reanalysis: On September 17th, Esther was a powerful hurricane between Puerto Rico and Bermuda. An approaching trough caused the ridge to the north to weaken allowing the hurricane to take more northwestward track. An ATSR penetration fix at 19Z on the 17th measured a central pressure of 927 mb, estimated surface winds of 120 kt and an eye diameter of 15 nm. An eye diameter of 15 nm suggests an RMW of about 10 nm and climatology indicates 15 nm. However, the NHRP aircraft measured a central pressure of 919 mb at 1914Z. This pressure suggests maximum sustained winds of 139 kt from the south of 25N and 133 kt from the north of 25N pressure-wind relationships. Based on a forward speed of 11 kt and an RMW smaller than climatology, an intensity of 140 kt is selected for 18Z on the 17th, up from 110 kt originally in HURDAT, a major intensity change. 140 kt is the peak intensity of Hurricane Esther, up from 125 kt originally in HURDAT from 12Z on the 18th to 18Z on the 19th.

September 18:

1. Maps and old HURDAT:
   - HWM analyzes a hurricane of at most 990 mb at 26.5N, 68.6W with a weakening stationary front to the northwest at 12Z.
   - HURDAT lists a 125 kt hurricane at 27.0N, 68.6W at 12Z.
   - Microfilm shows a closed low pressure of at most 1002 mb at 27.0N, 68.8W at 12Z.
2. Ship highlights:
   - 50 kt SE and 1012 mb at 27.2N, 64.1W at 00Z (COADS).
   - 55 kt SE and 1010 mb at 27.2N, 64.7W at 06Z (COADS).
   - 40 kt SSW and 1006 mb at 23.9N, 66.3W at 09Z (MWL).
   - 55 kt SE and 1010 mb at 27.1N, 65.5W at 12Z (COADS).
   - 55 kt E and 1014 mb at 30.3N, 66.2W at 15Z (COADS).
   - 55 kt E and 1006 mb at 30.0N, 69.3W at 18Z (COADS).
   - 45 kt SSE and 1013 mb at 29.6N, 65.0W at 21Z (micro).
3. Aircraft highlights:
   - Penetration center fix measured a central pressure of 928 mb, estimated flight level winds of 80 kt and an eye diameter of 16 nm at 25.6N, 67.5W at 0130Z (ATSR).
   - Penetration center fix measured a central pressure of 933 mb, estimated an eye diameter of 16 nm at 26.0N, 68.3W at 07Z (ATSR).

- Penetration center fix measured a central pressure of 936 mb and estimated surface winds of 140 kt at 27.0N, 68.8W at 13Z (ATSR/WALLET).
- Penetration center fix measured a central pressure of 946 mb and estimated an eye diameter of 40 nm at 27.6N, 69.4W at 16Z (ATSR/WALLET).
- Penetration center fix measured a central pressure of 943 mb at 28.2N, 69.8W at 19Z (ATSR/WALLET).

4. Discussion:
   - ATSR: "The track changed to a more northwesterly direction on the morning of the 18th as Esther headed toward Cape Hatteras."
   - Reanalysis: On September 18th, Esther continued on a northwestward track passing between Bermuda and the Bahamas. Ships on the 18th remained in the periphery of the hurricane and the highest winds reported were 55 kt. Reconnaissance aircraft continued to routinely penetrate the center of Esther. The first penetration fix on the 18th occurred at 0130Z measuring a central pressure of 928 mb, estimating flight level winds of 80 kt and an eye diameter of 16 nm. An eye diameter of 16 nm suggests an RMW of 12 nm and climatology indicates 15 nm. A central pressure of 928 mb suggests maximum sustained winds of 132 kt south of 25N and 125 kt north of 25N from the pressure-wind relationship. Based on a forward speed of 10 kt and an RMW smaller than climatology, an intensity of 135 kt is selected for 00Z on the 18th, up from 120 kt originally in HURDAT, a minor intensity change. A penetration fix at 07Z on the 18th measured a central pressure of 933 mb and an eye diameter of 16 nm. An eye diameter of 16 nm suggests an RMW of 12 nm and climatology indicates 15 nm. A central pressure of 933 mb suggests maximum sustained winds of 116 kt weakening north of 25N and 122 kt weakening south of 25N from the pressure-wind relationship. Based on a forward speed of 11 kt and an RMW smaller than climatology, an intensity of 125 kt is selected for 06Z on the 18th, up from 120 kt originally in HURDAT, a minor intensity change. Another penetration fix at 13Z on the 18th measured a central pressure of 936 mb and estimated surface winds of 140 kt. A central pressure of 936 mb suggests maximum sustained winds of 118 kt from the north of 25N pressure-wind relationship. Based on a forward speed of 14 kt, an intensity of 120 kt is selected for 12Z on the 18th, down from 125 kt originally in HURDAT, a minor intensity change. Another penetration fix at 19Z on the 18th measured a central pressure of 943 mb. At 16Z, a reconnaissance aircraft estimated an eye diameter of 40 nm. A central pressure of 943 mb suggests maximum sustained winds of 107 kt from the north of 25N weakening pressure-wind relationship. An eye diameter of 40 nm suggests an RMW of 30 nm and climatology indicates 17 nm. Based on a forward speed of 13 kt and an RMW larger than climatology, an intensity of 105 kt is selected for 18Z on the 18th, down from 125 kt originally in HURDAT, a major intensity change. Given the rather sudden increase in size and moderate filling of the central pressure, Esther may have undergone through a concentric eyewall cycle.

September 19:

1. Maps and old HURDAT:
   - HWM analyzes a hurricane of at most 990 mb at 30.6N, 71.5W with a warm front far to the north at 12Z.
   - HURDAT lists a 125 kt hurricane at 31.0N, 71.9W at 12Z.
   - Microfilm shows a closed low pressure of at most 1002 mb at 31.0N, 72.0W at 12Z.
2. Ship highlights:
   - 55 kt E and 1003 mb at 30.0N, 68.7W at 00Z (COADS).
   - 55 kt SSE and 1008 mb at 31.4N, 68.1W at 06Z (COADS).

- 50 kt SE and 1010 mb at 31.3N, 67.6W at 12Z (COADS).
- 40 kt NNE and 1008 mb at 33.2N, 74.7W at 15Z (micro).
- 55 kt NW at 30.9N, 74.7W at 18Z (micro).

3. Aircraft highlights:
   - Penetration center fix measured a central pressure of 950 mb and estimated an eye diameter of 25 nm at 29.4N, 70.4W at 01Z (ATSR).
   - Penetration center fix measured a central pressure of 943 mb at 29.8N, 71.1W at 0430Z (ATSR). (700 and 850 mb heights and temperatures from this drop suggest surface value of 948-949 mb, not consistent with 943 mb. Thus the 943 mb is considered erroneous.)
   - Penetration center fix measured a central pressure of 949 mb at 30.0N, 71.4W at 07Z (ATSR). (Value in vortex message indicated 948 mb.)
   - Penetration center fix measured a central pressure of 940 mb and estimated an eye diameter of 35 nm at 30.4N, 71.8W at 1030Z (WALLET).
   - Penetration center fix measured a central pressure of 943 mb, estimated flight level winds of 105 kt and an eye diameter of 35 nm at 30.8N, 71.9W at 13Z (WALLET).
   - Penetration center fix measured a central pressure of 949 mb and estimated surface winds of 100 kt at 31.4N, 72.3W at 1545Z (ATSR).
   - Penetration center fix measured a central pressure of 951 mb at 32.0N, 72.7W at 19Z (WALLET).
   - Penetration center fix measured a central pressure of 945 mb, estimated flight level winds of 95 kt and an eye diameter of 35 nm at 32.5N, 72.9W at 2155Z (WALLET).
4. Discussion/Reanalysis: On September 19th, Esther was still a major hurricane on a northwestward track toward the East Coast of the United States but filled some early in the day. A penetration fix at 01Z measured a central pressure of 950 mb. A central pressure of 950 mb suggests maximum sustained winds of 101 kt from the north of 25N weakening pressure-wind relationship. Based on a forward speed of 13 kt, an intensity of 105 kt is selected for 00Z on the 19th, down from 125 kt originally in HURDAT, a major intensity change. Another reconnaissance aircraft at 07Z on the 19th measured a central pressure of 949 mb. At 13Z on the 19th, a reconnaissance aircraft measured a central pressure of 943 mb and estimated an eye diameter of 35 nm. A central pressure of 943 mb suggests maximum sustained winds of 112 kt from the north of 25N from the pressure-wind relationship. An eye diameter of 35 nm suggests an RMW of 26 nm and climatology indicates 19 nm. Due to a forward speed of 13 kt and an RMW larger than climatology, an intensity of 105 kt is selected for 12Z on the 19th, down from 125 kt originally in HURDAT, a major intensity change. A penetration fix at 1545Z on the 19th measured a central pressure of 949 kt and estimated surface winds of 100 kt. At 19Z on the 19th, a central pressure of 951 mb was measured. A blend of these measurements gives 950 mb, which was already in HURDAT at 18Z and has been retained. A central pressure of 950 mb suggests maximum sustained winds of 105 kt north of 25N from the pressure-wind relationship. An intensity of 105 kt is selected for 18Z on the 19th, down from 125 kt originally in HURDAT, a major intensity change. It is noted that the 943 mb pressure measured around 12Z is somewhat lower than those measured earlier and later in the day and thus are questionable.

September 20:

1. Maps and old HURDAT:
   - HWM analyzes a hurricane of at most 990 mb at 35.0N, 73.2W with a weakening warm front to the north at 12Z.
   - HURDAT lists a 120 kt hurricane at 35.0N, 73.3W at 12Z.

- Microfilm shows a closed low pressure of at most 999 mb at 35.0N, 73.2W at 12Z.

2. Ship highlights:
   - 55 kt NNE and 1004 mb at 34.0N, 75.4W at 00Z (COADS).
   - 55 kt NW and 1004 mb at 31.5N, 74.5W at 03Z (micro).
   - 45 kt SE and 1007 mb at 35.0N, 70.0W at 06Z (COADS).
   - 45 kt WNW and 1005 mb at 31.8N, 74.3W at 09Z (micro).
   - 70 kt SE at 36.4N, 70.1W at 12Z (micro).
   - 45 kt S and 1003 mb at 33.9N, 70.2W at 15Z (micro).
   - 70 kt ESE and 1006 mb at 36.5N, 69.1W at 18Z (micro).
   - 40 kt NNW and 1006 mb at 37.5N, 76.1W at 21Z (COADS).
3. Land highlights:
   - 37 kt NNE and 1011 mb at Frying Pan Shoals, NC at 00Z (SWO).
   - 40 kt N and 1001 mb at Diamond Shoals, NC at 06Z (micro).
   - 28 kt N (31 kt peak) and 999 mb at Cape Hatteras, NC at 0955Z (SWO/CLIMO).
   - 25 kt NW and 1003 mb at 35.2N, 75.3W at Diamond Shoals, NC at 18Z (micro).
4. Aircraft highlights:
   - Penetration center fix measured a central pressure of 952 mb, estimated flight level winds of 95 kt and an eye diameter of 25-35 nm at 33.2N, 73.1W at 01Z (ATSR).
   - Penetration center fix measured a central pressure of 957 mb at 33.7N, 73.2W at 04Z (ATSR).
   - Penetration center fix measured a central pressure of 956 mb at 33.9N, 73.2W at 07Z (ATSR).
   - Penetration center fix measured a central pressure of 948 mb, estimated flight level winds of 115 kt and an eye diameter of 32 nm at 35.1N, 73.3W at 1215Z (ATSR).
   - Penetration center fix measured a central pressure of 953 mb and estimated an eye diameter of 25-40 nm at 35.9N, 72.9W at 1544Z (WALLET).
   - Radar center fix at 36.8N, 72.8W at 1845Z (ATSR).
   - Penetration center fix measured a central pressure of 962 mb extrapolated from 700 mb flight-level data and estimated surface winds of at least 65 kt at 37.7N, 72.3W at 23Z (ATSR).
5. Discussion:
   - MWR: "A gradual curving to the north and subsequently to the north-northeast took the center about 120 miles to the east of Cape Hatteras on the morning of the 20th."
   - ATSR: "After 1000Z on the 20th, when the center was approximately 130 miles east-southeast of Cape Hatteras, the hurricane began to recurve to the north-northeast. The track was nearly parallel to the east coast of the United States for the next 24 hours."
   - Reanalysis: Early on September 20th, Esther turned to the north passing about 110 nm east of Cape Hatteras, North Carolina. The Schwerdt et al. parametric hurricane wind model suggests that the highest sustained winds that impacted North Carolina were 40 kt in the Outer Banks. Surface observations show tropical force winds near the coast, especially at elevated sites, but the highest sustained winds measured at Cape Hatteras were 31 kt. Thus, North Carolina is not added to the list of states impacted by tropical storm force winds, although it is possible that somewhere along the Outer Banks winds may have reached gale-force on the

20th. Esther entered an area of heavier shipping traffic on the 20th along the East Coast of the United States and various ships reported tropical storm force winds, there was even a ship that experienced hurricane-force winds (70 kt) at 12Z and 18Z. At 01Z on the 20th, a reconnaissance aircraft measured a central pressure of 952 mb, estimated flight level winds of 95 kt and an elongated eye diameter of 25-35 nm. A central pressure of 952 mb suggests maximum sustained winds of 103 kt from the north of 25N pressure-wind relationship. An eye diameter of 25-35 nm suggests an RMW of 19-26 nm and climatology indicates 24 nm. Due to a forward speed of 10 kt and an RMW close to climatology, an intensity of 105 kt is selected for 00Z on the 20th, down from 120 kt originally in HURDAT, a minor intensity change. A reconnaissance aircraft measured a central pressure of 948 mb, estimated flight level winds of 115 kt and an eye diameter of 32 nm at 1215Z on the 20th. A central pressure of 948 mb suggests maximum sustained winds of 107 kt north of 25N and 112 kt intensifying from the Brown et al. pressure-wind relationship and 98 kt north of 35N from the Landsea et al. pressure-wind relationship. An eye diameter of 32 nm suggests an RMW of 24 nm and climatology indicates 25 nm. Due to a forward speed of 13 kt and an RMW close to climatology, an intensity of 105 kt is selected for 12Z on the 20th, down from 120 kt originally in HURDAT, a minor intensity change. Another penetration fix measured a central pressure of 953 mb at 1544Z on the 20th. A central pressure of 953 mb suggests maximum sustained winds of 95 kt north of 35N from the Landsea et al. pressure-wind relationship. Due to a forward speed of 16 kt, an intensity of 100 kt is selected for 18Z on the 20th, down from 120 kt originally in HURDAT, a major intensity change.

September 21:

1. Maps and old HURDAT:
   - HWM analyzes a hurricane of at most 990 mb at 40.0N, 71.2W at 12Z.
   - HURDAT lists a 110 kt hurricane at 40.4N, 71.1W at 12Z.
   - Microfilm shows a closed low pressure of at most 996 mb at 40.5N, 71.2W at 12Z.
2. Ship highlights:
   - 65 kt NE and 991 mb at 38.9N, 73.2W at 00Z (COADS).
   - 45 kt SW and 1004 mb at 36.0N, 70.1W at 03Z (micro).
   - 70 kt NW and 998 mb at 38.0N, 73.8W at 06Z (COADS).
   - 55 kt W and 1003 mb at 38.1N, 72.4W at 12Z (COADS).
   - 60 kt NW and 992 mb at 40.5N, 72.1W at 18Z (COADS).
3. Land highlights:
   - 988 mb at Block Island, RI (time unknown) (CLIMO).
   - 40 kt NW (gusts to 51 kt) and 1001 mb at Atlantic City, NJ at 0756Z (SWO).
   - 41 kt NNE (gusts to 55 kt) and 998 mb at 0958Z (SWO).
   - 41 kt NNE (gusts to 72 kt) at Block Island, RI at 10Z (SWO).
   - 42 kt NE and 991 mb at Block Island, RI at 12Z (SWO).
   - 48 kt N (gusts to 60 kt) at Calverton, NY at 13Z (SWO).
   - 50 kt N (gusts to 63 kt) at Calverton, NY at 15Z (SWO).
   - 33 kt NNE and 989 mb at Block Island, RI at 18Z (SWO).
4. Aircraft highlights:
   - Penetration center fix measured a central pressure of 962 mb at 37.9N, 72.4W at 01Z (ATSR).
   - Penetration center fix measured a central pressure of 967 mb at 38.4N, 72.2W at 0355Z (ATSR). (Note that

- Penetration center fix measured a central pressure of 970 mb at 40.0N, 71.9W at 1030Z (ATSR).
- Penetration center fix measured a central pressure of 974 mb at 40.2N, 71.6W at 13Z (ATSR).
- Radar center fix at 40.8N, 71.3W at 19Z (ATSR).

5. Discussion:
   - MWR: "…and to about 35 miles south-southeast of Block Island, RI, 24 hours later. Gales swept the coastal strip from the Outer Banks of North Carolina to New Jersey and, early on September 21, winds reached hurricane force from eastern Long Island to Block Island. Gusts hit 40 kt at Ocean City, MD, and 60 kt at Atlantic City, NJ. Montauk Point, RI, and Block Island, which were nearer the storm center, reported peak gusts of 94 kt and 72 kt, respectively, at 0500 EST on the 21st Cape Cod also experienced hurricane force gusts. Fortunately for New England, Esther weakened markedly in passing over colder waters north of 35°N, and also took a sharp eastward turn on the afternoon of September 21. This turn was the beginning of a large clockwise loop which carried the center southward almost to the latitude of Cape Hatteras then back to intersect the original path near Nantucket Island four days later."
   - ATSR: "As Esther deceased in intensity the track changed to the east on the morning of the 21st and eventually completed a large clockwise loop."
   - Reanalysis: On September 21st, Esther approached the Northeast of the United States before slowing its forward speed and turning to the east. The Schwerdt et al. parametric hurricane wind model suggests that the highest sustained winds that impacted New Jersey on the 21st were 39 kt. The model also suggests that New York experienced 59 kt winds, also 59 kt in Rhode Island and 52 kt in Connecticut. It is possible that higher winds could have affected the coast as the RMW used in the formula was the last available, reported at 1544Z on the 20th, and by the 21st, the RMW was likely larger. The highest sustained winds reported in New Jersey were 40 kt measured at Atlantic City at 0756Z and Newark at 1039Z on the 21st. The highest sustained winds in New York were 50 kt at Calverton at 15Z on the 21st. The highest sustained winds in Connecticut were 41 kt at Bridgeport at 0958Z on the 21st. And the highest sustained winds in Rhode Island were 42 kt at Block Island at 12Z on the 21st. Thus, New Jersey is added as a tropical storm impact with 40 kt winds, New York and Rhode Island with 60 kt winds, and Connecticut with 50 kt winds. The center of the hurricane passed about 30 nm south of Martha's Vineyard around 18Z on the 21st. A reconnaissance aircraft measured a central pressure of 962 mb at 01Z on the 21th. A central pressure of 962 mb suggests maximum sustained winds of 88 kt north of 35N from the pressure-wind relationship. Due to a forward speed of 15 kt, an intensity of 90 kt is selected for 00Z on the 21st, down from 115 kt originally in HURDAT, a major intensity change. Weakening below major hurricane status is analyzed at 06Z on the 21st, 24 hours earlier than originally shown in HURDAT. Another penetration fix measured a central pressure of 968 mb at 0355Z on the 21th. A central pressure of 968 mb suggests maximum sustained winds of 84 kt north of 35N from the pressure-wind relationship. Due to a forward speed of 15 kt, an intensity of 85 kt is selected for 06Z on the 21st, down from 110 kt originally in HURDAT, a major intensity change. A penetration fix at 1030Z on the 21st measured a central pressure of 970 mb. At 13Z on the 21st, a central pressure of 974 mb was measured. A blend of these measured gives 972 mb. A central pressure of 972 mb suggests maximum sustained winds of 80 kt north of 35N from the pressure-wind relationship. Due to a forward speed of 9 kt, an intensity of 75 kt is selected for 12Z on the 21st, down from 110 kt

originally in HURDAT, a major intensity change. The last aircraft reconnaissance occurred late on the 21st.

September 22:

1. Maps and old HURDAT:
   - HWM analyzes a tropical storm of at most 995 mb at 40.2N, 67.2W with a weakening stationary front far to the northwest and a warm front far to the east at 12Z.
   - HURDAT lists a 45 kt tropical storm at 40.8N, 67.9W at 12Z.
   - Microfilm shows a closed low pressure of at most 996 mb at 39.8.N, 67.0W at 12Z.
2. Ship highlights:
   - 50 kt W and 991 mb at 39.6N, 71.1W at 00Z (COADS).
   - 70 kt WSW and 993 mb at 39.5N, 69.0W at 06Z (COADS).
   - 40 kt W and 1002 mb at 38.8N, 68.2W at 12Z (COADS).
   - 20 kt SE and 991 mb at 39.6N, 67.3W at 12Z (COADS).
   - 50 kt NNW and 1001 mb at 39.2N, 68.5W at 18Z (COADS).
3. Land highlights:
   - 8 kt N and 995 mb at Nantucket Light, MA at 00Z (SWO).
   - 8 kt N and 997 mb at Nantucket Light, MA at 06Z (SWO).
4. Discussion:
   - MWR: "The storm was producing only 35- to 45-kt squalls on the 22nd, but showed some regeneration over the warmer waters at the southernmost part of the loop and when it moved northward again passed Cape Cod maximum winds where 50 to 60 knots."
   - Reanalysis: HURDAT originally showed an unrealistic drop in intensity from 105 kt at 18Z on the 21st to 60 kt at 00Z on September 22nd. Synoptic observations on the 22nd indicate that Esther moved southeastward, away from the Northeast of the United States. The hurricane continued to slowly lose strength and is analyzed to have weakened to a tropical storm at 18Z on the 22nd, 18 hours later than originally shown in HURDAT. Official advisories were ended at 16Z on the 22nd by the Boston Weather Bureau citing that the cyclone was no longer tropical. Ship and coastal observations do show a slight temperature gradient across Esther but the cyclone remained symmetric and no frontal boundaries developed, indicating that the system retained its tropical characteristics. Major intensity changes are analyzed at 06Z and 12Z on the 22nd. Intensities of 70 kt and 65 kt are selected, respectively, based upon a ship report of 70 kt at 06Z, and HURDAT originally showed 50 kt and 45 kt, respectively.

September 23:

1. Maps and old HURDAT:
   - HWM analyzes a tropical storm of at most 1000 mb at 38.4N, 64.7W with a cold front far to the northwest and weakening warm front to the northeast at 12Z.
   - HURDAT lists a 60 kt tropical storm at 37.9N, 64.9W at 12Z.
   - Microfilm shows a closed low pressure of at most 993 mb at 37.0N, 65.5W at 12Z.
2. Ship highlights:
   - 993 mb at 38.3N, 65.1W at 00Z (COADS).
   - 35 kt W and 998 mb at 36.1N, 66.3W at 00Z (COADS).
   - 45 kt N and 1005 mb at 39.5N, 67.3W at 06Z (COADS).
   - 45 kt NW and 1014 mb at 30.6N, 70.0W at 12Z (COADS).
   - 40 kt NNW and 1005 mb at 36.0N, 69.6W at 18Z (micro).

3. Discussion/Reanalysis: On September 23rd, Esther moved southward and southwestward toward warmer waters and the temperature gradient gradually disappeared. The intensity of the cyclone continued to decrease reaching 45 kt at 18Z on the 23rd, down from 60 kt originally in HURDAT, a minor intensity change. Various ships reported gale-force winds, including 45 kt at 06Z and 12Z.

September 24:

1. Maps and old HURDAT:
   - HWM analyzes a tropical storm of at most 1005 mb at 35.3N, 67.7W with a cold front to the north at 12Z.
   - HURDAT lists a 50 kt tropical storm at 35.7N, 67.4W at 12Z.
   - Microfilm shows a closed low pressure of at most 1008 mb at 35.0N, 68.0W with a frontal boundary to the northwest at 12Z.
2. Ship highlights:
   - 20 kt NNE and 997 mb at 36.2N, 66.8W at 00Z (COADS).
   - 35 kt NW and 1005 mb at 35.6N, 68.7W at 00Z (COADS).
   - 40 kt NE and 1013 mb at 39.0N, 69.0W at 06Z (COADS).
   - 40 kt E and 1013 mb at 39.1N, 67.7W at 12Z (COADS).
   - 50 kt W and 1009 mb at 35.3N, 65.8W at 18Z (COADS).
3. Discussion/Reanalysis: On September 24th, Esther turned to the west and northwest and began to regain strength late on the day. A ship reported 50 kt at 18Z on the 24th.

September 25:

1. Maps and old HURDAT:
   - HWM analyzes a tropical storm of at most 1000 mb at 37.7N, 70.3W with a frontal boundary to the north at 12Z.
   - HURDAT lists a 45 kt tropical storm at 38.1N, 70.5W at 12Z.
   - Microfilm shows a closed low pressure of at most 999 mb at 38.0N, 70.5W at 12Z.
2. Ship highlights:
   - 20 kt S and 995 mb at 36.1N, 68.6W at 00Z (COADS).
   - 40 kt NE and 998 mb at 37.3N, 70.2W at 00Z (COADS).
   - 50 kt SE and 994 mb at 37.2N, 69.9W at 06Z (COADS).
   - 30 kt NW and 990 mb at 37.9N, 71.3W at 12Z (COADS).
   - 50 kt SSE and 1000 mb at 37.9N, 70.0W at 12Z (micro).
   - 45 kt E and 999 mb at 39.5N, 71.2W at 18Z (COADS).
   - 25 kt WSW and 993 mb at 38.0N, 71.1W at 18Z (micro).
3. Discussion/Reanalysis: On September 25th, Esther turned to the north and once again took aim at the New England coast, although much weaker than a couple of days ago. Advisories were reinitiated by the Boston Weather Bureau at 14Z on the 25th announcing the approaching storm. Various ships reported tropical storm force winds, including 50 kt at 06Z and 12Z. The intensity of Esther remained at 50 kt on the 25th, 5 kt higher than originally shown in HURDAT, minor intensity changes.

September 26:

1. Maps and old HURDAT:
   - HWM analyzes a closed low pressure of at most 1005 mb at 44.2N, 70.5W in the warm sector of an extratropical cyclone of at most 1005 mb at 45.0N, 79.5W at 12Z.
   - HURDAT lists a 30 kt tropical storm at 44.7N, 69.8W at 12Z.
   - Microfilm shows a closed low pressure of at most 1002 mb at 44.7N, 70.3W with an extratropical cyclone to the west at 12Z.
2. Ship highlights:

- 40 kt S and 997 mb at 39.2N, 70.0W at 00Z (COADS).
- 20 kt SW and 997 mb at 39.0N, 70.0W at 00Z (COADS).
- 40 kt SW and 1008 mb at 39.5N, 68.5W at 06Z (COADS).
- 55 kt SW and 1013 mb at 41.0N, 66.5W at 12Z (COADS).
- 35 kt SW and 1018 mb at 40.9N, 65.4W at 18Z (COADS).

3. Land highlights:
   - 40 kt SSE and 1002 mb at Nantucket Light, MA at 00Z (SWO).
   - 55 kt SSW and 999 mb at Nantucket Light, MA at 06Z (SWO).
   - 4 kt NE and 1004 mb at Augusta, ME at 1158Z (SWO).
   - 8 kt SSW and 1002 mb at Loring AFB, ME at 2055Z (SWO).
4. Discussion:
   - MWR: "The storm accelerated northward through Maine on the 26th, gradually weakened, and turned northeastward toward Labrador as a frontal disturbance."
   - ATSR: "The storm became extratropical over Maine on the 26th. The Joint Hurricane Warning Center promulgated a total of 40 warnings on Esther during the period 12-21 September. In addition to aircraft reconnaissance, land-based radars located at Hatteras, Wilmington, Norfolk, Wallops Island, New York City, and Nantucket participated in the tracking of the hurricane from a position approximately 200 miles to the southeast of Cape Hatteras until the start of the loop. Gale force winds, rain and storm surge caused considerable damage along the eastern seaboard from the Virginia Capes to Nantucket Island. Storm surges ranged up to 5 feet above normal in some areas."
   - Reanalysis: On September 26th, Esther finished a long, clockwise loop that began late on the 21st. The tropical storm made landfall in Nantucket at 05Z on the 26th with 50 kt winds. An hour later, the center reached Cape Cod with the same intensity. Surface observations indicate that the strongest winds were located on the eastern quadrant. Cities in Massachusetts on the western quadrant did not experience tropical storm force winds based on the surface reports. The strongest winds were 55 kt, measured at Nantucket Light, MA, an elevated site of about 60 ft, at 06Z on the 26th. The winds reduced to 10 m are about 53 kt. An approaching extratropical cyclone from the west caused Esther to accelerate to the north and landfall in Maine is analyzed at 11Z on the 26th as a 35 kt tropical storm. Over land, Esther weakened to a tropical depression at 18Z on the 26th, six hours later than originally shown in HURDAT.

September 27:

1. Maps and old HURDAT:
   - HWM analyzes an extratropical cyclone of at most 1000 mb at 53.0N, 57.0W at 12Z.
   - HURDAT lists a 30 kt extratropical depression at 50.0N, 67.0W at 12Z. Microfilm shows an extratropical cyclone of at most 1005 mb at 52.0N, 57.0W at 12Z.
2. Land highlights:
   - 5 kt SSE and 1004 mb at Sainte Angele de Merici, Canada at 00Z (micro).
3. Discussion/Reanalysis: Surface observations indicate that Esther became extratropical around 00Z, same as originally shown. The system was absorbed by another extratropical system after 06Z. Thus dissipation after than time is unchanged.

Date	Original HURDAT Central	Evidence	Changes

	Pressure		
Sep 12 12Z	975 mb	Likely to be an analysis, not based on observation and may not be reasonable	Removed
Sep 12 18Z	967 mb	Penetration center fix: 967 mb at 2010Z	Retained
Sep 13 06Z		Penetration center fix: 969 mb at 09Z	969 mb
Sep 13 12Z	970 mb	Likely to be an analysis, but is reasonable	Retained
Sep 13 18Z	983 mb	Likely to be an analysis, not based on observation and may not be reasonable	Removed
Sep 14 06Z		Penetration center fix: 962 mb at 07Z	962 mb
Sep 14 12Z	975 mb	Likely to be an analysis, not based on observation and may not be reasonable	Removed
Sep 14 18Z	966 mb	Penetration center fix: 965 mb at 2017Z	965 mb
Sep 15 00Z	965 mb	Likely to be an analysis, but is reasonable	Retained
Sep 15 06Z	965 mb	Penetration center fix: 968 mb at 07Z	968 mb
Sep 15 12Z	966 mb	Penetration center fix: 966 mb at 13Z	Retained
Sep 15 18Z	961 mb	Likely to be an analysis, but is reasonable	Retained
Sep 16 00Z	960 mb	Penetration center fix: 960 mb at 01Z	Retained
Sep 16 06Z	956 mb	Penetration center fix: 954 mb at 07Z	954 mb
Sep 16 12Z	949 mb	Penetration center fix: 948 mb at 1255Z	948 mb
Sep 16 18Z	944 mb	Penetration center fix: 935 mb at ~18Z	935 mb
Sep 17 00Z	939 mb	Likely to be an analysis, not based on observation and may not be reasonable	Removed
Sep 17 06Z	934 mb	Penetration center fix: 924 mb at 07Z	924 mb
Sep 17 12Z	930 mb	Penetration center fix: 928 mb at 1333Z	928 mb
Sep 17 18Z	927 mb	Penetration center fixes: 919 mb at 1914Z	919 mb
Sep 18 00Z	928 mb	Penetration center fixes: 928 mb at 0130Z	Retained
Sep 18 06Z	933 mb	Penetration center fix: 933 mb at 07Z	Retained
Sep 18 12Z	938 mb	Penetration center fix: 936 mb at 13Z	936 mb
Sep 18 18Z	944 mb	Penetration center fix: 943 mb at 19Z	943 mb
Sep 19 00Z	948 mb	Penetration center fix: 950 mb at 01Z	950 mb
Sep 19 06Z	945 mb	Penetration center fix: 943 mb at 07Z	949 mb
Sep 19 12Z	942 mb	Penetration center fix: 940 mb at 13Z	943 mb
Sep 19 18Z	950 mb	Penetration center fix: 949 mb at 1545Z and 951 mb at 19Z	Retained
Sep 20 00Z	947 mb	Penetration center fix: 952 mb at 01Z	952 mb
Sep 20 06Z	957 mb	Penetration center fix: 956 mb at 07Z	956 mb
Sep 20 12Z	949 mb	Penetration center fix: 948 mb at 1215Z	948 mb
Sep 20 18Z	955 mb	Penetration center fix: 953 mb at 1544Z	953 mb
Sep 21 00Z	968 mb	Penetration center fix: 962 mb at 01Z	962 mb
Sep 21 06Z	972 mb	Penetration center fix: 967 mb at 0355Z	967 mb
Sep 21 12Z	978 mb	Penetration center fix: 970 mb at 1030Z and 974 mb at 13Z	972 mb
Sep 22 12Z	990 mb	Ship: 20 kt SE and 991 mb at 12Z	989 mb
Sep 23 00Z	993 mb	Ship: 993 mb (no wind reported) at 00Z	Retained
Sep 24 00Z		Ship: 20 kt NNE and 997 mb at 00Z	995 mb
Sep 25 00Z		Ship: 30 kt N and 996 mb at 12Z	993 mb
Sep 25 06Z	993 mb	A ship report near the center of 50 kt SE and 994 mb at 06Z on Sep 25 suggest a lower central pressure	Removed
Sep 25 12Z		Ship: 30 kt NW and 993 mb at 12Z	990 mb
Sep 25 18Z		Ship: 25 kt WSW and 993 mb at 18Z	990 mb
Sep 26 00Z	996 mb	A ship report near the center of 40 kt S and 997 mb at 00Z on Sep 26th suggest a lower central pressure	Removed

Sep 26 12Z	1002 mb	Portland, ME: 10 kt WSW and 1004 mb at 12Z	Retained

Sources: the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Monthly Weather Review, Navy reconnaissance book, Mariners Weather Log, National Hurricane Research Project, Local Climatological Data, NHC Storm Wallets, and Fett (1964, MWR).

Unnamed Tropical Storm [September 12–15, 1961]

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42125 09/12/1961 M= 4  6 SNBR= 913 NOT NAMED   XING=1 SSS=0

42130 09/12*  0   0   0    0*  0   0   0    0*258 780  25    0*260 780  30    0*
42130 09/12*  0   0   0    0*  0   0   0    0*258 780  25    0*260 780  25    0*
                                                                      **

42135 09/13*262 781  30    0*270 781  30    0*286 782  30    0*300 782  30    0*
42135 09/13*264 781  25    0*270 781  25    0*282 782  30    0*296 782  35    0*
            ***      **                **      ***               ***      **

42140 09/14*317 782  30    0*330 781  30    0*347 779  35    0*367 768  35    0*
42140 09/14*313 782  40    0*330 781  40    0*344 776  40    0*360 766  40    0*
            ***      **                **      *** ***  **      *** ***  **

42145 09/15*387 754  35    0*407 735  35    0*441 701  35    0*476 630  30    0*
42145 09/15*383 753  50    0*407 732  55  996E441 701  60  995*  0   0   0    0*
            *** ***  **          ***  **  ****         **  ***   *   *   *

42150 TS
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U.S. Tropical Storm Landfall

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09/14 12Z 34.4N 77.6W 40 kt NC
      21Z 37.1N 76.0W 45 kt VA
09/15 06Z 40.7N 73.2W 55 kt NY
      07Z 41.3N 72.7W 55 kt CT
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Significant Revisions:

1. Intensity boosted upward substantially on the 15th based upon ship and coastal observations;
2. Peak intensity raised from 35 kt to 55 kt as a tropical cyclone (60 kt intensity as an extratropical cyclone);
3. A few central pressures added based upon ship and coastal observations;
4. An extratropical cyclone phase added on the 15th before dissipation.

Daily Metadata:

September 10:

1. Maps and old HURDAT:
   - HWM analyzes a trough or tropical wave over the Windward Passage along longitude 74W at 12Z.
   - HURDAT does not list an organized storm on this day.
   - Microfilm shows a trough or tropical wave north of Hispaniola along longitude 71W at 12Z.
2. Discussion:

- FAY: "During the period from September 9 to 12, 1961, T1ROS III was well oriented for photographing the area south and east of Florida. On each of these days, nephanalyses from the photographs indicated a vortex present just east of the Bahamas. It is not possible to determine in what portion of the atmosphere these vortices were located, nor even if they were one and the same."
- Reanalysis: The unnamed tropical storm developed from a tropical wave that left the African coast early in September. The disturbance did not show signs of organization while crossing the eastern and central Atlantic. A paper by Richard Fay (MWR 1962, pg. 351) titled "Northbound Tropical Cyclone" shows a nephanalysis (fig. 1) of a TIROS III satellite image of September 9th while the system was north of Hispaniola. The nephanalysis suggests that the convection was located over the developed northern and eastern quadrant of the circulation. However, surface observations indicated that no closed circulation at the surface existed on that day.

September 11:

1. Maps and old HURDAT:
   - HWM analyzes a spot low pressure at 23.0N, 72.2W at 12Z.
   - HURDAT does not list an organized storm on this day.
   - Microfilm shows a trough or tropical wave over the central Bahamas at 12Z.
2. Discussion/Reanalysis: Surface observations show that a tropical wave reached the Bahamas on September 11th and a well-defined low-level center gradually developed.

September 12:

1. Maps and old HURDAT:
   - HWM analyzes a spot low pressure at 25.8N, 77.1W at 12Z.
   - HURDAT lists a 25 kt tropical depression at 25.8N, 78.0W at 12Z (first position).
   - Microfilm shows an elongated, closed low pressure of at most 1013 mb near 25.0N, 78.0W at 12Z.
2. Satellite fixes:
   - Fay (1962) estimates the position of the center from a TIROS III satellite image at 23.5N, 73.0W at 1935Z.
3. Discussion/Reanalysis: Genesis is analyzed at 12Z on September 12th as a 25 kt tropical depression, same as originally shown in HURDAT. Fig. 3 (Fay 1962) shows a TIROS III satellite image from September 12th at 1935Z.

September 13:

1. Maps and old HURDAT:
   - HWM analyzes a spot low pressure at 27.5N, 78.3W at 12Z.
   - HURDAT lists a 30 kt tropical depression at 28.6N, 78.2W at 12Z.
   - Microfilm shows an elongated, closed low pressure of at most 1013 mb near 28.0N, 78.6W at 12Z.
2. Discussion:
   - FAY: "By September 13 surface reports clearly indicated a cyclonic circulation east of Florida, and the edge of the circulation was again photographed by TIROS III (fig. 4), but while the clouds appear quite dense, the cyclonic circulation is not clearly defined in the reproduction."
   - Reanalysis: The weak tropical depression moved northward slowly gaining in forward speed on the 13th. A 30 kt observation over 100 nm from the center at 18Z is the basis for upgrading the system to a tropical storm at this time.

September 14:

1. Maps and old HURDAT:
   - HWM analyzes a closed low pressure of at most 1010 mb at 34.0N, 77.8W with a cold front well to the west at 12Z.
   - HURDAT lists a 35 kt tropical storm at 34.7N, 77.9W at 12Z.
   - Microfilm shows a closed low pressure of at most 1008 mb at 33.5N, 77.0W at 12Z.
2. Ship highlights:
   - 35 kt ESE and 1015 mb at 31.0N, 77.0W at 00Z (COADS).
   - 5 kt NE and 1003 mb at 37.1N, 76.3W at 37.1N, 76.3W at 21Z (COADS).
3. Land highlights:
   - 35 kt SE and 1012 mb at Frying Pan, NC at 06Z (micro).
   - 11 kt NW and 1008 mb at Wilmington, NC at 12Z (SWO).
   - 18 kt SSW (gusts to 32 kt) and 1002 mb at Elizabeth City, NC at 19Z (SWO)
4. Discussion:
   - FAY: "The photographs from subsequent orbital passes over the storm on September 14 and 15 failed to show any circulation in the general cloudiness in which it was imbedded. The tropical cyclone crossed the coast of North Carolina just east of Wilmington at about 0600 EST, September 14. At this time it was traveling toward the north-northeast at about 18 kt. The cyclone never moved far from the coastline and perhaps in this way maintained its tropical characteristics."
   - Reanalysis: The tropical storm continued northward early on the 14th, later turning to the northeast after crossing the coast. Landfall is analyzed east Wilmington, NC as a 40 kt tropical storm at 12Z on the 14th. The lowest pressure at Wilmington (1008 mb) allowed for an analysis of 1006 mb central pressure at landfall. The radar image from Hatteras, NC, on the 14th at 1630Z in the Fay report (MWR 1962, pg. 355) shows a low pressure with convection around the center. At the same time, a strong extratropical cyclone, remnants of Hurricane Carla, was located over the Great Lakes and moving northeastward. The small tropical storm, under the influence of the extratropical cyclone, accelerated over the East Coast of the United States and intensified, likely in part due to baroclinic forcing.

September 15:

1. Maps and old HURDAT:
   - HWM analyzes a closed low pressure of at most 995 mb at 44.5N, 69.5W with a cold front just to the west at 12Z.
   - HURDAT lists a 35 kt tropical storm at 44.1N, 70.1W at 12Z.
   - Microfilm shows a closed low pressure of at most 987 mb at 54.0N, 69.0W with a frontal boundary to the south (appears that the tropical cyclone has been absorbed) at 12Z.
2. Ship highlights:
   - 50 kt S and 1008 mb at 38.1N, 73.5W at 00Z (COADS).
   - 35 kt SW and 1009 mb at 37.5N, 74.6W at 06Z (COADS).
3. Land highlights:
   - Gusts to 60 kt at Point Judith, RI (no time given) (SD).
   - 70 kt (1-min) at Eastport, ME (no time given) (FAY, 1962).
   - 8 kt NNW and 1004 mb at Salisbury, MD at 2356Z (14th) (SWO).
   - 8 kt NW and 1003 mb at Atlantic City, NJ at 0258Z (SWO).
   - 34 kt SSE and 1010 mb at Nantucket Shoals, MA at 0555Z (SWO).
   - 14 kt WSW and 997 mb (from adjusted altimeter setting) at Suffolk AFB at 07Z (SWO).
   - 36 kt S (gusts to 45 kt) at Providence, RI at 0810Z (SWO/CLIMO).

- 27 kt S and 997 mb at Providence, RI at 0858Z (SWO).
- 6 kt S and 996 mb at Brunswick, ME at 1158Z (SWO).
- Gusts to 70 kt at Saint John, Canada at 16Z (FAY, 1962).

4. Discussion:
   - FAY: "From the forecast point of view, one of the problems was the acceleration which was continuous for the 27 hours when it was within the continental limits of the United States. During the final 2 hours it was moving at 60 kt. While the central pressure continued to decrease as the cyclone moved northward, the reported winds dropped off after it pressed Cape Hatteras. Highest gusts there were 38 kt, while Atlantic City recorded no winds of over 15 kt. By the time it reached Long Island, winds had again increased to 38 kt, which was recorded at Suffolk County Air Force Base as the center passed by. At about this time the Research Vessel Eugenie VIII, of the Woods Hole Oceanographic Institution was about 80 mi south-southeast of Block Island, R.I., and some 110 mi from the storm center. The captain, a man with long experience in small boats at sea, estimated winds of 50 kt and reported the sea condition as "very rough" and had some difficulty in bringing the vessel about to run before the wind. Point Judith, R.I., recorded gusts to 61 kt. and at Quonset Point, R.I., the carrier Lake Champlain parted her lines and drifted away from the dock. An airplane at the Groton (Conn.) Airport tore loose from three 1550-lb test nylon lines. At 0500 EST wave heights of 16 ft. were measured at a tower off the south coast of Martha's Vineyard. For a minimum duration of 3 hours, which is probably a maximum in this case, a sustained wind of 55 kt is required to produce this wave height; for a 2-hour minimum duration, winds over 70 kt are required. The winds caused a storm surge of 4.1 ft. in Narragansett' Bay. Fortunately the surge arrived at time of low tide, so no serious damage resulted. Highest winds and most damage to power lines occurred as the storm sped across eastern Maine. At Beals, Maine, a waterspout was reported, and apparently moved onshore where a new 26 ft by 52 ft boatshop was lifted from its foundation and moved 15 ft. Winds at' the top of an 800-ft. radio tower at Cutler, Maine, were recorded at 100 mph, while the surface winds were up to 70 mph. There was some evidence of a tornado in the Machias area; most trees were blown down from south to north, while a few were noted to have fallen from west to east and east to west. The triple register at Eastport, Maine, showed a 2-minute wind speed of close to 60 mph (52 kt) and 1-minute speed of about 80 mph (70 kt). There seems little doubt that the winds reached hurricane force at least occasionally during the time the storm moved across New England. Saint John, New Brunswick, reported gusts to 62 kt at 1000 EST, and to 70 kt at 1100. All the highest winds reported were from the south to southwest."
   - Reanalysis: The radar image from Atlantic City, NJ, on September 15th at 0330Z shows a well-organized tropical cyclone with convection around the center. A ship reported 50 kt at 00Z on the 15th and the intensity is increased to 50 kt at this time, up from 35 kt originally in HURDAT, a minor intensity change. Early on the 15th, the cold front associated with the extratropical cyclone was approaching the center of the small tropical cyclone. Despite its fast forward speed, surface observations indicate that the center remained closed early on the 15th. By 06Z on the 15th, the center of the tropical storm was just east of New York City, NY, based on the synoptic data. It is unclear from the surface observations if the circulation was still closed at this time. Fay (1962) mentions a research vessel located near 40.3N, 70.8W and the captain estimated sustained winds of 50 kt and rough conditions, and although it does not mention a time, based on the track of the tropical cyclone, it appears

that the estimate was around 06Z on the 15th. An intensity of 55 kt is selected at 06Z on the 15th, up from 35 kt originally in HURDAT, a major intensity change. 55 kt is also the peak intensity of this system as a tropical cyclone, up from 35 kt originally in HURDAT, a major intensity change. A central pressure of 996 mb is analyzed at 06Z from the 14 kt WSW and 997 mb at Suffolk AFB. By 12Z on the 15th, the surface observations suggest that the cold front had caught up to the tropical cyclone and the system was embedded within the frontal boundary, thus losing its tropical characteristics. Transition to an extratropical cyclone is analyzed at 12Z on the 15th. An intensity of 60 kt is selected at 12Z on the 15th, up from 35 kt originally in HURDAT. 6 kt S and 996 mb were reported at Brunswick, ME, at 1158Z, suggesting a central pressure of 995 mb, which has been added to HURDAT at 12Z on the 15th. Surface observations at 18Z on the 15th indicate that the weaker extratropical cyclone had been absorbed by the larger extratropical cyclone to the north. At about the same time, Eastport, ME experienced 1-min winds of 70 kt indicating that even though the system was absorbed, the larger extratropical cyclone contained quite vigorous winds. Thus, the last position is analyzed at 12Z on the 15th, six hours earlier than originally shown in HURDAT.

Sources: the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Monthly Weather Review, Mariners Weather Log, Surface Weather Observations, Local Climatological Data, National Hurricane Research Project Storm Data, Fay (1962), Frank (1963), and NHC Storm Wallets.

Hurricane Frances [September 30 – October 10, 1961]

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42155 09/30/1961 M=11  7 SNBR= 914 FRANCES     XING=0 SSS=0
42160 09/30*  0   0   0    0*160 570  30    0*161 587  35 1007*162 595  45 1006*
42160 09/30*  0   0   0    0*160 580  35    0*161 588  40    0*162 596  45 1005*
                              ***  **          ***  **    *             ****

42165 10/01*162 603  45    0*162 611  40    0*160 621  40 1004*159 631  40    0*
42165 10/01*162 604  45    0*162 612  50    0*160 623  45    0*159 633  40    0*
               ***             ***  **          ***  **    *     ***

42170 10/02*161 640  40 1010*162 650  45    0*164 661  50 1011*170 671  50 1010*
42170 10/02*160 642  40 1010*161 651  45    0*163 660  45 1011*170 670  45 1010*
               ***          *** ***          *** ***  **          ***  **

42175 10/03*178 679  50    0*185 686  50    0*192 691  50 1010*206 697  55    0*
42175 10/03*178 679  45    0*186 687  45    0*194 692  50    0*205 696  50    0*
                     **      *** ***  **      *** ***        * *** ***  **

42180 10/04*220 703  55 1005*230 707  60    0*243 713  65  999*254 716  70    0*
42180 10/04*218 702  55 1005*230 707  60    0*242 713  65  999*254 716  65    0*
           *** ***                           ***                       **

42185 10/05*269 712  75  997*274 711  80  991*287 707  85  974*292 703  90    0*
42185 10/05*265 718  65  997*275 714  75  991*284 709  90  973*291 703 100  963*
           *** ***  **      *** ***  **      *** ***  **  *** ***     ***  ***

42190 10/06*300 695  95  960*305 688 100    0*312 682 105  968*322 674 105  954*
42190 10/06*298 695 105  960*305 688 105    0*313 682 110    0*321 674 110  954*
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            ***     ***              ***      ***     ***    * ***     ***

42195 10/07*329 663 110  948*340 651 110    0*355 645 110    0*366 642 110    0*
42195 10/07*330 663 115  948*340 652 115    0*352 645 115    0*365 642 110    0*
            ***     ***          *** ***      ***     ***      ***

42200 10/08*385 642 105    0*392 647 100    0*401 652  95    0*412 660  70    0*
42200 10/08*379 642 105    0*391 647  95    0*401 652  80    0E412 660  70    0*
            ***               ***      **                **     *

42205 10/09*422 665  65    0*431 674  50    0E435 678  40    0E444 658  40    0*
42205 10/09E422 670  60    0E431 678  50    0E435 680  45    0E442 670  40    0*
            *    ***  **     *    ***             ***  **      *** ***

42210 10/10E450 640  35    0E460 592  35    0*  0   0   0    0*  0   0   0    0*
42210 10/10E448 645  35    0E453 605  35    0*  0   0   0    0*  0   0   0    0*
            ***  ***         *** ***

42215 HR
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Tropical Storm Landfall:

10/01 08Z 16.1N 61.6W 50 kt Guadeloupe
10/03 05Z 18.3N 68.5W 45 kt Dominican Republic

Significant Revisions:

1. A few central pressures removed, as they are likely analyses and not based upon observations;
2. Intensity substantially reduced on the 8th for a more realistic weakening trend;
3. Extratropical transition indicated to be 18 hours earlier.

Daily Summary:

September 28:

1. Maps and old HURDAT:
   - HWM analyzes a spot low pressure at 14.0N, 52.5W at 12Z.
   - HURDAT does not list an organized system on this date.
   - Microfilm does not show an organized system at 12Z.
2. Discussion/Reanalysis: A tropical wave left the African coast late in September and traveled westward showing little signs of development. Data over the eastern and central Atlantic is sparse and the first signs that the disturbance was becoming better organized occurred on September 28th when it was located about 500 nm east of the Lesser Antilles. Ship observations on the 28th and 29th show that a sharp trough was present but the disturbance lacked a closed low-level circulation.

September 29:

1. Maps and old HURDAT:
   - HWM analyzes a spot low pressure at 15.0N, 55.5W at 12Z.
   - HURDAT does not list an organized system on this date.
   - Microfilm does not show an organized system at 12Z.
2. Discussion/ATSR: "On the 29th of September, considerable shower activity and shifting winds indicated the possibility of a disturbed area just east of the Lesser Antilles."

September 30:

1. Maps and old HURDAT:
   - HWM analyzes a tropical storm at 16.0N, 58.5W at 12Z.
   - HURDAT lists a 35 kt tropical storm at 16.1N, 58.7W at 12Z.
   - Microfilm shows a tropical wave extended between 12-22N, 59W at 12Z.
2. Aircraft highlights:
   - Penetration center fix measured a central pressure of 1007 mb and estimated surface winds of 70 kt at 16.2N, 59.9W at 17Z (WALLET).
   - Penetration center fix measured a central pressure of 1005 mb and estimated surface winds of 70 kt at 16.1N, 59.9W at 19Z (WALLET).
3. Discussion:
   - MWR: "Although there were slight indications of a disturbed area east of the Antilles as early as September 28, it was not until the morning of the 30th that aircraft reconnaissance confirmed the development of tropical storm Frances. On this date the storm was very poorly organized with a sea level pressure no lower than 1005 mb (29.68 inches)."
   - ATSR: "Early on the 30th, a Navy reconnaissance plane investigated the area and found a poorly defined storm with very little radar presentation. It did find up to 70 knots of wind in a few squalls. Consequently, warning number one on Tropical Storm Frances was issued at 301930Z."
   - Reanalysis: Genesis is analyzed at 06Z on September 30th as a 35 kt tropical storm based on data later in the day, up from 30 kt originally in HURDAT, a minor intensity change. Time of genesis is the same as originally shown in HURDAT. Frances moved westward and steadily intensified. The first reconnaissance aircraft reached the storm at 17Z on the 30th measuring a central pressure of 1007 mb and estimating surface winds of 70 kt. At 19Z on the 30th, another penetration fix measured a central pressure of 1005 mb, estimated surface winds of 70 kt. The mission also reported a wind center that was 8 n mi across. The ATSR has other comments about that mission, which include "calm area in center very large", "pressure gradient flat", and "light winds all quadrants near center". Thus one cannot use this wind center diameter to estimate an RMW. A central pressure of 1005 mb suggests maximum sustained winds of 37 kt south of 25N from the Brown et al. pressure-wind relationship. Due to a slow forward speed of about 8 kt and using a blend between the pressure-wind value and the visual surface estimate, an intensity of 45 kt is analyzed at 18Z on the 30th, the same as originally in HURDAT. (Central pressures values for almost every 6 hour period were present in the original HURDAT between September 30th at 12Z and October 7th at 00Z. Some of these were obviously analyses that were added in, not based upon actual observations. Thus, based on actual observations, some were retained, others removed and new central pressure values added. Detailed information on these changes can be found in the table at the end.)

October 1:

1. Maps and old HURDAT:
   - HWM analyzes a tropical storm of at most 1010 mb at 15.2N, 61.9W at 12Z.
   - HURDAT lists a 40 kt tropical storm at 16.0N, 62.1W at 12Z.
   - Microfilm shows a closed low pressure of at most 1014 mb at 16.0N, 62.0W at 12Z.
2. Ship highlights:
   - 60 kt ESE and 1012 mb at 16.4N, 60.8W at 04Z (micro/WALLET/MWR).
   - 45 kt SSE and 1002 mb (low pressure bias) at 15.6N, 61.7W at 12Z (micro).
3. Aircraft highlights:
   - Radar center fix at 16.2N, 60.9W at 0445Z (ATSR).

- Penetration center fix measured a central pressure of 1012 mb and estimated surface winds of 35 kt at 15.9N, 62.8W at 1455Z (ATSR).
- Penetration center fix measured a central pressure of 1010 mb, estimated surface winds of 35 kt and an eye diameter of 25 nm at 16.2N, 63.8W at 2130Z (WALLET).

4. Discussion:
   - MWR: "Tropical storm Frances passed between the islands of Marie Galante and Guadaloupe, French Antilles between 0000 and 0100 EST on October 1. At 0100 EST, the Netherlands steamship *Viajero* near 16.4 north, 60.8 west just off the island of La Desirade, French Antilles, reported 60 knots winds from 120° during a heavy squall. At 0230 EST an amateur radio operator at Guadeloupe reported wind gusting to 50 to 60 miles per hour from the south. In the passage from Guadeloupe, French Antilles, to Dominica, West Indies Federation, the appears that the wind field was completely distorted by the 6000 foot mountains on Dominica and the 5000 foot range on Guadeloupe. The occasionally happens to tropical storms passing between or over these two islands while in the developmental stage. Frances never recovered its earlier intensity while in the Caribbean. Indeed, it was here the forecasters were confronted with a most difficult problem. Reconnaissance planes were able to follow and an area of weather and relative calm moving westward, while other planes were tracking a very weak circulation moving northwestward toward the extreme eastern portion of Hispaniola. That latter turn out to be the most important and the one that eventually intensified. The absence of a good divergence field at high levels was noted during this period and perhaps this was the paramount reason for the slow development and the disorganized state of the storm."
   - ATSR: "Already diffuse, the storm became completely disorganized as it headed westward and passed between the mountainous islands of Guadeloupe and Dominica early on 1 October. This lack of organization presented a serious forecasting and reconnaissance problem as the storm entered the Caribbean. Seemingly, Frances split into two separate areas of weather or circulations. One circulation moved westward and did not develop, another moved northwestward, passed over eastern Hispaniola and finally intensified. Lack of a good outflow mechanism in the upper air flow in the area of the storm is thought to have contributed to Frances' slow development."
   - Reanalysis: Frances continued westward on October 1st as it crossed into the eastern Caribbean Sea. A ship at 04Z on the 1st reported 60 kt SE and 1012 mb in a heavy squall. Observations from nearby ships and island stations seem to indicate that this measurement had a high bias but it cannot be disregarded due to the small size of the tropical cyclone and earlier visual estimates from the reconnaissance aircraft. The tropical storm made landfall in Guadeloupe around 08Z with an intensity of 50 kt. Frances weakened over the eastern Caribbean Sea during the 1st based on observations from reconnaissance aircrafts and synoptic data. Penetration center fixes at 1455Z and 1558Z on the 1st measured central pressures of 1012 mb and 1011 mb, respectively, and the surface wind estimates were only 35 kt. Observations from nearby ships and island stations show that

these pressure values likely do not represent the central pressure as the synoptic data indicates slightly lower pressure values, thus they were not added to HURDAT as central pressures. Nonetheless, it shows that the tropical cyclone was less organized on the 1st than 24 hours earlier.

October 2:

1. Maps and old HURDAT:
   - HWM analyzes a tropical storm of at most 1010 mb at 16.1N, 65.9W at 12Z.
   - HURDAT lists a 50 kt tropical storm at 16.4N, 66.1W at 12Z.
   - Microfilm shows a closed low pressure of at most 1011 mb at 16.6N, 66.3W at 12Z.
2. Ship highlights:
   - 40 kt ESE and 1010 mb at 16.7N, 64.7W at 03Z (micro).
   - 15 kt E and 1008 mb at 16.1N, 65.5W at 06Z (COADS).
   - 35 kt SE and 1010 mb at 15.9N, 65.8W at 18Z (COADS).
   - 35 kt SSE and 1010 mb at 16.7N, 66.2W at 21Z (micro/MWL).
3. Aircraft highlights:
   - Penetration center fix measured a central pressure of 1010 mb and flight level winds of 50 kt at 16.1N, 64.4W at 0050Z (WALLET).
   - Penetration center fix measured a central pressure of 1011 mb and estimated surface winds of 50 kt at 16.2N, 65.7W at 1140Z (WALLET).
   - Penetration center fix measured a central pressure of 1010 mb and estimated surface winds of 50 kt at 16.2N, 67.6W at 1845Z (WALLET).
4. Discussion/Reanalysis: On the 2nd, the weakened tropical storm passed south of Puerto Rico. Ships observations and reconnaissance aircraft indicate that the low-level circulation of Frances became much disorganized on the 2nd and the tropical cyclone may have weakened to a strong tropical wave. One piece of evidence that it still retained a closed circulation was the 1008 mb ship near the center at 06Z. Late on the 2nd, reconnaissance aircraft data indicate that they were following two centers, one moving westward into the central Caribbean and the other moving northwestward toward Hispaniola. The system is retained as a tropical storm on the 2nd and early on the 3rd due to the small size of the circulation, which may have persisted but was difficult to locate, and because ship observations indicate that it was producing gale-force winds.

October 3:

1. Maps and old HURDAT:
   - HWM analyzes a tropical storm of at most 1010 mb at 19.5N, 69.5W at 12Z.
   - HURDAT lists a 50 kt tropical storm at 19.2N, 69.1W at 12Z.
   - Microfilm shows a closed low pressure of at most 1011 mb at 19.5N, 69.3W at 12Z.
2. Ship highlights:
   - 35 kt SE and 1010 mb at 17.1N, 66.8W at 00Z (COADS).
   - 40 kt SE and 1010 mb at 18.3N, 67.7W at 06Z (COADS).
   - 40 kt SE and 1008 mb at 19.0N, 68.3W at 09Z (micro/MWL).
   - 40 kt SE and 1010 mb at 19.9N, 68.3W at 12Z (COADS).
   - 45 kt SSE and 1008 mb at 21.6N, 69.7W at 21Z (micro).
3. Aircraft highlights:
   - Radar center fix at 16.7N, 69.5W at 03Z (WALLET).
   - Radar center fix at 18.7N, 68.7W at 06Z (WALLET).
   - Radar center fix at 19.4N, 69.3W at 13Z; observation of 25 kt and 1010 mb at 13Z (WALLET).

- Penetration center fix measured a central pressure of 1006 mb and estimated surface winds of 50 kt at 21.3N, 70.0W at 2150Z (WALLET).

4. Discussion/Reanalysis: Ships, coastal and reconnaissance aircraft observations indicate that the northwestward-bound center of Frances became the dominant center. Landfall in southeast Dominican Republic is analyzed at 05Z on the 3rd as a 45 kt tropical storm. Observations over the northeastern coast of the Dominican Republic late on the 3rd indicate that a closed low-level circulation was present. The tropical cyclone began to intensify later on the 3rd as it passed about 60 nm east of the Turks and Caicos.

October 4:

1. Maps and old HURDAT:
   - HWM analyzes a hurricane of at most 1000 mb at 23.7N, 71.5W at 12Z.
   - HURDAT lists a 65 kt hurricane at 24.3N, 71.3W at 12Z.
   - Microfilm shows a closed low pressure of at most 1005 mb at 24.2N, 71.2W at 12Z.
2. Ship highlights:
   - 35 kt ESE and 1013 mb at 22.8N, 68.0W at 03Z (micro).
   - 35 kt SE and 1012 mb at 22.3N, 67.9W at 06Z (micro).
   - 40 kt ESE and 1011 mb at 26.1N, 70.4W at 12Z (COADS).
   - 35 kt SE and 1012 mb at 27.6N, 69.8W at 21Z (micro).
3. Aircraft highlights:
   - Penetration center fix measured a central pressure of 1005 mb at 22.3N, 70.0W at 01Z (WALLET).
   - Radar center fix at 23.6N, 70.8W at 07Z (WALLET).
   - Penetration center fix measured a central pressure of 999 mb and estimated surface winds of 100 kt at 24.2N, 71.2W at 12Z (WALLET/ATSR).
   - Penetration center fix estimated surface winds of 70 kt at 25.0N, 71.6W at 1615Z (WALLET).
   - Radar center fix at 25.4N, 71.5W at 1835Z (Northern Hemisphere maps).
   - Penetration center fix measured a central pressure of 994 mb and estimated surface winds of 60 kt at 26.0N, 71.5W at 2145Z (WALLET).
4. Discussion:
   - ATSR: "Steadily intensifying as she moved north-northwestward, Frances reached hurricane force on the 4th."
   - Reanalysis: A reconnaissance aircraft measured a central pressure of 1005 mb at 01Z on October 4th. A central pressure of 1005 mb suggests maximum sustained winds of 37 kt from the south of 25N pressure-wind relationship. Due to the small circulation of Frances, forward speed of about 13 kt and a ship report of 45 kt at 21Z on the 3rd, an intensity of 55 kt is analyzed at 0Z on the 4th, same as originally shown in HURDAT. The next reconnaissance aircraft measured a central pressure of 999 mb and estimated surface winds of 100 kt at 12Z on the 4th. A central pressure of 999 mb suggests maximum sustained winds of 49 kt from the south of 25N pressure-wind relationship. Based on a forward speed of 14 kt, small size of the circulation and weighting in the visual estimate, an intensity of 65 kt is analyzed at 12Z on the 4th, same as originally shown in HURDAT. Intensification to a hurricane is analyzed at 12Z on the 4th, same as originally shown in HURDAT. Late on the 4th, the track of Frances turned to the north while located east of the northwestern Bahamas.

October 5:

1. Maps and old HURDAT:
   - HWM analyzes a hurricane of at most 1000 mb at 27.8N, 70.8W at 12Z.
   - HURDAT lists an 85 kt hurricane at 28.7N, 70.7W at 12Z.
   - Microfilm shows a closed low pressure of at most 1014 mb at 28.5N, 70.5W at 12Z.
2. Ship highlights:
   - 35 kt SE and 1011 mb at 27.2N, 70.3W at 00Z (COADS).
   - 45 kt S and 1007 mb at 26.6N, 70.8W at 03Z (micro).
   - 40 kt SW and 1009 mb at 26.5N, 71.0W at 06Z (COADS).
   - 35 kt NNE and 1016 mb at 29.4N, 75.6W at 15Z (MWL).
   - 55 kt W and 963 mb at 29.5N, 70.0W at 21Z (micro).
3. Aircraft highlights:
   - Penetration center fix measured a central pressure of 997 mb and an eye diameter of 12 nm at 26.7N, 71.9W at 01Z (WALLET).
   - Penetration center fix measured a central pressure of 991 mb and an eye diameter of 11-13 nm at 27.5N, 71.1W at 07Z (WALLET).
   - Penetration center fix measured a central pressure of 973 mb at 28.6N, 70.6W at 1410Z (ATSR/micro).
   - Penetration center fix measured a central pressure of 963 mb at 29.3N, 70.2W at 1840Z (ATSR/advisories).
   - Penetration center fix at 29.7N, 69.7W at 2140Z (ATSR).
4. Discussion/Reanalysis: On October 5th, the small hurricane continued to gain strength while turning to the northeast ahead of an approaching frontal boundary. A reconnaissance aircraft measured a central pressure of 997 mb and estimated an eye diameter of 12 nm. A central pressure of 997 mb suggests maximum sustained winds of 49 kt from the north of 25N pressure-wind relationship. An eye diameter of 12 nm suggests an RMW of 9 nm and the climatological value is 20 nm. Due to a forward speed of 11 kt and an RMW smaller than the climatological value, an intensity of 65 kt is analyzed at 00Z on the 5th, down from 75 kt originally in HURDAT, a minor intensity change. The next penetration center fix occurred at 07Z on the 5th measuring a central pressure of 991 mb and an eye diameter of 11-13 nm. A central pressure of 991 mb suggests maximum sustained winds of 60 kt from the north of 25N intensifying pressure-wind relationship. An eye diameter of 11-13 nm suggests an RMW of about 9 nm and the climatological value is 22 nm. Due to a forward speed of 10 kt and an RMW smaller than the climatological value, an intensity of 75 kt is analyzed at 06Z on the 5th, down from 80 kt originally in HURDAT, a minor intensity change. Another penetration center fix occurred at 1410Z on the 5th measuring a central pressure of 973 mb. A central pressure of 973 mb suggests maximum sustained winds of 85 kt from the intensifying north of 25N pressure-wind relationship. Due to a forward speed of 9 kt and the small size of the circulation, an intensity of 90 kt is analyzed at 12Z on the 5th, up from 85 kt originally in HURDAT, a minor intensity change. Advisory #22 of Hurricane Frances issued on the 5th at 22Z shows that a central pressure of 963 mb was measured by the reconnaissance aircraft. The Navy book indicates that penetration center fixes occurred at 1840Z and 1950Z on the 5th corresponding to the advisory data. For the purpose of this reanalysis, the central pressure measurement has been assigned to the 1840Z penetration center fix, which is closer to the 18Z time slot on the 5th. A central pressure of 963 mb suggests maximum sustained winds of 96 kt from the intensifying north of 25N pressure-wind relationship. Due to the small size of the circulation and forward speed of 9 kt, an intensity of 100 kt is analyzed at 18Z on the 5th, up from 90 kt originally in HURDAT. Intensification to a major hurricane is analyzed

twelve hours earlier than originally shown in HURDAT. At 21Z on the 5th, a ship passed near the center of Frances and reported 55 kt W and 963 mb.

October 6:

1. Maps and old HURDAT:
   - HWM analyzes a hurricane of at most 995 mb at 31.0N, 68.2W at 12Z.
   - HURDAT lists a 105 kt hurricane at 31.2N, 68.2W at 12Z.
   - Microfilm shows a closed low pressure of at most 1002 mb at 31.5N, 67.6W with a frontal boundary to the northwest at 12Z.
2. Ship highlights:
   - 45 kt WSW and 984 mb at 29.0N, 69.5W at 00Z (micro).
   - 35 kt SE and 1013 mb at 29.9N, 64.3W at 12Z (micro).
   - 35 kt NE and 1011 mb at 31.5N, 69.5W at 18Z (COADS).
   - 35 kt NNE and 1011 mb at 34.0N, 67.3W at 21Z (micro).
3. Aircraft highlights:
   - Penetration center fix measured a central pressure of 965 mb at 31.1N, 69.1W at 1115Z (ATSR/micro).
   - Penetration center fix measured a central pressure of 954 mb at 32.6N, 67.2W at 19Z (ATSR/advisories).
   - Penetration center fix measured a central pressure of 948 mb, estimated surface winds of 125 kt and an eye diameter of 20 nm at 32.7N, 66.6W at 22Z (WALLET).
4. Discussion:
   - MWR: "Frances moved just to the west of Bermuda on October 6. The lowest sea level pressure reported was 948 mb (27.99 inches) which is in good agreement with the maximum winds estimated at 110 kt (127 mph). The maximum intensity occurred when the hurricane was west and northwest of Bermuda and gales were reported throughout the islands at this time. As it turned out, flooding along the south coastal plain of Puerto Rico caused more damage than at any place along the entire path, mainly to roads and bridges. There has been no loss of life reported in connection with Frances."
   - ATSR: "After turning northeastward in advance of an approaching cold front and buffeting Bermuda with gale force winds on the 6th, Frances pointed for the coast of Maine."
   - Reanalysis: On October 6th, Frances continued to the northeast and kept intensifying. Microfilm shows a central pressure of 965 mb measured by a dropsonde at 11Z on the 6th. It appears that the dropsonde missed the small center of Frances based on data later in the day. A central pressure of 954 mb was in HURDAT at 18Z on the 6th and has been retained. A penetration center fix occurred at 19Z, which may have measured that central pressure, and advisory #26 at 22Z on the 6th also mentions a central pressure of 954 mb. A central pressure of 954 mb suggests maximum sustained winds of 106 kt from the north of 25N intensifying pressure-wind relationship. Based on the small size of the circulation and a forward speed of 14 kt, an intensity of 110 kt is analyzed at 18Z on the 6th, up from 105 kt originally shown in HURDAT.

October 7:

1. Maps and old HURDAT:
   - HWM analyzes a hurricane of at most 995 mb at 35.1N, 64.5W with a stationary boundary to the northeast at 12Z.
   - HURDAT lists a 110 kt hurricane at 35.5N, 64.5W at 12Z.
   - Microfilm shows a closed low pressure of at most 1011 mb at 35.0N, 65.0W at 12Z.
2. Ship highlights:

- 35 kt NE and 1015 mb at 28.4N, 69.0W at 06Z (COADS).
- 35 kt ENE and 1014 mb at 37.7N, 65.9W at 12Z (micro).
- 35 kt ENE and 1017 mb at 39.3N, 61.6W at 18Z (COADS).

3. Land highlights:
   - 35 kt SSE and 1008 mb at Bermuda at 00Z (micro).
4. Aircraft highlights:
   - Penetration center fix at 35.8N, 64.5W at 1330Z (ATSR).
   - Penetration center fix at 36.7N, 64.0W at 19Z (ATSR).
5. Discussion/Reanalysis: A reconnaissance aircraft measured a central pressure of 948 mb, estimated surface winds of 125 kt and an eye diameter of 20 nm at 22Z on the 6th. A central pressure of 948 mb suggests maximum sustained winds of 112 kt from the north of 25N intensifying pressure-wind relationship. An eye diameter of 20 nm suggests an RMW of 15 nm and the climatological value is 22 nm. Due to a forward speed of 14 kt and an RMW smaller than climatology, an intensity of 115 kt is analyzed at 00Z on the 7th, up from 110 originally shown in HURDAT. 115 kt is also the peak intensity of this tropical cyclone, up from 110 kt originally shown in HURDAT, a minor intensity change. Early on the 7th, Frances passed about 120 nm northwest of Bermuda where it produced gale-force winds. Late on the 7th, the hurricane turned to the north. Penetration center fixes occurred late on the 7th but no central pressures were reported.

October 8:

1. Maps and old HURDAT:
   - HWM analyzes a hurricane of at most 1000 mb at 39.7N, 65.5W at 12Z.
   - HURDAT lists a 95 kt hurricane at 40.1N, 65.2W at 12Z.
   - Microfilm shows a closed low pressure of at most 1002 mb at 40.0N, 65.0W at 12Z.
2. Ship highlights:
   - 35 kt E and 1018 mb at 40.2N, 60.3W at 00Z (COADS).
   - Ship-based radar fix 38.8N 64.5W at 05Z (Northern Hemisphere maps).
   - 40 kt N and 1017 mb at 39.5N, 67.7W at 06Z (COADS).
   - 55 kt NE and 1002 mb at 40.7N, 65.1W at 12Z (COADS).
   - 60 kt ESE and 1006 mb at 41.0N, 62.8W at 16Z (MWL).
   - 40 kt SE and 1006 mb at 41.2N, 65.3W at 18Z (COADS).
   - 40 kt SE and 1006 mb at 41.2N, 65.3W at 18Z (COADS).
   - 60 kt W and 1006 mb at 40.9N, 66.8W at 21Z (MWL).
3. Aircraft highlights:
   - Penetration center fix at 40.3N, 65.2W at 14Z (ATSR).
   - Penetration center fix at 41.7N, 66.5W at 19Z (ATSR).
4. Discussion:
   - MWR: "…then threatened Maine on October 8th. It later made an abrupt turn to the right and dissipated over Nova Scotia."
   - Reanalysis: On October 8th, Frances turned to the northwest posing a threat to the Northeast of the United States. Cooler sea-surface temperatures caused the hurricane to rapidly weaken on the 8th and weakening below major hurricane intensity is analyzed at 06Z on the 8th, six hours earlier than originally shown in HURDAT. As the hurricane crossed 40N, cold, dry air started to enter the circulation and the system began to acquire extratropical characteristics.

October 9:

1. Maps and old HURDAT:
   - HWM analyzes a tropical storm of at most 1010 mb at 43.1N, 67.8W with a stationary front to the north at 12Z.

- HURDAT lists a 40 kt extratropical cyclone at 43.5N, 67.8W at 12Z.
- Microfilm shows a closed low pressure of at most 1011 mb at 43.5N, 67.8W with a frontal boundary to the north at 12Z.

2. Ship highlights:
   - 45 kt W and 1008 mb at 41.8N, 67.9W at 00Z (micro).
   - 40 kt W and 1008 mb at 42.0N, 68.1W at 06Z (COADS).
   - 45 kt WSW and 1011 mb at 41.9N, 68.0W at 12Z (COADS).
3. Discussion:
   - ATSR: "Coming to within 50 miles of the mainland on the 9th, the decaying storm was caught in a westerly current, sharply turned to the northeast and dissipated over Nova Scotia."
   - Reanalysis: Transition to an extratropical cyclone is analyzed at 00Z on the 9th, twelve hours earlier than originally shown in HURDAT. A warm frontal boundary can be analyzed east of the system reaching toward the center of Frances at that time. Frances stopped its westward advancement around 12Z and turned to the northeast toward Nova Scotia on October 9th. Weakening below hurricane intensity is analyzed at 00Z on the 9th, six hours earlier than originally shown in HURDAT.

October 10:

1. Maps and old HURDAT:
   - HWM analyzes a tropical storm of at most 1010 mb at 44.0N, 56.5W with an extratropical cyclone to the north at 12Z.
   - HURDAT lists a 35 kt extratropical cyclone at 46.0N, 59.2W at 06Z (last position).
   - Microfilm shows an extratropical cyclone of at most 1008 mb at 50.0N, 62.0W at 12Z.
2. Discussion/Reanalysis: The small extratropical cyclone continued to weaken on the 9th and 10th, and it finally merged with another extratropical cyclone to the north around 12Z on the 10th. The last position is analyzed at 06Z on the 10th, same as originally shown in HURDAT.

Date	Original HURDAT Central Pressure	Evidence	Changes
Sep 30 12Z	1007 mb	Penetration center fix occurred at 17Z, closer to the 18Z time slot	Removed
Sep 30 18Z	1006 mb	Penetration center fix: 1005 mb at 19Z	1005 mb
Oct 1 12Z	1004 mb	Ship reported 45 kt SSE and 1002 mb, and penetration center fixes reported 1012 mb at 1455Z and 1011 mb at 1558Z	Removed
Oct 2 00Z	1010 mb	Penetration center fix: 1010 mb at 2130Z on Oct 1st	Retained
Oct 2 12Z	1011 mb	Penetration center fix: 1011 mb at 1140Z	
Oct 2 18Z	1010 mb	Penetration center fix: 1010 mb at 1845Z	
Oct 3 12Z	1010 mb	Synoptic data indicate a central pressure lower than 1010 mb	Removed
Oct 4 00Z	1005 mb	Penetration center fix: 1005 mb at 01Z	Retained
Oct 4 12Z	999 mb	Penetration center fix: 999 mb at 12Z	
Oct 5 00Z	997 mb	Penetration center fix: 997 mb at 00Z	
Oct 5 06Z	991 mb	Penetration center fix: 991 mb at 12Z	
Oct 5 12Z	974 mb	Penetration center fix: 973 mb at 1410Z	973 mb
Oct 5 18Z		Penetration center fix: 963 mb at 1840Z	963 mb

Oct 6 00Z	960 mb	Likely to be an analysis not based on observation, and is not a reasonable value	Removed
Oct 6 12Z	968 mb	Likely to be an analysis not based on observation, but is a reasonable value	Retained
Oct 6 18Z	954 mb	Penetration center fix: 954 mb at 19Z	Retained
Oct 7 00Z	948 mb	Penetration center fix: 948 mb at 22Z on Oct 6th	

Sources: the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Monthly Weather Review, Navy reconnaissance book, Mariners Weather Log, Advisories, Northern Hemisphere Surface Chart, and NHC Storm Wallets.

Tropical Storm Gerda [October 16-22, 1961]

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42220 10/16/1961 M= 7  8 SNBR= 915 GERDA       XING=0 SSS=0
42220 10/16/1961 M= 6  8 SNBR= 915 GERDA       XING=0 SSS=0
                    *

(The 16th has been removed from HURDAT.)
42225 10/16*175 770  30    0*183 775  30    0*189 778  30 1005*194 779  30    0*

42230 10/17*199 779  30    0*204 780  30    0*210 780  30    0*215 780  30    0*
42230 10/17*197 779  30 1003*201 780  30 1002*205 780  30    0*210 780  30 1002*
            ***         **** ***         **** ***            ***         ****

42235 10/18*220 780  30 1003*228 778  30    0*237 777  30 1004*247 768  30    0*
42235 10/18*216 780  30 1002*225 779  35    0*235 777  35 1003*245 772  40 1003*
            ***         **** *** ***  **      ***      **  **** *** ***  **  ****

42240 10/19*257 758  30 1003*268 744  30    0*288 730  30 1001*315 715  55  996*
42240 10/19*256 763  40 1003*268 750  50 1001*284 735  55  999*303 718  60  989*
            *** ***  **          ***  ** **** *** ***  ** **** *** ***  **  ****

42245 10/20*340 700  55    0*372 686  55    0*395 684  55  987*413 668  60    0*
42245 10/20*335 702  60    0*370 688  60 988E393 682  60    0E407 675  60    0*
            *** ***  **      ***  ***  **  ******* ***  **    *****  ***

42250 10/21E420 650  60  993E429 630  50    0E434 616  40  994E440 587  30    0*
42250 10/21E415 660  65    0E424 645  60    0E432 627  50  994E440 612  45    0*
            *** ***  **    * *** ***  **      ***  ***  **          ***  **

42255 10/22E440 565  30    0E440 527  30    0E440 490  30    0E440 450  30    0*
42255 10/22E442 585  35    0E444 540  35    0E446 493  35    0*  0    0    0    0*
            *** ***  **      ***  ***  **      ***  ***  **        *    *    *

42260 TS
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Significant Revisions:

1. Genesis is begun 24 hours later than HURDAT, as the system did not have a center until the 17th;
2. Several central pressures were added primarily from aircraft reconnaissance and station observations;
3. Intensification to a tropical storm at 06Z on the 18th is indicated to have occurred 30 hours earlier than HURDAT;

4. Substantial intensity increase indicated on the 19th based upon aircraft reconnaissance;
5. Substantial south-southwestward adjustment of the track on the 19th based upon aircraft reconnaissance;
6. Substantial westward adjustment of the track on the 21st and 22nd based upon coastal and ship observvations;
7. Substantial increase in the intensity (while extratropical) on the 21st based upon coastal and ship observations.

Daily Metadata:

October 14:

1. Maps and old 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 1008 mb at 15.5N, 80.5W at 12Z.
2. Discussion/Reanalysis: A broad disturbance developed in the central Caribbean Sea around October 14th. Under weak steering currents, the disturbance slowly drifted northward becoming better organized.

October 15:

1. Maps and old HURDAT:
   - HWM analyzes a spot low pressure at 15.2N, 78.1W with a cold front far to the northwest at 12Z.
   - HURDAT does not list an organized system on this date.
   - Microfilm shows a tropical wave or trough over the central Bahamas and eastern Cuba, with a frontal boundary to the northwest at 12Z.
2. Discussion/ATSR: "On the 15th of October, conditions began to appear very unsettled in the Central Caribbean."

October 16:

1. Maps and old HURDAT:
   - HWM analyzes a closed low pressure at 18.0N, 78.0W at 12Z.
   - HURDAT lists a 30 kt tropical depression at 18.9N, 77.8W at 12Z.
   - Microfilm shows a closed low pressure of at most 1008 mb at 18.0N, 79.0W at 12Z.
2. Land highlights:
   - 20 kt SE and 1004 mb at Cabo Cruz, Cuba at 18Z (micro).
3. Discussion:
   - MWR: "Several days before tropical storm Gerda developed, a Navy reconnaissance aircraft investigated an easterly wave in the eastern Caribbean, finding widespread shower activity and some evidence of a weak circulation. However, winds were not strong, generally less than 25 mph. The wave continued slowly westward and began to show evidence of intensification the night of the 15th with pressures dropping in the central Caribbean and heavy rain beginning over Jamaica and eastern Cuba. By the morning of the 16th, pressure at Kingston had dropped to 1005 mb with winds both at the surface and aloft indicating a circulation with the center a short distance north of Jamaica."
   - ATSR: "By the 15th of October, widespread shower activity and evidence of a circulation appeared, although wind velocities in general were light. The lowest pressure observed at this time was 1005.9 mb at Jamaica. The

circulation remained weak and poorly organized as it began moving northward across Cuba."

- Reanalysis: The system remained embedded in a large area of low pressure and was elongated southwest-northeast on the 16th. As the system did not have a center, genesis is delayed until 00Z on the 17th, a day later than shown in HURDAT.

October 17:

1. Maps and old HURDAT:
   - HWM analyzes a closed low pressure of at most 1005 mb at 20.0N, 78.0W at 12Z.
   - HURDAT lists a 30 kt tropical depression at 21.0N, 78.0W at 12Z.
   - Microfilm shows an elongated area of low pressure of at most 1004 mb with two centers located at 18.5N, 82.0W and 20.8N, 77.5W with a frontal boundary to the north at 12Z.
2. Ship highlights:
   - 15 kt and 1005 mb at 18.8N, 77.6W at 00Z (COADS).
   - 10 kt NE and 1003 mb at 20.3N 80.0W at 06Z (COADS).
3. Land highlights:
   - 40 kt S and 1005 mb at Santiago de Cuba, Cuba at 00Z (micro).
   - 10 kt NE and 1004 mb at Cabo Cruz, Cuba at 00Z (micro).
   - 1004 mb at Cabo Cruz, Cuba at 12Z (micro).
   - 15 kt SW and 1004 mb at Cabo Cruz, Cuba at 18Z (micro).
1. Discussion/Reanalysis: Cabo Cruz, Cuba reported 10 kt NE and 1004 mb at 00Z on October 17th, suggesting a central pressure of 1003 mb, which has been added to HURDAT. Santiago de Cuba reported 40 kt S at 00Z on the 17th but it was determined that this station continuously reported winds higher than nearby observations, which is suspect. Thus the tropical cyclone was retained at tropical depression intensity. On the 17th, surface observations indicate that the center of the tropical depression was still somewhat ill-defined and the system resembled a trough of low pressure extended from eastern Cuba to the eastern coast of Nicaragua. The ill-defined center of the tropical depression made landfall in Cuba around 15Z on the 17th. Perez et al. (2000) does not show this system as a tropical storm impacting Cuba, same as our reanalysis. Camaguey, Cuba reported 5 kt NE and 1004 mb at 18Z on the 17th, suggesting a central pressure of 1003 mb, which has been added to HURDAT. While in the Caribbean Sea, Gerda resembled Tropical Storm Nicole in 2010 by not having a well-defined low level circulation.

October 18:

1. Maps and old HURDAT:
   - HWM analyzes a closed low pressure of at most 1005 mb at 23.0N, 78.0W with a warm front far to the north at 12Z.
   - HURDAT lists a 30 kt tropical depression at 23.7N, 77.7W at 12Z.
   - Microfilm shows a closed low pressure of at most 1005 mb at 23.5N, 77.3W with a frontal boundary to the north at 12Z.
2. Ship highlights:
   - 35 kt ENE and 1012 mb at 24.9N, 80.1W at 03Z (micro);
   - 25 kt NNE and 1005 mb at 23.2N, 80.2W at 06Z (COADS);
   - 40 kt N and 1009 mb at 24.9N, 79.9W at 15Z (micro).
3. Land highlights:
   - 30 kt S and 1005 mb at Santiago de Cuba, Cuba at 00Z (micro).
   - 10 kt SW and 1004 mb at Cabo Cruz, Cuba at 00Z (micro).

- 15 kt NE and 1005 mb at Andros Island, Bahamas at 12Z (micro).
- 10 kt NNE and 1004 mb at Andros Island, Bahamas at 18Z (micro).

4. Discussion:
   - MWR: "The poorly organized disturbance moved slowly northward across central Cuba, thence northeastward through the western Bahamas on the 18th with slow deepening but winds still only 25 to 40 mph in scattered squalls."
   - ATSR: "Reconnaissance was hampered by air space restrictions, but on the 18th two separate Navy flights investigated areas north and south of Cuba, with one flight finding a low pressure area of 1005 mb just east of Andros Island in the Bahamas. No sign of development was encountered."
   - Reanalysis: On the 18th, the low-level circulation became better organized as the tropical depression moved into the western Bahamas. A 35 kt ship observation is the basis for development into a tropical storm by 06Z, 30 hours earlier than originally shown. Andros Island reported 10 kt NNE and 1004 mb at 18Z on the 18th, suggesting a central pressure of 1003 mb, which has been added to HURDAT.

October 19:

1. Maps and old HURDAT:
   - HWM analyzes a closed low pressure of at most 1000 mb at 28.0N, 73.5W with a warm front to the north at 12Z.
   - HURDAT lists a 30 kt tropical depression at 28.8N, 73.0W at 12Z.
   - Microfilm shows a closed low pressure of at most 1002 mb at 28.5N, 73.0W with a frontal boundary to the north at 12Z.
2. Ship highlights:
   - 40 kt SE and 1007 mb at 25.3N, 73.6W at 00Z (COADS).
   - 50 kt SSE and 1007 mb at 24.9N, 73.0W at 03Z (micro/MWL).
   - 45 kt SE and 1007 mb at 24.5N, 72.4W at 06Z (COADS).
   - 20 kt SW and 1003 mb at 26.6N, 74.8W at 06Z (COADS).
   - 35 kt S and 1004 mb at 27.7N, 71.4W at 12Z (COADS).
   - 55 kt SW (47 kt in MWL) and 1003 mb at 27.8N, 72.0W at 14Z (micro/MWL).
   - 55 kt S and 1000 mb at 29.2N, 70.9W at 18Z (COADS).
   - 40 kt SE and 993 mb at 34.0N, 67.1W at 21Z (micro).
3. Aircraft highlights:
   - 25 kt S and 1001 mb at 28.5N 72.0W at 1253Z (micro).
4. Discussion:
   - MWR: "North of the Bahamas, reconnaissance aircraft found winds up to 60 mph on the morning of the 19th, although the storm still remained poorly organized with a large center and no evidence of a wall cloud."
   - ATSR: "However, on the 19th, ship reports indicated deepening had occurred overnight since 45-knot winds were reported in the eastern quadrant of the low. The first warning on Gerda was issued at 192200Z."
   - Reanalysis: Gerda intensified on the 19th as it moved away from the Bahamas. A ship reported 20 kt SW and 1003 mb at 06Z on the 19th, suggesting a central pressure of 1001 mb, which has been added to HURDAT. An aircraft reconnaissance mission flew into Gerda around 12-15Z. While no tropical storm force winds were measured (perhaps because they stayed

near the large light-wind center), an observation around 12Z allowed for a determination of a central pressure around 999 mb. This replaces the 1001 mb in HURDAT originally. At 21Z, a ship with 40 kt wind and 993 mb suggests a central pressure of 989 mb, which is added into HURDAT at 18Z. This central pressure suggests an intensity of 63 kt from the north of 25N intensifying Brown et al. pressure-wind relationship. Based on this as well as surface observations of 50 kt at 03Z and 55 kt at 14Z and 18Z, an intensity of 50 kt is analyzed at 06Z, 55 kt at 12Z, and 60 kt at 18Z on the 19th. The changes at 06Z and 12Z were major upward revisions. 60 kt is also the peak intensity of this system as a tropical cyclone, the same as that originally shown in HURDAT.

October 20:

1. Maps and old HURDAT:
   - HWM analyzes a closed low pressure of at most 990 mb at 39.5N, 67.8W with weakening frontal boundaries to the north at 12Z.
   - HURDAT lists a 55 kt tropical storm at 39.5N, 68.4W at 12Z.
   - Microfilm shows a closed low pressure of at most 990 mb at 40.0N, 68.0W with a frontal boundary to the north at 12Z.
2. Ship highlights:
   - 50 kt SSW and 993 mb at 33.4N, 67.5W at 00Z (micro).
   - 55 kt SW and 995 mb at 33.9N, 68.5W at 03Z (micro).
   - 40 kt S and 994 mb at 36.2N, 67.1W at 06Z (COADS).
   - 25 kt SSE and 991 mb at 37.2N, 68.6W at 06Z (COADS).
   - 50 kt SSW and 1004 mb at 39.7N, 63.6W at 12Z (COADS).
   - 55 kt S and 999 mb at 39.9N, 61.8W at 18Z (COADS).
   - 63 kt S and 1000 mb at 39.7N, 61.0W at 21Z (MWL).
3. Land highlights:
   - 45 kt NE (gusts to 57 kt) and 999 mb at Nantucket Shoals, MA at 0855Z (SWO).
   - 68 kt NE (gusts to 74 kt) and 993 mb at Georges Shoals, MA at 1455Z (SWO).
   - 42 kt N (peak winds, gusts to 54 kt) at Nantucket, MA at 1630Z (SWO).
   - 65 kt NE (gusts to 78 kt) and 989 mb at Georges Shoals, MA at 2055Z (SWO).
   - 68 kt NNE (peak winds, gusts to 80 kt) at Georges Shoals, MA at 2255Z (SWO).
4. Discussion:
   - MWR: "Gerda moved north-northeastward to a position just off Nantucket on the 20th reaching its maximum intensity at that time. Texas Towers off the Massachusetts coast reported whole gale winds, occasionally of hurricane force for short periods."
   - ATSR: "Under the influence of a long wave positioned over the eastern seaboard of the United States, Gerda moved in a north-northeasterly direction to a point approximately 120 miles east of Nantucket on the 20th where reports showed it reached its maximum intensity. Texas towers Bravo and Charlie received wind gusts of hurricane force for a short period at this time. The storm then turned east-northeastward, accelerated."
   - Reanalysis: Gerda increased in forward speed on October 20th traveling between Bermuda and East Coast of the United States. A ship reported 25

kt SSE and 991 mb at 06Z on the 20th, suggesting a central pressure of 988 mb, which has been added to HURDAT. A central pressure of 987 mb was present in HURDAT at 12Z on October 20th. This was apparently an analysis pressure value, not based upon specific observations near the center, and thus have been removed. Synoptic observations indicate that Gerda began to transition into an extratropical cyclone around midday on the 20th with a distinct temperature gradient across the circulation and the beginning of frontogenesis. Transition to an extratropical cyclone is analyzed at 12Z on the 20th, twelve hours earlier than originally shown in HURDAT. Gerda remained a powerful extratropical cyclone and the offshore platforms off Massachusetts recorded hurricane-force winds. Georges Shoals, MA reported 68 kt at 1455Z and 2255Z. At an elevation of 200 feet, this suggests sustained winds of about 60 kt at the surface.

October 21:

1. Maps and old HURDAT:
   - HWM analyzes a closed low pressure of at most 1000 mb at 43.0N, 60.0W with a frontal boundary going through the center at 12Z.
   - HURDAT lists a 40 kt extratropical cyclone at 43.4N, 61.6W at 12Z.
   - Microfilm shows an extratropical cyclone of at most 996 mb at 43.2N, 61.5W at 12Z.
2. Ship highlights:
   - 63 kt S and 1000 mb at 39.8N, 61.4W at 00Z (MWL).
   - 35 kt S and 984 mb at 41.0N, 65.6W at 00Z (COADS).
   - 25 kt NW and 991 mb at 41.6N, 65.2W at 06Z (COADS).
   - 60 kt N and 1000 mb at 41.6N, 67.9W at 06Z (micro).
   - 50 kt SW and 999 mb at 42.0N, 62.0W at 12Z (COADS).
   - 15 kt SSW and 996 mb at 43.5N, 62.2W at 12Z (COADS).
   - 45 kt ENE and 1008 mb at 46.5N, 57.0W at 18Z (COADS).
   - 15 kt SW and 999 mb at 43.4N, 61.1W at 18Z (COADS).
3. Land highlights:
   - Estimated 50 kt N (gusts to 60 kt) at Georges Shoals, MA at 0055Z (SWO).
   - Estimated 60 kt N (gusts to 75 kt) at Georges Shoals, MA at 0458Z (SWO).
   - 42 kt NNW (gusts to 49 kt) and 1006 mb at Georges Shoals, MA at 1158Z (SWO).
   - 34 kt NE (gusts to 42 kt) and 1009 mb at Georges Shoals, MA at 1456Z (SWO).
4. Discussion:
   - MWR: "From this position Gerda turned to an east-northeastward course gradually accelerating and becoming extratropical on the 21st. Although Gerda had most of the characteristics of a tropical storm at low levels, conditions in the upper troposphere were not favorable for strong deepening."
   - ATSR: "...became extratropical on the 21st."
   - Reanalysis: A ship reported 63 kt at 21Z on the 20th and 00Z on the 21st. An intensity of 65 kt is analyzed at 00Z on the 21st, up from 60 kt originally in HURDAT, a minor intensity change. A central pressure of 993 mb was present in HURDAT at 00Z on the 21st and has been removed due to a ship close to the center that reported 35 kt SSW and 984 mb. On the 21st, the extratropical cyclone turned to the northeast and moved away from the

United States while gradually losing strength. Weakening below hurricane intensity is analyzed at 06Z on the 21st. A central pressure of 994 mb is present in HURDAT at 12Z. This value appears to have been an analysis pressure, not based upon specific observations near the center, but is reasonable and thus retained. HURDAT originally showed the extratropical cyclone weakening below gale-force at 18Z on the 21st but ship observations suggest that it retained minimal gale-force winds until dissipation.

October 22:

2. Maps and old HURDAT:
   - HWM analyzes a spot low pressure at 43.2N, 49.5W with a frontal boundary close to the north at 12Z.
   - HURDAT lists a 30 kt extratropical depression at 44.0N, 49.0W at 12Z.
   - Microfilm shows an extratropical cyclone of at most 1008 mb at 44.0N, 48.0W at 12Z.
3. Ship highlights:
   - 35 kt NE and 1009 mb at 46.5N, 55.6W at 00Z (COADS).
   - 35 kt SW and 1012 mb at 41.1N, 48.0W at 06Z (COADS).
   - 35 kt WSW and 1019 mb at 40.6N, 46.3W at 18Z (COADS).
4. Discussion/Reanalysis: On October 22nd, the extratropical cyclone continued to weaken and was absorbed within a frontal boundary over the north Atlantic after 12Z on the 22nd. The last position is analyzed at 12Z on the 22nd, six hours earlier than originally shown in HURDAT.

October 23:

1. Maps and old HURDAT:
   - HWM analyzes an extratropical cyclone of at most 995 mb at 49.0N, 27.0W at 12Z.
   - HURDAT does not list an organized system on this date.
   - Microfilm shows an extratropical cyclone at 49.5N, 25.8W at 12Z.
2. Ship highlights:
   - 40 kt SW and 998 mb at 46.4N, 26.6W at 12Z (COADS).
3. Discussion:
   - MWR: "Reconnaissance aircraft did not report any indication of wall cloud formation or spiral bands at any time of the strong winds at the course of the storm. Even at the time of the strong winds at the Texas towers, an Air Force reconnaissance aircraft very near their location reported winds of only 10 kt at 700 mb. A low-level injection of polar air into Gerda was occurring at this time and the circulation apparently was quite shallow...Damage through the New England area was about the same as that from a typical wintertime northeaster. The strong winds reported by the Texas Towers did not occur on the coast where 30 to 50 mph were the strongest winds reported."
   - ATSR: "Except for its nascent stage, Gerda seemed to exhibit both tropical and extratropical characteristics. There was never any reports signifying the existence of either a wall cloud or spiral bands throughout the life of the storm. At the same time that the Texas towers were being buffeted with hurricane force gusts, an Air Force reconnaissance plane at 700 mn, near the same location, found only light winds, indicating a shallow system. Throughout Gerda's cycle a cold low was located over the eastern United States in the upper levels and her existence appeared to begin and end in the warm tongue to the east of the cold low…The New England area received only moderate gale winds along the coastal sections."

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

Hurricane Hattie [October 27 – November 1, 1961]

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42265 10/27/1961 M= 6  9 SNBR= 916 HATTIE      XING=0 SSS=0
42265 10/26/1961 M= 7  9 SNBR= 916 HATTIE      XING=0 SSS=0
                    *
(The 26th is new to HURDAT.)
42270 10/26*105 790  25    0*106 795  30    0*107 800  35    0*108 805  35    0*

42270 10/27*  0   0   0    0*  0   0   0    0*116 815  45    0*120 816  55    0*
42270 10/27*110 810  35    0*113 815  40    0*116 818  50    0*120 818  60    0*
            *** ***  **      *** ***  **          ***  **          ***  **

42275 10/28*128 817  65  991*129 817 100    0*135 816 105  991*141 815 110  969*
42275 10/28*124 817  70    0*129 817  80    0*135 816  90  969*142 815 105  956*
            ***      **    *           **                 **  *** ***     ***  ***

42280 10/29*150 814 110  952*161 812 110    0*169 813 110  963*177 819 110    0*
42280 10/29*150 814 110  952*160 812 100  960*169 813 100  963*177 818 100  956*
                         ***     ***  ***         ***                ***  ***

42285 10/30*182 824 115  956*185 838 120  942*184 841 130  937*182 852 140    0*
42285 10/30*181 825 100  958*185 836 115  942*184 844 120  937*182 852 135  923*
            *** *** ***  ***     *** ***          *** ***                ***  ***

42290 10/31*179 861 140  920*176 871 140    0*172 881 120  930*169 889  60    0*
42290 10/31*180 861 145  914*175 872 135  920*171 883 130  924*168 893  75    0*
            ***     ***  *** *** *** ***  *** *** *** ***  *** *** ***  **

42295 11/01*166 896  55    0*157 901  45    0*  0   0   0    0*  0   0   0    0*
42295 11/01*164 902  45    0*160 911  30    0*  0   0   0    0*  0   0   0    0*
            *** ***  **      *** ***  **

42300 HR
(Simone - in the NE Pacific - to be removed)
03845 11/01/1961 M= 3  9 SNBR= 118 SIMONE      XING=1 SSS=0
03850 11/01*  0   0   0    0*140 920  25    0*139 934  25    0*143 944  45    0*
03855 11/02*150 950  45    0*158 958  25    0*166 957  25    0*172 959  25    0*
03860 11/03*176 954  25    0*180 952  25    0*186 946  25    0*  0   0   0    0*
03865 TS
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Hurricane Landfall

10/31 12Z 17.1N 88.3W 130 kt Belize

Significant Revisions:

1. Genesis indicated to be 30 hours earlier based upon ship and coastal observations;
2. Several central pressures were added, primarily based upon aircraft reconnaissance;

3. Large downward revisions made to the intensity to some time periods on the 28th and 30th based primarily upon aircraft observations;
4. Large upward revision to the intensity made late on the 31st based upon ship observations;
5. Large downward revision made to the intensity on the 1st based primarily upon the Kaplan-DeMaria inland wind decay model;
6. Related change to the NE Pacific HURDAT: Removal of Tropical Storm Simone from HURDAT.

Daily Metadata:

October 25:

1. Maps and old HURDAT:
   - HWM and HURDAT do not analyze an organized system on this date.
   - Microfilm shows a closed low pressure of at most 1008 mb at 11.0N, 79.2W at 12Z.
2. Discussion/Reanalysis: Synoptic observations over the southern Caribbean Sea indicate that a tropical disturbance developed north of Panama around October 25th, likely associated with the Eastern Pacific monsoon trough extending into the Caribbean.

October 26:

1. Maps and old HURDAT:
   - HWM analyzes a spot low pressure at 10.2N, 82.0W at 12Z.
   - HURDAT does not list an organized system on this date.
   - Microfilm shows a closed low pressure of at most 1008 mb at 10.0N, 80.2W at 12Z.
2. Ship highlights:
   - 35 kt E and 1009 mb at 13.5N, 77.6W at 12Z (COADS).
3. Discussion:
   - ATSR: "Not since Hurricane Charlie of 1951 and Hurricane Janet of 1955 has a tropical storm in the western Caribbean taken a great toll of human life as the "killer" storm of the 1961 season, Hurricane Hattie, which claimed at least 300 victims with many more missing and presumed dead. Considerable rainfall, widespread altostratus, and slighly higher than normal winds were observed in the extreme southwestern Caribbean early on the 26th of October."
   - A closed surface circulation was indicated by 00Z and winds in the northern semicircle gradually increased during the day. Genesis is at 00Z, 30 hours earlier than originally in HURDAT. Intensification to a tropical storm is at 12Z, based upon a 35 kt ship north of the center.

October 27:

1. Maps and old HURDAT:
   - HWM analyzes a tropical storm of at most 1005 mb at 11.2N, 81.5W at 12Z.
   - HURDAT lists a 45 kt tropical storm at 11.6N, 81.5W at 12Z (first position).
   - Microfilm shows a closed low pressure of at most 1008 mb at 11.8N, 81.4W at 12Z.
2. Ship highlights:
   - 30 kt S and 1007 mb at 10.9N, 80.1W at 00Z (COADS).
   - 20 kt NE and 1004 mb at 11.4N, 82.0W at 06Z (COADS).
3. Land highlights:
   - 40 kt ESE and 1004 mb at San Andres, Colombia at 18Z (micro).
4. Discussion:

- MWR: "Hurricane Hattie was the killer storm of the 1961 hurricane season, although property damage mas much greater in Carla. Approximately 275 people perished in Hattie. Not since hurricane Janet, 1955, has a storm inflicted so much damage in the Yucatan Peninsula region. The first indication of a tropical storm came from a ship, located about 120 miles south-southeast of San Andres Island at 1900 EST, October 26, reporting the 40-kt southerly wind. By 1000 EST, October 27, the airport at San Andres Island reported that it was closed because of 40- to 50-kt. easterly winds and, based on this report, the first tropical storm advisory for Hattie was issued by the Miami Weather Bureau at 1700 EST."
- ATSR: "A ship about 120 miles south-southeast of San Andres Island reported a southerly wind of 30 knots at 270000Z with 8-foot seas from the south. At 271500Z the airport at San Andres radioed that it was closed due to 30 to 40 knot easterly winds and foul weather. The first warning for Hattie was issued at 272200Z. After passing over San Andres Island on the afternoon of the 27th, the storm moved northward and intensified."
- Reanalysis: Hattie moved slowly northward in the general direction of the Colombian island of San Andres. The tropical storm steadily intensification, based primarily upon observations early on the 28th.

October 28:

1. Maps and old HURDAT:
   - HWM analyzes a hurricane of at most 1000 mb at 13.3N, 81.6W at 12Z.
   - HURDAT lists a 105 kt hurricane at 13.5N, 81.6W at 12Z.
   - Microfilm shows a closed low pressure of at most 1002 mb at 13.9N, 81.6W at 12Z.
2. Ship highlights:
   - 25 kt ENE and 1005 mb at 13.5N, 81.5W at 00Z (COADS).
   - 30 kt NW and 1005 mb at 12.8N, 83.0W at 18Z (COADS).
3. Land highlights:
   - 70 kt (gusts to 90 kt) at San Andres, Colombia (time not given, likely early on the 28th) (MWR).
   - 50 kt ESE and 993 mb at San Andres, Colombia at 00Z (micro).
   - 991 mb at San Andres, Colombia at 01Z (MWR).
   - 15 kt SW and 1004 mb at San Andres, Colombia at 12Z (micro).
   - 35 kt W and 1005 mb at San Andres, Colombia at 18Z (micro).
   - 15 kt NW and 1001 mb at Puerto Cabezas, Nicaragua at 21Z (micro).
4. Aircraft highlights:
   - Radar center fix at 12.4N, 81.5W at 0322Z (ATSR).
   - Penetration center fix measured a central pressure of 998 mb and an eye diameter of 20 nm at 13.0N, 81.7W at 07Z (ATSR). (The actual fix says 998 mb. However, the extrapolation of the fix 700 mb data is 990 mb, while the extrapolation from the dropsonde data is 1001-1004 mb. None of these values appears to be realistic, given the preceeding and subsequent observations.)
   - Penetration center fix measured a central pressure of 969 mb, estimated surface winds of 110 kt and an eye diameter of 20 nm at 13.6N, 81.6W at 1247Z (ATSR).
   - Penetration center fix measured a central pressure of 963 mb at 13.8N, 81.6W at 15Z (ATSR). (This pressure is problematic. The fix reports an extrapolated pressure of 963 mb. However, the 700 mb data suggests an extrapolated pressure of 969 mb. In addition, the associated dropsonde reported 969 mb, but it has an apparent serious error in the 700 mb height. The extrapolated 850 mb data from the drop is 970 mb.)

- Penetration center fix estimated surface winds of 110 kt and an eye diameter of 10 nm at 14.4N, 81.6W at 1935Z (ATSR).
- Penetration center fix measured a central pressure of 956 mb and estimated surface winds of 100 kt at 14.3N, 81.6W at 20Z (ATSR).

5. Discussion:
   - MWR: "Hattie passed over or just to the west of San Andres in the late afternoon of the 27th. A minimum pressure of 991 mb was observed at 2100 EST, October 27, and highest steady winds were 70 kt with 90-kt gusts."
   - ATSR: "A Navy reconnaissance plane obtained a nighttime fix on Hattie early on the 28th and reported a poorly defined eye and a surface pressure by dropsonde of 998 mb.
   - Reanalysis: Late on the 27th, San Andres began to report gale-force winds and winds reached hurricane-force very late on the 27th and early on October 28th. Thus, intensification to a hurricane is analyzed at 00Z on the 28th, same as originally shown in HURDAT. A central pressure of 991 mb was present in HURDAT at 00Z on the 28th and has been removed since MWR does not indicate that this was a central pressure (MWR says minimum pressure) and at 00Z on the 28th San Andres was reporting 50 kt ESE and 993 mb, indicating a central pressure lower than 991 mb. At 07Z on the 28th, the first reconnaissance aircraft reported a central pressure of 998 mb from dropsonde and an eye diameter of 20 nm. The actual fix says 998 mb. However, the extrapolation of the fix 700 mb data is 990 mb, while the extrapolation from the dropsonde data is 1001-1004 mb. None of these values appears to be realistic, given the preceeding and subsequent observations. No central pressure is indicated at 06Z. Hurricane Hattie steadily intensified on the 28th as it moved away from San Andres. The next reconnaissance aircraft measured a central pressure of 969 mb, estimated surface winds of 110 kt and an eye diameter of 20 nm at 1247Z on the 28th. A central pressure of 969 mb suggests maximum sustained winds of 92 kt south of 25N intensifying from the south of 25N Brown et al. pressure-wind relationship. An eye diameter of 20 nm suggests an RMW of 15 nm and the climatological value is 12 nm. An intensity of 90 kt is selected at 12Z on the 28th, down from 105 kt originally shown in HURDAT, a minor intensity change. A central pressure of 991 mb was present in HURDAT at 12Z on the 28th and has been replaced with 969 mb. Another reconnaissance aircraft measured a central pressure of 956 mb and estimated surface winds of 100 kt at 20Z on the 28th. An eye diameter of 10 nm was estimated at 1935Z. A central pressure of 956 mb suggests maximum sustained winds of 107 kt south of 25N intensifying from the south of 25N pressure-wind relationship. An eye diameter of 10 nm suggests an RMW of about 8 nm and the climatological value is 12 nm. Due to an RMW close or slightly smaller than climatology and a forward speed of 8 kt, an intensity of 105 kt is selected at 18Z on the 28th, down from 110 kt originally shown in HURDAT, a minor intensity change. A central pressure of 969 mb was present in HURDAT at 18Z on the 28th and has been replaced with 956 mb. Intensification to a major hurricane is analyzed at 18Z on the 28th, 36 hours later than originally shown in HURDAT. Hattie likely produced tropical storm-force winds over northeastern Nicaragua and Honduras late on the 28th and early the next day.

October 29:

1. Maps and old HURDAT:
   - HWM analyzes a hurricane of at most 990 mb at 16.5N, 81.2W at 12Z.
   - HURDAT lists a 110 kt hurricane at 16.9N, 81.3W at 12Z.

- Microfilm shows a closed low pressure of at most 1002 mb at 16.5N, 81.2W at 12Z.

2. Ship highlights:
   - 30 kt NW and 1004 mb at 14.4N, 83.1W at 00Z (COADS).
   - 35 kt E and 1009 mb at 19.5N, 79.0W at 06Z (micro).
   - 35 kt SSW and 1004 mb at 15.2N, 80.7W at 09Z (micro).
   - 35 kt ESE and 1010 mb at 19.9N, 79.9W at 12Z (COADS).
   - 35 kt SSW and 1007 mb at 15.7N, 81.0W at 15Z (micro).
   - 40 kt NE and 1006 mb at 19.2N, 83.3W at 18Z (COADS).
   - 50 kt NE at 19.5N, 84.0W at 21Z (micro).
3. Land highlights:
   - 10 kt N and 1003 mb at Cabo Gracias a Dios, Honduras at 00Z (micro).
   - 15 kt NE and 1005 mb at Swan Islands, Honduras at 09Z (micro).
   - 25 kt NE and 1004 mb at Grand Cayman at 18Z (micro).
   - 30 kt E and 1002 mb at Grand Cayman at 21Z (micro).
4. Aircraft highlights:
   - Penetration center fix measured a central pressure of 952 mb at 15.1N, 81.4W at 0030Z (WALLET).
   - Penetration center fix measured a central pressure of 960 mb and estimated an eye diameter of 12 nm at 16.3N, 81.2W at 07Z (ATSR). (Note that the vortex message indicated 966 mb central pressure, but the drop surface pressure, 700 mb heights/temps, and 850 mb heights/temps all indicate 960 mb, which is accepted as the central pressure.)
   - Penetration center fix measured a central pressure of 963 mb, estimated surface winds of 110 kt and an eye diameter of 40 nm at 17.0N, 81.4W at 13Z (ATSR).
   - Penetration center fix measured a central pressure of 956 mb, estimated surface winds of 110 kt and an eye diameter of 40 nm at 18.0N, 82.2W at 1915Z (ATSR).

5. Discussion:
   - ATSR: "Twenty-four hours later another Navy aircraft reported a 963 mb surface pressure, showing rapid development had occurred. Hattie continued her northerly course until approximately 291000Z, then began a wide cyclonic curve before eventually ending up on a west-southwest course."
   - Reanalysis: Early on October 29th, the tropical cyclone moved northward fluctuating in intensity. Late on the 29th, Hattie turned to the northwest. The first reconnaissance aircraft on the 29th arrived at 0030Z measuring a central pressure of 952 mb. A central pressure of 952 mb suggests maximum sustained winds of 111 kt from the south of 25N intensifying pressure-wind relationship. An intensity of 110 kt is selected at 00Z on the 29th, same as originally shown in HURDAT. A central pressure of 952 mb was present in HURDAT at 00Z on the 29th and has been retained. It is apparent that Hattie began a concentric eyewall replacement cycle early on the 29th based on reconnaissance aircraft data and radar images available in the 1961 Navy book (pg. 229 and 233). At 07Z on the 29th, a penetration center fix measured a central pressure of

960 mb and an eye diameter (of the inner eye) of 12 nm. A central pressure of 960 mb suggests maximum sustained winds of 98 kt from the south of 25N weakening pressure-wind relationship. An eye diameter of 12 nm suggests an RMW of about 9 nm and the climatological value is 13 nm. An intensity of 100 kt is selected at 06Z on the 29th, down from 110 kt originally in HURDAT, a minor intensity change. A central pressure of 960 mb has been added to HURDAT at 06Z on the 29th. The next reconnaissance aircraft measured a central pressure of 963 mb and estimated surface winds of 110 kt and an eye diameter of 40 nm at 13Z on the 29th. A central pressure of 963 mb was present in HURDAT at 12Z and has been retained. Another reconnaissance aircraft measured a central pressure of 956 mb and estimated surface winds of 110 kt and an eye diameter of 40 nm at 1915Z on the 29th. A central pressure of 956 mb suggests maximum sustained winds of 105 kt from the south of 25N intensifying pressure-wind relationship. An eye diameter of 40 nm suggests an RMW of about 30 nm and the climatological value is 12 nm. Due to an RMW larger than the climatological value and forward speed of 6 kt, an intensity of 100 kt is selected at 18Z on the 29th, down from 100 kt originally shown in HURDAT, a minor intensity change. A central pressure of 956 mb was added to HURDAT at 18Z on the 29th.

October 30:

1. Maps and old HURDAT:
   - HWM analyzes a hurricane of at most 990 mb at 18.0N, 84.3W at 12Z.
   - HURDAT lists a 130 kt hurricane at 18.4N, 84.1W at 12Z.
   - Microfilm shows a closed low pressure of at most 993 mb at 18.5N, 84.5W at 12Z.
2. Ship highlights:
   - 40 kt N at 18.2N, 83.6W at 00Z (COADS).
   - 35 kt SW and 1005 mb at 16.3N, 82.5W at 06Z (COADS).
   - 50 kt N and 1004 mb at 18.0N, 85.3W at 12Z (COADS).
   - 45 kt NW and 999 mb at 17.4N, 85.2W at 15Z (micro).
   - 70 kt W and 1000 mb at 17.4N, 85.2W at 18Z (micro).
   - 75 kt SSW and 991 mb at 17.1N, 85.0W at 21Z (micro).
3. Land highlights:
   - 15 kt NNW and 1002 mb at Swan Islands, Honduras at 00Z (micro).
   - 20 kt W and 1000 mb at Swan Islands, Honduras at 06Z (micro).
   - 30 kt WSW and 997 mb at Swan Islands, Honduras at 09Z (micro).
   - 35 kt SW and 996 mb at Swan Islands, Honduras at 12Z (micro).
   - 50 kt SW and 999 mb at Swan Islands, Honduras at 15Z (micro).
   - 45 kt SSW and 1002 mb at Swan Islands, Honduras at 18Z (micro).
   - 40 kt S and 1002 mb at Swan Islands, Honduras at 21Z (micro).
4. Aircraft highlights:
   - Penetration center fix measured a central pressure of 958 mb and estimated an eye diameter of 30 nm at 18.1N, 82.6W at 01Z (ATSR).
   - Penetration center fix measured a central pressure of 942 mb and estimated an eye diameter of 28 nm at 18.5N, 83.9W at 07Z (ATSR).
   - Penetration center fix measured a central pressure of 937 mb, estimated surface winds of 115 kt and an eye diameter of 25 nm at 18.5N, 84.2W at 10Z (ATSR).
   - Penetration center fix measured a central pressure of 924 mb, estimated surface winds of 130 kt and an eye diameter of 20 nm at 18.4N, 84.5W at 15Z (ATSR).

- Penetration center fix measured a central pressure of 923 mb and estimated an eye diameter of 20 nm at 18.3N, 85.0W at 17Z (ATSR).
- Penetration center fix measured a central pressure of 914 mb and estimated an eye diameter of 22 nm at 18.0N, 86.0W at 22Z (ATSR). (Note that the drop reported 927 mb at the surface. However, the 700 mb temps/heights from the drop as well as the aircraft flight-level temps/heights indicate 914 mb. This value is used as the central pressure.)

5. Discussion:
   - MWR: "From this point Hattie continued on a generally northerly course for the next 36 hours and intensified with the central pressure reaching 952 mb near 15°N. By 1900 EST, October 29, a change to a more westerly course became clearly evident. The storm continued on a cyclonic turn passing between Swan and Cayman Islands with maximum winds on these two islands remaining under hurricane force. Hattie finally settled on a west-southwestward course and intensified markedly during the morning of October 30 when the central pressure probably reached its lowest value, 924 mb at 0800 EST. A lower pressure of 920 mb was computed at 1700 EST; however, this was based upon the 700 mb height and not determined by dropsonde."
   - ATSR: "On the 30th a central pressure of 923 mb was reported by dropsonde."
   - Reanalysis: On October 30th, Hattie experienced a period of rapid intensification as the system turned to the west and west-southwest. Early on the 30th, the hurricane passed between Swan Island and the Cayman Islands, producing gale-force winds. The first reconnaissance aircraft on the 30th measured a central pressure of 958 mb and an eye diameter of 30 nm at 01Z. A central pressure of 958 mb suggests maximum sustained winds of 105 kt from the south of 25N intensifying pressure-wind relationship. An eye diameter of 30 nm suggests an RMW of about 23 nm and the climatological value is 12 nm. Due to the large circulation and forward speed of about 10 kt, an intensity of 100 kt is selected at 00Z on the 30th, down from 115 kt originally shown in HURDAT, a minor intensity change. A central pressure of 956 mb was present in HURDAT at 00Z on the 30th and has been replaced with 958 mb. The next reconnaissance aircraft measured a central pressure of 942 mb and estimated an eye diameter of 28 nm at 07Z on the 30th. A central pressure of 942 mb suggests maximum sustained winds of 121 kt from the south of 25N intensifying pressure-wind relationship. An eye diameter of 28 nm suggests an RMW of about 21 nm and the climatological value is 11 nm. Based on an RMW larger than climatology and forward speed of about 11 kt, an intensity of 115 kt is selected at 06Z on the 30th, down from 120 kt originally shown in HURDAT, a minor intensity change. A central pressure of 942 mb was present in HURDAT at 06Z on the 30th and has been retained. At 10Z on the 30th, a penetration center fix measured a central pressure of 937 mb, estimated surface winds of 115 kt and an eye diameter of 25 nm. A central pressure of 937 mb suggests maximum sustained winds of 126 kt from the south of 25N intensifying pressure-wind relationship. An eye diameter of 25 nm suggests an RMW of about 19 nm and the climatological value is 11 nm. Based on an RMW larger than climatology and forward speed of about 6 kt, an intensity of 120 kt is selected at 12Z on the 30th, down from 130 kt originally shown in HURDAT, a minor intensity change. A central pressure of 937 mb was present in HURDAT at 12Z on the 30th and has been retained. Another penetration center fix measured a central pressure of 923 mb and an eye diameter of 20 nm at 17Z on the 30th. A central pressure of 923 mb suggests maximum sustained winds of 139 kt

from the south of 25N intensifying pressure-wind relationship. An eye diameter of 20 nm suggests an RMW of about 15 nm and the climatological value is 10 nm. Based on an RMW larger than climatology and forward speed of about 10 kt, an intensity of 135 kt is selected at 18Z on the 30th, down from 140 kt originally shown in HURDAT, a minor intensity change. A central pressure of 923 mb was added to HURDAT at 18Z on the 30th. Late on the 30th, ships near the tropical cyclone reported hurricane-force winds.

October 31:

1. Maps and old HURDAT:
   - HWM analyzes a hurricane of at most 985 mb at 17.1N, 88.0W at 12Z.
   - HURDAT lists a 120 kt hurricane at 17.2N, 88.1W at 12Z.
   - Microfilm shows a closed low pressure of at most 1002 mb at 17.2N, 88.2W at 12Z.
2. Ship highlights:
   - 65 kt SW and 980 mb at 17.3N, 85.0W at 00Z (micro).
   - 40 kt SE and 1009 mb at 19.8N, 84.7W at 03Z (micro).
   - 60 kt SE and 996 mb at 17.8N, 85.4W at 06Z (COADS).
   - 30 kt E and 1003 mb at 18.1N, 85.5W at 12Z (COADS).
   - 35 kt NW and 1005 mb at 13.4N, 94.0W at 18Z (micro).
3. Land highlights:
   - 25 kt SE and 1005 mb at Swan Islands, Honduras at 00Z (micro).
   - 25 kt NW and 999 mb at Belize City, Belize at 06Z (micro).
   - 966 mb at Belize City, Belize at 11Z (WALLET).
   - 924 mb at 11Z (ship located between Belize City and Stann Creek) (WALLET).
   - 40 kt W and 1001 mb at San Pedro Sula, Honduras at 12Z (micro).
   - 10 kt S and 999 mb at Santa Barbara, Honduras at 18Z (micro).
4. Aircraft highlights:
   - Radar center fix at 18.1N, 86.1W at 00Z (ATSR).
   - Penetration center fix measured a central pressure of 920 mb and estimated an eye diameter of 22 nm at 17.5N, 87.3W at 07Z (ATSR). (The drop reported 930 mb at the surface. However, the 700 mb temps from the drop were 9C, while the peak 700 mb flight temps were 22C. Using this value at 700 mb, gives an extrapolated sea level pressure of 920 mb, which is used here.)
   - Radar center fix estimated an eye diameter of 25 nm at 17.2N, 88.1W at 1130Z (ATSR).
5. Discussion:
   - MWR: "Hattie moved inland on the British Honduras coast about sunrise on October 31. The center of the radar eye, which measured approximately 25 miles in diameter, passed 20 miles southeast of Belize. The lowest pressure on the barograph at Stanley Field, Belize, was 972 mb indicating a gradient of some 45 to 50 mb in the 20 miles between that point and the center of the eye. A trained observer estimated winds from 150 to 160 mph at Belize with unofficial estimates to 200 mph or more. A copy of the Dines anemometer record is shown in figure 14. The pen remained at the top of the graph for a while. Storm tides of 10 to 11 feet along the Belize waterfront were general and waves deposited mud on the third floor of some buildings. Other locations near Belize reported storm tides up to 14 feet. Seventy-five percent of Belize, the capital of British Honduras, was either destroyed or severely damaged. Some communities such as Stann Creek were almost completely erased. Damage was so great in Belize that plans are under consideration for its relocation farther inland. Latest

fatality figures show 262 dead in British Honduras...Hattie continued west-southwestward and southwestward through British Honduras and Guatemala, dissipating in the mountains of Guatemala. Tropical Storm Simone was already in existence in the Pacific Ocean as Hattie passed near Belize, and the remnants of Hattie developed into neither Simone nor Inga."

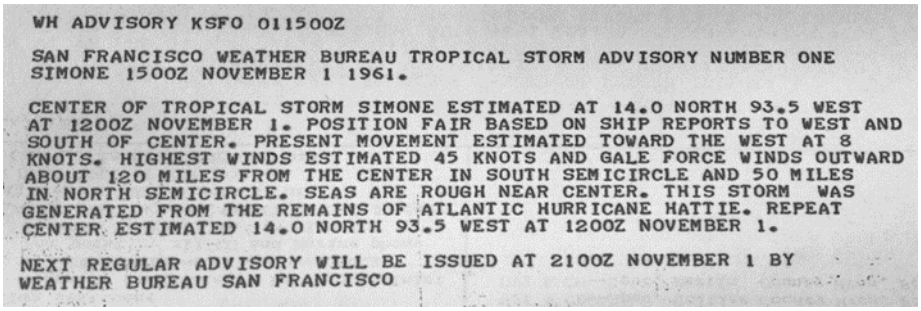
- ATSR: "The storm entered the coast of British Honduras about 20 miles south of Belize at approximately 311300Z and wreaked such destruction that this capitol city has since been relocated further inland. Hattie then dissipated in the mountains of Guatemala. The final warning was issued at 311600Z."
- Reanalysis: On October 31st, powerful hurricane Hattie moved southwestward toward central Belize. At 22Z on the 30th, a reconnaissance aircraft measured a central pressure of 914 mb and estimated an eye diameter of 16 nm at 2330Z. A central pressure of 914 mb suggests maximum sustained winds of 146 kt from the south of 25N intensifying pressure-wind relationship. An eye diameter of 16 nm suggests an RMW of about 12 nm and the climatological value is 10 nm. Based on an RMW near climatology and a forward speed of 9 kt, an intensity of 145 kt is selected at 00Z on the 31th, 5 kt higher than originally shown. Thus, it is analyzed that Hattie did become a category 5 in the Saffir-Simpson scale as originally shown in HURDAT. 145 kt is the peak intensity of Hattie (up from 140 kt originally), as the hurricane began weakening some before landfall. A central pressure of 920 mb was present in HURDAT at 00Z on the 31st and has been replaced with 914 mb. The next penetration center fix measured a central pressure of 920 mb and estimated an eye diameter of 22 nm at 07Z on the 31st. A central pressure of 920 mb suggests maximum sustained winds of 139 kt from the south of 25N pressure-wind relationship. An eye diameter of 22 nm suggests an RMW of about 17 nm and the climatological value is 10 nm. Due to the large RMW and forward speed of 10 kt, an intensity of 135 kt is selected at 06Z on the 31th, down from 140 kt originally shown in HURDAT, a minor intensity change. A central pressure of 920 mb was added to HURDAT at 06Z on the 31st. As the hurricane approached the coastline of Belize, a British ship named "M.V. Tactician" was caught between Belize City and Stann Creek. The captain of the ship wrote a detailed account about the experience and the letter reached the US Weather Bureau on June 1st, 1962, about three months after the 1961 Hurricane Season summary had been published in the Monthly Weather Review. A comparison between the reported central pressures by the ship and Belize City indicates that the barometer was well calibrated. According to the captain, a central pressure of 924 mb was recorded at 11Z on the 31st. The captain also recounts a lull that lasted about 45 minutes, providing enough time to reposition the ship ahead of the second half of the hurricane. Hence, a central pressure of 924 mb was added to HURDAT at 12Z. In this time slot HURDAT originally had 930 mb. A central pressure of 924 mb suggests maximum sustained winds of 135 kt from the south of 25N pressure-wind relationship. At 1135Z, a reconnaissance aircraft made a radar center fix and estimated an eye diameter of 25 nm. An eye diameter of 25 nm suggests an RMW of about 19 nm and the climatological value is 9 nm. Based on an RMW larger than the climatological value and a forward speed of about 11 kt, an intensity of 130 kt is selected at 12Z on the 31st, up from 120 kt originally in HURDAT, a minor intensity change. Landfall in analyzed at 12Z on the 31st near 17.1N 88.3W, or about 25 nm south of Belize City, Belize. The impact of the northern eyewall of Hattie on Belize City was devastating, causing the rebuilding of the city to take place farther inland.

November 1:

1. Maps and old HURDAT:
   - HWM analyzes a tropical storm of at most 995 mb at 14.0N, 91.5W and a spot low pressure at 13.5N, 93.5W at 12Z.
   - HURDAT lists a 45 kt tropical storm at 15.7N, 90.1W at 06Z (last position).
   - Microfilm shows a closed low pressure of at most 1002 mb at 14.0N, 93.5W at 12Z.
2. Ship highlights:
   - 25 kt NNW and 1004 mb at 12.7N, 92.3W at 00Z (micro).
   - 35 kt W and 1000 mb at 13.5N, 93.1W at 12Z (COADS).
   - 40 kt W and 1002 mb at 14.0N, 94.4W at 18Z (COADS).

3. Discussion:

- Randerson: "After moving inland, Hattie began to curve to the southwest and dissipate rapidly into a tropical storm over Guatemala…This analysis shows that the surface pressures along the west coast of Guatemala were subnormal and that a well-organized cyclone was still present. As tropical storm Hattie moved into the Gulf of Tehuantepec, the San Francisco Weather Bureau named it tropical storm Simone and noted that this Pacific storm was the remnants of hurricane Hattie."
- Reanalysis: After landfall, the large hurricane continued inland on a southwest course and rapidly weakened. The Kaplan and DeMaria model was run for 18Z on the 31st, and 00Z, and 06Z on November 1st yielding 81 kt, 56 kt and 41 kt, respectively. Data over western Central America and southeastern Mexico was sparse and no winds of tropical storm intensity were reported on land during those three time periods. An intensity of 75 kt is selected for 18Z on the 31st, 45 kt at 00Z and 30 kt at 06Z on the 1st (up from 60 kt at 18Z on the 31st, down from 55 kt and 45 kt at 00Z and 06Z, respectively, on the 1st, originally in HURDAT), minor intensity changes. The analyzed intensity is below that suggested by Kaplan-DeMaria due to the mountainous terrain in Central America. Weakening to a tropical storm is analyzed at 00Z on the 1st, six hours later than originally shown in HURDAT. The last position of Hattie is analyzed at 06Z on the 1st, same as originally shown in HURDAT. Over the Eastern Pacific, synoptic data indicates that the circulation of Hattie remained the dominant feature as the hurricane made landfall in Belize and moved southwestward toward that ocean basin. There is no evidence to support the statement in the Monthly Weather Review that Tropical Storm Simone was already in existence as Hattie made landfall in Belize. Furthermore, the first advisory issued on Simone clearly indicates the opinion at the time was that this tropical cyclone was the former Atlantic hurricane:



WH ADVISORY KSFO 011500Z

SAN FRANCISCO WEATHER BUREAU TROPICAL STORM ADVISORY NUMBER ONE SIMONE 1500Z NOVEMBER 1 1961.

CENTER OF TROPICAL STORM SIMONE ESTIMATED AT 14.0 NORTH 93.5 WEST AT 1200Z NOVEMBER 1. POSITION FAIR BASED ON SHIP REPORTS TO WEST AND SOUTH OF CENTER. PRESENT MOVEMENT ESTIMATED TOWARD THE WEST AT 8 KNOTS. HIGHEST WINDS ESTIMATED 45 KNOTS AND GALE FORCE WINDS OUTWARD ABOUT 120 MILES FROM THE CENTER IN SOUTH SEMICIRCLE AND 50 MILES IN NORTH SEMICIRCLE. SEAS ARE ROUGH NEAR CENTER. THIS STORM WAS GENERATED FROM THE REMAINS OF ATLANTIC HURRICANE HATTIE. REPEAT CENTER ESTIMATED 14.0 NORTH 93.5 WEST AT 1200Z NOVEMBER 1.

NEXT REGULAR ADVISORY WILL BE ISSUED AT 2100Z NOVEMBER 1 BY WEATHER BUREAU SAN FRANCISCO

Instead, the remnants of Hurricane Hattie became a Central American Gyre (lacking an inner core well-defined center structure required for a tropical cyclone) on November 1st while located along the Pacific coast of

southeastern Mexico and Guatemala. Gale force westerly winds were occurring on the 1st south of Gyre's trough axis.

November 2:

1. Maps and old HURDAT:

- HWM analyzes a closed low pressure of at most 1000 mb at 16.5N, 97.8W at 12Z.
- HURDAT does not list an organized system in the Atlantic Ocean on this date.
- Microfilm shows a closed low pressure of at most 1002 mb at 16.0N, 97.7W at 12Z.

2. Ship highlights:

- 20 kt W and 1001 mb at 15.8N, 98.9W at 00Z (micro).
- 30 kt SW and 1005 mb at 14.8N, 96.0W at 12Z (micro).

3. Discussion

- Randerson: "On 2 November, this tropical storm [Simone] began to curve to the north toward Saline Cruz, Mexico. As tropical storm Simone crossed the Isthmus of Tehuantepec, the rugged mountainous terrain of this region dissipated Simpon to a weak tropical depression".
- Reanalysis: The Central American Gyre interacted with a powerful mid-latitude shortwave trough to substantially deepen and expand in area on the 2nd while located over southeastern Mexico and northern Central America. Gale force westerly winds continued to occur on the 2nd south of the Gyre's trough axis. By late on the 2nd and during the 3rd, an extratropical low pressure center had formed over the Bay of Campeche with a front extending from the low north-northeastward over the Gulf of Mexico to the southeastern United States while still low pressure with the Gyre also existed along the southern Mexico coast.

November 3:

1. Maps and old HURDAT:

- HWM analyzes a closed low pressure of at most 1000 mb at 19.2N, 94.2W with a weakening cold front to the north at 12Z.
- HURDAT does not list an organized system in the Atlantic Ocean on this date.
- Microfilm shows a closed low pressure of at most 1002 mb at 21.5N, 95.3W with a frontal boundary to the north at 12Z.

2. Discussion/Reanalysis: By late on the 3rd, it appears that the Central American Gyre had dissipated, leaving only a broad, extratropical low pressure system in the Gulf of Mexico. Based on the ship and coastal observations, it appears that Simone never had a closed low-level circulation and therefore, was not been a tropical cyclone. Thus, in addition to alterations for Hattie, Simone is to be removed from the Northeast Pacific HURDAT.

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, the NHC Storm Wallets, and Randerson (Weatherwise, 1963).

Hurricane Jenny [November 2-11, 1961]

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42305 11/01/1961 M= 9 10 SNBR= 917 JENNY       XING=0 SSS=0
42305 11/02/1961 M=10 10 SNBR= 917 JENNY       XING=0 SSS=0
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(The 1st is removed from HURDAT.)

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42310 11/01*  0   0   0    0*  0   0   0    0*170 620  30    0*193 610  30 1006*

42315 11/02*210 600  30    0*223 590  30    0*238 580  30    0*248 572  30    0*
42315 11/02*225 590  30    0*235 580  30    0*245 573  30    0*254 567  30    0*
            *** ***          *** ***          *** ***          *** ***

42320 11/03*260 568  30    0*267 556  30    0*269 545  30    0*270 529  30    0*
42320 11/03*262 563  30    0*267 556  30    0*269 545  30    0*270 529  30    0*
            *** ***

42325 11/04*270 513  30    0*270 489  30    0*270 470  30 1002*260 460  30    0*
42325 11/04*270 510  30    0*270 489  30    0*267 470  30 1002*262 460  30 1001*
            *** ***                         ***              ***          ****

42330 11/05*257 450  30    0*259 438  30    0*265 432  30    0*276 435  30  991*
42330 11/05*259 450  30    0*259 440  35    0*265 435  40    0*274 440  45  988*
            ***                   ***  **         ***  **      *** ***  **  ***

42335 11/06*288 470  45  976*284 491  55    0*280 510  65    0*283 523  70  974*
42335 11/06*280 465  50    0*283 491  55    0*284 510  65    0*285 522  70  974*
            *** ***  **    * ***            ***              *** ***

42340 11/07*285 524  70    0*287 525  65    0*288 528  60  988*297 519  60    0*
42340 11/07*287 528  70    0*290 532  65    0*293 529  60    0*297 523  60  985*
            *** ***          *** ***          *** ***          *     ***      ***

42345 11/08*304 517  55  985*311 509  50    0*318 504  50    0E324 493  45    0*
42345 11/08*304 517  55    0*311 510  50    0*318 502  50    0*324 492  45    0*
                         *     ***              ***          *     ***

42350 11/09E327 486  40  987E332 475  40    0E338 465  35    0E345 458  35    0*
42350 11/09*330 484  40  987*336 475  40    0*342 465  35    0*352 457  40    0*
            ***  ***         ****            ****             **** ***  **

(November 10th and 11th are new to HURDAT)
42351 11/10*365 450  45    0*382 443  50    0*400 435  55    0*430 430  55    0*
42353 11/11E465 415  55    0E490 390  45    0*  0   0   0    0*  0   0   0    0*
42355 HR
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Significant Revisions:

1. Genesis delayed by 12 hours based upon ship and coastal observations;
2. Intensity significantly boosted on the 5th based on ship observations;
3. Transition to extratropical delayed by two days based upon ship observations;
4. Dissipation delayed by 36 hours based upon ship observations.

Daily Summaries:

October 31:

1. Maps and old 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 or trough over the eastern Caribbean at 12Z.
2. Land highlights:
   - 10 kt S and 1005 mb at Dominique at 18Z (micro).

November 1:

1. Maps and old HURDAT:
   - HWM does not analyze an organized system at 12Z.
   - HURDAT lists a 30 kt tropical depression at 17.0N, 62.0W at 12Z.
   - Microfilm shows a tropical wave or trough over the eastern Caribbean at 12Z.
2. Ship highlights:
   - 15 kt S and 1005 mb at 16.4N, 62.0W at 18Z (COADS).
3. Discussion:
   - MWR: "Jenny, the tenth and last cyclone for which advisories were issued in the 1961 hurricane season, was only quasi-tropical, resembling the Kona Low of the Pacific or what has been called the "subtropical" storm in the Atlantic. These develop in connection with cold-core cyclones and are more likely to occur outside the usual hurricane season. Some other examples were hurricane Greta of 1956 and the unusual May hurricane in 1951. The disturbance which eventually became Jenny was first noted in the vicinity of the Windward Islands on November 1, at which time it was only a broad area of unsettled weather with lowest pressure around 1005 mb. The formation of the disturbance coincided with the development of a cut-off Low in the middle and upper troposphere just to the north of Puerto Rico. The depression moved northeastward during the next two days then turned abruptly eastward in advance of a deepening upper-level trough in the westerlies."
   - ATSR: "The disturbance which became the tenth and last tropical storm of the season originated near Antigua in the Windward Islands on 1 November. Navy reconnaissance aircraft investigating the area on the 1st reported what appeared to be "the joining of the Intertropical Convergence Zone and a polar trough east of Puerto Rico." The low began to move rapidly to the northeast while filling slightly."
   - Reanalysis: A tropical wave entered the eastern Caribbean Sea late in October generating an area of disturbed weather. In an environment of weak steering currents, the disturbance slowly moved northeastward and became better organized. On November 1st, the sharp trough stretched from the southeast Caribbean Sea, across the Leeward Islands, and into the Atlantic Ocean. HURDAT originally indicated that genesis occurred at 12Z on November 1st but synoptic observations show that the disturbance did not have a closed low-level circulation at this time.

November 2:

1. Maps and old HURDAT:
   - HWM analyzes a closed low pressure of at most 1010 mb at 23.0N, 59.0W at 12Z.
   - HURDAT lists a 30 kt tropical depression at 23.8N, 58.0W at 12Z.
   - Microfilm shows a closed low pressure of at most 1008 mb at 22.5N, 57.5W at 12Z.
2. Discussion:
   - Reanalysis: Based upon ship observations, genesis is analyzed at 00Z on November 2nd as a 30 kt tropical depression, 12 hours later than originally shown in HURDAT.

November 3:

1. Maps and old HURDAT:
   - HWM analyzes a closed low pressure of at most 1005 mb at 26.0N, 54.5W with a weakening cold front to the north at 12Z.
   - HURDAT lists a 30 kt tropical depression at 26.9N, 54.5W at 12Z.

- Microfilm shows a closed low pressure of at most 1014 mb at 29.0N, 52.5W at 12Z.

2. Ship highlights:

- 35 kt NE and 1018 mb at 31.0N, 53.8W at 23Z (COADS).

3. Discussion:

- ATSR: "It continued on this course until the third when reports from Ocean Station Echo indicated considerable deepening of an upper level trough to the northwest of the surface disturbance. The low on the surface appeared to react by turning eastward abruptly."
- Reanalysis: The broad tropical depression moved northeastward during the 2nd and turned to the east on November 3rd. During this time, the synoptic-scale pressure gradient increased to the northwest of the cyclone and gale-force winds began to be reported about 300 nm from the center. During most of the lifetime of the tropical cyclone (with the exception of the 6th and 7th), the system exhibited characteristics of a subtropical cyclone. The Monthly Weather Review mentions the similarities of this cyclone with previous cyclones that have exhibited subtropical characteristics like Hurricane Greta in 1956. Furthermore, they mention the term "subtropical" to describe this tropical cyclone, a milestone. Previously the term used to describe these cyclones was quasi-tropical.

November 4:

1. Maps and old HURDAT:

- HWM analyzes a closed low pressure of at most 1005 mb at 26.5N, 48.0W with a warm front to the north at 12Z.
- HURDAT lists a 30 kt tropical depression at 27.0N, 47.0W at 12Z.
- Microfilm shows a closed low pressure of at most 1008 mb at 26.0N, 45.0W with a frontal boundary to the north at 12Z.

2. Ship highlights:

- 25 kt NW and 1003 mb at 24.7N, 46.3W at 18Z (micro).

3. Discussion:

- Reanalysis: On November 4th, there were numerous reports of gale- to storm-force winds northwest and north of the center that were 300 to 500 nm away from the center of the system. Even considering that the system was perhaps subtropical in nature, these are too large for an RMW for a tropical or subtropical cyclone. Additionally, these observations were outside of the outer closed isobar and outside of the circulation of the system. Thus they are not considered to be representative of the intensity of this system on the 4th. A central pressure of 1002 mb is present in HURDAT at 12Z on November 4th is apparently an analysis and not based upon an observation. But as it is reasonable, it is retained in HURDAT. A ship reported 20 kt NE and 1003 mb at 18Z on the 4th, suggesting a central pressure of 1001 mb, which has been added to HURDAT. A central pressure of 1001 mb suggests maximum sustained winds of 41 kt from the north of 25N and 44 kt from the south of 25N Brown et al. pressure-wind relationship. While the tropical cyclone had a forward speed of 19 kt, the analyzed intensity is 30 kt due to its large circulation and ship observations near the center showing winds below gale-force, same as originally shown in HURDAT.

November 5:

1. Maps and old HURDAT:

- HWM analyzes a closed low pressure of at most 1000 mb at 26.0N, 44.0W with warm front to the north at 12Z.
- HURDAT lists a 30 kt tropical depression at 26.5N, 43.2W at 12Z.

- Microfilm shows a closed low pressure of at most 996 mb at 25.7N, 43.0W with a frontal boundary to the north at 12Z.

2. Ship highlights:

- 40 kt (50 kt in micro) NE and 1010 mb at 30.3N, 47.2W at 00Z (COADS).
- 15 kt NE and 1002 mb at 25.8N, 47.7W at 06Z (micro).
- 20 kt NE and 999 mb at 27.5N, 43.7W at 12Z (COADS).
- 35 kt SE and 991 mb at 27.9N, 43.1W at 18Z (COADS).

3. Discussion:

- MWR: "On November 5, the 500 mb charts showed that the trough had sheared, cutting off an intense cold Low some 300 miles northwest of the position of the surface disturbance.
- ATSR: "On the 5th the upper level trough sheared, cutting off a cold upper low approximately 300 miles to the north of the surface system. This cold low moved southwestward as a warm high pressure cell moved eastward across its northern boundary. The surface system came under the upper low and radically altered its course to the west while deepening rapidly to hurricane intensity."
- Reanalysis: On November 5th, synoptic observations indicate that the tropical cyclone became better organized and the gale-force winds were being reported closer to the center. Intensification to a tropical storm is analyzed at 06Z on the 5th, eighteen hours earlier than originally shown in HURDAT. A ship reported 35 kt SE and 991 mb near the center of Jenny at 18Z. This indicates a central pressure of about 988 mb, which replaces the 991 mb already in HURDAT. A central pressure of 988 mb suggests maximum sustained winds of 62 kt from the north of 25N pressure-wind relationship. Due to the large size of the circulation, an intensity of 45 kt is analyzed at 18Z on the 5th, up from 30 kt originally in HURDAT, a major intensity change.

November 6:

1. Maps and old HURDAT:

- HWM analyzes a hurricane of at most 985 mb at 28.0N, 51.1W with warm front to the north at 12Z.
- HURDAT lists a 65 kt hurricane at 28.0N, 51.0W at 12Z.
- Microfilm shows a closed low pressure of at most 987 mb at 28.5N, 51.5W at 12Z.

2. Ship highlights:

- 40 kt SE and 1008 mb at 32.5N, 44.0W at 00Z (COADS).
- 55 kt SE and 1007 mb at 32.1N, 45.3W at 06Z (COADS).
- 60 kt NW and 992 mb at 28.1N, 52.6W at 12Z (COADS).
- 65 kt E and 989 mb at 29.7N, 51.9W at 18Z (micro).
- 70 kt SE and 986 mb at 28.8N, 51.7W at 21Z (MWL).

3. Aircraft highlights:

- Penetration center fix measured a central pressure of 974 mb and estimated surface winds of 70 kt at 28.4N, 52.4W at 1910Z (WALLET).

4. Discussion:

- MWR: "This Low moved southwestward during the next 24 hours and the surface Low, apparently steered by the upper system, reversed its course and moved rapidly westward. As the surface Low began to move under the upper cyclone, it deepened rapidly and the central pressure on November 6 was 974 mb. Maximum winds were barely of hurricane force near the center but gales extended outward as much as 600 miles to the north and 300 miles to the south. This was evidently due to reflection in the surface pressure gradients of the upper Low and not to a true tropical development. However, the latitude of the storm and the concentration of winds of hurricane force

about the center made it advisable to treat the storm as tropical for purposes of marine advisories. It has been observed in "subtropical" storms that a warm core may exist within the circulation of the larger cold Low. The possibility that this was true in the case of Jenny cannot be ruled out but it could have been for only a matter of hours and was not observed by the reconnaissance flight on November 6, which reported "no eye, no temperature rise, no spiral bands." It was never a threat to land and the only known damage was to the ship *Venore,* an 8000-ton ore carrier, which required assistance after becoming disabled in the storm on the afternoon of November 6."

- ATSR: "Warning number one went out on hurricane Jenny at 062200Z."
- Reanalysis: A central pressure of 976 mb was present in HURDAT at 00Z on November 6th and it has been removed since there is no evidence that it was an actual observation, nor does it appear reasonable. A reconnaissance aircraft reached Jenny at 1910Z on the 6th measuring a central pressure of 974 mb and estimated surface winds of 70 kt. A central pressure of 974 mb suggests maximum sustained winds of 83 kt from the north of 25N intensifying pressure-wind relationship. Due to the very large size of the circulation and forward speed of about 12 kt, an intensity of 70 kt is analyzed at 18Z on the 6th, same as originally shown in HURDAT. 70 kt is also the peak intensity of this hurricane, same as originally shown in HURDAT. Intensification to a hurricane is analyzed at 12Z on the 6th, same as originally shown in HURDAT. A central pressure of 974 mb was present in HURDAT at 18Z on the 6th and has been retained. Late on the 6th, ships observations near the center indicated that Jenny had developed a strong, tighter core. A couple of ships reported hurricane-force winds, up to 70 kt.

November 7:

1. Maps and old HURDAT:

- HWM analyzes a hurricane of at most 985 mb at 28.4N, 52.3W with a weakening stationary front to the north at 12Z.
- HURDAT lists a 40 kt tropical storm at 28.8N, 52.8W at 12Z.
- Microfilm shows a closed low pressure of at most 990 mb at 29.2N, 52.5W at 12Z.

2. Ship highlights:

- 50 kt ENE and 983 mb at 29.3N, 52.7W at 00Z (micro).
- 30 kt NNW and 985 mb at 28.7N, 53.4W at 03Z (micro).
- 60 kt NNW and 990 mb at 29.0N, 53.7W at 06Z (COADS).
- 45 kt NNW and 990 mb at 28.8N, 53.8W at 09Z (micro).
- 50 kt N and 994 mb at 28.0N, 54.5W at 12Z (COADS).
- 40 kt SSE and 994 mb at 30.3N, 50.8W at 18Z (micro).

3. Aircraft highlights:

- Penetration center fix at 29.0N, 52.6W at 1155Z (ATSR).
- Penetration center fix measured a central pressure of 988 mb at 28.8N, 52.5W at 1554Z (WALLET).
- Penetration center fix estimated surface winds of 55 kt at 29.5N, 52.0W at 1610Z (WALLET).
- Penetration center fix measured a central pressure of 985 mb and estimated surface winds of 60 kt at 29.8N, 51.8W at 19Z (WALLET).

4. Discussion:

- MWR: "Jenny became essentially stationary on November 7, then began to move to the northeast and weaken, becoming clearly extratropical during the next two days."

- ATSR: "By the 7th, the upper level pressure rises had moved northeast of the storm, enabling it to turn once again to a northeastward course."
- Reanalysis: On November 7th, Jenny turned to the northeast ahead of a frontal boundary. The period of intensification observed on the 5th and 6th came to a stop early on the 7th and Jenny began to weaken. The next reconnaissance aircraft measured a central pressure of 988 mb at 1554Z and 985 mb at 19Z. A central pressure of 988 mb was present in HURDAT at 12Z on the 7th and has been removed since the observation was closer to the 18Z time slot. A central pressure of 985 mb was present at 00Z on November 8th and has been moved to 18Z on the 7th. A central pressure of 985 mb suggests maximum sustained winds of 66 kt from the north of 25N pressure-wind relationship. Due to the very large size of the circulation, forward speed of about 10 kt and visual estimate from the aircraft of 60 kt, an intensity of 60 kt is analyzed at 18Z on the 7th, same as originally shown in HURDAT. Weakening below hurricane intensity is analyzed at 12Z on the 7th, same as originally shown in HURDAT.

November 8:

1. Maps and old HURDAT:

- HWM analyzes a tropical storm of at most 995 mb at 31.4N, 50.4W with a frontal boundary close to the north at 12Z.
- HURDAT lists a 50 kt tropical storm at 31.8N, 50.4W at 12Z.
- Microfilm shows a closed low pressure of at most 993 mb at 31.7N, 49.0W at 12Z.

2. Ship highlights:

- 40 kt SW and 1004 mb at 26.2N, 51.2W at 00Z (COADS).
- 35 kt SSE and 1007 mb at 32.3N, 45.1W at 06Z (COADS).
- 40 kt S and 994 mb at 29.8N, 48.1W at 09Z (micro).
- 40 kt WSW and 999 mb at 30.0N, 50.2W at 12Z (COADS).
- 35 kt S and 998 mb at 31.3N, 46.6W at 18Z (COADS).

3. Discussion:

- ATSR: "The final warning was issued at 081600Z."
- Reanalysis: Jenny increased in forward speed to the northeast on the 8th and continued to lose strength. HURDAT shows transition to an extratropical cyclone at 18Z on the 8th but synoptic observations indicate that Jenny remained a tropical storm in the warm sector of an approaching frontal boundary. The circulation remained symmetric and the data shows no signs of frontal boundaries associated with Jenny on that date.

November 9:

1. Maps and old HURDAT:

- HWM analyzes a closed low pressure of at most 995 mb at 33.2N, 47.0W with an extratropical cyclone to the west at 12Z.
- HURDAT lists a 35 kt extratropical cyclone at 33.8N, 46.5W at 12Z.
- Microfilm shows a closed low pressure of at most 993 mb at 34.0N, 46.0W at 12Z.
- Ship highlights:
- 40 kt SSW and 997 mb at 30.8N, 47.3W at 00Z (COADS).
- 35 kt WSW and 999 mb at 31.0N, 47.3W at 06Z (COADS).
- 30 kt NE and 993 mb at 34.5N, 46.7W at 12Z (micro).
- 30 kt ESE and 1001 mb at 36.9N, 44.5W at 18Z (micro).

2. Discussion:

- ATSR: "Jenny was clearly extratropical by the 9th."

November 10:

1. Maps and old HURDAT:

- HWM analyzes a closed low pressure of at most 990 mb at 40.0N, 43.0W with a cold front to the west at 12Z.
- HURDAT does not list an organized system on this date.
- Microfilm shows a closed low pressure of at most 996 mb at 39.2N, 43.0W at 12Z.

2. Ship highlights:

- 35 kt E and 997 mb at 37.5N, 45.0W at 00Z (COADS).
- 35 kt S and 999 mb at 38.3N, 43.6W at 06Z (COADS).
- 35 kt SE and 988 mb at 40.2N, 42.7W at 12Z (COADS).
- 56 kt SSE and 1001 mb at 39.8N, 42.8W at 12Z (MWL).
- 30 kt WNW and 999 mb at 42.7N, 44.0W at 18Z (COADS).

3. Discussion:

- Reanalysis: As the frontal boundary got closer to Jenny, the storm continued to gain in forward speed and began to re-intensify over the North Atlantic. A ship reported 55 kt SE at 12Z on the 10th near the center of Jenny.

November 11:

1. Maps and old HURDAT:

- HWM analyzes a spot low pressure at 50.2N, 35.0W with a frontal boundary close to the west at 12Z.
- HURDAT does not list an organized system on this date.
- Microfilm is not available on this date.

2. Ship highlights:

- 45 kt SW and 1009 mb at 47.4N, 34.1W at 06Z (COADS).

3. Discussion:

- ATSR: "From her inception, Jenny appeared to be only quasitropical in nature. Although scarce data in the area of the storm precluded accurate temperature and pressure analyses, all available reports from Ocean Station Echo and reconnaissance aircraft indicated that the upper level structure around the storm was extratropical. The deepening of Jenny, which coincided with its movement underneath an upper level low, indicated that jenny had extratropical characteristics. After the central pressure dropped to 974 mb, maximum winds did not exceed an average of 65 knots, although some gusts to as 600 miles, and, as depicted on surface charts at the time that Jenny was most intense, she resembled a wintertime "Nor'easter." It is conjectured that a small warm core could have existed within the circulation of the larger low."
- Reanalysis: Transition to an extratropical cyclone is analyzed at 00Z on the 11th, 54 hours later than originally shown in HURDAT. The last position in HURDAT was at 18Z on the 9th but surface observations show that Jenny retained a well-defined center into November 10th and early on the 11th. Ship observations at 12Z on the 11th indicate that Jenny had been absorbed by a larger extratropical cyclone, thus the last position is analyzed at 06Z on the 11th, 36 hours later than originally shown in HURDAT. Furthermore, it is probable that Jenny was a post-tropical cyclone on the 9th and 10th but without satellite images it is not possible to use this classification.

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.

Tropical Storm Inga [November 4-8, 1961]

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42360 11/05/1961 M= 4 11 SNBR= 918 INGA        XING=0 SSS=0                    L
42360 11/04/1961 M= 5 11 SNBR= 918 INGA        XING=0 SSS=0
         **         *                                                        *

(November 4th is new in HURDAT)
42363 11/04*197 943  40    0*199 944  50    0*201 945  60    0*204 946  60    0*
            *** ***  **      *** ***  **      *** ***  **      *** ***  **

42365 11/05*208 947  40    0*215 955  45    0*221 959  45  997*225 960  50    0*
42365 11/05*209 949  60  997*214 954  60    0*220 959  60  997*223 960  55    0*
            *** ***  **  *** *** ***  **      ***      **      ***      **

42370 11/06*225 959  50  992*219 958  55    0*212 955  55  998*202 947  60    0*
42370 11/06*223 959  50  998*221 958  55    0*217 957  55    0*202 947  60 1000*
            ***          *** ***            *** ***        *               ****

42375 11/07*195 940  60 1004*195 939  60    0*195 938  60    0*195 938  60    0*
42375 11/07*197 940  60 1004*196 939  60    0*195 938  60 1004*193 937  60 1006*
            ***          ***                          **** *** ***      ****

42380 11/08*195 938  60    0*195 938  55    0*194 937  50    0*  0    0   0    0*
42380 11/08*193 933  55    0*193 927  55    0*194 919  55    0*  0    0   0    0*
            *** ***  **      *** ***              ***  **

(Special position at 15Z on November 6th)
42370 11/06*209 952  60  998*

42385 TS
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Significant Revisions:

1. Genesis begun a day earlier based upon ship and coastal observations;
2. Intensity rasied significantly on the 5th based upon aircraft observations;
3. A few central pressures were added based primarly upon aircraft obsevations.

Daily Summaries:

November 3:

1. Maps and old HURDAT:

- HWM analyzes a closed low pressure of at most 1000 mb at 19.2N, 94.2W with a weakening cold front to the north at 12Z.
- HURDAT lists a 25 kt tropical depression at 18.6N, 94.6W at 12Z (last position of Eastern Pacific's Simone).
- Microfilm shows a closed low pressure of at most 1002 mb at 21.5N, 95.3W with a frontal boundary to the north at 12Z.

2. Discussion:

- Randerson: "On 3 November the remnants of Simone were distinguishable as a tropical depression in the Bay of Campeche."
- Reanalysis: Tropical Storm Inga had a unique time and place of formation. The remnants of Hurricane Hattie became a Central American Gyre (lacking an inner core well-defined center structure required for a tropical cyclone) on November 1st while located along the Pacific coast of southeastern Mexico and Guatemala. Gale force westerly winds were occurring on the 1st south of Gyre's trough axis. The Gyre interacted with a powerful mid-latitude shortwave trough to substantially deepen and expand in area on the 2nd while

located over southeastern Mexico and northern Central America. Gale force westerly winds continued to occur on the 2nd south of the Gyre's trough axis. By late on the 2nd and during the 3rd, an extratropical low pressure center had formed over the Bay of Campeche with a front extending from the low north-northeastward over the Gulf of Mexico to the southeastern United States while still low pressure with the Gyre also existed along the southern Mexico coast. By late on the 3rd, it appears that the Central American Gyre had dissipated, leaving only a broad, extratropical low pressure system in the Gulf of Mexico.

November 4:

1. Maps and old HURDAT:

- HWM analyzes a closed low pressure of at most 1000 mb at 19.9N, 94.8W with a weakening cold front to the north at 12Z.
- HURDAT does not list an organized system on this date.
- Microfilm shows a closed low pressure of at most 999 mb at 20.5N, 95.4W with a frontal boundary to the north at 12Z.

2. Ship highlights:

- 40 kt NW and 1006 mb at 19.5N, 94.5W at 00Z (COADS).
- 70 kt NNW and 1001 mb at 20.0N, 95.0W at 11Z (micro).
- 45 kt NW and 1005 mb at 20.0N, 95.3W at 13Z (micro, COADS).
- 40 kt NW and 1008 mb at 19.9N, 95.5W at 18Z (COADS).

3. Land highlights:

- 40 kt NW and 1007 mb at Veracruz, Mexico at 00Z (micro).

4. Aircraft highlights:

- Penetration center fix measured a central pressure of 997 mb, estimated an eye diameter of 15 nm and surface winds of 40 kt at 20.6N, 94.6W at 2215Z (ATSR).

5. Discussion:

- MWR: "Inga, a very late-season tropical cyclone in the Gulf of Mexico, moved and behaved quite erratically. It was of true tropical nature during only part of its life, and the first of record to form in November in the Gulf. Early on November 4, the SS Navigator reported northwesterly winds estimated at 70 to 80 kt with pressure dropping rapidly to 1001 mb at a position about 100 miles northeast of Vera Cruz, Mexico. That afternoon the Navy reconnaissance plane located the center of the storm circulation about 150 miles northeast of Vera Cruz with a central pressure of 998 mb and the highest winds 50 kt."
- ATSR: "Early on the 4th of November, reports from Vera Cruz, Mexico, and the SS MAASLLOYD indicated an area of gale force winds in the extreme southwestern Gulf of Campeche. This phenomenon was thought at the time to be associated with a cold front which had moved into the area. At 041200Z the SS NAVIGATOR, at a position about 90 miles northeast of Vera Cruz reported northwesterly winds of 70 to 80 knots and a pressure of 1001 mb falling rapidly. A short time later Navy reconnaissance verified the existence of a short circulation about 100 miles north-northeast of Vera Cruz. This flight reported a central pressure of 997 mb and a maximum wind of only 40 knot. Direction of movement appeared to be northwest."
- Randerson: "24 hours later [12Z November 4th] the tropical depression was redeveloping into a tropical storm over the warm water in the Gulf of Mexico."
- Reanalysis: Genesis may have occurred in the Bay of Campeche late on the 3rd but the first position is analyzed at 00Z on November 4th, 24 hours earlier than originally shown in HURDAT, based on synoptic data. The initial intensity is assessed at 40 kt based on a ship near the center that reported

40 kt NW and 1006 mb at 00Z on the 4th. The tropical storm steadily intensified and reached a peak intensity of 60 kt at 12Z on the 4th. 60 kt is also the original peak intensity in HURDAT. At this time, a ship named "SS Navigator" near the center reported 70 kt and 1001 mb. A significant pressure gradient had developed over the western and northwestern quadrants as a strong ridge moved into the central United States behind the frontal boundary just northwest of the tropical cyclone. Note that there is a component to the winds that is due to the cold air funneling that occurs along the east coast of Mexico. However, the very low pressures – 1005 and 1001 mb – from two separate ships around 12Z argue strongly for a tropical cyclone or – at the very least a hybrid – on this date worthy of inclusion into HURDAT.

November 5:

1. Maps and old HURDAT:

- HWM analyzes a closed low pressure of at most 1000 mb at 22.0N, 95.7W with a cold front far to the north at 12Z.
- HURDAT lists a 45 kt tropical storm at 22.1N, 95.9W at 12Z.
- Microfilm shows a closed low pressure of at most 1002 mb at 22.1N, 95.9W with a frontal boundary far to the north at 12Z.

2. Ship highlights:

- 35 kt NW and 1004 mb at 20.3N, 95.6W at 00Z (COADS).
- 35 kt W and 1005 mb at 20.5N, 95.7W at 06Z (COADS).
- 30 kt W and 1003 mb at 21.3N, 95.0W at 12Z (COADS).
- 35 kt E and 1003 mb at 23.6N, 93.6W at 22Z (micro).

3. Aircraft highlights:

- Penetration center fix measured a central pressure of 997 mb, estimated an eye diameter of 5 nm and surface winds of 50 kt at 22.1N, 95.9W at 1223Z (ATSR).
- Penetration center fix estimated surface winds of 50 kt at 22.2N, 95.9W at 16Z (ATSR).
- Penetration center fix measured a central pressure of 998 mb, estimated an eye diameter of 25 nm and surface winds of 50 kt at 22.3N, 95.7W at 2155Z (ATSR). (The vortex message indicated 992 mb, but the drop gave 998 mb at the surface and the same from 850 mb heights/temps. 998 mb accepted as central pressure.)

4. Discussion:

- ATSR: "Warning number one on tropical storm Inga was issued at 050000Z. By noon of the 5th, a cold front had pushed southward off the Texas coast in advance of a strong surface high pressure ridge."
- Reanalysis: At 2215Z on the 4th, the first reconnaissance aircraft reached Inga measuring a central pressure of 997 mb, estimating surface winds of 40 kt and an eye diameter of 15 nm. A central pressure of 997 mb suggests maximum sustained winds of 53 kt 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 17 nm. Due to an RMW smaller than the climatological value, forward speed of 6 kt and strong pressure gradient, an intensity of 60 kt is analyzed at 00Z on November 5th, up from 40 kt originally in HURDAT, a major intensity change. A central pressure of 997 mb was added to HURDAT at 00Z on the 5th. Even though the first reconnaissance aircraft visually estimated weaker winds than those reported by the SS Navigator, it is possible that the ship's measurement was high biased slightly and/or was a transient event. The ESRL Daily Mean Wind Shear for the 4th indicates that Inga was being affected by moderate southwest vertical wind shear. It is possible that Inga may have reached hurricane

intensity for a brief period early on the 4th. An analog is Tropical Storm Alberto in 2006, which while in the northern Gulf of Mexico under strong vertical wind shear, a significant convective burst caused the winds to increase to 60 kt. On the 5th, Inga moved northwestward before stalling late in the day as another frontal boundary moved into the Gulf of Mexico. At 1223Z on the 5th, a reconnaissance aircraft reported a central pressure of 997 mb, estimated surface winds of 50 kt and an eye diameter of 5 nm. A central pressure of 997 mb suggests maximum sustained winds of 53 kt from the south of 25N pressure-wind relationship. An eye diameter of 5 nm suggests an RMW of about 4 nm and the climatological value is 17 nm. Due to an RMW much smaller than the climatological value but a forward speed of only 3 kt, an intensity of 60 kt is analyzed at 12Z on the 5th, up from 45 kt originally in HURDAT, a minor intensity change. A central pressure of 997 mb was present in HURDAT at 12Z on the 5th and has been retained.

November 6:

1. Maps and old HURDAT:

- HWM analyzes a closed low pressure of at most 1005 mb at 21.3N, 95.8W with a cold front close to the northwest at 12Z.
- HURDAT lists a 55 kt tropical storm at 21.2N, 95.5W at 12Z.
- Microfilm shows a closed low pressure of at most 1002 mb at 21.5N, 95.4W with a frontal boundary to the northwest at 12Z.

2. Ship highlights:

- 35 kt NNW at 20.9N, 96.7W at 00Z (micro).
- 45 kt NW and 1009 mb at 21.2N, 96.8W at 12Z (COADS).
- 60 kt WNW and 1003 mb at 19.5N, 94.9W at 18Z (COADS).

3. Aircraft highlights:

- Penetration center fix measured a central pressure of 998 mb at 22.3N, 95.7W at 00Z (ATSR).
- Penetration center fix measured a central pressure of 998 mb, estimated an eye diameter of 3 nm and surface winds of 60 kt at 20.6N, 95.0W at 1425Z (ATSR).
- Penetration center fix measured a central pressure of 1000 mb, estimated an eye diameter of 3 nm and surface winds of 60 kt at 20.0N, 94.5W at 19Z (ATSR).
- Penetration center fix measured a central pressure of 1004 mb and estimated surface winds of 40 kt at 19.6N, 93.8W at 2326Z (ATSR).

4. Discussion:

- MWR: “The storm moved north-northwest to a position about 100 miles east of Tampico by the night of the 5th. A strong pressure rise and cold front pushed southward out of Texas into the northwestern Gulf and southward along the Mexican coast during the night of the 5th. The strong pressure rises to the northwest of the storm caused it to turn southward, and at 0800 EST on the 6th a Navy plane located the center about 100 miles east-northeast of Tuxpan. The plane flew on southward and located a second eye at 0900 EST about 80 miles southeast of the first eye. The cold air apparently moved into the first eye and it dissipated rapidly, leaving the southern eye as the main center. This center moved slowly southeastward and became stationary in the Gulf of Campeche about 160 miles east-northeast of Vera Cruz on the afternoon of the 6th. It continued essentially stationary in this area and gradually became extratropical as the cold air moved into it.”
- ATSR: “The combination of high pressure and cold air seemed to have a marked effect on the storm for it made a sharp turn early on the 6th and, almost retracing its previous track, moved slowly toward the southeast. An oddity occurred later on the 6th. A Navy reconnaissance plane staging out of Corpus

Christi located the storm as it was moving on its southeasterly heading; then, about 80 miles further to the southeast, the plane found a separate eye. Subsequent reports led forecasters to believe that the first eye filled and the second eye became the storm circulation."

- Reanalysis: At 2155Z on the 5th, another penetration fix measured a central pressure of 998 mb, estimated surface winds of 50 kt and an eye diameter of 25 nm. A central pressure of 998 mb suggests maximum sustained winds of 51 kt from the south of 25N pressure-wind relationship. An eye diameter of 25 nm suggests an RMW of about 19 nm and the climatological value is 18 nm. Due to an RMW close to the climatological value, being almost stationary, and weighting the surface wind estimate, an intensity of 50 kt is analyzed at 00Z on November 6th, unchanged from HURDAT originally. A central pressure of 992 mb was present in HURDAT and has been replaced by 998 mb. After a period when the movement of the storm was almost stationary, Inga started to move to the southeast later on the 6th. Observations from the reconnaissance aircraft investigating the tropical cyclone around midday on the 6th indicate that the original low-level center dissipated after 13Z and another low-level center was fixed about an hour later about 80 nm to the southeast. An analog of a system in the Gulf that had a center dissipate and a new one form elsewhere is Tropical Storm Arlene in 1993. At 1425Z on the 6th, a penetration fix measured a central pressure of 998 mb, estimated surface winds of 60 kt and an eye diameter of 3 nm. A central pressure of 998 mb suggests maximum sustained winds of 51 kt from the south of 25N pressure-wind relationship. An eye diameter of 3 nm suggests an RMW of about 2 nm and the climatological value is 16 nm. Based on a tiny RMW and ship data later on the day, an intensity of 60 kt is analyzed at 12Z on the 6th, up from 55 kt originally in HURDAT, a minor intensity change. A central pressure of 998 mb was present in HURDAT at 12Z on the 6th and has been moved to a special 15Z best track position due to the reformation of the center farther to the southeast as it did not represent the central pressure of the old center at 12Z. At 19Z, another penetration center fix measured a central pressure of 1000 mb, estimated surface winds of 60 kt and an eye diameter of 3 nm. A central pressure of 1000 mb suggests maximum sustained winds of 47 kt from the south of 25N weakening pressure-wind relationship. An eye diameter of 3 nm suggests an RMW of about 2 nm and the climatological value is 16 nm. Based on a tiny RMW, forward speed of about 5 kt and a ship at 16Z that measured 60 kt, an intensity of 60 kt is analyzed at 18Z on the 6th, same as originally shown in HURDAT. A central pressure of 1000 mb has been added to HURDAT at 18Z on the 6th.

November 7:

1. Maps and old HURDAT:

- HWM analyzes a closed low pressure of at most 1005 mb at 19.4N, 93.5W with a cold front close to the northwest at 12Z.
- HURDAT lists a 60 kt tropical storm at 19.5N, 93.8W at 12Z.
- Microfilm does not show a closed low pressure but a tropical cyclone symbol at 19.6N, 93.5W with a frontal boundary to the north at 12Z.

2. Ship highlights:

- 55 kt NW and 1007 mb at 19.0N, 94.6W at 00Z (COADS).
- 50 kt NW and 1011 mb at 19.4N, 95.3W at 06Z (COADS).
- 65 kt NW and 1010 mb at 19.4N, 95.4W at 12Z (COADS).
- 45 kt NW and 1013 mb at 19.6N, 96.1W at 18Z (micro).
- 45 kt NW and 1008 mb at 19.8N, 94.8W at 21Z (micro).

3. Land highlights:

- 40 kt NNW at Veracruz, Mexico at 00Z (micro).

4. Aircraft highlights:

- Penetration center fix measured a central pressure of 1004 mb, estimated an eye diameter of 20 nm and surface winds of 60 kt at 19.5N, 93.8W at 13Z (ATSR).
- Penetration center fix measured a central pressure of 1003 mb and estimated surface winds of 60 kt at 19.3N, 93.9W at 16Z (ATSR/WALLET).
- Penetration center fix measured a central pressure of 1006 mb and estimated surface winds of 65 kt at 19.3N, 93.7W at 19Z (ATSR).

5. Discussion:

- ATSR: "Inga became stationary by the 7th in the south central Gulf of Campeche."
- Reanalysis: A final penetration fix on the 6th occurred at 2326Z and measured a central pressure of 1004 mb and estimated surface winds of 40 kt. A central pressure of 1004 mb suggests maximum sustained winds of 41 kt from the south of 25N weakening pressure-wind relationship. Based on ship data early on November 7th, an intensity of 60 kt is analyzed at 00Z on the 7th, same as originally shown in HURDAT. On the 7th, Inga stalled again in the Bay of Campeche. Ships observations indicate that the strong pressure gradient continued over the western quadrant of Inga, generating winds up to hurricane force. These winds were in part caused by Inga but it is difficult to determine if they were part of the circulation and what portion of the winds were due to funneling induced by interaction of the cold front with the orography, thus the intensity is retained at 60 kt, as originally shown in HURDAT, just below hurricane intensity. Dry, cold air behind the cold front was present as far south as Tampico but ship observations near the center of Inga show that the tropical storm retained its tropical characteristics. Penetration center fixes occurred at 13Z and 19Z on the 7th measuring central pressures of 1004 mb and 1006 mb, respectively, which have been added to HURDAT.

November 8:

1. Maps and old HURDAT:

- HWM analyzes a stationary front over the southern Gulf of Mexico at 12Z.
- HURDAT lists a 50kt tropical storm at 19.4N, 93.7W at 12Z (last position).
- Microfilm shows a frontal boundary over the southern Gulf of Mexico at 12Z.

2. Ship highlights:

- 55 kt NW and 1011 mb at 19.7N, 95.2W at 00Z (COADS).
- 45 kt NW and 1014 mb at 19.7N, 95.2W at 06Z (COADS).
- 40 kt NW and 1016 mb at 20.3N, 95.1W at 12Z (COADS).
- 55 kt NW and 1017 mb at 19.5N, 95.4W at 18Z (micro).

3. Aircraft highlights:

- Penetration center fix found no closed circulation, lowest pressure was 1012 mb and estimated surface winds of 45 kt at 19.4N, 91.7W at 13Z (ATSR).

4. Discussion:

- MWR: "On the morning of the 8th, the flight into the area encountered no closed circulation but ships a short distance northeast of Vera Cruz continued to report winds of gale force until that night."
- ATSR: "Navy reconnaissance on the 8th found no wind circulation and a low pressure of 1012 mb. The final warning on Inga was issued at 081600Z. It is interesting to note that the same flight on the 8th which could find no evidence of a circulation did find an area of 45-knot northwesterly winds near Inga's original birthplace. This couples with the even more interesting fact that no ship ever reported strong winds in the eastern quadrant of the storm, yet a number of ships reported gale to hurricane force northwesterly

winds between the circulation center and the Mexican coast, a distance of approximately 180 miles. It is believed that the Sierra Madre Orion mountain range, which juts outward to the coast near Vera Cruz, had some effect on Inga's abnormal windfield, or conceivably, triggered the disturbance initially."

- Reanalysis: Early on November 8th, Inga began to move to the east and slightly weakened before dissipating and being absorbed by the cold front after 12Z. The last position is analyzed at 12Z on the 8th, same as originally shown in HURDAT. Inga is the only tropical cyclone since 1851 to have formed in the Bay of Campeche in the month of November.

November 9:

1. Maps and old HURDAT:

- HWM analyzes a stationary front over the southern Gulf of Mexico at 12Z.
- HURDAT does not list an organized system on this date.
- Microfilm shows a closed low pressure of at most 1012 mb at 19.4N, 92.8W at 12Z.

2. Ship highlights:

- 40 kt NW and 1016 mb at 19.4N, 95.6W at 00Z (COADS).
- 40 kt NW and 1016 mb at 19.5N, 95.5W at 06Z (COADS).

November 10:

1. Maps and old HURDAT:

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

2. Discussion:

- MWR: "The storm was apparently a shallow system, because its movement was determined mainly by the forces at low levels. On the 6th, the strong pressure rises moving southward along the Mexican coast ahead of the cold front apparently caused the new eye or center to develop in the same area where the original circulation was found. This first circulation developed as a strong pressure rise pushed southward along the Mexican coast ahead of a weak cold front of the night of the 3rd. This area of development is about 100 miles east of the position where a high mountain range in Mexico protrudes eastward to near the coast in the vicinity of Nautla. The New Orleans hurricane center hypothesized that the funneling effect set up by these mountains may be a factor in the development of the circulations in that particular area. The lowest pressure reported by dropsondes from reconnaissance was 997 mb (992 mb from the low-level extrapolation), and the highest wind was 65 kt in the cold air to the west and south of the circulation on the afternoon of the 7th, after the storm had been stationary for about 24 hours in the Gulf of Campeche and was becoming extratropical. During the period when the storm was predominantly tropical in nature, the highest winds were about 50 kt."

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

New Tropical Storm [November 17-21, 1961]

37265 11/17/1961 M= 5 12 SNBR= 820 UNNAMED XING=0 SSS=0

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37265 11/17*  0   0   0    0*  0   0   0    0*  0   0   0    0*225 550  25    0*
37265 11/18*240 543  25    0*254 536  25 1004*266 530  30    0*273 523  30    0*
37265 11/19*278 510  30    0*283 495  35    0*295 475  40    0*314 460  40    0*
37265 11/20*330 445  40    0*345 425  40    0*354 410  45    0*362 395  50    0*
37265 11/21E370 382  50    0E384 370  50    0*  0   0   0    0*  0   0   0    0*
37275 TS
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Significant Revisions:

1. A new tropical storm has been added into HURDAT based upon ship observations.

Daily Summary:

November 16:

1. Maps and old HURDAT:
   - HWM analyzes a closed low pressure of at most 1010 mb at 19.0N, 51.0W at 12Z.
   - Microfilm shows a closed low pressure of at most 1011 mb over the northeastern Caribbean Sea near 17.0N, 64.0W at 12Z.
2. Discussion/Reanalysis: The origin of this unnamed tropical storm is uncertain but the Historical Weather Maps indicate that a trough of low pressure led to the development of a surface circulation around mid-November over the central Atlantic. The broad and elongated low pressure moved northward and slowly became better organized on the 16th and 17th.

November 17:

1. Maps and old HURDAT:
   - HWM analyzes an elongated area of low pressure with a center at 21.2N, 60.0W and another center at 22.2N, 48.2W and a stationary front to the north at 12Z.
   - Microfilm shows a closed low pressure of at most 1008 mb at 21.0N, 60.0W at 12Z.
2. Discussion/Reanalysis: A 25-kt tropical depression is analyzed to have formed on November 17th at 18Z, as the system developed a closed center and was non-frontal.

November 18:

1. Maps and old HURDAT:
   - HWM analyzes a closed low pressure of at most 1000 mb at 27.2N, 53.2W with a frontal boundary going through the center at 12Z.
   - Microfilm shows a closed low pressure of at most 1008 mb at 25.0N, 53.5W at 12Z.
2. Ship highlights:
   - 10 kt WNW and 1005 mb at 23.9N, 53.9W at 06Z (COADS).
   - 25 kt S and 1001 mb at 26.9N, 52.8W at 12Z (COADS).
   - 30 kt WSW and 1001 mb at 25.2N, 52.6W at 18Z (COADS).
3. Discussion/Reanalysis: A ship reported 10 kt WNW and 1005 mb at 06Z on November 18th, which suggests a central pressure of 1004 mb, which has been added to this time slot. A central pressure of 1004 mb suggests maximum sustained winds of 39 kt from the south of 25N Brown et al. and 36 kt from

the north of 35N from the Landsea et al. pressure-wind relationships. Due to the large circulation of the tropical cyclone and synoptic observations, an intensity of 25 kt is selected at 06Z on the 18th. At 12Z on the 18th, a ship reported 25 kt S and 1001 mb, indicating that the tropical cyclone was intensifying. The intensity is increased to 30 kt at 12Z on the 18th. The HWM at 12Z on the 18th shows frontal features associated with this system. This depiction appears erroneous as there is no temperature gradient across the circulation. At the same time, microfilm shows a low pressure without frontal features. Ship observations late on the 18th showed that the circulation was more symmetrical, but it retained its large size. It is probable that the system had some subtropical characteristics.

November 19:

1. Maps and old HURDAT:
   - HWM analyzes a closed low pressure of at most 1005 mb at 29.0N, 48.0W with a cold front to the east and a cold front to the south at 12Z.
   - Microfilm shows a closed low pressure of at most 999 mb at 30.5N, 47.0W with a frontal boundary going through the center at 12Z.
2. Ship highlights:
   - 20 kt SE and 1002 mb at 28.1N, 51.0W at 00Z (COADS).
   - 15 kt WNW and 1000 mb at 27.2N, 50.0W at 06Z (COADS).
   - 40 kt SW and 1005 mb at 28.6N, 46.7W at 12Z (COADS).
   - 35 kt S and 1006 mb at 28.6N, 45.7W at 12Z (COADS).
   - 40 kt SW and 1005 mb at 29.0N, 45.2W at 18Z (COADS).
   - 25 kt S and 1000 mb at 31.5N, 45.8W at 18Z (COADS).
3. Discussion/Reanalysis: Intensification to a tropical storm is analyzed at 06Z on November 19th, based upon two gales subsequently being record at 12Z. These were from two ships in the southern quadrant reporting 40 kt SW and 35 kt S, about 60-90 nm from the center. HWM and microfilm depict the system with frontal features at 12Z on the 19th, but surface observations indicate that the environment was warm and moist around the center and no temperature gradient was present across the circulation. Two more ships reported gale-force winds at 18Z on the 19th.

November 20:

1. Maps and old HURDAT:
   - HWM analyzes a closed low pressure of at most 1010 mb at 35.0N, 41.0W with a warm front to the northeast and weakening cold front to the south and an approaching weakening front to the west at 12Z.
   - Microfilm shows a closed low pressure of at most 1005 mb at 33.0N, 46.5W with a frontal boundary to the west at 12Z.
2. Ship highlights:
   - 30 kt NE and 1002 mb at 33.5N, 46.0W at 00Z (COADS).
   - 40 kt SE and 1014 mb at 34.3N, 39.6W at 00Z (COADS).
   - 30 kt NE and 998 mb at 33.6N, 45.1W at 06Z (COADS).
   - 35 kt S and 995 mb at 35.3N, 40.1W at 12Z (COADS).

- 40 kt SE and 1013 mb at 34.5N, 36.1W at 12Z (COADS).
- 30 kt W and 992 mb at 35.6N, 40.8W at 18Z (COADS).
- 40 kt W and 1003 mb at 32.6N, 40.8W at 18Z (COADS).

3. Discussion/Reanalysis: On November 20th, a frontal boundary began to approach the tropical cyclone. A ship at 12Z on the 20th reported 35 kt S and 995 mb. A peripheral pressure of 995 mb suggests maximum surface winds greater than 52 kt from the north of 25N Brown et al. and 56 kt from the north of 35N Landsea et al. pressure-wind relationships. Due to the large size of the circulation, an intensity of 45 kt is selected at 12Z on the 20th. At 18Z on the 20th, a ship reported 30 kt W and 992 mb. A peripheral pressure of 992 mb suggests maximum surface winds greater than 60 kt from the north of 35N pressure-wind relationship. An intensity of 50 kt is selected at 18Z on the 20th. 50 kt is the peak intensity of this tropical storm.

November 21:

1. Maps and old HURDAT:
   - HWM analyzes a closed low pressure of at most 990 mb at 40.0N, 33.5W with a warm front to the southeast and cold front to the south at 12Z.
   - Microfilm is not available on this date, storm has moved off the map.
2. Ship highlights:
   - 35 kt SW and 998 mb at 34.3N, 36.6W at 00Z (COADS).
   - 40 kt SE and 1007 mb at 34.7N, 32.0W at 00Z (COADS).
   - 15 kt SW and 987 mb at 38.0N, 36.8W at 06Z (COADS).
   - 40 kt E and 997 mb at 40.7N, 37.4W at 06Z (COADS).
   - 45 kt W and 991 mb at 37.7N, 38.2W at 12Z (COADS).
   - 55 kt NNE and 987 mb at 41.1N, 41.7W at 18Z (COADS).
3. Discussion/Reanalysis: Synoptic data late on the 20th indicate that the tropical cyclone was beginning to acquire extratropical characteristics as it interacted with the approaching frontal boundary. Transition to an extratropical cyclone is analyzed at 00Z on November 21st. Ship observations at 12Z on the 21st indicate that the system had merged with a developing extratropical cyclone associated with the frontal boundary. The last position is analyzed at 06Z on the 21st.

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

1961 Additional Notes

1) May 16-20: Historical Weather Maps show a trough of low pressure over the eastern Bahamas on May 16th. The disturbance moved northward ahead of a frontal boundary and surface observations indicate that a tropical depression may have developed by May 18th. COADS indicate that the peak winds associated with this system stayed below gale-force. The disturbance began to interact with the frontal boundary on May 19th and became absorbed the next day. Therefore, because the system did not produce winds of tropical storm intensity, it is not added to HURDAT. This disturbance was in Jack Beven's and David Roth's List of Suspects.

Day	Latitude	Longitude	Status
May 16	22N	72W	Trough
May 17	26N	71W	Trough
May 18	29N	68W	Tropical Depression?
May 19	32N	68W	Tropical Depression?
May 20			Absorbed

2) June 8-14: Historical Weather Maps and Microfilm indicate that a tropical wave reached the western Caribbean Sea on June 8th. The disturbance slowly became better organized as it moved toward the southeastern Gulf of Mexico and a closed surface circulation developed early on the 10th as it moved across South Florida toward the Atlantic Ocean. The disturbance moved generally northeastward along the east coast of the United States producing winds up to 30 kt based on synoptic observations. At 15Z on the 12th, one ship reported 35 kt, the only definite piece of evidence to indicate that this disturbance may have been a small tropical storm. An approaching frontal boundary caused the small system to accelerate northeastward and on the 13th it appears that it weakened to a trough of low pressure east of New England. By the 14th, it was absorbed by an extratropical cyclone over eastern Canada. Therefore, because there is not enough evidence to support upgrading this system to a tropical storm, it is not added to HURDAT. This disturbance was in Jack Beven, David Roth and Ryan Truchelut's List of Suspects.

Day	Latitude	Longitude	Status
June 8	11N-26N	81W	Tropical Wave
June 9	15N-30	83W	Tropical Wave
June 10	28N	80W	Tropical Depression
June 11	31N	78W	Tropical Depression
June 12	36N	74W	Tropical Storm?
June 13	41N	63W	Trough
June 14			Absorbed

3) July 28-31: Historical Weather Maps show a low pressure over the eastern Atlantic during the last few days of July. Synoptic data over the eastern Atlantic is sparse and no winds of gale-force were observed. Therefore, because the disturbance did not produce tropical storm force winds and that it may not have been a closed low, it is not added to HURDAT. This disturbance was in Ryan Truchelut's List of Suspects.

Day	Latitude	Longitude	Status
July 28	14N	21W	Tropical Wave?
July 29	14N	23W	Tropical Depression?
July 30	14N	26W	Tropical Depression?
July 31			Dissipated

4) August 2-5: Historical Weather Maps indicate that a tropical wave left the African coast early on August. Synoptic data over the eastern Atlantic show that the disturbance steadily moved westward. COADS indicate that winds stayed below tropical storm force. Therefore, because the disturbance did not produce tropical storm force winds and that it may not have been a closed low, it is not added to HURDAT. This disturbance was in Ryan Truchelut's List of Suspects.

Day	Latitude	Longitude	Status
August 2	13N	22W	Tropical Depression?
August 3	13N	25W	Tropical Depression?
August 4	13N	28W	Tropical Wave?
August 5			Dissipated

5) October 10-15: Historical Weather Maps show a trough over the northwest Bahamas on October 10th. The disturbance moved initially northward and slowly became better organized. On the 12th, the system turned to the northeast and intensified to a tropical depression while on a high-pressure environment. Over the next two days, the circulation of the system became much better organized and synoptic data show a discernible decrease in pressure. Yet, COADS indicate that winds remained below gale-force and lowest pressure was only 1009 mb. On the 15th, the system merged with an approaching frontal boundary. Therefore, because the disturbance did not produce tropical storm force winds, it is not added to HURDAT. This disturbance was in Jack Beven and David Roth's List of Suspects.

Day	Latitude	Longitude	Status
October 10	28N	74W	Trough
October 11	29N	76W	Trough
October 12	34N	71W	Tropical Depression
October 13	36N	66W	Tropical Depression
October 14	37N	61W	Tropical Depression
October 15			Merged

6) October 20-30: Historical Weather Maps indicate that a weakening frontal boundary entered the Atlantic Ocean from the United States on October 20th. A low pressure system quickly developed in the tail-end of front and moved to the northeast. The extratropical cyclone occluded on the 22nd but became entangled with another frontal boundary on the 23rd. Over the next couple of days, the disturbance moved northeastward into the North Atlantic and was absorbed on the 30th. COADS indicate that the system was producing gale-force winds on the 22nd, when it was occluded, but it also shows that it maintained a cold core. Therefore, because the system remained non-tropical, it is not added to HURDAT. This disturbance was in Jack Beven's List of Suspects.

Day	Latitude	Longitude	Status
October 20	East Coast		Weakening cold front
October 21	33N	74W	Extratropical
October 22	37N	72W	Occluded
October 23	37N	67W	Extratropical
October 24	40N	65W	Extratropical
October 25	42N	60W	Extratropical
October 26	46N	60W	Extratropical
October 27	50N	50W	Extratropical
October 28	50N	36W	Extratropical
October 29	50N	35W	Extratropical
October 30			Absorbed

7) November 19-27: Historical Weather Maps show a frontal boundary entering the Atlantic Ocean from the United States on November 18th. An extratropical low pressure developed on November 20th off the southeast coast of the United States and initially traveled northeastward. Beginning on the 21st, the extratropical cyclone began to move southeastward and occluded. The disturbance reached its southernmost latitude on the 24th and 25th. Surface analyses indicate that the frontal boundaries had dissipated and the environment around the system was warmer and the temperature gradient had decreased across the circulation, but at this time it was large low pressure producing winds below gale force. On the 26th, an approaching cold front caused the disturbance to move northward and gales were registered about 300 nm northeast of the center due to the strong pressure-gradient. On the 27th, it had been absorbed by a stronger extratropical cyclone over the north Atlantic. Therefore, because observations indicate that the system did not acquire tropical characteristics, it is not added to HURDAT. This disturbance was in Jack Beven and David Roth's List of Suspects.

Day	Latitude	Longitude	Status
November 19	30N	78W	Cold front
November 20	36N	73W	Extratropical
November 21	41N	67W	Extratropical
November 22	40N	63W	Extratropical
November 23	37N	57W	Occluded
November 24	33N	54W	Occluded
November 25	33N	50W	Occluded
November 26	38N	49W	Occluded
November 27			Absorbed

1962 Atlantic Hurricane Database Reanalysis – Sandy Delgado and Chris Landsea

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

Hurricane Alma [August 26 – September 2, 1962] – AL011962

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42390 08/26/1962 M= 8  1 SNBR= 919 ALMA        XING=1 SSS=0
42390 08/26/1962 M= 8  2 SNBR= 919 ALMA        XING=1 SSS=0
                         *

42395 08/26*  0   0   0    0*  0   0   0    0*253 797  25    0*264 801  25    0*
42395 08/26*  0   0   0    0*  0   0   0    0*257 797  25    0*268 801  30    0*
                                             ***             ***       **

42400 08/27*277 803  25    0*292 802  30 1007*306 797  40    0*318 788  45    0*
42400 08/27*279 803  30    0*292 802  35 1007*304 797  40    0*315 788  45 1002*
            ***      **                **      ***             ***         ****

42405 08/28*329 777  45 1002*341 766  50    0*352 753  65  986*369 735  75  991*
42405 08/28*326 777  45 1002*338 766  55 1000*352 753  65    0*369 735  75  990*
            ***              ***      ** ****                *               ***

42410 08/29*387 717  80  988*401 704  85    0*410 694  80  990*415 687  75    0*
42410 08/29*387 717  75  988*401 702  75    0*410 694  70  990*415 687  65  984*
                     **          ***  **                **                **  ***

42415 08/30*415 679  60  994*413 670  55    0*410 665  45    0E408 651  40    0*
42415 08/30*415 678  60    0*413 669  55    0*410 660  45    0E408 651  40    0*
                ***         *     ***             ***

42420 08/31E405 643  40    0E399 635  40    0E391 633  40    0E386 638  35    0*
42420 08/31E404 643  40    0E399 640  40    0E391 638  40    0E386 641  35    0*
            ***                    ***             ***         *** ***

42425 09/01E383 644  35    0E384 651  35    0E388 656  35    0E393 652  35    0*
42425 09/01E383 645  35    0E384 650  35    0E386 655  35    0E390 654  35    0*
                ***              ***           *** ***         *** ***

42430 09/02E397 650  35    0E409 636  25 1002E422 610  15    0E453 555  15    0*
42430 09/02E395 650  35    0E404 636  35    0*  0   0   0    0*  0   0   0    0*
            ***              ***      **    **  *   *   *     *  *   *   *

42435 HR

U.S. Tropical Storm Impact
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08/28 11Z 35.0N 75.1W  40 kt North Carolina
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Highlights:

1. A few central pressures were added based upon aircraft reconnaissance;

2. Extratropical transition indicated to be 12 hours earlier based upon synoptic observations;
3. Dissipation indicated to be 12 hours earlier based upon synoptic observations.

Daily Summaries:

August 13:

1. Maps and old HURDAT:

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

August 14:

1. Maps and old HURDAT:

- HWM does not analyze an organized system at 12Z.
- HURDAT does not list an organized storm on this date.
- Microfilm shows a tropical wave near longitude 40W at 12Z.

2. Discussion:

- MWR: "A possible weak circulation center was first noted in the eastern Atlantic by TIROS V on August 14."
- MICRO: "Special TIROS Bulletin. TIROS V Photographs at 14/1606Z show a well defined circulation in 14 degrees north 38 degrees west with the main band spiraling from the center to 15 degrees north 40 degrees west to 15 degrees north 35 degrees west then south east. A second band is evident from 15 degrees west to 15 degrees north 32 degrees west. Major cloudiness is in the east and north east quadrants with little cloudiness south west thru north west."
- Reanalysis: Hurricane Alma developed from a strong tropical wave that left the African coast around August 11th. The tropical wave traveled westward becoming better organized. The TIROS V satellite captured an image of the disturbance on August 14th at 1606Z located near 14N, 38W depicted in the microfilm nephanalysis at 18Z on the 14th showing an area of convection over the center with banding features over the northern and eastern quadrant. (The actual satellite picture is not available.) The surface data over the eastern Atlantic is sparse and it is not possible to determine if a closed, low-level circulation was present.

August 15:

1. Maps and old HURDAT:

- HWM does not analyze an organized system at 12Z.
- HURDAT does not list an organized storm on this date.
- Microfilm shows a closed low pressure of at most 1014 mb at 18.5N, 42.2W at 12Z.

2. Discussion:

- MICRO: "Flight summary. No significant radar weather encountered entire track area invof 1510N 4418W overcast with cs. Max obsd sfc wnd 15 kts min obsd slp 1012 mb by drop min 700 mb hgt."
- Reanalysis: The system continued westward and was investigated by a reconnaissance aircraft on August 15th, which did not find a closed circulation and the lowest sea level pressure measured by a drop was 1012 mb.

August 16:

1. Maps and old HURDAT:

- HWM analyzes a spot low pressure at 12.2N, 41.6W at 12Z.
- HURDAT does not list an organized storm on this date.
- Microfilm shows a tropical wave near longitude 42W at 12Z.

August 17:

1. Maps and old HURDAT:
- HWM analyzes a spot low pressure at 12.2N, 46.9W at 12Z.
- HURDAT does not list an organized storm on this date.
- Microfilm shows a tropical wave near longitude 45W at 12Z.

August 18:

1. Maps and old HURDAT:
- HWM analyzes a spot low pressure at 12.3N, 51.7W at 12Z.
- HURDAT does not list an organized storm on this date.
- Microfilm shows a tropical wave near longitude 50W at 12Z.
2. Discussion:
- MWR: "Subsequent westward movement at about 10 kt. brought the perturbation to the vicinity of 12.5N, 51W on August 18 where Weather Bureau research aircraft, on a routine flight to the Cape Verdes, located a weak center."

August 19:

1. Maps and old HURDAT:
- HWM analyzes a spot low pressure at 11.1N, 56.1W at 12Z.
- HURDAT does not list an organized storm on this date.
- Microfilm does not show an organized system at 12Z.

August 20:

1. Maps and old HURDAT:
- HWM and microfilm do not show an organized system at 12Z.
- HURDAT does not list an organized storm on this date.
2. Discussion:
- MWR: "Crossing the Windward Islands during August 20, the circulation moved west northwestward at 10 kt …"

August 21:

1. Maps and old HURDAT:
- HWM does not analyze an organized system at 12Z.
- HURDAT does not list an organized storm on this date.
- Microfilm shows a tropical wave near longitude 65W at 12Z.
2. Discussion/Reanalysis: Late on August 20th and early on the 21st, the disturbance crossed the Windward Islands and surface observations suggest that a closed surface circulation may have been present, but the circulation was likely transient based on subsequent synoptic data late on the 21st.

August 22:

1. Maps and old HURDAT:
- HWM does not analyze an organized system at 12Z.
- HURDAT does not list an organized storm on this date.
- Microfilm shows a tropical wave near longitude 67W at 12Z.
2. Discussion:
- MWR: "and was again located by Weather Bureau reconnaissance aircraft near 21N, 69W on August 22."

August 23:

1. Maps and old HURDAT:
- HWM analyzes a tropical wave along longitude 76W at 12Z.
- HURDAT does not list an organized storm on this date.
- Microfilm shows a tropical wave near longitude 72W at 12Z.

August 24:

1. Maps and old HURDAT:
- HWM analyzes a broad low pressure of at most 1010 mb at 19.0N, 81.0W at 12Z.
- HURDAT does not list an organized system on this date.
- Microfilm shows a tropical wave over the Windward Passage at 12Z.
2. Discussion:

- MWR: "Gradually recurving, the Low moved across eastern Cuba on August 24 remaining weak and unorganized."
- ATSR: "The first significant tropical disturbance of the 1962 Hurricane Season appeared in the form of an easterly wave moving across the Caribbean during the period of 24 to 26 August attended by considerable shower activity, below normal pressures and gusty winds."
- Reanalysis: The sharp tropical wave continued across the Caribbean Sea, turning to the north on August 24th.

August 25:

1. Maps and old HURDAT:

- HWM analyzes a low pressure of at most 1010 mb at 22.3N, 79.8W at 12Z.
- HURDAT does not list an organized system on this date.
- Microfilm shows a tropical wave over central Cuba and western Bahamas at 12Z.

2. Ship highlights:

- 35 kt SE and 1013 mb at 22.0N, 74.4W at 00Z (COADS).

August 26:

1. Maps and old HURDAT:

- HWM analyzes a low pressure of at most 1010 mb at 25.5N, 79.6W at 12Z.
- HURDAT lists a 25 kt tropical depression at 25.3N, 79.7W at 12Z (first position).
- Microfilm shows a closed low pressure of at most 1011 mb at 26.0N, 79.5W at 12Z.

2. Discussion:

- MWR: "On the morning of August 26, slow development began between the Florida east coast and the western Bahamas, with the depression moving on a course which kept it a short distance off the United States east coast until August 29."
- ATSR: "Imposing an immediate threat to the U.S. Coastline, a weak vortex formed off ships reporting winds of 30 knots."
- Reanalysis: While approaching the Florida peninsula, the disturbance became better organized and intensified into a 25 kt tropical depression at 12Z on August 26th, same as originally shown in HURDAT, just off Miami. The tropical depression moved northward on the 26th paralleling the east coast of Florida and turned to the northeast on August 27th.

August 27:

1. Maps and old HURDAT:

- HWM analyzes a tropical storm of at most 1010 mb at 30.2N, 80.1W at 12Z.
- HURDAT lists a 40 kt tropical storm at 30.6N, 79.7W at 12Z.
- Microfilm shows a closed low pressure of at most 1011 mb at 29.5N, 79.0W at 12Z.

2. Ship highlights:

- 35 kt SSW and 1011 mb at 28.9N, 77.7W at 12Z (COADS).
- 45 kt SSE and 1005 mb at 30.8N, 78.2W at 15Z (COADS).
- 40 kt SE and 1011 mb at 31.8N, 77.1W at 18Z (COADS).
- 20 kt S and 1004 mb at 31.6N, 77.9W at 18Z (COADS).
- 45 kt S and 1005 mb at 32.3N, 78.0W at 21Z (micro).

3. Discussion:

- MWR: "As deepening continued, the first advisory was issued on August 27 when Alma was about 150 mi. east of the Georgia coast."
- ATSR: "While moving northward in the circulation pattern of the Bermuda High, slow intensification occurred and a Tropical Disturbance Warning was

issued at 271500Z followed by the first numbered warning on Tropical Storm Alma at 271830Z."

- Reanalysis: Intensification to a tropical storm is analyzed at 06Z on the 27th, six hours earlier than originally shown in HURDAT based upon gales observed later in the day. A central pressure of 1007 mb was present in HURDAT at 06Z on the 27th and has been retained as this is a reasonable value, though not based upon direct observations. The first gales were reported at 12Z on the 27th on the eastern quadrant of the tropical cyclone. At 15Z and 21Z on the 27th, two ships reported 45 kt near the center of Alma. A ship reported 20 kt SE and 1004 mb at 18Z on the 27th, suggesting a central pressure of 1002 mb, which has been added to HURDAT. A central pressure of 1002 mb suggests maximum sustained winds of 40 kt from the north of 25N Brown et al. pressure-wind relationship. Based on a forward speed of about 15 kt and synoptic data, an intensity of 45 kt is selected at 18Z on the 27th, same as originally shown in HURDAT.

August 28:

1. Maps and old HURDAT:

- HWM analyzes a closed low pressure of at most 995 mb at 35.5N, 74.6W with a warm front to the north at 12Z.
- HURDAT lists a 65 kt hurricane at 35.2N, 75.3W at 12Z.
- Microfilm shows a closed low pressure of at most 1005 mb at 34.5N, 75.5W at 12Z.

2. Ship highlights:

- 45 kt S and 1006 mb at 32.8N, 77.2W at 00Z (COADS).
- 20 kt NE and 1002 mb at 33.0N, 78.2W at 03Z (micro).
- 10 kt and 1001 mb at Frying Pan Shoals, NC at 05Z (SWO).
- 50 kt S and 1007 mb at 34.0N, 76.0W at 06Z (COADS).
- 55 kt SSE and 1006 mb at 34.4N, 74.2W at 10Z (COADS).
- 55 kt S and 1005 mb at 34.3N, 74.2W at 12Z (COADS).
- 50 kt NNW and 993 mb at 36.5N 74.5W at 15Z (micro).
- 60 kt SSW and 1006 mb at 35.0N, 74.2W at 15Z (micro).
- 50 kt W and 990 mb at 36.7N, 73.8W at 18Z (COADS).
- 50 kt NNW and 1002 mb at 36.6N, 73.7W at 21Z (micro).

3. Land highlights:

- 997 mb (min pressure) at Cape Hatteras WB, NC at 1105Z (WALLET).
- 35 kt NNE (peak winds, gusts to 42 kt) at Cape Hatteras WB, NC at 1110Z (CLIMO/WALLET).

4. Aircraft highlights:

- Penetration center fix measured a central pressure of 990 mb and estimated surface winds of 80 kt at 37.9N, 72.7W at 2054Z (ATSR).
- Penetration center fix at 38.0N, 72.2W at 2215Z (ATSR).

5. Discussion:

- MWR: "Hurricane Alma reached maximum intensity August 28 north of the Virginia Capes but was classified as a hurricane for only 12 hours. No well defined eye with wall cloud development was ever observed and radar tracking was difficult. On the North Carolina Capes, Nags Head reported gusts to 53 mph and Hatteras 48 mph. Tides in general were about 2 ft. above normal in the Hatteras-Norfolk area but up to 3 ft. at Nags Head. Beach erosion was slight. Over 8 in. of rain fell at Cape Hatteras on August 27-28. After moving northeastward from the Capes, the storm increased in intensity and during the afternoon of the 28th) aircraft reconnaissance reported a sustained wind speed of 92 mph."

- ATSR: "By 281200Z, while moving northeastward from a point about 120 miles off the Virginia coast, ALMA began rapid intensification under the influence of a strong, divergent, high level flow immediately in advance of a 200 MB trough approaching from the west. Hurricane force winds were reported by 281800Z."
- Reanalysis: A central pressure of 1002 mb was present in HURDAT at 00Z on August 28th. While there were no measurements of this, the value is reasonable and is thus retained. At 03Z on the 28th, a ship reported 20 kt NE and 1002 mb near the center and Frying Pan Shoals, NC, had 10 kt with 1001 mb at 05Z, both suggesting a central pressure of 1000 mb, which has been added to HURDAT at 06Z on the 28th. At 06Z on the 28th, two ships reported 50 kt on the eastern quadrant. A central pressure of 1000 mb suggests maximum surface winds of 47 kt from the north of 25N pressure-wind relationship. Based on a forward speed of about 17 kt and synoptic data, an intensity of 55 kt is selected at 06Z on the 28th, same as originally shown in HURDAT. Alma made its closest approach to the Outer Banks of North Carolina, passing about 10 nm east of Hatteras Island, around 11Z on the 28th. At 1110Z on the 28th, WB Cape Hatteras, NC reported sustained winds of 35 kt and gusts to 42 kt, and five minutes earlier, the station reported its minimum pressure for the day of 997 mb. The Schwerdt et al. parametric hurricane wind model suggests that the highest sustained winds that impacted North Carolina reached 40 kt. Therefore, Alma is analyzed as a tropical storm impact for North Carolina. Intensification to a hurricane is analyzed at 12Z on the 28th, same as originally shown in HURDAT. A central pressure of 986 mb was present in HURDAT at 12Z on the 28th and has been removed since there was no central pressure measured by a ship or reconnaissance aircraft around 12Z on the 28th. Observations from Cape Hatteras, NC, and subsequent reconnaissance data indicate that the central pressure was likely higher than 986 mb at 12Z on the 28th. At 15Z on the 28th, a ship reported 60 kt SW and 1006 mb. The reconnaissance aircraft to investigating Alma on the 28th at 2054Z measured a central pressure of 990 mb and estimated surface winds of 80 kt. A central pressure of 990 mb suggests maximum surface winds of 63 kt from the north of 35N pressure-wind relationship. Based on a forward speed of about 25 kt, an intensity of 75 kt is analyzed at 18Z on the 28th, same as originally shown in HURDAT. 75 kt is also the peak intensity of this tropical cyclone, down from 85 kt originally in HURDAT, a minor intensity change.

August 29:

1. Maps and old HURDAT:

- HWM analyzes a closed low pressure of at most 990 mb at 41.2N, 69.0W with a weakening warm front to the northeast at 12Z.
- HURDAT lists an 80 kt hurricane at 41.0N, 69.4W at 12Z.
- Microfilm shows a closed low pressure of at most 993 mb at 40.9N, 69.4W with a frontal boundary to the northeast at 12Z.

2. Ship highlights:

- 55 kt SE and 992 mb at 38.8N, 71.0W at 00Z (COADS).
- 45 kt NE and 1002 mb at 40.7N, 69.5W at 03Z (micro).
- 45 kt NE and 1002 mb at 40.5N, 69.4W at 06Z (micro).
- 25 kt ESE and 992 mb at 41.0N, 69.0W at 09Z (micro).
- 19 kt and 990 mb at Nantucket Light, MA at 11Z (SWO).
- 35 kt and 993 mb at Pollock Rip Lightship, MA at 12Z (SWO).
- 35 kt ENE and 992 mb at 41.5N, 68.9W at 12Z (COADS).
- 50 kt NE and 990 mb at 41.8N, 68.8W at 15Z (micro).
- 45 kt ENE and 992 mb at 42.0N, 68.8W at 18Z (COADS).

- 36 kt and 994 mb at Pollock Rip Lightship, MA at 18Z (SWO).
- 45 kt NE and 1002 mb at 43.3N, 68.5W at 21Z (COADS).

3. Land highlights:

- 28 kt N (gusts to 42 kt) and 994 mb at Nantucket, MA at 0957Z (SWO).

4. Aircraft highlights:

- Penetration center fix measured a central pressure of 992 mb at 41.5N, 68.9W at 1447Z (WALLET).
- Penetration center fix measured a central pressure of 984 mb at 41.8N, 68.6W at 1850Z (WALLET).

5. Discussion:

- MWR: "Alma began to weaken to tropical storm strength at about the time the center passed some 60 mi to the east of Nantucket. Coastal areas of Massachusetts and Rhode Island were buffeted by northerly gales gusting to 60 mph."
- Wallet: From the 1447Z recon mission: "REMARKS NO TROPICAL STORM CHARACTERISTIC . NO SPIRAL CLOUDS . WELL DEFINED CLOSE LOW."
- Reanalysis: A central pressure of 988 mb was present in HURDAT at 00Z on August 29th. This value is reasonable given the 55 kt 992 mb ship at the same time. Thus the value is retained in HURDAT. The existing central pressure of 990 mb in HURDAT at 12Z on the 29th has also been retained based on surface observations near the center. A reconnaissance aircraft investigated the hurricane at 1850Z on the 29th measuring a central pressure of 984 mb. A central pressure of 984 mb suggests maximum surface winds of 69 kt from the north of 35N pressure-wind relationship. Based on a forward speed of about 8 kt, an increase in the size of the circulation of the hurricane, and description from the reconnaissance mission, an intensity of 65 kt is selected at 18Z on the 29th, down from 75 kt originally in HURDAT, a minor intensity change. Note that the remarks from the recon weather officer suggested a structure that lacks spiral clouds with "no tropical storm charactistic." It is possible that the system began extratropical transition (which was delayed until 18Z on the 30th) or that it lost deep convection and became a "Low". Without satellite data to confirm, the system is retained on the 29th as a tropical cyclone.

August 30:

1. Maps and old HURDAT:

- HWM analyzes a closed low pressure of at most 1000 mb at 41.2N, 65.8W with a weakening warm front to the north at 12Z.
- HURDAT lists a 45 kt tropical storm at 41.0N, 66.5W at 12Z.
- Microfilm shows a closed low pressure of at most 1005 mb at 40.5N, 65.5W at 12Z.

2. Ship highlights:

- 40 kt SW and 994 mb at 40.8N, 68.0W at 00Z (COADS).
- 50 kt NE and 1010 mb at 40.5N, 71.0W at 06Z (COADS).
- 25 kt NW and 1001 mb at 40.2N, 67.7W at 12Z (COADS).
- 25 kt NE and 1002 mb at 41.5N, 66.7W at 18Z (micro).
- 35 kt E and 1013 mb at 42.1N, 67.1W at 23Z (COADS).

3. Discussion:

- MWR: "Blocking over eastern Canada prevented complete recurvature into the westerlies. During the period August 30 through September 1, Alma drifted on a clockwise loop 200-300 mi. east-southeast of Cape Cod and slowly filled."
- ATSR: "After coming under the influence of a cold low at the 500 MB level, ALMA dissipated and her course was radically defected to the eastward. The last advisory was transmitted at 301000Z, making a total of twelve. Storm damage was widespread, but minor, along the eastern seaboard, mostly

confined to small craft and moorings with some erosion along the mid-eastern states. Rainfall in excess of 10 inches was reported in some areas north of Cape Hatteras."

- Reanalysis: Early on August 30th, Alma turned to the southeast and continued to lose strength. Weakening to a tropical storm is analyzed at 00Z on the 30th, same as originally shown in HURDAT. A central pressure of 994 mb was present in HURDAT at 00Z on the 30th and has been removed based on surface observations indicating a lower central pressure. Synoptic data late on the 29th and early on the 30th indicates that Alma began to acquire extratropical characteristics over the cool waters south of Nova Scotia, Canada. However, the process apparently was a lengthy one and full transition to an extratropical cyclone is retained at 18Z on the 30th. This is based on the development of frontal features and a temperature-gradient between the eastern and western quadrant.

August 31:

1. Maps and old HURDAT:

- HWM analyzes a closed low pressure of at most 1005 mb at 39.1N, 63.8W with a warm front to the north at 12Z.
- HURDAT lists a 40 kt extratropical storm at 39.1N, 63.3W at 12Z.
- Microfilm shows a closed low pressure of at most 1008 mb at 38.5N, 63.3W at 12Z.

2. Ship highlights:

- 35 kt NE and 1013 mb at 43.3N, 64.5W at 00Z (COADS).
- 15 kt WSW and 1004 mb at 40.0N, 64.3W at 00Z (COADS).
- 40 kt NE and 1014 mb at 43.5N, 64.0W at 06Z (COADS).
- 35 kt SSW and 1015 mb at 41.6N, 58.2W at 12Z (COADS).

September 1:

1. Maps and old HURDAT:

- HWM analyzes a closed low pressure of at most 1010 mb at 38.5N, 65.9W with a warm front to the north at 12Z.
- HURDAT lists a 35 kt extratropical storm at 38.8N, 65.6W at 12Z.
- Microfilm shows a closed low pressure of at most 1011 mb at 38.0N, 65.0W at 12Z.

2. Ship highlights:

- 35 kt N and 1013 mb at 38.4N, 68.1W at 00Z (COADS).
- 35 kt N and 1010 mb at 38.7N, 66.3W at 06Z (COADS).

3. Discussion/Reanalysis: The extratropical cyclone continued to weaken on August 31st and September 1st while performing a small clock-wise loop south of Nova Scotia.

September 2:

1. Maps and old HURDAT:

- HWM analyzes an extratropical cyclone of at most 995 mb at 54.0N, 63.0W (Alma appears to have been absorbed) at 12Z.
- HURDAT lists a 25 kt extratropical depression at 42.2N, 61.0W at 12Z.
- Microfilm shows an extratropical cyclone of at most 995 mb at 54.0N, 62.0W (Alma appears to have been absorbed) at 12Z.

2. Ship highlights:

- 35 kt SW and 1013 mb at 39.9N, 63.0W at 06Z (COADS).

3. Discussion:

- MWR: "On September 2 Alma accelerated northeastward and was absorbed by an active trough in the westerlies."
- Reanalysis: An approaching frontal boundary caused the weak cyclone to turn to the northeast late on the 1st and surface observations indicate that it was absorbed after 06Z on the 2nd. Thus, the last position is analyzed at 06Z

on the 2nd, twelve hours earlier than originally shown in HURDAT. A central pressure of 1002 mb was present in HURDAT at 06Z on the 2nd and has been removed based on surface observations indicating a higher central pressure.

September 3:

1. Maps and old HURDAT:

- HWM analyzes an extratropical cyclone of at most 995 mb at 54.0N, 50.0W (Alma appears to have been absorbed) at 12Z.
- HURDAT does not list an organized storm on this date.
- Microfilm shows an extratropical cyclone of at most 1002 mb at 48.0N, 62.0W (Alma appears to have been absorbed) at 12Z.

2. Discussion:

- MWR: "Damage along the east coast was comparatively minor with no fatalities and only one injury. Tides were generally less than 2 ft. above normal and there was little flooding of low-lands and shore roads. However, huge waves pounded exposed coastal installations inflicting widespread but mostly minor damage. Damage also resulted from wind and wave action. More than 100 small pleasure craft were sunk along the Massachusetts coast. Total damage was estimated at less than $1,000,000 along the New England coast and $35,000 to crops and property in North Carolina. Benefits to agriculture and water supplies in the drought areas of New England more than offset property damage inflicted by the storm."

Sources: the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Monthly Weather Review, Navy reconnaissance book, Mariners Weather Log, State Climatological Data, Atlas of Cloud Vortex Patterns, and NHC Storm Wallets.

Tropical Storm Becky [August 27 – September 1, 1962] – AL021962

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42440 08/27/1962 M= 6  2 SNBR= 920 BECKY       XING=0 SSS=0
42440 08/27/1962 M= 6  3 SNBR= 920 BECKY       XING=0 SSS=0
                       *

42445 08/27*  0   0   0    0*160 188  15    0*160 198  15    0*161 207  15    0*
42445 08/27*  0   0   0    0*160 180  40    0*161 190  40    0*163 199  40    0*
                           ***  **      ***  ***  **      ***  ***  **

42450 08/28*164 217  15    0*171 223  25    0*182 233  30    0*195 233  35    0*
42450 08/28*167 207  40    0*176 215  40    0*187 220  40    0*201 225  40    0*
            ***  ***  **      ***  ***  **      ***  ***  **      ***  ***  **

42455 08/29*211 235  35    0*229 239  35    0*246 248  35    0*260 260  35    0*
42455 08/29*219 230  40    0*239 235  45    0*255 242  50    0*269 254  50    0*
            ***  ***  **      ***  ***  **      ***  ***  **      ***  ***  **

42460 08/30*274 271  35    0*290 282  35    0*307 288  35    0*326 279  35    0*
42460 08/30*281 270  50    0*293 282  50    0*307 288  50    0*322 281  50    0*
            ***  ***  **      ***       **                **      ***  ***  **

42465 08/31*343 268  35    0E360 252  30    0E374 236  25    0E390 219  25    0*
42465 08/31*338 270  50    0*354 254  45    0*370 238  40    0E388 221  35    0*
            ***  ***  **      ****  ***  **      ****  ***  **      ***  ***  **

42470 09/01E407 195  25    0E421 170  20    0E433 154  15    0E449 140  15    0*
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42470 09/01E407 195 25   0* 0 0 0 0* 0 0 0 0* 0 0 0 0*
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42475 TS

Highlights:

1. Large upward revisions to the intensity on the 27th to the 31st based upon ship observations;
2. A substantial east-northeastward shift in the position on the 28th based upon ship and coastal observations;
3. Extratropical transition delayed 12 hours on the 31st based upon ship observations;
4. Dissipation indicated to be 18 hours earlier based upon ship observations.

Daily Metadata:

August 26:

1. Maps and old HURDAT:
- HWM analyzes a spot low pressure at 15.8N, 19.9W at 12Z.
- HURDAT does not list an organized system on this date.
- Microfilm does not show an organized system on this date.

2. Discussion/Reanalysis: Tropical Storm Becky developed from a strong tropical wave that left the African coast late on August 26th based on surface observations from ships and coastal stations.

August 27:

1. Maps and old HURDAT:
- HWM analyzes a closed low pressure of at most 1010 mb at 15.5N, 20.0W at 12Z.
- HURDAT lists a 15 kt tropical depression at 16.0N, 19.8W at 12Z.
- Microfilm does not show an organized system at 12Z.

2. Ship highlights:
- 40 kt SSW and 1005 mb at 14.8N, 17.7W at 06Z (COADS).
- 25 kt S and 1005 mb at 16.7N, 17.7W at 18Z (COADS).

3. Discussion:
- MWR: "The first indication of Becky in the eastern Atlantic Ocean was an increase in cloudiness and showers in the Cape Verde Islands beginning at 1200 GMT, August 27. The bad weather lasted about 30 hr and was accompanied by a surface pressure drop to about 1008 mb."
- ATSR: "The first indication of a tropical disturbance in the eastern Atlantic ocean was an increase in cloudiness and showers in the vicinity of the Cape Verdes Islands on 27 August."
- Reanalysis: The first position is analyzed at 06Z on August 27th off the African coast, same as originally shown in HURDAT. The initial intensity is analyzed at 40 kt based on a ship report of 40 kt SW and 1005 mb at 06Z on the 27th, up from 15 kt originally shown in HURDAT, a major intensity change. Intensification to a tropical storm is analyzed at 06Z on the 27th, 36 hours earlier than originally shown in HURDAT.

August 28:

1. Maps and old HURDAT:
- HWM analyzes a closed low pressure of at most 1010 mb at 18.0N, 23.0W at 12Z.
- HURDAT lists a 30 kt tropical depression at 18.2N, 23.3W at 12Z.
- Microfilm does not show an organized system at 12Z.

2. Discussion:

- MWR: "The wind backed gradually from east and northeast to west and southwest by 1800 GMT, August 28, which suggested that a Low had moved northward east of the Islands."
- Reanalysis: Becky moved to the northwest passing about 90 nm northeast of the Cape Verde Islands early on August 28th. Surface observations over the far eastern Atlantic are generally sparse due to the low shipping traffic. A large position change was made at 12Z 28th toward the east-northeast based ship and Cabo Verde island observations. The other changes later on the 28th and 29th were based upon interpolation from 12Z 28th through the next time with observations near the center - 12Z 30th.

August 29:

1. Maps and old HURDAT:

- HWM analyzes a tropical storm of at most 1005 mb at 24.5N, 25.1W at 12Z.
- HURDAT lists a 35 kt tropical storm at 24.6N, 24.8W at 12Z.
- Microfilm does not show an organized system at 12Z.

2. Discussion:

- MWR: "Cloud pictures from the TIROS satellite on August 29, 1106 GMT, confirmed an area of weather with a possible vortex near 25N, 25W. Even though it is difficult to infer flow patterns from the TIROS data in the early stages of tropical cyclone development, once a well developed tropical cyclone appears, past experience suggests cloud patterns take on definite characteristics. The TIROS picture on the 29th had all the characteristics of a tropical storm."
- ATSR: "Two days later, at 291106Z, the TIROS satellite revealed a cloud area with a possible vortex near 25°N – 25°W."
- Reanalysis: On August 29th, the TIROS V satellite captured an image of the tropical storm at 1106Z, showing a large circulation with organized convection and banding features. The satellite image also indicates that wind shear from the south was affecting Becky and the center of circulation was tucked in the southern portion of the area of convection.

August 30:

1. Maps and old HURDAT:

- HWM analyzes a tropical storm of at most 1005 mb at 30.5N, 28.8W at 12Z.
- HURDAT lists a 35 kt tropical storm at 30.7N, 28.8W at 12Z.
- Microfilm shows a closed low pressure of at most 1005 mb at 30.0N, 27.5W at 12Z.

2. Ship highlights:

- 50 kt NE and 1006 mb at 30.7N, 29.2W at 1130Z (micro/WALLET, MWR indicates 45 kt).

3. Discussion:

- MWR: "Further verification was received 24 hr later from a ship reporting NE winds force 9 (45 kt.) and rough seas near 30.7N, 29.2W. On the basis of this information, the US Fleet Weather Central at Port Lyautey issued an advisory at 1730 GMT. The Weather Bureau does not normally issue advisories for Atlantic storms east of longitude 35W, but arrangements have been made with military forecasting offices having responsibility in this area to use names from the official list of tropical cyclone names."
- ATSR: "Twenty-four hours later a ship reported 45 knots winds and rough seas near 31°N – 29°W. On the basis of this information, the U.S. Fleet Weather Central, Port Lyautey issued the first of nine warnings on Tropical Storm Becky at 291730Z."
- Reanalysis: A ship reported 50 kt NE in the northwest quadrant at 1130Z. Based on the satellite image on the 29th and this ship observation, an intensity of 50 kt is selected between 12Z on the 29th and 12Z on the 30th, up

from 35 kt originally in HURDAT, a major intensity change. (It is noted that the MWR and ATSR instead indicate that the ship reported 45 kt. It is uncertain which value is correct. However, even if the observation is actually 45 kt, assuming an intensity of slightly stronger – 50 kt – is reasonable.) 50 kt is also the peak intensity of this tropical cyclone, up from 35 kt originally in HURDAT, a major intensity change. The peak intensity of Becky is uncertain due to the lack of data and it is possible the system may have been significantly stronger than shown. An approaching frontal boundary caused Becky to turn to the northeast on the 30th and the system began to weaken.

August 31:

1. Maps and old HURDAT:

- HWM analyzes a closed low pressure of at most 1010 mb at 37.8N, 23.2W with a cold front just to the west at 12Z.
- HURDAT lists a 25 kt extratropical depression at 37.4N, 23.6W at 12Z.
- Microfilm shows a closed low pressure of at most 1011 mb at 38.2N, 21.8W at 12Z.

2. Ship highlights:

- 40 kt SE at 38.6N, 20.4W at 12Z (micro).

3. Aircraft highlights:

- Penetration center fix at 39.1N, 22.0W at 1845Z (WALLET).

4. Discussion:

- MWR: "The first of two reconnaissance flights was made on the 31st when an eye fix at 1845 GMT located the storm at 39.1N, 21.8W. At this time there was no evidence of a warm center since the 500-mb temperature was -10°C. The normal increase in temperature within the eye also was not indicated and the pilot added the remark that the storm showed no tropical characteristics. There is little doubt that the storm was extratropical at this time."
- ATSR: "On the 31st of September [should be "August"] the first of two Air Force reconnaissance flights fixed the storm's eye position approximately 175 miles soth of the Azores. Shortly thereafter, as BECKY moved over colder waters, she became extratropical while continuing on a northeasterly track toward the British Isles."
- Reanalysis: Due to the potential threat the tropical storm posed to the Azores, a reconnaissance aircraft from the Air Force investigated Becky late on August 31st and found that it had lost its tropical characteristics. Transition to an extratropical cyclone is analyzed at 18Z on the 31st, twelve hours later than originally shown in HURDAT.

September 1:

1. Maps and old HURDAT:

- HWM analyzes a spot low at 43.3N, 15.9W with a cold front just to the west at 12Z.
- HURDAT lists a 15 kt extratropical depression at 43.3N, 15.4W at 12Z.
- Microfilm shows a closed low pressure of at most 1011 mb at 44.0N, 16.0W at 12Z.

2. Discussion:

- MWR: "A second flight on the next day did not even find a circulation at 500 mb."
- Reanalysis: Surface observation after 00Z on September 1st indicate that Becky had been absorbed by the frontal boundary, thus the last position is analyzed at 00Z on the 1st, eighteen hours earlier than originally shown in HURDAT.

September 2:

1. Maps and old HURDAT:

- HWM analyzes an extratropical cyclone of at most 990 mb at 57.0N, 28.0W (Becky appears to have been absorbed) at 12Z.
- HURDAT does not analyze an organized storm on this date.
- Microfilm does not show an organized storm at 12Z.

Sources: the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Monthly Weather Review, Navy reconnaissance book, Mariners Weather Log, Atlas of Cloud Vortex Patterns, and NHC Storm Wallets.

Tropical Storm Celia [September 12-21, 1962] – AL031962

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2480 09/12/1962 M=10  3 SNBR= 921 CELIA       XING=0 SSS=0
2480 09/12/1962 M=10  4 SNBR= 921 CELIA       XING=0 SSS=0
                      *

42485 09/12*159 459  25    0*160 467  25    0*162 475  30    0*164 487  35    0*
42485 09/12*159 459  35    0*160 468  40    0*162 477  45    0*164 487  55    0*
                     **          ***  **          ***  **                **

42490 09/13*166 498  40    0*170 512  50    0*175 526  60  995*179 539  50    0*
42490 09/13*166 499  60    0*170 512  60    0*175 526  60  995*180 539  55    0*
                  ***  **                **                     ***      **

42495 09/14*184 551  45    0*188 562  45 1005*193 573  45 1007*197 580  45    0*
42495 09/14*184 551  50    0*188 562  45 1005*193 572  45 1005*197 580  45    0*
                     **                          ***     ****

42500 09/15*201 586  40    0*208 594  35    0*216 601  30 1010*231 605  30    0*
42500 09/15*202 588  40    0*208 596  35    0*218 601  35 1010*231 605  30    0*
            *** ***               ***          ***      **

42505 09/16*246 605  25    0*260 605  25    0*275 603  25    0*287 597  25    0*
42505 09/16*246 609  25    0*260 610  25    0*274 608  25    0*287 605  25    0*
                  ***               ***          ***  ***          ***  ***

42510 09/17*297 589  25 1010*301 576  25    0*298 563  25    0*300 550  25    0*
42510 09/17*300 595  25 1010*305 580  25    0*305 565  30    0*304 550  30    0*
            *** ***          *** ***          ***  ***  **       ***      **

42515 09/18*303 536  25    0*305 525  25    0*300 516  30    0*296 518  30    0*
42515 09/18*303 537  30    0*302 527  30    0*300 521  30    0*297 518  35    0*
                  ***  **      *** ***  **          ***          ***      **

42520 09/19*291 522  30    0*292 525  35    0*292 528  40    0*293 536  40 1005*
42520 09/19*294 520  40    0*292 523  45    0*292 528  45    0*293 536  45 1005*
            *** ***  **          ***  **                **                **

42525 09/20*296 544  40    0*307 552  30    0*319 555  25 1009*327 552  25    0*
42525 09/20*296 544  40    0*305 551  40    0*315 555  40 1007*326 552  40    0*
                           *** ***  **       ***       **  **** ***      **

42530 09/21*336 548  25    0*358 537  25    0E380 526  25    0E407 521  25    0*
42530 09/21*338 545  40    0*358 535  40    0*380 520  35    0*  0    0    0    0*
            *** ***  **          ***  **     *    ***  **     *  *    *    *
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42535 TS

Highlights:

1. Intensity significantly boosted on the 12th and 13th based upon ship observations;
2. Intensity significantly boosted on the 20th and 21st based upon aircraft reconnaissance and ship observations.
3. No extratropical stage is now indicated, as the system dissipated without undergoing extratropical transition.

Daily Summary:

September 9:

1. Maps and old HURDAT:

- HWM analyzes a spot low pressure at 8.5N, 34.8W at 12Z.
- HURDAT does not list an organized system on this date.
- Microfilm does not show an organized system on this date.

September 10:

1. Maps and old HURDAT:

- HWM analyzes a closed low pressure of at most 1010 mb at 10.5N, 38.7W at 12Z.
- HURDAT does not list an organized system on this date.
- Microfilm does not show an organized system on this date.

September 11:

1. Maps and old HURDAT:

- HWM analyzes a closed low pressure of at most 1010 mb at 13.3N, 45.0W at 12Z.
- HURDAT does not list an organized system on this date.
- Microfilm does not show an organized system at 12Z.

2. Discussion:

- MWR: "A photograph from the weather satellite TIROS V showed an unorganized cloud mass near 12N, 40W at 0000 GMT, September 11, which was probably the storm in an early depression stage."
- Reanalysis: Tropical Storm Celia developed from a tropical wave that left the African coast around September 6th. The tropical wave moved westward and the first indications that it was becoming better organized came from a satellite image from the TIROS V on September 11th mentioned in the hurricane season summary of the Monthly Weather Review describing an unorganized cloud mass near 12N, 40W at 00Z. Ship data over the eastern and central Atlantic, especially between Africa and the Lesser Antilles, is sparse and it is difficult to assess the time of genesis.

September 12:

1. Maps and old HURDAT:

- HWM analyzes a closed low pressure of at most 1010 mb at 16.2N, 47.7W at 12Z.
- HURDAT lists a 30 kt tropical depression at 16.2N, 47.5W at 12Z.
- Microfilm shows a tropical wave along longitude 49W at 12Z.

2. Ship highlights:

- 35 kt E and 1015 mb at 18.4N, 50.7W at 12Z (COADS).
- 40 kt E and 1008 mb at 17.1N, 49.6W at 18Z (micro).
- 60 kt E and 1008 mb at 17.0N, 49.6W at 21Z (micro).

3. Satellite highlights:

- Center fix at 16.8N, 47.7W around 12Z from TIROS V (ATSR).

4. Aircraft highlights:

- Penetration center fix measured a central pressure of 1011 mb and estimated surface winds of 35 kt at 16.9N, 48.0W at 2237Z (ATSR).

5. Discussion:

- MWR: "Tropical storm Celia formed in an easterly wave in the tropical atlantic on September 12, 1962. The first indication of development was an observation from the ship Mormacbay at 18.4N, 50.7W which reported an east wind of 35 kt, pressure 1014.9 mb and an easterly swell of 13 ft. at 1200 GMT, September 12. As the Mormacbay continued southeastward, its pressure fell rapidly and at 2100 GMT on the 12th it reported a pressure of 1007.8 mb with an east wind of 60 kt. A TIROS V photograph on September 12 showed a definite circulatory pattern with spiral bands centered near 17.0N, 47.5W. Navy reconnaissance aircraft reached the storm area the evening of September 12, but did not obtain a good eye fix due to darkness and because radar coverage was not feasible."
- ATSR: "On the morning of 12 September, a ship in the vicinity of 16N 47W reported winds to 35 knots with increasing seas. The unsetted area appeared to be associated with a moderate easterly wave which had been under observation during the previous 24 to 36 hours. A Navy reconnaissance aircraft was immediately dispatched from Puerto Rico. Shortly thereafter, a TIROS V satellite photograph indicated a possible vortex at 16.8N and 47.7W. The circulation indicated by TIROS V was partially verified by reconnaissance at 122137Z when the aircraft reported an apparent eye with a wide area of considerable shower and thunderstorm activity and maximum winds of 35 knots. Coincidently, at 2100Z, the same ship which had initially been affected by the disturbance reported winds reaching 50 knots approximately 60 miles to the east-northeast of the area."
- Reanalysis: The disturbance continued westward and the first position, not genesis, is analyzed at 00Z on September 12th, same as HURDAT, as a 35 kt tropical storm, up from 25 kt originally shown in HURDAT. Intensification to a tropical storm is analyzed 18 hours earlier than originally shown in HURDAT. The first gale was reported at 12Z on the 12th, a ship northwest of the center reported 35 kt E and 1015 mb. Later at 21Z on the 12th, a ship reported 60 kt E and 1008 mb. These reports are the basis for indicating 35 kt at the initial point at 00Z on the 12th, 55 kt at 18Z on the 12th, and 60 kt at 00Z on the 13th, up from 25, 35 kt and 40 kt, respectively, major intensity changes to the original HURDAT. 60 kt is also the peak intensity of this tropical cyclone, same as originally analyzed in HURDAT. The TIROS V satellite captured an image of Celia at 1850Z on the 12th showing a large, organized area of convection centered near 16N, 48W with banding features over the northern and eastern quadrant. The center appears to be displaced, just under the convection in the southwest corner.

September 13:

1. Maps and old HURDAT:

- HWM analyzes a tropical storm of at most 1005 mb at 17.2N, 51.9W at 12Z.
- HURDAT lists a 60 kt tropical storm at 17.5N, 52.6W at 12Z.
- Microfilm shows a closed low pressure of at most 1005 mb at 17.5N, 52.9W at 12Z.

2. Ship highlights:

- 35 kt ENE and 1011 mb at 17.9N, 50.5W at 00Z (micro).
- 60 kt E and 1011 mb at 17.1N, 49.1W at 03Z (micro).
- 35 kt ESE and 1014 mb at 19.0N, 50.9W at 12Z (micro).
- 35 kt SE and 1013 mb at 18.7N, 50.9W at 15Z (micro).
- 35 kt SE and 1012 mb at 18.2N, 50.9W at 18Z (micro).

3. Aircraft highlights:

- Penetration center fix measured a central pressure of 995 mb and an eye diameter of 16 nm at 17.8N, 53.4W at 1340Z (ATSR/WALLET).
- Penetration center fix measured a central pressure of 1007 mb, estimated surface winds of 45 kt and an eye diameter of 6 nm at 18.5N, 54.6W at 1922Z (ATSR).

4. Discussion:

- MWR: "The first advisory on Tropical Storm Celia, issued by the San Juan Weather Bureau Office at 0000 GMT, September 13, located the storm near 16.4N, 48.6W. with winds near the center estimated to be 55 to 60 mph. A hurricane watch was issued for the northern Leeward Islands at 1600 GMT September 13. Navy reconnaissance located the eye of Celia at 1000 GMT, September 13, near 17.4N, 52.5W. The eye was poorly defined, maximum winds were 45 kt, and minimum sea level pressure was 995 mb by dropsonde. This was the lowest pressure ever measured during the life cycle of Celia."
- ATSR: "The first warning on Tropical Storm CELIA was issued at 130000Z. As CELIA moved toward the northwest, a cyclonic circulation was observed northeast of the Leeward Islands at the 200 MB level. CELIA reached an intensity slightly under 1000 MBS with winds to 60 knots during a brief period on 13 September."
- Reanalysis: The first reconnaissance aircraft reached the tropical cyclone late on the 12th estimating surface winds of 35 kt and measuring a central pressure of 1011 mb. Based on synoptic data, it is likely that the dropsonde missed the center of the tropical cyclone, thus it is not added to HURDAT. Another ship reported 60 kt E at 03Z on the 13th. The next reconnaissance aircraft investigated Celia at 10Z on the 13th measuring a central pressure of 995 mb and an eye diameter of 16 nm. A central pressure of 995 mb suggests maximum surface winds of 56 kt from the south of 25N Brown et al. pressure-wind relationship. An eye diameter of 16 nm suggests an RMW of about 12 nm and the climatological value is 14 nm. Based on a forward speed of about 15 kt, an RMW close to climatology and surface observations, an intensity of 60 kt is selected at 12Z on the 13th, same as originally shown in HURDAT. As the tropical storm moved closer to the Lesser Antilles, it likely encountered a less favorable environment and began to gradually weaken. A reconnaissance aircraft reached Celia at 1922Z on the 13th estimating surface winds of 45 kt and a central pressure of 1007 mb. It appears likely that the dropsonde missed the center of the tropical cyclone due to the irregularities observed in the measurements on the 13th and 14th, possibly due to the poor organization of the tropical cyclone, thus the value measured was likely not a central pressure and it is not added to HURDAT.

September 14:

1. Maps and old HURDAT:

- HWM analyzes a tropical storm of at most 1005 mb at 19.3N, 57.1W at 12Z.
- HURDAT lists a 45 kt tropical storm at 19.3N, 57.3W at 12Z.
- Microfilm shows a closed low pressure of at most 1005 mb at 19.2N, 57.5W at 12Z.

2. Aircraft highlights:

- Penetration center fix measured a central pressure of 1012 mb and estimated an eye diameter of 20 nm at 18.2N, 54.2W at 0053Z (ATSR).
- Penetration center fix measured a central pressure of 1005 mb at 18.8N, 56.6W at 0940Z (ATSR).
- Penetration center fix measured a central pressure of 1005 mb and estimated surface winds of 55 kt at 19.3N, 57.6W at 1245Z (ATSR).

3. Discussion:

- MWR: "On the 14th the storm began to take a more northwestward course and appeared to be very poorly organized. In fact, Navy reconnaissance late on the 14th reported that the associated weather no longer resembled a tropical cyclone. The hurricane watch for the northern Leewards was discontinued at 1600 GMT, September 14."
- Reanalysis: The next penetration fix occurred at 0053Z on September 14th measuring a central pressure of 1012 mb, which also likely was not at the center. Another penetration fix occurred at 0940Z on the 14th measuring a central pressure of 1005 mb. A central pressure of 1005 mb was present in HURDAT at 06Z and has been retained. A central pressure of 1005 mb suggests maximum surface winds of 39 kt from the south of 25N weakening pressure-wind relationship. Based on a forward speed of about 13 kt, an intensity of 45 kt is analyzed at 06Z on the 14th, same as originally shown in HURDAT. Ship data indicates that no gales or low pressures were reported on the 14th. A reconnaissance aircraft investigated Celia at 1245Z on the 14th measuring a central pressure of 1005 mb and estimating surface winds of 55 kt. A central pressure of 1007 mb was present in HURDAT at 12Z on the 14th and has been replaced with 1005 mb. An intensity of 45 kt is analyzed at 12Z on the 14th, same as originally shown in HURDAT.

September 15:

1. Maps and old HURDAT:

- HWM analyzes a closed low pressure of at most 1010 mb at 21.2N, 60.8W with a weakening stationary front far to the north at 12Z.
- HURDAT lists a 30 kt tropical depression at 21.6N, 60.1W at 12Z.
- Microfilm shows a trough northeast of the Leeward Islands at 12Z.

2. Ship highlights:

- 20 kt SSE and 1000 mb at 21.6N, 58.9W at 09Z (micro – pressure appears to be too low).
- 35 kt SE and 1013 mb at 22.6N, 58.0W at 12Z (COADS).

3. Aircraft highlights:

- Penetration center fix measured a central pressure of 1014 mb at 22.5N, 57.2W at 01Z (ATSR).

4. Discussion:

- MWR: "Reconnaissance early on the 15th confirmed that the storm was no longer in evidence and the last advisory on Celia was issued by the Miami Weather Bureau Office at 1600 GMT, September 15. The storm had moved underneath the eastern side of a trough in the westerlies at middle and upper tropospheric levels. At the surface there was a marked absence of any significant easterly gradient winds over a large area to the north and northwest of the storm. These factors no doubt contributed to the degeneration of Celia in an area climatologically favorable for development."
- ATSR: "As CELIA approached the trough, she veered to the north and by the 15th had lost tropical storm intensity. The final warning was issued at 151600Z."
- Reanalysis: On September 15th, Celia turned to the north, passing about 225 nm to the northeast of the Leeward Islands early on the day. A reconnaissance aircraft investigated the tropical cyclone at 01Z on the 15th reporting a central pressure of 1014 mb and a center fix about 200 nm east of the analyzed position, an indication of the poorly organized state of the system. The aircraft again may have missed the center, thus the central pressure value is not added to HURDAT. A central pressure of 1010 mb is present in HURDAT at 12Z on the 15th and a ship reported 35 kt SE and 1013 mb at 12Z on the 15th. Thus the 1010 mb central pressure is reasonable and is retained. Weakening to a tropical depression is analyzed at 18Z on the 15th,

six hours later than originally shown in HURDAT. It is also possible that the system opened up into a trough late on the 15th and on the 16th. However, a few west and southwest observations suggest that it did retain a closed circulation, though weak.

September 16:

1. Maps and old HURDAT:
   - HWM analyzes a closed low pressure of at most 1015 mb at 27.2N, 60.8W with a frontal boundary far to the northwest at 12Z.
   - HURDAT lists a 25 kt tropical depression at 27.5N, 60.3W at 12Z.
   - Microfilm shows a spot low pressure at 28.3N, 57.8W at 12Z.
2. Satellite highlights: Center fix near 29.5N, 59.0W from TIROS at 1813Z (micro).
3. Discussion:
   - ATSR: "In a weakened stage, the cyclone continued north-northeast and on the 16th TIROS photographed the circulation near 30N 58W."
   - Reanalysis: Synoptic observations late on the 15th and on September 16th indicate that Celia was very poorly organized and may have weakened to a tropical wave. The data is inconclusive, thus Celia is retained as a tropical depression during that time. At 1821Z on the 16th, the TIROS V satellite captured another image of Celia, showing a sheared system with a poorly organized center and all the convection over the northeast quadrant.

September 17:

1. Maps and old HURDAT:
   - HWM analyzes a closed low pressure of at most 1015 mb at 29.5N, 57.0W with a stationary front to the north at 12Z.
   - HURDAT lists a 25 kt tropical depression at 29.8N, 56.3W at 12Z.
   - Microfilm shows a closed low pressure of at most 1014 mb at 32.5N, 54.0W with a frontal boundary just to the northwest at 12Z.
2. Discussion:
   - MWR: "Celia was not in evidence from data on surface weather charts from the time of the last advisory until late on September 17 when it became apparent that there was a weak surface circulation well to the southeast of Bermuda. This no doubt was the remains of Celia and it apparently was reintensifying slightly."
   - ATSR: "…completed a small clockwise loop near 30N 55W during the period 17 thru the 20th."
   - Reanalysis: Late on the 16th, an approaching frontal boundary caused the tropical cyclone to turn to the northeast and to the east on September 17th. A central pressure of 1010 mb is present in HURDAT at 00Z on the 17th and is retained as it is reasonable given nearby ship observations.

September 18:

1. Maps and old HURDAT:
   - HWM analyzes a closed low pressure of at most 1015 mb at 30.0N, 52.0W with a warm front to the north at 12Z.
   - HURDAT lists a 30 kt tropical depression at 30.0N, 51.6W at 12Z.
   - Microfilm shows a closed low pressure of at most 1017 mb at 30.0N, 51.0W with a frontal boundary just to the north at 12Z.
2. Discussion/Reanalysis: On September 18th, the forward motion of Celia slowed down and on September 19th, the tropical cyclone turned to the west while performing a clock-wise loop. In the meantime, Celia became better organized and it is analyzed to have regained tropical storm status at 18Z on the 18th based upon susbsequent ship data (45 kt at 06Z on the 19th), twelve hours earlier than originally shown in HURDAT.

September 19:

1. Maps and old HURDAT:

- HWM analyzes a tropical storm of at most 1010 mb at 29.2N, 52.9W at 12Z.
- HURDAT lists a 40 kt tropical storm at 29.2N, 52.8W at 12Z.
- Microfilm shows a closed low pressure of at most 1008 mb at 29.2N, 52.8W at 12Z.

2. Ship highlights:

- 45 kt SSW and 1009 mb at 29.1N, 50.9W at 06Z (COADS).
- 35 kt SSE and 1009 mb at 29.5N, 52.0W at 12Z (COADS).
- 35 kt SE and 1016 mb at 30.7N, 50.7W at 18Z (COADS).
- 30 kt S and 1008 mb at 28.7N, 52.6W at 18Z (micro).

3. Discussion:

- MWR: "Surface ship reports in the area indicate that Celia probably regained tropical storm intensity for about 24 hr around September 19 before turning northward and becoming extratropical. During this period of regeneration it apparently made a loop in the area some 600 mi. east-southeast of Bermuda."
- Reanalysis: At 06Z on the 19th, a ship reported 45 kt SSW and 1009 mb. An intensity of 45 kt is analyzed at 06Z on the 19th, up from 35 kt originally in HURDAT. A central pressure of 1005 mb is present in HURDAT at 18Z on the 19th and appears reasonable based on a ship report of 30 kt S and 1008 mb near the center, thus it is retained. A central pressure of 1005 mb suggests maximum surface winds of 34 kt from the north of 25N pressure-wind relationship. Based on synoptic data, an intensity of 45 kt is analyzed at 18Z on the 19th, up from 40 kt originally in HURDAT, a minor intensity change.

September 20:

1. Maps and old HURDAT:

- HWM analyzes a closed low pressure of at most 1015 mb at 31.7N, 55.8W with a weakening stationary front to the northwest at 12Z.
- HURDAT lists a 25 kt tropical depression at 31.9N, 55.5W at 12Z.
- Microfilm shows a closed low pressure of at most 1011 mb at 32.3N, 55.5W at 12Z.

2. Discussion:

- MWR: "A reconnaissance flight from Bermuda investigated the area early on the 20th and reported lowest pressure 1009.0 mb with maximum winds 28 kt."
- ATSR: "After completing the loop the cyclone resumed its northward movement and appeared to regenerate as reconnaissance aircraft reported a wind eye together with a dispersed area of squally weather at 201300Z at a position 500 miles east-southeast of Bermuda."
- Reanalysis: On September 20th, Celia turned to the northeast ahead of a frontal boundary. A central pressure of 1009 mb at 12Z on the 20th is present in HURDAT and has been replaced with 1007 mb based on a reconnaissance aircraft investigation which reported 1009 mb and 15 kt SW at 1230Z on the 20th.

September 21:

1. Maps and old HURDAT:

- HWM analyzes a closed low pressure of at most 1010 mb at 38.0N, 53.0W with a cold front just to the west at 12Z.
- HURDAT lists a 25 kt extratropical depression at 38.0N, 52.6W at 12Z.
- Microfilm shows a closed low pressure of at most 1011 mb at 38.0N, 51.5W with an extratropical cyclone just to the northwest at 12Z.

2. Ship highlights:

- 35 kt SE and 1018 mb at 31.7N, 53.2W at 00Z (micro).
- 40 kt SE and 1012 mb at 36.0N, 52.4W at 06Z (COADS).
- 35 kt SW and 1014 mb at 36.1N, 52.5W at 12Z (COADS).

3. Discussion:

- ATSR: "On the 21st the circulation again decreased in intensity and finally merged with a developing extratropical low off the Grand Banks of Newfoundland."
- Reanalysis: HURDAT originally had Celia weakening to a tropical depression at 06Z on September 21st but ship observations indicate that the tropical cyclone continued to produce gale-force winds until it was absorbed. HURDAT also originally indicated that Celia became extratropical at 12Z on the 21st but synoptic data show that the system retained its tropical characteristics until becoming absorbed after 12Z on the 21st. The last position is analyzed at 12Z on the 21st, six hours earlier than originally shown in HURDAT.

September 22:

1. Maps and old HURDAT:

- HWM analyzes an extratropical cyclone of at most 985 mb at 55.5N, 40.0W (Celia appears to have been absorbed) at 12Z.
- HURDAT does not list an organized storm on this date.
- Microfilm shows an extratropical cyclone of at most 996 mb at 54.5N, 38.0W (Celia appears to have been absorbed) at 12Z.

Sources: the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Monthly Weather Review, Navy reconnaissance book, Mariners Weather Log, Atlas of Cloud Vortex Patterns, and NHC Storm Wallets.

Hurricane Daisy [September 29 – October 9, 1962] – AL041962

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2540 09/29/1962 M=11  4 SNBR= 922 DAISY       XING=0 SSS=0
2540 09/29/1962 M=11  6 SNBR= 922 DAISY       XING=0 SSS=0
                      *

42545 09/29*  0   0   0    0*145 489  25    0*148 505  25    0*150 523  30    0*

42550 09/30*152 540  30    0*155 556  30    0*158 572  30    0*163 588  30    0*
42550 09/30*152 540  30    0*155 557  30    0*158 574  30 1005*163 590  35 1006*
                           ***           ***    ****    ***  **  ****

42555 10/01*169 599  30    0*174 607  30    0*178 612  30    0*190 620  30    0*
42555 10/01*168 601  35    0*174 608  35    0*180 614  35 1004*190 619  35    0*
           *** ***  **         ***  **      *** ***  ** ****    ***  **

42560 10/02*203 626  30    0*213 628  30 1003*218 632  40    0*225 638  45    0*
42560 10/02*201 623  35    0*211 626  35 1003*220 630  35 1005*225 638  40    0*
           *** ***  **      *** ***  **      *** ***  ** ****          **

42565 10/03*228 644  50    0*231 651  55    0*233 656  60    0*236 663  65    0*
42565 10/03*228 645  45 1003*231 651  50    0*233 656  50 1000*236 662  55  995*
                ***  ** ****          **                ** ****    ***  **  ***

42570 10/04*239 670  65  994*241 673  65    0*243 681  65    0*248 689  70  986*
42570 10/04*239 668  55  994*241 674  60    0*243 681  65  992*247 688  70  986*
                ***  **         ***  **                    *** *** ***

42575 10/05*255 694  80    0*264 698  85    0*272 698  85    0*280 696  95  969*
42575 10/05*252 693  70  985*260 696  70  984*270 696  80  973*280 696  85  969*
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            *** ***  **  *** *** ***  **  *** *** ***  **  ***          **

42580 10/06*292 696  90    0*310 686  80    0*328 681  85  965*345 675  95  968*
42580 10/06*292 693  85  970*308 686  90    0*326 679  90  965*348 672  90  968*
                ***  **  *** ***      **      *** ***  **      *** ***  **

42585 10/07*371 663  95    0*391 654  70  975*422 666  65    0*427 669  65    0*
42585 10/07*375 663  90    0*398 658  90  963E420 664  90  950E427 669  80    0*
            ***      **      *** ***  **  ******* ***  **  ****         **

42590 10/08*435 665  65    0*441 648  65    0E447 628  55    0E451 603  50    0*
42590 10/08E435 665  70    0E441 648  65    0E447 633  55    0E453 615  50    0*
           *        **     *                      ***         *** ***

42595 10/09E455 577  50    0E460 549  50    0*  0   0   0    0*  0   0   0    0*
42595 10/09E455 595  50    0E460 549  50    0*  0   0   0    0*  0   0   0    0*
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42600 HR

Highlights:

1. Several central pressures are added based upon aircraft reconnaissance;
2. The intensity is significantly reduced on the 5th based upon aircraft observations;
3. Extratropical transition indicated to have occurred 24 hours earlier based upon ship and station data;
4. The intensity is significantly boosted on the 7th based upon aircraft observations;
5. The position is adjusted westward on the 8th and 9th based upon ship and station observations.

Daily Summaries:

September 24:

1. Maps and old HURDAT:

- HWM analyzes a closed low pressure of at most 1015 mb at 8.6N, 26.8W at 12Z.
- HURDAT does not list an organized system on this date.
- Microfilm does not show an organized system on this date.

September 25:

1. Maps and old HURDAT:

- HWM analyzes a spot low pressure at 10.3N, 31.3W at 12Z.
- HURDAT does not list an organized system on this date.
- Microfilm does not show an organized system on this date.

September 26:

1. Maps and old HURDAT:

- HWM analyzes a spot low pressure at 11.6N, 36.3W at 12Z.
- HURDAT does not list an organized system on this date.
- Microfilm shows a tropical wave along longitude 45W at 12Z.

2. Discussion:

- ATSR: "The origin of the fourth tropical cyclone can be synoptically traced to 26 September when the TIROS satellite nephanalysis revealed a cloud mass at 12°N and 36°W. In approximately the same area, surface analysis indicated a moderate easterly wave."

September 27:

1. Maps and old HURDAT:

- HWM analyzes a spot low pressure at 13.0N, 41.5W at 12Z.

- HURDAT does not list an organized system on this date.
- Microfilm shows a tropical wave along longitude 47W at 12Z.

September 28:

1. Maps and old HURDAT:

- HWM analyzes a spot low pressure at 14.5N, 46.2W at 12Z.
- HURDAT does not list an organized system on this date.
- Microfilm shows a closed low pressure of at most 1005 mb at 17.5N, 52.9W at 12Z.

2. Satellite highlights:

- Center fix from TIROS at 13.5N, 47W at 1303Z (micro).

3. Discussion:

- MWR: "It was nearly a week after the discovery of a weak circulation that Daisy reached hurricane intensity. On September 28 ship reports and a TIROS satellite picture indicated a circulation well to the east of the Antilles."
- ATSR: "On the 28th, analysis and extrapolation placed the wave at a position where TIROS again photographed a possible vortex near 13.5°N and 47°W."
- Reanalysis: Hurricane Daisy developed from a tropical wave that left the African coast late in September. The system moved westward and slowly became better organized. Data over the eastern and central Atlantic is sparse, thus the time of genesis is uncertain. The first indication that the tropical wave was developing was a TIROS VI satellite image on September 28th at 1303Z showing a large area of convection with some banding features on the northern quadrant, as depicted in the nephanalysis at 12Z on the 28th.

September 29:

1. Maps and old HURDAT:

- HWM analyzes a spot low pressure at 14.5N, 51.0W at 12Z.
- HURDAT lists a 25 kt tropical depression at 14.8N, 50.5W at 12Z.
- Microfilm shows a closed low pressure of at most 1011 mb at 14.0N, 52.0W at 12Z.

2. Aircraft highlights:

- Radar center fix near 15.0N, 52.0W at 1710Z (micro).

3. Discussion:

- MWR: "The next day [29] reconnaissance aircraft located a tropical depression near 15N, 52W. The core of this circulation was cold and remained so for several days."
- ATSR: "Subsequently, three NAVY reconnaissance flights were dispatched into the area on 29 and 30 September."
- Reanalysis: The first position is analyzed at 06Z on September 29th as a 25 kt tropical depression, same as originally shown in HURDAT. The ship data around 06Z on the 29th is sparse, thus it cannot be confirmed if a closed low-level circulation was present at that time.

September 30:

1. Maps and old HURDAT:

- HWM analyzes a closed low pressure of at most 1010 mb at 15.5N, 57.5W at 12Z.
- HURDAT lists a 30 kt tropical depression at 15.8N, 57.2W at 12Z.
- Microfilm shows a closed low pressure of at most 1011 mb at 15.5N, 56.5W at 12Z.

2. Aircraft highlights:

- Penetration center fix measured a central pressure of 1005 mb at 14.8N, 57.6W at 13Z (ATSR).
- Penetration center fix measured a central pressure of 1006 mb and estimated surface winds of 35 kt at 16.3N, 58.8W at 1726Z (ATSR).

3. Satellite highlights:
- Center fix from TIROS at 15.0N, 56.3W at 1356Z (micro).

4. Discussion:
- ATSR: "The last flight prompted the first of 31 advisories on DAISY at 301930Z."
- Reanalysis: The tropical cyclone moved westward at a rapid forward speed of about 17 kt on the 29th and 30th. A reconnaissance aircraft reached the tropical depression at 13Z on September 30th measuring a central pressure of 1005 mb. A central pressure of 1005 mb suggests maximum surface winds of 37 kt from the Brown et al. south of 25N pressure-wind relationship. As the aircraft did not report tropical storm force winds in this initial fix, the system is kept at 30 kt at 12Z. However, at 1726Z another center fix was accompanied by 35 kt surface wind estimate. Intensification to a tropical storm is thus analyzed at 18Z on the 30th, 42 hours earlier than originally shown in HURDAT.

October 1:

1. Maps and old HURDAT:
- HWM analyzes a closed low pressure of at most 1010 mb at 18.0N, 61.0W at 12Z.
- HURDAT lists a 30 kt tropical depression at 17.8N, 61.2W at 12Z.
- Microfilm shows a closed low pressure of at most 1008 mb at 18.0N, 61.0W at 12Z.

2. Aircraft highlights:
- Penetration center fix measured a central pressure of 1006 mb and estimated surface winds of 28 kt at 17.8N, 60.9W at 1137Z (ATSR). (However, aircraft reported 20 kt SSW with 1006 mb southeast of the center. Thus 1004 mb is analyzed as central pressure used here.)
- Penetration center fix measured a central pressure of 1009 mb and estimated surface winds of 30 kt at 18.6N, 62.1W at 1615Z (ATSR).

3. Discussion:
- MWR: "The depression moved toward the west-northwest, turned northward on October 1."
- Reanalysis: On October 1st, Daisy turned to the northwest and decreased in forward speed, passing about 30 nm northeast of Barbuda, closest approach to the Leeward Islands.

October 2:

1. Maps and old HURDAT:
- HWM analyzes a tropical storm of at most 1005 mb at 22.1N, 63.5W at 12Z.
- HURDAT lists a 40 kt tropical storm at 21.8N, 63.2W at 12Z.
- Microfilm shows a closed low pressure of at most 1008 mb at 22.0N, 63.0W at 12Z.

2. Ship highlights:
- 35 kt E and 1011 mb at 23.0N, 60.9W at 06Z (COADS).
- 35 kt E at 24.2N, 62.5W at 12Z (micro).
- 35 kt ESE and 1012 mb at 24.8N, 61.1W at 17Z (micro).

3. Aircraft highlights:
- Penetration center fix measured a central pressure of 1005 mb, estimated surface winds of 35 kt and an eye diameter of 4 nm at 22.2N, 63.0W at 1140Z (ATSR).
- Penetration center fix measured a central pressure of 1003 mb and estimated surface winds of 40 kt at 22.5N, 64.4W at 23Z (WALLET).

4. Discussion:
- MWR: "…reached storm intensity on the 2nd."

- ATSR: "The track of DAISY shows several marked changes in direction of movement following a northwesterly course to a position north of the Leeward Islands, then a dogleg to the west followed by a northerly track for approximately 60 hours."
- Reanalysis: Surface observations and data from the reconnaissance aircrafts on October 1st and 2nd indicate that the system remained a weak tropical storm with only minor fluctuations in intensity. The first non-aircraft gale-force wind was reported on the 2nd at 06Z by a ship in the northeast quadrant of Daisy.

October 3:

1. Maps and old HURDAT:

- HWM analyzes a tropical storm of at most 1005 mb at 23.1N, 65.5W with a warm front far to the north at 12Z.
- HURDAT lists a 40 kt tropical storm at 23.3N, 65.6W at 12Z.
- Microfilm shows a closed low pressure of at most 1008 mb at 22.2N, 65.8W with a frontal boundary far to the north at 12Z.

2. Ship highlights:

- 50 kt SSE (gusts to 58 kt) and 1003 mb at 22.8N, 64.4W at 09Z (micro).
- 45 kt SSW and 1011 mb at 20.9N, 64.2W at 15Z (micro).
- 45 kt SW and 1008 mb at 22.0N, 65.0W at 18Z (COADS).
- 15 kt and 999 mb at 22.8N, 66.2W at 21Z (micro).

3. Aircraft highlights:

- Penetration center fix measured a central pressure of 1000 mb and estimated surface winds of 40 kt at 23.5N, 64.8W at 1051Z (WALLET).
- Penetration center fix measured a central pressure of 995 mb and estimated surface winds of 57 kt at 23.6N, 66.5W at 1830Z (WALLET).
- Penetration center fix measured a central pressure of 994 mb and estimated surface winds of 55 kt at 23.7N, 66.5W at 2152Z (WALLET).

4. Discussion:

- MWR: "…and hurricane force on the 3rd. The main intensification occurred from October 3 to October 5."
- Reanalysis: The tropical cyclone began to deepen on October 3rd while located north of Puerto Rico. Tropical storm conditions stayed north of the islands. A reconnaissance aircraft at 23Z on the 2nd reported a central pressure of 1003 mb and estimated surface winds of 40 kt. A central pressure of 1003 mb suggests maximum surface winds of 41 kt from the south of 25N pressure-wind relationship. Based on a forward speed of about 7 kt and synoptic observations, an intensity of 45 kt is analyzed at 00Z on the 3rd, down from 50 kt originally in HURDAT, a minor intensity change. A ship at 09Z on the 3rd reported 50 kt SSE and 1003 mb. Another penetration fix occurred at 1051Z on the 3rd measuring a central pressure of 1000 mb and estimated surface winds of 40 kt. A central pressure of 1000 mb suggests maximum surface winds of 47 kt from the south of 25N pressure-wind relationship. Based on a forward speed of about 9 kt and 50 kt ship data, an intensity of 50 kt is analyzed at 12Z on the 3rd, down from 60 kt originally in HURDAT, a minor intensity change. A penetration fix occurred at 1830Z on the 3rd measuring a central pressure of 995 mb and estimated surface winds of 57 kt. A central pressure of 995 mb suggests maximum surface winds of 56 kt from the south of 25N pressure-wind relationship. Based on a forward speed of about 8 kt, an intensity of 55 kt is analyzed at 18Z on the 3rd, down from 65 kt originally in HURDAT, a minor intensity change.

October 4:

1. Maps and old HURDAT:

- HWM analyzes a hurricane of at most 995 mb at 24.3N, 68.8W with a stationary front to the north at 12Z.
- HURDAT lists a 65 kt hurricane at 24.3N, 68.1W at 12Z.
- Microfilm shows a closed low pressure of at most 1002 mb at 24.5N, 68.5W with a frontal boundary to the north at 12Z.

2. Ship highlights:

- 15 kt SSE and 998 mb at 23.6N, 66.1W at 00Z (micro).
- 35 kt S and 1001 mb at 23.3N, 66.2W at 06Z (micro).
- 40 kt SE and 1003 mb at 24.3N, 66.4W at 09Z (COADS).
- 40 kt SE and 1007 mb at 24.9N, 66.4W at 12Z (COADS).
- 35 kt SW and 1006 mb at 22.7N, 68.2W at 15Z (micro).
- 45 kt ESE and 1005 mb at 26.1N, 67.2W at 18Z (micro).
- 45 kt SE and 1007 mb at 25.7N, 66.5W at 21Z (micro).

3. Aircraft highlights:

- Ship radar fix at 24.2N, 67.3W at 02Z (WALLET).
- Penetration center fix at 24.5N, 67.4W at 0630Z (WALLET).
- Penetration center fix measured a central pressure of 992 mb, estimated surface winds of 50 kt and an eye diameter of 10 nm at 24.2N, 68.1W at 1105Z (WALLET/ATSR).
- Penetration center fix measured a central pressure of 986 mb, estimated surface winds of 65 kt and an eye diameter of 12 nm at 24.8N, 68.9W at 19Z (ATSR).
- Penetration center fix measured a central pressure of 985 mb at 25.1N, 69.1W at 2135Z (ATSR).

4. Discussion/Reanalysis: At 2152Z on the 3rd, another reconnaissance aircraft investigated Daisy measuring a central pressure of 994 mb and estimating surface winds of 55 kt. A central pressure of 994 was already present in HURDAT at 00Z on October 4th and it is retained. An intensity of 55 kt is selected at 00Z on the 4th, down from 65 kt originally in HURDAT, a minor intensity change. The next reconnaissance aircraft measured a central pressure of 992 mb, estimated surface winds of 50 kt and an eye diameter of 10 nm at 1105Z. A central pressure of 992 mb suggests maximum surface winds of 61 kt and 56 kt from the south of 25N and north of 25N pressure-wind relationships, respectively. An eye diameter of 10 nm suggests an RMW of about 8 nm and the climatological value is 20. Based on an RMW smaller than the climatological value and a forward speed of about 8 kt, an intensity of 65 kt is selected at 12Z on the 4th, same as originally shown in HURDAT. Intensification to a hurricane is analyzed at 12Z on the 4th, 18 hours later than originally shown in HURDAT. The TIROS V satellite captured an image of Daisy at 1312Z on the 4th showing a well-organized tropical cyclone with a central dense overcast and an eye. A penetration center fix measured a central pressure of 986 mb, estimated surface winds of 65 kt and an eye diameter of 12 nm at 19Z on the 4th. A central pressure of 986 mb suggests from the pressure-wind relationship maximum surface winds of 70 kt south of 25N, 65 kt north of 25N, and 68 kt north of 25N intensifying subset. An eye diameter of 12 nm suggests an RMW of about 9 nm and the climatological value is 20. Based on an RMW smaller than the climatological value and a forward speed of about 8 kt, an intensity of 70 kt is selected at 18Z on the 4th, same as originally shown in HURDAT.

October 5:

1. Maps and old HURDAT:

- HWM analyzes a hurricane of at most 995 mb at 26.6N, 69.8W with a weakening stationary front to the northeast and a cold front to the northwest at 12Z.
- HURDAT lists an 85 kt hurricane at 27.2N, 69.8W at 12Z.

- Microfilm shows a closed low pressure of at most 993 mb at 26.8N, 69.5W with a frontal boundary to the northwest at 12Z.

2. Ship highlights:

- 45 kt SE and 1008 mb at 25.1N, 66.6W at 00Z (micro).
- 45 kt SE and 1008 mb at 24.0N, 66.5W at 03Z (micro).
- 50 kt SSE and 1008 mb at 24.0N, 66.4W at 06Z (micro).
- 40 kt SSW and 1003 mb at 25.0N, 68.5W at 09Z (micro).
- 45 kt SE and 1010 mb at 26.6N, 67.2W at 12Z (micro).
- 50 kt E and 1010 mb at 28.2N, 69.0W at 15Z (micro).
- 60 kt SE and 1006 mb at 29.0N, 67.0W at 18Z (micro).
- 60 kt NW and 1000 mb at 27.0N, 68.0W at 21Z (micro).

3. Aircraft highlights:

- Penetration center fix measured a central pressure of 984 mb at 25.5N, 69.1W at 0345Z (WALLET).
- Penetration center fix measured a central pressure of 973 mb at 26.6N, 69.7W at 1025Z (WALLET).
- Penetration center fix at 27.1N, 69.4W at 13Z (WALLET).
- Penetration center fix at 27.3N, 69.5W at 1430Z with estimated flight-level winds of 80 kt and an RMW of 35-40 nm from a research mission (WALLET).
- Penetration center fix measured a central pressure of 969 mb, estimated surface winds of 85 kt and an eye diameter of 35 nm at 27.8N, 69.7W at 1801Z (ATSR).

4. Discussion/Reanalysis: Another center fix measured a central pressure of 985 mb at 2135Z on the 4th. An intensity of 70 kt is analyzed at 00Z on the 5th, down from 80 kt originally shown in HURDAT. On October 5th, Daisy turned to the north gradually intensifying. At 0345Z on the 5th, the reconnaissance aircraft measured a central pressure of 984 mb. A central pressure of 984 mb suggests maximum surface winds of 68 kt from the north of 25N pressure-wind relationship. Based on a forward speed of about 10 kt, an intensity of 70 kt is selected at 06Z on the 5th, down from 85 kt originally shown in HURDAT. Another penetration fix measured a central pressure of 973 mb at 1025Z on the 5th. A central pressure of 973 mb suggests maximum surface winds of 81 kt from the north of 25N pressure-wind relationship. Based on a forward speed of about 10 kt, an intensity of 80 kt is selected at 12Z on the 5th, down from 85 kt originally shown in HURDAT. The TIROS V satellite captured an image of 1245Z on the 5th showing a well-organized tropical cyclone. The next reconnaissance aircraft measured a central pressure of 969 mb, estimated surface winds of 85 kt and an eye diameter of 35 nm at 1801Z on the 5th. A central pressure of 969 mb suggests maximum surface winds of 86 kt from the north of 25N pressure-wind relationship. An eye diameter of 35 nm suggests an RMW of about 26 nm and the climatological value is 22. Based on an RMW close or slightly larger than climatology and a forward speed of about 10 kt, an intensity of 85 kt is selected at 18Z on the 5th, down from 95 kt originally shown in HURDAT.

October 6:

1. Maps and old HURDAT:

- HWM analyzes a hurricane of at most 995 mb at 32.5N, 68.5W with a weakening front to the northwest and a warm front to the northeast at 12Z.
- HURDAT lists an 85 kt hurricane at 32.8N, 68.1W at 12Z.
- Microfilm shows a closed low pressure of at most 1005 mb at 32.6N, 68.5W with an extratropical cyclone to the northwest at 12Z.

2. Ship highlights:

- 55 kt N and 1002 mb at 29.9N, 70.6W at 00Z (micro).
- 45 kt SE and 1011 mb at 30.0N, 65.5W at 03Z (micro).

- 35 kt SSE and 1011 mb at 27.2N, 65.4W at 06Z (micro).
- 35 kt ESE and 1009 mb at 35.1N, 67.1W at 09Z (COADS).
- 45 kt WNW and 1011 mb at 30.7N, 69.3W at 12Z (micro).
- 35 kt NNE and 1001 mb at 36.2N, 69.2W at 18Z (COADS).

3. Land highlights:

- 35 kt SSE (gusts to 43 kt) and 1004 mb at Bermuda at 12Z (micro).
- 30 kt SSW (gusts to 46 kt) and 1003 mb at Bermuda at 18Z (micro).

4. Aircraft highlights:

- Penetration center fix with 970 mb extrapolated central pressure at 29.3N, 68.6W at 0030Z (ATSR).
- Radar center fix estimated an eye diameter of 45 nm at 29.4N, 69.2W at 0130Z (ATSR).
- Penetration center fix measured a central pressure of 965 mb and estimated surface winds of 90 kt at 32.3N, 68.3W at 1010Z (WALLET).
- Penetration center fix with 966 mb extrapolated central pressure at 13Z (ATSR).
- Penetration center fix measured a central pressure of 968 mb, estimated surface winds of 100 kt and an eye diameter of 50 nm at 35.1N, 66.8W at 1924Z (ATSR).

5. Discussion:

- MWR: "The hurricane passed well west of Bermuda on the 6th and the lowest central pressure, 965 mb, was reported at that time with winds of about 100 mph. The combined impact in New England of a "northeaster" on the 5th and 6th and tropical storm Daisy on the 6th and 7th produced widespread and heavy damage. … Highest winds were experienced over the coastal areas of Maine, especially the central sections where speeds of 60 to more than 70 mph. were reported. Coastal installations were hammered by giant waves."
- ATSR: "DAISY passed 200 miles to the west of Bermuda early on the 6th."
- Reanalysis: On October 6th, Daisy turned to the northeast and passed about 150 nm west of Bermuda. A penetration center fix at 1010Z on the 6th measured a central pressure of 965 mb and estimated surface winds of 90 kt. A central pressure of 965 mb suggests maximum surface winds of 90 kt from the north of 25N pressure-wind relationship. Based on a forward speed of 23 kt and large circulation, an intensity of 90 kt is analyzed at 12Z on the 6th, up from the 85 kt originally shown in HURDAT, a minor intensity change. 90 kt is also the peak intensity of this tropical cyclone, down from 95 kt originally in HURDAT (at 18Z on the 6th and 00Z on the 7th).

October 7:

1. Maps and old HURDAT:

- HWM analyzes a hurricane of at most 975 mb at 42.0N, 66.9W with a cold front to the southeast and a warm front to the northeast at 12Z.
- HURDAT lists a 65 kt hurricane at 42.2N, 66.6W at 12Z.
- Microfilm shows an extratropical cyclone of at most 990 mb at 42.0N, 67.0W at 12Z.

2. Ship highlights:

- 65 kt NNW and 995 mb at 38.1N, 68.4W at 00Z (COADS).
- 70 kt ENE at 39.9N, 68.0W at 03Z (micro).
- 50 kt W and 992 mb at 38.0N, 68.0W at 06Z (COADS).
- 60 kt N and 963 mb at 42.0N, 68.0W at 12Z (COADS).
- 5 kt SW (70 kt in micro) and 990 mb at 39.7N, 65.3W at 12Z (COADS).
- 959 mb (no wind given) at 42.0N, 66.5W at 12Z (micro).
- 70 kt WSW and 996 mb at 40.0N, 64.4W at 15Z (COADS).
- 60 kt SW and 997 mb at 40.3N, 63.0W at 18Z (COADS).

3. Land highlights:

- 18 kt N and 997 mb at Nantucket, MA at 0555Z (SWO).
- 18 kt NW and 992 mb at Nantucket, MA at 1158Z (SWO).
- 50 kt ESE and 975 mb at Yarmouth, Canada at 15Z (micro).
- 40 kt ENE and 983 mb at Eastport, ME at 18Z (micro).

4. Aircraft highlights:

- Penetration center fix extrapolated a central pressure of 963 mb at 40.0N, 65.4W at 0633Z (ATSR).
- Penetration center fix measured a central pressure of 975 mb and estimated an eye diameter of 8 nm at 40.7N, 64.9W at 0733Z (ATSR). (Note that these central pressure and center location are not valid based upon previous and subsequent fixes.)
- Penetration center fix extrapolated a central pressure of 950 mb at 41.8N, 66.4W at 1140Z (ATSR).
- Penetration center fix measured a central pressure of 960 mb at 42.0N, 66.7W at 13Z (WALLET). (Note that this central pressure is not valid based upon the previous fix and nearby ship reports.)

5. Discussion:

- MWR: "Cold air began feeding into the circulation October 7. It reached land near Yarmouth, Nova Scotia, late that day and turned sharply eastward. Yarmouth reported 977 mb as the weakening center passed there."
- ATSR: "On 7 October the circulation associated with a mid-tropospheric low approaching from the west briefly turned the storm to the northwest so that it skirted the New England coast with high winds and excessive precipitation. Late on the 7th the storm's circulation merged with the upper level circulation and thereafter, DAISY rapidly lost tropical characteristics. The last warning was issued at 072200Z calling for the storm to become extratropical during the forecast period."
- Reanalysis: On October 7th, Daisy turned to the northwest and slowed its forward speed. Early on October 7th, Daisy began to acquire extratropical characteristics and at the same time substantially deepen. Numerous synoptic observations indicate that it became an extratropical cyclone around 12Z on the 7th while located south of Nova Scotia. Transition to an extratropical cyclone is analyzed 24 hours earlier than originally shown in HURDAT. A central pressure of 963 mb was extrapolated at 0633Z from aircraft. This suggests an intensity of 88 kt from the Landsea et al. north of 35N pressure-wind relationship. 90 kt – continued from the same intensity on the 6th – is analyzed at 06Z, a major increase from the 70 kt previously. The system continued to deepen and reached 950 mb at 1140Z, at about the same time that it became extratropical. 90 kt is analyzed as the intensity at 12Z, up considerably from 65 kt originally. The windfield expanded producing strong winds, gusts over 70 kt, across the coastal areas of the Northeast of the United States and the southeastern Canada while the system was extratropical. The strong winds produced large waves that battered the coastline and heavy rains led to flooding.

October 8:

1. Maps and old HURDAT:

- HWM analyzes a hurricane of at most 985 mb at 44.5N, 63.1W with a cold front to the north at 12Z.
- HURDAT lists a 55 kt extratropical storm at 44.7N, 62.8W at 12Z.
- Microfilm shows a closed low pressure of at most 981 mb at 45.0N, 63.0W at 12Z.

2. Ship highlights:

- 60 kt SW and 1001 mb at 40.7N, 61.5W at 00Z (COADS).

- 45 kt SW and 996 mb at 40.1N, 62.8W at 06Z (micro).
- 40 kt SW and 989 mb at 42.3N, 62.8W at 12Z (COADS).
- 45 kt WSW and 996 mb at 41.6N, 61.2W at 18Z (COADS).
- 15 kt NE and 984 mb at 46.0N, 62.0W at 18Z (micro).

3. Land highlights:

- 20 kt SE and 978 mb at Yarmouth, Canada at 00Z (micro).
- 20 kt SE and 985 mb at Halifax, Canada at 06Z (micro).
- 15 kt N and 982 mb at Halifax, Canada at 12Z (micro).

4. Discussion/Reanalysis: On October 8th, the extratropical cyclone turned to the east-northeast increasing in forward speed while crossing Nova Scotia. Weakening below hurricane intensity is analyzed at 12Z on the 8th, same as originally shown in HURDAT.

October 9:

1. Maps and old HURDAT:

- HWM analyzes a closed low pressure of at most 995 mb at 45.0N, 50.0W with a cold front going through the center at 12Z.
- HURDAT lists a 50 kt extratropical storm at 46.0N, 54.9W at 06Z (last position).
- Microfilm shows a closed low pressure of at most 990 mb at 48.5N, 47.0W at 12Z.

2. Ship highlights:

- 50 kt NW and 1000 mb at 41.5N, 63.1W at 00Z (COADS).
- 40 kt NE and 1005 mb at 48.2N, 61.2W at 06Z (COADS).
- 40 kt S and 1003 mb at 46.2N, 40.5W at 12Z (COADS).

3. Discussion/Reanalysis: Daisy continued to weaken on the 9th and synoptic observations indicate that it was absorbed by a larger extratropical cyclone after 06Z. The last position is analyzed at 06Z on the 9th, same as originally shown in HURDAT.

October 10:

1. Maps and old HURDAT:

- HWM analyzes an extratropical cyclone of at most 985 mb at 57.0N, 40.0W at 12Z.
- HURDAT does not list an organized storm on this date. Microfilm shows a closed low pressure of at most 990 mb at 48.5N, 47.0W at 12Z.

Date	Original HURDAT Central Pressure	Evidence	Changes
Sep 30 12Z		Penetration center fix: 1005 mb at 13Z on Sep 30th	1005 mb
Sep 30 18Z		Penetration center fix: 1006 mb at 1726Z on Sep 30th	1006 mb
Oct 01 12Z		Aircraft measured 1006 mb and estimated 20 kt SSW at 1045Z on Oct 01th	1004 mb
Oct 02 06Z	1003 mb	No central pressure report but appears reasonable based on synoptic observations	Retained
Oct 02 12Z		Penetration center fix: 1005 mb at 1140Z on Oct 02nd	1005 mb
Oct 03 00Z		Penetration center fix: 1003 mb at 23Z on Oct 02nd	1003 mb
Oct 03 12Z		Penetration center fix: 1000 mb at 1051Z on Oct 03rd	1000 mb
Oct 03 18Z		Penetration center fix: 995 mb at 1830Z on Oct 03rd	995 mb
Oct 04 00Z	994 mb	Penetration center fix: 994 mb at 2152Z on Oct 03rd	Retained
Oct 04 12Z		Penetration center fix: 992 mb at 1105Z on Oct 04th	992 mb
Oct 04 18Z	986 mb	Penetration center fix: 986 mb at 19Z on Oct 04th	Retained

Oct 05 00Z		Penetration center fix: 985 mb at 2135Z on Oct 04th	985 mb
Oct 05 06Z		Penetration center fix: 984 mb at 0345Z on Oct 05th	984 mb
Oct 05 12Z		Penetration center fix: 973 mb at 1025Z on Oct 05th	973 mb
Oct 05 18Z	969 mb	Penetration center fix: 969 mb at 1801Z on Oct 05th	Retained
Oct 06 00Z		Penetration center fix: 970 mb at 0030Z on Oct 06th	970 mb
Oct 06 12Z	965 mb	Penetration center fix: 965 mb at 1010Z on Oct 06th	Retained
Oct 06 18Z	968 mb	Penetration center fix: 968 mb at 1924Z on Oct 06th	
Oct 07 06Z	975 mb	Penetration center fix: 963 mb at 0633Z on Oct 7th	963 mb
Oct 07 12Z		Penetration center fix: 950 mb at 1140Z on Oct 07th	950 mb

Sources: the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Monthly Weather Review, Navy reconnaissance book, Mariners Weather Log, Surface Weather Observations, Environment Canada and NHC Storm Wallets.

Hurricane Ella [October 14-25, 1962] – AL051962

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42605 10/14/1962 M=10  5 SNBR= 923 ELLA        XING=0 SSS=0                    L
42605 10/14/1962 M=10  7 SNBR= 923 ELLA        XING=0 SSS=0
                       *                                                       *

42610 10/14*  0   0   0    0*  0   0   0    0*  0   0   0    0*221 714  25    0*
42610 10/14*  0   0   0    0*225 730  30    0*230 728  30    0*234 725  30    0*
                           *** ***  **      *** ***  **      *** ***  **

42615 10/15*238 721  25 1002*247 721  30    0*250 721  35    0*252 721  40 1002*
42615 10/15*238 723  30    0*242 722  30    0*247 721  35    0*252 721  40 1002*
              ***  **    * *** ***          ***

42620 10/16*258 722  40 1002*261 726  50    0*263 732  55    0*264 740  60 1002*
42620 10/16*257 722  40 1002*261 726  40    0*263 732  45 1002*264 740  45 1002*
           ***                       **                **  ****          **

42625 10/17*267 748  60  994*270 751  60  997*274 752  60  992*281 754  70  987*
42625 10/17*266 748  50  994*270 751  50  997*275 752  55  992*282 754  65  989*
           ***      **                **      ***      **      ***      **  ***

42630 10/18*287 756  75    0*292 757  70  981*297 758  70  978*302 758  70  976*
42630 10/18*290 755  65    0*295 756  65  981*298 758  70  978*302 760  75  973*
           *** ***  **      *** ***  **      ***                 ***  **  ***

42635 10/19*307 758  75    0*307 751  80  973*307 746  90  969*313 736 100  962*
42635 10/19*306 760  75  974*307 756  75  973*307 746  80  969*311 736  90  962*
           *** ***     ***     ***  **                **      ***      **

42640 10/20*319 728 100    0*330 718  85  960*339 708  85  960*346 696  85  964*
42640 10/20*319 727  95  960*330 718  90  963*339 708  90  960*345 697  85  964*
              ***  **  ***          **  ***          **          ***

42645 10/21*352 681  80    0*360 663  75    0*367 646  70  972*375 626  65  950*
42645 10/21*352 681  85    0*360 663  80    0*367 645  80  961*375 626  80  958*
                     **                **          ***  **  ***          **  ***

42650 10/22*395 597  65    0E429 563  60    0E467 534  60    0E490 500  60    0*
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42650 10/22*395 599  75     0*429 572  65     0E460 540  60     0E480 490  60     0*
                ***  **      *    ***  **       *** ***          *** ***
42655 10/23E520 451  60     0E541 414  60     0E562 370  60     0*  0    0    0     0*
42655 10/23E510 451  60     0E541 421  60     0E555 390  60     0E560 350  55     0*
           ***                    ***          *** ***          **** ***  **
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(October 24th and 25th are new to HURDAT)

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42657 10/24E570 310  50     0E580 270  50     0E590 230  50     0E600 175  50     0*
42659 10/25E605 105  50     0E610 055  50     0*  0    0    0     0*  0    0    0     0*
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42660 HR

Highlights:

1. Genesis indicated to have occurred 12 hours earlier based upon ship, coastal, and aircraft observations;
2. Intensity significantly reduced on the 16th based upon aircraft observations;
3. Peak intensity reduced from Category 3 (100 kt) to Category 2 (90 kt) on the 19th and 20th;
4. Intensity significantly boosted (and central pressures corrected) on the 21st based upon aircraft observations;
5. Two days added at the end of the system's lifetime while an extratropical cyclone.

Daily Summary:

October 11:

1. Maps and old 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 near the Lesser Antilles along longitude 59W.

2. Discussion/Reanalysis: Hurricane Ella developed from a tropical wave that was first detected as it approached the Lesser Antilles on October 11th.

October 12:

1. Maps and old 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 Lesser Antilles.

2. Aircraft highlights:

- Flight level winds of 35 kt and a pressure of 1010 mb at 14.8N, 63.8W at 1130Z (micro).

October 13:

1. Maps and old HURDAT:

- HWM analyzes a closed low pressure of at most 1010 mb at 16.8N, 75.8W at 12Z.
- HURDAT does not list an organized system on this date.
- Microfilm shows a tropical wave over Hispaniola and attached is a closed low pressure of at most 1011 mb at 17.7N, 72.7W at 12Z.

2. Discussion:

- MWR: "The only prior indication of a disturbance was an area of increasing cloudiness and shower activity centered about 200 mi northeast of Turks Island on the 13th. This area coincided with the northern portion of a weak 500-mb Low which had become cut off at the base of a polar trough and was drifting slowly west-northwestward. The surface charts on the 13th showed a

rather weak gradient with general easterly flow and a minor inverted trough with cyclonic curvature and shear in the vicinity of the unsettled weather."

- ATSR: "First evidence of a surface disturbance was a weak inverted trough located north of Hispaniola coast on 13 October. This was attended by squally weather and stratus type clouds while peripheral ships to the north of the center were reporting winds of 20-25 knots."
- Reanalysis: The disturbance moved northwestward across the Greater Antilles and reached the southeastern Bahamas on October 13th.

October 14:

1. Maps and old HURDAT:

- HWM analyzes a closed low pressure of at most 1010 mb at 23.0N, 72.0W at 12Z.
- HURDAT lists a 25 kt tropical depression at 22.1N, 71.4W at 18Z (first position).
- Microfilm shows a closed low pressure of at most 1011 mb at 23.0N, 72.0W at 12Z.

2. Ship highlights:

- 35 kt ENE and 1011 mb at 24.3N, 72.2W at 00Z (COADS).

3. Aircraft highlights:

- Penetration center fix measured a central pressure of 1012 mb, estimated surface winds of 18 kt and an eye diameter of 20 nm at 23.8N, 73.0W at 20Z (ATSR).

4. Discussion:

- MWR: "The depression which was to grow into hurricane Ella developed in the southeastern Bahamas on October 14. Ships and islands near and to the north of the circulation center reported winds of 20 to 30 knots on that date."
- ATSR: "The unsettled area drifted north and then west-northwest so that the 14th it was located in the extreme southeastern Bahamas area. Early on the 14th aircraft reconnaissance reported that a depression had formed and this prompted the first of four tropical depression warnings issued at 141805Z. The depression remained to the east of the Bahamas while gradually intensifying."
- Reanalysis: Surface observations early on October 14th indicate that a closed, low-level circulation was forming and intensification to a 30 kt tropical depression is analyzed at 06Z on the 14th, twelve hours earlier than originally shown in HURDAT. In an area of weak steering currents, the tropical depression slowly moved northward while becoming better organized. The first reconnaissance aircraft to investigate the tropical cyclone arrived at 20Z on the 14th measuring a central pressure of 1012 mb. Synoptic observations indicate that the dropsonde missed the center, thus the value reported is not a central pressure and was not added to HURDAT.

October 15:

1. Maps and old HURDAT:

- HWM analyzes a closed low pressure of at most 1010 mb at 24.2N, 72.9W with a weakening cold front to the north at 12Z.
- HURDAT lists a 35 kt tropical storm at 25.0N, 72.1W at 12Z.
- Microfilm shows a closed low pressure of at most 1008 mb at 24.8N, 71.2W with a frontal boundary to the north at 12Z.

2. Ship highlights:

- 35 kt NE and 1011 mb at 26.2N, 74.1W at 15Z (micro).
- 40 kt NE and 1011 mb at 28.5N, 69.6W at 18Z (COADS).
- 35 kt ENE and 1012 mb at 28.1N, 71.7W at 21Z (micro).

3. Aircraft highlights:

- Penetration center fix measured a central pressure of 1002 mb, estimated surface winds of 40 kt and an eye diameter of 20 nm at 25.5N, 72.4W at 1850Z (WALLET).
- Penetration center fix measured a central pressure of 1003 mb and estimated surface winds of 40 kt at 25.3N, 71.8W at 2125Z (WALLET).

4. Discussion:

- MWR: "The depression drifted toward the north, then west-northwestward, and gradually intensified. It attained tropical storm force on the 15th, but remained poorly organized."
- ATSR: "Tropical storm force was reached by late afternoon on the 15th. The first numbered advisory on Tropical Storm ELLA was issued at 152200Z."
- Reanalysis: A ship reported 40 kt E at 00Z on October 15th and appears to have a high bias compared to ships nearby. Intensification to a tropical storm is analyzed at 12Z on the 15th, same as originally shown in HURDAT. The first gale-force winds were reported at 18Z on the 15th. This tropical cyclone presented a large circulation and the gale-force winds were reported about 200 nm north of the center but within the envelope of the outermost closed isobar. It is possible that Ella had some subtropical characteristics. (Central pressures values for almost every 6 hour period were present in the original HURDAT between October 15th at 00Z and October 21st at 18Z. Some of these were obviously analyses that were added in, not based upon actual observations. Thus, based on actual observations, some were retained and new central pressure values added. Detailed information on these changes can be found in the table at the end.) The next reconnaissance aircraft reached Ella at 1850Z on the 15th measuring a central pressure of 1002 mb, estimating surface winds of 40 kt and an eye diameter of 20 nm. A central pressure of 1002 mb suggests maximum surface winds of 43 kt from the south of 25N Brown et al. pressure-wind relationship. Due to the large circulation of the tropical cyclone and forward speed of only 4 kt, an intensity of 40 kt is selected at 18Z on the 15th, same as originally shown in HURDAT.

October 16:

1. Maps and old HURDAT:

- HWM analyzes a tropical storm of at most 1005 mb at 26.4N, 73.3W with a warm front to the northeast at 12Z.
- HURDAT lists a 55 kt tropical storm at 26.3N, 73.2W at 12Z.
- Microfilm shows a closed low pressure of at most 1008 mb at 25.5N, 74.0W at 12Z.

2. Ship highlights:

- 40 kt NE and 1014 mb at 29.8N, 70.3W at 00Z (COADS).
- 45 kt NE and 1011 mb at 29.0N, 74.0W at 03Z (micro).
- 35 kt ENE and 1009 mb at 27.6N, 74.0W at 06Z (COADS).
- 35 kt NE and 1012 mb at 28.7N, 74.0W at 12Z (COADS).
- 5 kt NW and 1002 mb at 25.5N, 73.5W at 12Z (HWM).
- 40 kt NE and 1012 mb at 30.0N, 73.9W at 18Z (COADS).

3. Land highlights:

- 35 kt N and 1009 mb at North Eleuthera, Bahamas at 12Z (micro).

4. Aircraft highlights:

- Penetration center fix measured a central pressure of 1006 mb via a low-level fix (but 1002 mb from 700 mb), estimated surface winds of 70 kt and an eye diameter of 20 nm at 26.4N, 73.7W at 1353Z (WALLET/ATSR).
- Penetration center fix measured a central pressure of 1002 mb and estimated surface winds of 70 kt at 26.4N, 73.8W at 16Z (WALLET).

- Penetration center fix measured a central pressure of 994 mb, estimated flight level winds of 60 kt and an eye diameter of 25 nm at 26.6N, 74.9W at 2242Z (WALLET).

5. Discussion/Reanalysis: Another reconnaissance aircraft investigated the tropical storm late on the 15th suggesting that the system was generally stationary between 1745Z and 2315Z, measuring a central pressure of 1002 mb and estimating surface winds of 40 kt. On October 16th, Ella turned to the northwest and began to deepen later in the day. The first reconnaissance aircraft on the 16th reached the tropical cyclone at 16Z measuring a central pressure of 1002 mb and estimating surface winds of 70 kt. An intensity of 45 kt is selected at 18Z on the 16th based on a blend between the reconnaissance aircraft data and synoptic observations, down from 60 kt originally in HURDAT, a minor intensity change.

October 17:

1. Maps and old HURDAT:

- HWM analyzes a tropical storm of at most 1000 mb at 27.5N, 75.4W with a warm front to the northeast at 12Z.
- HURDAT lists a 60 kt tropical storm at 27.4N, 75.2W at 12Z.
- Microfilm shows a closed low pressure of at most 993 mb at 28.1N, 75.2W at 12Z.

2. Ship highlights:

- 35 kt E and 1010 mb at 29.2N, 71.6W at 00Z (COADS).
- 35 kt NE and 1010 mb at 30.6N, 74.9W at 06Z (COADS).
- 25 kt WSW and 999 mb at 26.1N, 74.2W at 09Z (micro).
- 35 kt SW and 1000 mb at 26.9N, 73.9W at 12Z (COADS).
- 45 kt SE and 1000 mb at 29.4N, 73.5W at 15Z (micro).
- 60 kt NE and 994 mb at 28.9N, 76.6W at 18Z (micro).
- 40 kt SSE and 997 mb at 28.6N, 73.7W at 21Z (micro).

3. Land highlights:

- 20 kt W and 1005 mb at San Salvador, Bahamas at 00Z (micro).
- 30 kt NW and 1005 mb at Central Abaco, Bahamas at 12Z (micro).
- 30 kt NW and 1004 mb at Central Abaco, Bahamas at 18Z (micro).

4. Aircraft highlights:

- Penetration center fix measured a central pressure of 997 mb at 27.1N, 75.0W at 04Z (WALLET).
- Penetration center fix measured a central pressure of 992 mb and estimated surface winds of 60 kt at 27.5N, 75.1W at 1215Z (WALLET).
- Penetration center fix measured a central pressure of 989 mb, estimated surface winds of 75 kt and an eye diameter of 80 nm at 28.5N, 75.4W at 1735Z (WALLET).

5. Discussion:

- MWR: "A turn to the north-northwest occurred on the 17th and Ella reached hurricane intensity about noon on that date. Intermittent gales and heavy seas affected the central and northern Bahamas but the hurricane-force winds were well to the north of the islands."
- ATSR: "After attaining hurricane force, aircraft reconnaissance reported eyes from 60 to 100 miles in diameter as she progressed in a northeasterly direction off the Atlantic coastline."
- Reanalysis: Another penetration fix at 2242Z on the 16th measured a central pressure of 994 mb and an eye diameter of 25 nm. A central pressure of 994 mb suggests maximum surface winds of 53 kt and 56 kt from the north of 25N and the intensifying subset pressure-wind relationship, respectively. An eye diameter of 25 nm suggests an RMW of about 19 nm and the climatological value is 20 nm. Based on a forward speed of about 8 kt, an RMW close to

climatology and the large circulation of the tropical cyclone, an intensity of 50 kt is selected at 00Z on the 17th, down from 60 kt originally in HURDAT, a minor intensity change. At 04Z on the 17th, another penetration fix measured a central pressure of 997 mb. An intensity of 50 kt is analyzed at 06Z on the 17th, down from 60 kt originally in HURDAT, a minor intensity change. The next penetration fix measured a central pressure of 992 mb and estimated surface winds of 60 kt at 1215Z. A central pressure of 992 mb suggests maximum surface winds of 56 kt from the north of 25N pressure-wind relationship. An intensity of 55 kt is analyzed at 12Z on the 17th, down from 60 kt originally shown in HURDAT, a minor intensity change. Numerous ships reported gale-force winds on the 17th, not just in the periphery like in the previous days, but also close to the center. The highest wind reported on the 17th was 60 kt NE and 994 mb at 18Z. A reconnaissance aircraft measured a central pressure of 989 mb, estimated surface winds of 75 kt and an eye diameter of 80 nm at 1735Z on the 17th. A central pressure of 989 mb suggests maximum surface winds of 61 kt from the north of 25N pressure-wind relationship. An eye diameter of 80 nm suggests an RMW of about 60 nm and the climatological value is 23 nm. Based on a blend of the forward speed of about 6 kt, large circulation, surface wind estimates, and synoptic data, an intensity of 65 kt is selected at 18Z on the 17th, down from 70 kt originally in HURDAT, a minor intensity change. A central pressure of 987 mb was present in HURDAT at 18Z on the 17th and has been replaced by 989 mb.

October 18:

1. Maps and old HURDAT:

- HWM analyzes a tropical storm of at most 990 mb at 29.7N, 75.7W with a cold front to the northwest at 12Z.
- HURDAT lists a 70 kt hurricane at 29.7N, 75.8W at 12Z.
- Microfilm shows a closed low pressure of at most 986 mb at 30.1N, 75.5W with a frontal boundary to the northwest at 12Z.

2. Ship highlights:

- 35 kt S and 1000 mb at 28.3N, 73.4W at 00Z (COADS).
- 50 kt NE and 1009 mb at 32.2N, 78.6W at 00Z (COADS).
- 40 kt NE and 1016 mb at 33.7N, 74.3W at 06Z (COADS).
- 40 kt SSE and 999 mb at 30.7N, 73.0W at 09Z (micro).
- 35 kt S and 999 mb at 28.3N, 73.6W at 12Z (micro).
- 90 kt SSE (gusts to 100 kt) and 987 mb at 30.6N, 74.5W at 15Z (micro).
- 85 kt SSE and 983 mb at 30.5N, 74.5W at 18Z (micro, wallet indicates “80/90 MPH”).
- 60 kt S and 995 mb at 30.9N, 73.9W at 21Z (micro).

3. Land highlights:

- 35 kt NE and 1008 mb at Diamond Shoals, NC at 15Z (micro).

4. Aircraft highlights:

- Penetration center fix measured a central pressure of 981 mb at 29.5N, 75.4W at 0726Z (WALLET).
- Penetration center fix measured a central pressure of 978 mb and estimated surface winds of 60 kt at 29.8N, 76.0W at 1247Z (WALLET).
- Penetration center fix measured a central pressure of 973 mb, estimated surface winds of 75 kt and an eye diameter of 61-84 nm at 30.5N, 76.3W at 1910Z (ATSR).

5. Discussion:

- MWR: “On October 18, Ella continued toward the north-northwest with gradual deepening. Central pressure dropped to 976 mb and maximum winds were

reported as 80 kt. A ship 90 mi southeast of the center reported heavy confused seas ranging up to 40 to 45 ft."

- Reanalysis: On October 18th, Ella moved very slowly to the north-northwest while intensifying. A reconnaissance aircraft measured a central pressure of 981 mb at 0726Z on the 18th. A central pressure of 981 mb suggests maximum surface winds of 71 kt from the north of 25N pressure-wind relationship. Due to the large circulation of Ella and forward speed of about 6 kt, an intensity of 65 kt is analyzed at 06Z on the 18th, down from 70 kt originally in HURDAT, a minor intensity change. Intensification to a hurricane is analyzed at 00Z on October 18th, six hours later than originally shown in HURDAT. The next penetration fix measured a central pressure of 978 mb and estimated surface winds of 60 kt at 1247Z on the 18th. A central pressure of 978 mb suggests maximum surface winds of 75 kt from the north of 25N pressure-wind relationship. Due to the large circulation of Ella and forward speed of about 6 kt, an intensity of 70 kt is analyzed at 12Z on the 18th, down from 70 kt originally in HURDAT, a minor intensity change. The final penetration fix on the 18th occurred at 1910Z measuring a central pressure of 973 mb, estimating surface winds of 75 kt and an eye diameter of 61-84 nm. A central pressure of 973 mb suggests maximum surface winds of 81 kt from the north of 25N pressure-wind relationship. An eye diameter of 61-84 nm suggests an RMW of about 46-63 nm and the climatological value is 23 nm. Due to the large circulation of Ella and forward speed of about 5 kt, an intensity of 75 kt is analyzed at 18Z on the 18th, up from 70 kt originally in HURDAT, a minor intensity change. Many ships reported gale-force winds on the 18th. The ship "CHRV" appears to have a high bias reporting 90 kt at 15Z and 95 kt at 18Z. It is interesting to note that Monthly Weather Review mentions the waves reported by the ship "CHRV" but does not mention the winds, possibly an indication that Gordon Dunn did not have confidence in the measurements.

October 19:

1. Maps and old HURDAT:

- HWM analyzes a hurricane of at most 985 mb at 30.7N, 74.7W with a weakening stationary front just to the northwest at 12Z.
- HURDAT lists a 90 kt hurricane at 30.7N, 74.6W at 12Z.
- Microfilm shows a closed low pressure of at most 1005 mb at 30.5N, 74.5W at 12Z.

2. Ship highlights:

- 50 kt N and 1006 mb at 32.2N, 79.0W at 00Z (COADS).
- 40 kt S and 992 mb at 29.7N, 73.7W at 06Z (COADS).
- 55 kt WNW and 1004 mb at 27.9N, 76.5W at 12Z (COADS).
- 105 kt SW and 999 mb at 30.3N, 74.4W at 15Z (micro).
- 80 kt W and 982 mb at 30.2N, 74.3W at 18Z (micro).
- 75 kt W and 993 mb at 29.5N, 73.8W at 21Z (MWL).

3. Aircraft highlights:

- Penetration center fix with extrapolated central pressure of 974 mb at 30.6N, 75.9W at 01Z (WALLET).
- Penetration center fix measured a central pressure of 976 mb and an eye diameter of 40-60 nm at 30.7N, 75.9W at 04Z (WALLET).
- Penetration center fix measured a central pressure of 973 mb and estimated surface winds of 95 kt at 30.3N, 75.5W at 07Z (WALLET).
- Penetration center fix measured a central pressure of 969 mb, estimated surface winds of 90 kt and an eye diameter of 55 nm at 30.7N, 74.5W at 1205Z (WALLET).

- Penetration center fix measured a central pressure of 962 mb, estimated flight level winds of 105 kt and an eye diameter of 50 nm at 31.2N, 73.6W at 19Z (WALLET).

4. Discussion:

- MWR: "The hurricane came under the influence of a short-wave trough passing to the north on the 19th and changed course first to the east, then to the northeast, accelerating from about 5 kt to 12 to 15 kt."
- ATSR: "The passage of a short wave late on the 19th veered ELLA to the east then northeast."
- Reanalysis: On October 19th, Ella turned to the east and later northeast, as it continued to strengthen. A reconnaissance aircraft reached the hurricane at 1205Z on the 19th measuring a central pressure of 969 mb, estimated surface winds of 90 kt and an eye diameter of 55 nm. A central pressure of 969 mb suggests maximum surface winds of 86 kt from the north of 25N pressure-wind relationship. An eye diameter of 55 nm suggests an RMW of about 41 nm and the climatological value is 23 nm. (Note that the research aircraft measured an RMW of 30-35 nm, in agreement with a value larger than climatology.) Due to the large circulation of Ella and a forward speed of about 10 kt, an intensity of 80 kt is selected at 12Z on the 19th, down from 90 kt originally shown in HURDAT, a minor intensity change. The next reconnaissance aircraft investigated the hurricane at 19Z on the 19th measuring a central pressure of 962 mb and an eye diameter of 50 nm. A central pressure of 962 mb suggests maximum surface winds of 93 kt and 97 kt from the north of 25N and intensifying subset pressure-wind relationship, respectfully. An eye diameter of 50 nm suggests an RMW of about 38 nm and the climatological value is 22 nm. Due to the large circulation of Ella and a forward speed of about 10 kt, an intensity of 90 kt is selected at 18Z on the 19th, down from 100 kt originally shown in HURDAT, a minor intensity change.

October 20:

1. Maps and old HURDAT:

- HWM analyzes a hurricane of at most 985 mb at 33.6N, 70.9W with a weakening stationary front just to the south and a warm front to the north at 12Z.
- HURDAT lists an 85 kt hurricane at 33.9N, 70.8W at 12Z.
- Microfilm shows a closed low pressure of at most 1005 mb at 33.5N, 70.5W at 12Z.

2. Ship highlights:

- 80 kt S and 968 mb at 32.0N, 72.3W at 00Z (COADS).
- 85 kt E and 969 mb at 32.7N, 72.3W at 03Z (COADS).
- 55 kt SSE and 972 mb at 33.6N, 70.5W at 06Z (micro).
- 50 kt SW and 979 mb at 32.4N, 70.5W at 12Z (COADS).
- 45 kt SW and 988 mb at 32.5N, 75.5W at 15Z (micro).
- 50 kt SW and 994 mb at 31.8N, 69.4W at 18Z (COADS).

3. Aircraft highlights:

- Penetration center fix measured a central pressure of 960 mb, estimated flight level winds of 78 kt and an eye diameter of 50 nm at 32.2N, 72.7W at 0204Z (WALLET/ATSR).
- Penetration center fix measured a central pressure of 963 mb at 33.3N, 71.7W at 0705Z (WALLET/ATSR).
- Penetration center fix measured a central pressure of 960 mb, estimated surface winds of 85 kt and an eye diameter of 100 nm at 33.9N, 70.4W at 13Z (WALLET).

- Penetration center fix measured a central pressure of 964 mb, estimated surface winds of 85 kt and an eye diameter of 100 nm at 34.5N, 69.7W at 19Z (WALLET).

4. Discussion:

- MWR: "Some further intensification occurred with a minimum pressure of 960 mb and maximum winds of about 90 kt on the 20th."
- Reanalysis: On October 20th, hurricane Ella began to move to the northeast, away from the United States while holding its strength. A penetration center fix at 0204Z measured a central pressure of 960 mb and an eye diameter of 50 nm. A central pressure of 960 mb suggests maximum surface winds of 95 kt from the north of 25N pressure-wind relationship and 99 kt from the intensifying subset. An eye diameter of 50 nm suggests an RMW of about 38 nm and the climatological value is 24 nm. Due to the large circulation of Ella and a forward speed of about 12 kt, an intensity of 95 kt is selected at 00Z on the 20th, down from 100 kt originally shown in HURDAT, a minor intensity change. 95 kt is also the peak intensity of this tropical cyclone, down from 100 kt originally shown in HURDAT, a minor intensity change. Thus, it is analyzed that Ella did not reach major hurricane intensity. Another penetration center fix occurred at 13Z on the 20th and measured a central pressure of 960 mb, estimated surface winds of 85 kt and an eye diameter of 100 nm. A central pressure of 960 mb suggests maximum surface winds of 95 kt from the north of 25N Brown et al. pressure-wind relationship and 90 kt from the north of 35N Landsea et al. pressure-wind relationship. An eye diameter of 100 nm suggests an RMW of about 75 nm and the climatological value is 26 nm. Due to the large circulation of Ella and a forward speed of about 11 kt, an intensity of 90 kt is selected at 12Z on the 20th, up from 85 kt originally shown in HURDAT, a minor intensity change. The final penetration center fix on the 20th occurred at 19Z and measured a central pressure of 964 mb and an eye diameter of 100 nm. A central pressure of 964 mb suggests maximum surface winds of 91 kt and 87 kt from the north of 25N and north of 35N pressure-wind relationships, respecfully. An eye diameter of 100 nm suggests an RMW of about 75 nm and the climatological value is 26 nm. Due to the large circulation of Ella and a forward speed of about 17 kt, an intensity of 85 kt is selected at 18Z on the 20th, same as originally shown in HURDAT. Numerous ships experienced gale-force winds on the 20th, including a few up to hurricane intensity.

October 21:

1. Maps and old HURDAT:

- HWM analyzes a hurricane of at most 975 mb at 36.3N, 64.9W with a weakening warm front to the north at 12Z.
- HURDAT lists a 70 kt hurricane at 36.7N, 64.6W at 12Z.
- Microfilm shows a closed low pressure of at most 990 mb at 36.7N, 64.6W with a frontal boundary to the north at 12Z.

2. Ship highlights:

- 60 kt SE and 1011 mb at 32.1N, 65.9W at 00Z (COADS).
- 40 kt WNW and 977 mb at 35.8N, 62.5W (longitude likely 5 degrees off to the east) at 06Z (COADS).
- 65 kt SW and 992 mb at 34.3N, 64.8W at 12Z (COADS).
- 50 kt W and 1001 mb at 34.1N, 64.9W at 18Z (COADS).
- 55 kt S and 997 mb at 37.3N, 57.3W at 21Z (MWL).

3. Aircraft highlights:

- Penetration center fix measured a central pressure of 961 mb, estimated surface winds of 60 kt and an eye diameter of 100 nm at 36.8N, 64.2W at 13Z (WALLET).

- Penetration center fix measured a central pressure of 958 mb, estimated surface winds of 70 kt and an eye diameter of 100 nm at 37.9N, 62.3W at 19Z (WALLET).

4. Discussion:

- MWR: "A gradual rise in central pressure followed, accompanied by a slow decrease in maximum winds and a spread of the gale area as Ella moved northeastward more rapidly on the 21st and 22nd of October. An interesting feature of Ella was an unusually large eye. The diameter was reported as 25 mi. on the 16th, 40 to 60 mi on the 19th, and 100 mi on the 21st."
- ATSR: "This course was maintained until the hurricane merged with a frontal system south of Newfoundland and became extratropical on the 21st."
- Reanalysis: On October 21st, Ella continued moving to the northeast while gradually acquiring extratropical characteristics. A central pressure of 972 mb appears in HURDAT at 12Z on the 21st, likely a dropsonde measurement. The list of aircraft reconnaissance fixes available in the Storm Wallets of Ella indicates that the central pressure adjusted to the surface from 700 mb is 961 mb. This appears more reasonable and has been used to replace the existing 972 mb at 12Z on the 21st. Similarly, at 18Z on the 21st, HURDAT has a central pressure of 950 mb and the list of aircraft reconnaissance fixes indicates that the central pressure adjusted from 700 mb is 958 mb. This also appears more reasonable and has been used to replace the existing 950 mb at 18Z on the 21st.

October 22:

1. Maps and old HURDAT:

- HWM analyzes a closed low pressure of at most 975 mb at 44.5N, 51.5W with a warm front to the east at 12Z.
- HURDAT lists a 60 kt extratropical storm at 46.7N, 53.4W at 12Z.
- Microfilm shows an extratropical cyclone of at most 984 mb at 47.3N, 54.7W at 12Z.

2. Ship highlights:

- 75 kt SE and 994 mb at 37.2N, 57.5W at 00Z (COADS/MWL).
- 65 kt SE and 999 mb at 39.1N, 52.9W at 06Z (COADS).
- 55 kt S and 1002 mb at 41.2N, 48.4W at 12Z (COADS).
- 50 kt SW and 994 mb at 44.2N, 46.8W at 18Z (micro).

3. Discussion:

- MWR: "However, by the evening of the 21st, her broad circulation pattern had begun to merge with that of a developing frontal wave moving through Nova Scotia with a resultant gradual loss of tropical characteristics."
- ATSR: "However advisories were continued with the final warning being issued at 221600Z."
- Reanalysis: Synoptic observations at 12Z on the 22nd indicate that a temperature-gradient had developed across the tropical cyclone, along with frontal features. Transition to an extratropical cyclone is analyzed at 12Z on October 22nd, six hors after that shown originally in HURDAT. Ella is analyzed to have absorbed a frontal low to its north at about the same time that it became extratropical. Weakening below hurricane intensity is analyzed at 12Z on the 22nd, six hours later than originally shown in HURDAT. Numerous ships reported gale-force winds on the 22nd and hurricane-force winds were registered at 00Z and 06Z on this date.

October 23:

1. Maps and old HURDAT:

- HWM analyzes an extratropical cyclone of at most 970 mb at 56.0N, 38.0W at 12Z.

- HURDAT lists a 60 kt extratropical storm at 56.2N, 37.0W at 12Z (last position).
- Microfilm shows an extratropical cyclone of at most 1002 mb at 54.7N, 42.7W at 12Z.

2. Ship highlights:

- 50 kt W and 1007 mb at 43.5N, 49.0W at 00Z (COADS).
- 50 kt SW and 994 mb at 50.7N, 37.6W at 06Z (COADS).
- 50 kt SSW and 987 mb at 53.0N, 36.2W at 12Z (COADS).
- 50 kt SW and 993 mb at 52.8N, 35.5W at 15Z (COADS).
- 30 kt SW and 973 mb at 56.1N, 34.1W at 18Z (micro).

October 24:

1. Maps and old HURDAT:

- HWM analyzes an extratropical cyclone of at most 985 mb at 61.0N, 19.0W at 12Z.
- HURDAT does not list an organized storm on this date.
- Microfilm shows a closed low pressure of at most 999 mb at 58.5N, 20.0W at 12Z.

2. Ship highlights:

- 45 kt NE and 998 mb at 62.1N, 32.7W at 00Z (COADS).
- 50 kt N and 997 mb at 58.6N, 35.0W at 06Z (COADS).
- 45 kt SW and 990 mb at 55.0N, 21.8W at 12Z (COADS).
- 45 kt NE and 993 mb at 62.2N, 18.3W at 18Z (COADS).

October 25:

1. Maps and old HURDAT:

- HWM analyzes an extratropical cyclone of at most 985 mb at 72.0N, 11.0E at 12Z.
- HURDAT does not list an organized storm on this date.
- Microfilm is not available on this date (cyclone outside the map).

2. Ship highlights:

- 35 kt N and 997 mb at 58.9N, 19.1W at 00Z (COADS).
- 50 kt NE and 999 mb at 61.3N, 10.7W at 06Z (COADS).
- 45 kt N and 1001 mb at 58.8N, 9.2W at 12Z (COADS).

3. Discussion:

- MWR: "Property damage associated with Ella was minor, consisting mostly of beach erosion along the middle Atlantic coast."
- Reanalysis: Over the next couple of days, the extratropical cyclone moved northeastward across the North Atlantic passing south of Greenland on October 23rd and between Iceland and the United Kingdom on October 24th and 25th. The system gradually weakened and began to interact with a larger extratropical cyclone on the 24th. Synoptic data early on the 25th indicate that Ella was absorbed after 06Z. Thus, the last position is analyzed at 06Z on the 25th, 42 hours later than originally shown in HURDAT.

Date	Original HURDAT Central Pressure	Evidence	Changes
Oct 15 00Z	1002 mb	No observations available, may have been an analysis	Removed
Oct 15 18Z	1002 mb	Penetration center fix: 1002 mb at 1850Z on Oct 15th	Retained
Oct 16 00Z	1002 mb	Penetration center fix: 1002 mb at 1745Z-2315Z on Oct 01th	Retained
Oct 16 12Z		Ship with 1002 mb and 5 kt NW at 12Z	1002 mb
Oct 16 18Z	1002 mb	Penetration center fix: 1002 mb at 16Z on Oct 15th	Retained

Oct 17 00Z	994 mb	Penetration center fix: 994 mb at 2242Z on Oct 15th	Retained
Oct 17 06Z	997 mb	Penetration center fix: 997 mb at 04Z on Oct 17th	Retained
Oct 17 12Z	992 mb	Penetration center fix: 992 mb at 1215Z on Oct 17th	Retained
Oct 17 18Z	987 mb	Penetration center fix: 989 mb at 1735Z on Oct 17th	989 mb
Oct 18 06Z	981 mb	Penetration center fix: 981 mb at 0726Z on Oct 18th	Retained
Oct 18 12Z	978 mb	Penetration center fix: 978 mb at 1247Z on Oct 18th	
Oct 18 18Z	976 mb	Penetration center fix: 973 mb at 1910Z on Oct 18th	973 mb
Oct 19 00Z		Penetration center fix: 974 mb at 01Z on Oct 19th	974 mb
Oct 19 06Z	973 mb	Penetration center fix: 973 mb at 07Z on Oct 19th	Retained
Oct 19 12Z	969 mb	Penetration center fix: 969 mb at 1205Z on Oct 19th	
Oct 19 18Z	962 mb	Penetration center fix: 962 mb at 19Z on Oct 19th	
Oct 20 00Z		Penetration center fix: 960 mb at 0204Z on Oct 20th	960 mb
Oct 20 06Z	960 mb	Penetration center fix: 963 mb at 0705Z on Oct 20th	963 mb
Oct 20 12Z	960 mb	Penetration center fix: 960 mb at 13Z on Oct 20th	Retained
Oct 20 18Z	964 mb	Penetration center fix: 964 mb at 19Z on Oct 20th	
Oct 21 12Z	972 mb	Penetration center fix: 961 mb at 13Z on Oct 21th	961 mb
Oct 21 18Z	950 mb	Penetration center fix: 958 mb at 19Z on Oct 21th	958 mb

Sources: NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Monthly Weather Review, Navy reconnaissance book, Mariners Weather Log, Local Climatological Data, National Hurricane Research Project and NHC Storm Wallets.

Unnamed Tropical Storm [June 29 – July 6, 1962] – AL061962

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42125 06/29/1962 M= 8  1 SNBR= 913 NOT NAMED   XING=0 SSS=0
42130 06/29E322 777  40    0E324 770  40    0E327 762  40    0E332 756  45    0*
42135 06/30E338 754  50    0E344 757  50 1000E350 761  55 1000*354 760  55  998*
42140 07/01*350 757  55  999*348 751  50 1000*350 741  50    0*352 730  45    0*
42145 07/02*354 710  45    0*356 685  40    0*359 660  40    0E362 630  40    0*
42150 07/03E368 610  45    0E380 585  45    0E400 545  45    0E437 523  45    0*
42155 07/04E475 550  40    0E485 590  35    0E477 625  35    0E470 640  35    0*
42160 07/05E450 650  30    0E432 650  25    0E425 644  25    0E430 637  25    0*
42165 07/06E435 630  25    0E442 625  25    0*  0   0   0    0E  0   0   0    0*
42170 TS

U.S. Tropical Storm Landfall
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06/30 21Z 35.2N 75.8W 55 kt NC
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Highlights:

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

Daily Metadata:

June 28:

1. Maps and old HURDAT:

- HWM and microfilm analyze a stationary front over the western Atlantic at 12Z.

June 29:

1. Maps and old HURDAT:

- HWM analyzes an extratropical cyclone of at most 1015 mb at 32.0N, 77.0W at 12Z.

- Microfilm shows an extratropical cyclone of at most 1014 mb at 33.3N, 75.0W at 12Z.

2. Ship highlights:

- 38 kt NE and 1023 mb at 33.5N, 77.6W at 00Z (Frying Pan Shoals, SWO, micro).
- 35 kt E and 1015 mb at 35.0N, 75.1W at 12Z (COADS).
- 38 kt ENE and 1021 mb at 33.6N, 77.6W at 18Z (Frying Pan Shoals, SWO, micro).
- 35 kt E and 1016 mb at 35.4N, 74.1W at 23Z (COADS).

3. Discussion:

- CLIMO: "On June 29 an offshore storm caused torrential rains over the central section of the coast, with very heavy rains extending inland fifty to sixty miles. Cedar Island reported 17 inches in about 18 hours, the second greatest one-day rain in North Carolina weather history. Several stations in that section of the State had their greatest 24-hour rainfall of record and their greatest June total of record. Agricultural losses from the storm rainfall were very high."
- Reanalysis: A weakening frontal boundary over the western Atlantic led to the formation of an extratropical cyclone early on June 29th off the southeast of the United States. The first position is analyzed at 00Z on June 29th as a 40 kt extratropical cyclone based on synoptic data.

June 30:

1. Maps and old HURDAT:

- HWM analyzes an extratropical cyclone of at most 1005 mb at 35.0N, 75.0W at 12Z.
- Microfilm shows an extratropical cyclone of at most 1002 mb at 35.5N, 76.2W at 12Z.

2. Ship highlights:

- 50 kt NW and 1003 mb at 33.7N, 76.7W at 00Z (COADS).
- 10 kt NW and 1001 mb at 34.3N, 75.9W at 06Z (COADS).
- 55 kt W and 1008 mb at 34.0N, 76.5W at 12Z (COADS).
- 40 kt W and 1009 mb at 33.9N, 74.9W at 18Z (COADS).
- 35 kt SSW and 1006 mb at 35.8N, 74.0W at 23Z (MWL).

3. Land highlights:

- 21 kt NNW and 1003 mb at Cherry Point, NC at 1058Z (SWO).
- 20 kt SE and 1002 mb at Cape Hatteras, NC at 12Z (micro).
- 20 kt W and 1000 mb at Cape Hatteras, NC at 1558Z (SWO).

4. Discussion/Reanalysis: The extratropical cyclone moved northeastward, turning to the north and northwest on June 30th. The system gradually intensified and a couple of ships reported winds of 40 kt on the 29th, 50 kt at 00Z on the 30th and 55 kt at 06Z on the 30th. A ship reported 10 kt NW and 1001 mb at 06Z on the 30th, suggesting a central pressure of 1000 mb, which has been added to the corresponding time slot. Cape Hatteras, NC, reported 20 kt SE and 1002 mb at 12Z on the 30th, suggesting a central pressure of 1000 mb, which was also added to the appropriate time slot. Transition to a tropical storm was gradual and based on the synoptic data, is analyzed to have occurred at 18Z on the 30th. At this time, there was no temperature gradient across the circulation and the strongest winds were about 60 nm from the center. Given that an upper-level low was directly over the system, it may have been a subtropical storm. However, without the availability of satellite images, it is analyzed as a tropical storm. 55 kt is analyzed as the peak intensity. Cape Hatteras, NC, measured 20 kt W and 1000 mb at 1558Z on the 30th suggesting a central pressure of 998 mb, which has been added at 18Z on this day. (A central pressure of 998 mb suggests maximum surface winds of 47 kt from the north of 25N Brown et al. and 52 kt from the north

of 35N Landsea et al. pressure-wind relationships. The analyzed intensity at 18Z on the 30th is 55 kt based on the pressure-wind relationship and synoptic data. The tropical storm moved to the southeast late on the 30th making landfall in the Outer Banks of North Carolina.

July 1:

1. Maps and old HURDAT:
   - HWM analyzes an extratropical cyclone of at most 1010 mb at 36.0N, 71.0W at 12Z.
   - Microfilm shows a closed low pressure of at most 1002 mb at 36.0N, 73.5W at 12Z.
2. Ship highlights:
   - 6 kt SW and 1000 mb (min P, 6 hourly) at 35.2N, 75.5W (Diamond Shoals) at 00Z (SWO).
   - 50 kt SW and 1006 mb at 34.5N, 74.3W at 00Z (COADS).
   - 35 kt W and 1010 mb at 33.0N, 75.5W at 06Z (COADS).
   - 4 kt NE and 1001 mb at 35.2N 75.5W (Diamond Shoals) at 06Z (SWO).
   - 35 kt NE and 1013 mb at 40.5N, 68.9W at 12Z (micro).
   - 35 kt WSW at 34.7N, 73.0W at 18Z (COADS).
3. Discussion/Reanalysis: An approaching frontal boundary caused the tropical cyclone to move northeastward increasing in forward speed on July 1st. Gales were also reported on the 1st, up to 50 kt. Observations at Diamond Shoals allowed for an analysis of a 999 mb central pressure at 00Z and 1000 mb at 06Z.

July 2:

1. Maps and old HURDAT:
   - HWM analyzes an extratropical cyclone of at most 1010 mb at 39.0N, 67.0W at 12Z.
   - Microfilm shows a closed low pressure of at most 1005 mb at 36.7N, 64.3W with a frontal boundary just to the northwest at 12Z.
2. Ship highlights:
   - 35 kt SW and 1008 mb at 34.0N, 66.3W at 12Z (COADS).
   - 35 kt SW and 1009 mb at 34.6N, 62.8W at 18Z (COADS).
3. Discussion/Reanalysis: The tropical storm weakened on July 1st and 2nd as it moved away from the United States. Late on the 2nd, the tropical cyclone interacted with the approaching frontal boundary and transition back to an extratropical cyclone is analyzed at 18Z on the 2nd.

July 3:

1. Maps and old HURDAT:
   - HWM analyzes an extratropical cyclone of at most 995 mb at 41.0N, 54.0W at 12Z.
   - Microfilm shows an extratropical cyclone of at most 999 mb at 40.0N, 54.0W at 12Z.
2. Ship highlights:
   - 45 kt NNE and 999 mb at 36.6N, 66.5W at 00Z (COADS).
   - 55 kt (or 25 kt) SE and 1002 mb at 37.5N, 58.5W at 06Z (micro).
   - 45 kt SSE and 996 mb at 40.1N, 53.5W at 12Z (COADS/micro).
   - 35 kt NW and 1003 mb at 42.0N, 53.0W at 18Z (COADS).
3. Discussion/Reanalysis: A ship at 06Z on July 3rd appears in microfilm suggesting 55 kt SE and 1002 mb. It is possible that the reading was 25 kt since the triangle is unfilled and 55 kt appears substantially too high compared to the surrounding ships. The reported pressure also appears inconsistent with the surrounding synoptic data. Because of all the inconsistencies, it is not used in this reanalysis.

July 4:

1. Maps and old HURDAT:
   - HWM analyzes an occluded extratropical cyclone of at most 1000 mb at 48.0N, 63.0W at 12Z.
   - Microfilm shows a closed low pressure of at most 1005 mb at 47.0N, 63.5W at 12Z.
2. Ship highlights:
   - 40 kt SW and 1005 mb at 46.0N, 51.5W at 00Z (COADS).
   - 40 kt E and 1009 mb at 50.4N, 52.0W at 03Z (COADS).
3. Land highlights:
   - 35 kt NE and 1013 mb at Anticosti Island, Canada at 18Z (micro).
4. Discussion/Reanalysis: The extratropical cyclone moved across Newfoundland on July 4th and across New Brunswick and Nova Scotia on July 5th while performing a large counter-clockwise loop.

July 5:

1. Maps and old HURDAT:
   - HWM does not analyze an organized system at 12Z.
   - Microfilm shows a closed low pressure of at most 1008 mb at 47.0N, 64.5W at 12Z.
2. Discussion/Reanalysis: Weakening below gale-force is analyzed at 00Z on the 5th.

July 6:

1. Maps and old HURDAT:
   - HWM analyzes an extratropical cyclone of at most 1005 mb at 40.5N, 61.5W (original cyclone appears to have been absorbed) at 12Z.
   - Microfilm shows a closed low pressure of at most 1008 mb at 43.0N, 62.0W at 12Z.
2. Land highlights:
   - 40 kt ESE and 1015 mb at Fatima, Canada at 06Z (micro).
3. Discussion/Reanalysis: A rapidly developing extratropical cyclone approached the weakening system early on July 6th and synoptic data suggests that both merged after 06Z on this day. The last position is analyzed at 06Z on the 6th.

Sources: the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Mariners Weather Log, Surface Weather Observations, and Local Climatological Data. This disturbance was in Jack Beven's List of Suspects.

Unnamed Hurricane [November 26 – December 6, 1962] – AL071962

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42125 11/26/1962 M=11  8 SNBR= 913 NOT NAMED   XING=0 SSS=0                    L
42130 11/26*  0   0   0    0*  0   0   0    0E330 730  70    0E330 745  70    0*
42135 11/27E327 757  70    0E320 764  70    0E313 766  65    0E302 762  65    0*
42140 11/28*291 756  65  992*288 745  65    0*288 732  60    0*295 722  60  997*
42145 11/29*303 716  55    0*308 714  55    0*310 717  50    0*310 722  50    0*
42150 11/30*308 728  50    0*305 736  55    0*305 742  55    0*310 744  60    0*
42155 12/01*317 744  65    0*324 740  70    0*330 737  75    0*337 743  80    0*
42160 12/02*343 749  80    0*341 753  75  992*337 755  70    0*331 758  65  991*
42165 12/03*326 760  60    0*321 755  55    0*320 749  50    0*325 744  50    0*
42170 12/04*330 742  50    0*333 740  50    0*338 737  50    0*346 730  55  992*
42175 12/05E356 720  60    0E364 710  65    0E370 699  70    0E376 687  70    0*
42175 12/06E380 670  60    0E385 652  50    0*  0   0   0    0*  0   0   0    0*
42180 TS
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U.S. Tropical Storm Impact

12/01 18Z 33.7N 74.3W 40 kt North Carolina

Highlights:

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

Note:
Within the Daily Summaries, a "#" indicates a synoptic observation outside of the outer closed isobar.

Daily Summaries:
November 25:

1. Maps:
   - HWM analyzes a stationary front over the western Atlantic at 12Z.
   - Microfilm shows a frontal boundary over the western Atlantic at 12Z.
2. Discussion/Reanalysis: A frontal boundary is observed in the Historical Weather Maps over the southeast of the United States and extended into the western Atlantic on November 25th.

November 26:

1. Maps:
   - HWM analyzes an extratropical cyclone of at most 1005 mb at 33.5N, 73.0W at 12Z.
   - Microfilm shows a closed low pressure of at most 1008 mb at 33.0N, 72.5W at 12Z.
2. Ship highlights:
   - 40 kt NE and 1023 mb at 37.2N, 74.0W at 06Z (COADS).
   - 70 kt NE and 1009 mb at 35.0N, 74.0W at 12Z (COADS).
   - 70 kt NE and 1006 mb at 34.8N, 74.2W at 15Z (COADS).
   - 70 kt NE and 1003 mb at 34.6N, 74.4W at 18Z (COADS).
   - 60 kt ENE and 1005 mb at 34.5N, 74.6W at 21Z (COADS).
3. Land highlights:
   - 40 kt NNE (peak winds) at WB Cape Hatteras, NC (time unknown) (CLIMO).
   - 35 kt NNE and 1021 mb at Flying Pan, NC at 11Z (SWO).
   - 50 kt NNE and 1017 mb at Flying Pan, NC at 17Z (SWO).
   - 43 kt H (peak winds) at Cape Henry WB, VA at 2151Z (MWL).
   - Gusts to 77 kt NNE at Oak Island, NC at 22Z (MWL).
   - 64 kt NNE (peak winds) and 1011 mb at Flying Pan, NC at 23Z (SWO).
   - 51 kt N (peak winds) (gusts to 57 kt N) at Wilmington, NC at 2311Z (MWL).
4. Discussion:
   - WASHINGTON WEATHER BUREAU BULLETIN: "The pressure center of this storm is located about 200 miles east-southeast of Cape Hatteras, North Carolina with very little movement expected during the next 12 to 24 hours. Highest winds along the coast have been 56 mph in gusts at Cape Hatteras but winds over 60 mph have been reported by vessels."
   - Reanalysis: Synoptic observations late on the 25th and early on November 26th indicate that an extratropical cyclone rapidly organized and is analyzed to have developed around 12Z on the 26th. A strong ridge over the northeast of the United States and the intensifying cyclone combined to produce a strong pressure gradient and gale-force winds quickly developed. At 12Z on the 26th, two ships reported hurricane-force winds about 200 nm

north of the center and the intensity at the first position is analyzed at 70 kt. Gale-force winds affected the coastal areas of Virginia and North Carolina late on the 26th with recorded gusts up to 77 kt.

November 27:

1. Maps:

- HWM analyzes an occluded extratropical cyclone of at most 1000 mb at 29.5N, 75.5W at 12Z.
- Microfilm shows a closed low pressure of at most 1005 mb at 31.5N, 76.5W at 12Z.

2. Ship highlights:

- 70 kt ENE and 1000 mb at 33.9N, 75.9W at 00Z (COADS).
- 60 kt NE and 1020 mb at 37.2N, 74.5W at 06Z (COADS).
- 50 kt NNE and 1011 mb at 32.3N, 78.2W at 12Z (COADS).
- 65# kt NE and 1014 mb at 35.1N, 74.8W at 18Z (COADS).
- 50 kt SW and 1002 mb at 27.8N, 74.7W at 18Z (COADS).

3. Land highlights:

- 38 kt NNE (peak winds) at WB Cape Hatteras, NC (time unknown) (CLIMO).
- 61 kt NNE and 1011 mb at Flying Pan, NC at 05Z (SWO).
- 55 kt NNE and 1013 mb at Flying Pan, NC at 11Z (SWO).
- 36 kt NNE and 1016 mb at Flying Pan, NC at 17Z (SWO).
- 36 kt NNE and 1016 mb at Flying Pan, NC at 23Z (SWO).

4. Disussion:

- MIAMI WEATHER BUREAU BULLETIN: “The severe winter type storm has drifted a few miles southward and is now centered about 300 miles east of Jacksonville, Florida. It is expected to remain essentially stationary for the next 24 hours. No reports have been received from the immediate vicinity of the storm center but winds of as much as 60 to 70 mph are being reported by ships some 300 miles north of the center.”
- Reanalysis: The intense extratropical cyclone initially moved westward but turned to the south and southeast on November 27th. On the 27th, the pressure gradient remained strong and gale-force winds were being reported over 300 nm northeast of the center.

November 28:

1. Maps:

- HWM analyzes an occluded extratropical cyclone of at most 1005 mb at 29.0N, 74.0W at 12Z.
- Microfilm shows a closed low pressure of at most 999 mb at 28.8N, 73.0W at 12Z.

2. Ship highlights:

- 60# kt ENE and 1010 mb at 34.9N, 73.9W at 00Z (COADS).
- 35 kt SE and 994 mb at 29.2N, 75.4W at 00Z (COADS).
- 10 kt SW and 994 mb at 28.8N, 75.1W at 00Z (COADS).
- 40 kt E and 1008 mb at 30.8N, 74.5W at 00Z (COADS).
- 60 kt E and 1005 mb at 29.9N, 74.0W at 06Z (COADS).
- 50 kt ENE and 1013 mb at 31.4N, 68.5W at 12Z (COADS).
- 60# kt E and 1019 mb at 36.0N, 71.5W at 18Z (COADS).
- 45 kt NE and 1013 mb at 33.1N, 71.8W at 18Z (COADS).
- 20 kt W and 999 mb at 29.8N, 72.3W at 18Z (COADS).

3. Land highlights:

- 35 kt NE and 1017 mb at Flying Pan, NC at 05Z (SWO).
- 36 kt NE and 1017 mb at Flying Pan, NC at 11Z (SWO).
- 35 kt SE and 1015 mb at Bermuda at 18Z (micro).

4. Discussion:

- MIAMI WEATHER BUREAU BULLETIN: "At 5 pm EST the large intense Atlantic storm was located some 600 miles east of Daytona Beach moving eastward 15 mph. Continued eastward movement of 15 mph is forecast for the next 24 hours. Gales from 35 to 55 knots extend outward some 300 miles from the center except to near 600 miles in the northeast quadrant. No worsening of the flooding and erosion problem along the southeast coast is expected, however, it will be late Thursday before any important decrease in the seas take place. Seas of near 30 feet have been reported some 100 miles east of St. Augustine, Florida while winds of 59 knots were recorded at Bermuda."
- Reanalysis: Late on the 27th, synoptic data indicates that the system became more symmetric with a decrease in the temperature gradient. Ship reports and satellite imagery that a tropical cyclone-type inner core existed on 28 November. However, it is also apparent that abundant cold air is moving across the Florida Peninsula and the Bahamas, suggesting that baroclinicity was still playing a role. Despite this, dewpoints in the inner core reached the 60s F, suggesting that sufficient modification of the air mass occurred to promote deep convective processes. Transition to a tropical cyclone is analyzed at 00Z on November 28th with an intensity of 65 kt based upon a ship report near the center at 06Z on the 28th of 60 kt E and 1005 mb. Synoptic data on the 28th shows that even though storm-force winds were being measured near the center of the hurricane, the strong pressure gradient continued to also produce storm-force winds over 500 nm northeast of center. The gradient winds outside of the outermost closed isobar are not considered part of the circulation of the hurricane. The tropical cyclone is analyzed to have weakened to a tropical storm at 12Z on the 28th based on ship data. TIROS VI captured an image of the tropical storm at 1951Z on the 28th showing a sheared cyclone with most of the convection over the north and eastern quadrants. The system also is co-located with an upper-level low, suggesting a subtropical cyclone structure. However, without detailed and more frequent satellite imagery, subtropical status is not a valid option to indicate. Thus the system is formally considered a tropical cyclone.

November 29:

1. Maps:

- HWM analyzes an occluded extratropical cyclone of at most 1000 mb at 30.0N, 73.0W at 12Z.
- Microfilm shows a closed low pressure of at most 1008 mb at 31.0N, 72.0W at 12Z.

2. Ship highlights:

- 50# kt E and 1020 mb at 36.7N, 71.3W at 00Z (COADS).
- 45 kt ENE and 1008 mb at 32.2N, 71.4W at 00Z (COADS).
- 50 kt E and 1017 mb at 34.5N, 75.1W at 06Z (COADS).
- 50# kt ENE and 1022 mb at 37.2N, 68.6W at 12Z (COADS).
- 40 kt SW and 1003 mb at 30.0N, 71.3W at 12Z (COADS).
- 50 kt ENE and 1015 mb at 33.2N, 76.5W at 18Z (COADS).

3. Land highlights:

- 35 kt NE and 1017 mb at Flying Pan, NC at 17Z (SWO).
- 38 kt NE and 1016 mb at Flying Pan, NC at 23Z (SWO).

4. Discussion:

- MIAMI WEATHER BUREAU BULLETIN: "The large and intense Atlantic storm remains stationary some 600 miles east of Jacksonville, Florida. Gales with very rough seas are occurring over most of the area from off the middle Atlantic coast to the north and east to the north and east of Bermuda and southward in the area east of the northern Bahamas."

- Reanalysis: After moving eastward early on the 28th, the tropical storm moved northeast late on this date and early on November 29th. Synoptic observations on the 29th continued to show gale-force winds near the center of the tropical storm, up to 45 kt.

November 30:

1. Maps:

- HWM analyzes a closed low pressure of at most 1005 mb at 31.0N, 73.0W with a warm front to the north at 12Z.
- Microfilm shows a closed low pressure of at most 996 mb at 30.5N, 74.5W at 12Z.

2. Ship highlights:

- 55 kt NE and 1015 mb at 33.8N, 75.8W at 00Z (COADS).
- 55 kt NE and 1013 mb at 32.6N, 77.6W at 06Z (COADS).
- 55 kt NE and 1006 mb at 32.9N, 73.9W at 12Z (COADS).
- 55 kt NE and 1014 mb at 33.5N, 77.0W at 18Z (COADS).

3. Land highlights:

- 34 kt NE and 1016 mb at Frying Pan, NC at 05Z (SWO).
- 40 kt NE and 1015 mb at Flying Pan, NC at 11Z (SWO).
- 42 kt NE and 1016 mb at Flying Pan, NC at 17Z (SWO).
- 38 kt NE and 1014 mb at Flying Pan, NC at 23Z (SWO).

4. Discussion:

- MIAMI WEATHER BUREAU BULLETIN: "The intense Atlantic storm was located about 550 statute miles east of Jacksonville at noon and has moved southward between 5 and 10 mph during the past 12 hours. Gales with very rough seas cover an area approximately 400 miles wide from the middle Atlantic coast to Bermuda. Ships near the storm center have reported 45 to 60 mph winds and 25 foot seas. A ship about 100 miles southeast of Wilmington, North Carolina is currently reporting 65 mph."
- Reanalysis: Late on the 29th, the tropical cyclone moved to the southwest and turned to the west on November 30th. Late on the 30th, the erratic tropical storm turned to the north and began to intensify. Winds near the center reported by ships reached up to 55 kt on the 30th. Another TIROS VI image of the tropical storm was captured at 1933Z on the 30th showing a large area of convection, especially in the northeast quadrant, and an eye-like feature.

December 1:

1. Maps:

- HWM analyzes a closed low pressure of at most 1005 mb at 32.5N, 75.0W with a warm front to the north at 12Z.
- Microfilm shows a closed low pressure of at most 1002 mb at 33.0N, 74.0W at 12Z.

2. Ship highlights:

- 45 kt NNE and 1014 mb at 34.3N, 76.1W at 00Z (COADS).
- 45 kt N and 1002 mb at 32.7N, 75.4W at 06Z (COADS).
- 50 kt N and 1003 mb at 34.3N, 75.6W at 12Z (COADS).
- 75 kt NE and 1004 mb at 35.2N, 75.0W at 18Z (COADS/MWL).
- 55 kt NNE and 988 mb at 34.1N, 75.0W at 20Z (MWL).

3. Land highlights:

- 35 kt NE and 1013 mb at Frying Pan, NC at 05Z (SWO).
- 39 kt NNE (peak winds) at WB Cape Hatteras, NC (time unknown) (CLIMO).
- 33 kt NNE (gusts to 48 kt) and 1006 mb at Cape Hatteras, NC at 1949Z (SWO).

4. Discussion:

- MIAMI WEATHER BUREAU BULLETIN: "At 5 pm EST the severe Atlantic storm was moving northward abreast of the North Carolina coast some 100 miles offshore. Gale winds extend over an area 250 statute miles north and west of the center and 150 miles to the east and south. Ships have reported winds up to 50 to 60 mph in heavier squalls near the center and during the afternoon winds gusts up to 50 mph where recorded in the vicinity of Hatteras, North Carolina."
- Reanalysis: On December 1st, the strong ridge over the Northeast of the United States weakened and the region of gale-force winds shrank to about 150 nm away from the center. Synoptic observations late on the 1st show that the tropical cyclone had strengthened and it is analyzed to have regained hurricane intensity at 00Z on the 1st. Two ships reported hurricane intensity at 18Z on the 1st, 75 kt NE and 95 kt N. The ship report of 95 kt appears to have a high bias compared to the neighboring observations, thus a blend of the two observations have been used to come up with an intensity of 80 kt at 18Z on the 1st. 80 kt is also the peak intensity of this hurricane. Climatological Data indicates that 45 mph (fastest mile) was measured on the 1st in Cape Hatteras, NC, time unknown. This measurement likely occurred late on the 1st or early on the 2nd (Zulu time). Thus, North Carolina is added as a tropical storm impact. It is important to note that the surface observation also show very dry/cold air moving off of the coasts of North and South Carolina into the cyclone. However, the dewpoints in the inner core for these dates reached the 60s F, suggesting that sufficient modification of the air mass occurred to promote deep convective processes.

December 2:

1. Maps:

- HWM analyzes an extratropical cyclone of at most 1005 mb at 34.0N, 74.0W at 12Z.
- Microfilm shows a closed low pressure of at most 999 mb at 33.5N, 75.0W at 12Z.

2. Ship highlights:

- 55 kt N and 1002 mb at 35.0N, 75.3W at 00Z (COADS).
- 50 kt N and 1006 mb at 34.0N, 76.4W at 06Z (COADS).
- 25 kt S and 995 mb at 33.9N, 75.3W at 06Z (COADS).
- 60 kt E and 1004 mb at 34.6N, 74.5W at 12Z (COADS).
- 50 kt N and 1000 mb at 33.3N, 76.5W at 18Z (COADS).
- 30 kt NE and 994 mb at 33.6N, 76.0W at 18Z (COADS).

3. Land highlights:

- 38 kt NNE and 1011 mb at Frying Pan, NC at 17Z (SWO).
- 40 kt NNE and 1010 mb at Frying Pan, NC at 23Z (SWO).

4. Discussion:

- WASHINGTON WEATHER BUREAU BULLETIN: "At 5 pm today the center of the Atlantic storm was located about 125 miles south of Cape Hatteras. The movement of the storm continued to be erratic and since early this morning it has moved slowly toward the southwest. During the next 12 hours it is expected to drift slowly southward with a tendency to move toward the east thereafter."
- Reanalysis: The hurricane turned to the southwest on December 2nd and gradually weakened. Storm-force winds up to 60 kt were reported by ships near the center. TIROS VI captured an image of the hurricane at 1919Z on the 2nd showing a large area of convection all around the center and no signs of strong wind shear.

December 3:

1. Maps:

- HWM analyzes a closed low pressure of at most 1005 mb at 33.0N, 75.0W with a stationary front to the north at 12Z.
- Microfilm shows a closed low pressure of at most 1008 mb at 32.0N, 75.0W at 12Z.

2. Ship highlights:

- 45 kt NNE and 1009 mb at 33.1N, 77.1W at 00Z (COADS).
- 35 kt N and 1006 mb at 33.3N, 76.9W at 06Z (COADS).
- 45 kt N and 1010 mb at 33.1N, 77.1W at 12Z (COADS).
- 35 kt E and 1010 mb at 34.3N, 75.0W at 18Z (micro).

3. Land highlights:

- 36 kt NNE and 1011 mb at Frying Pan, NC at 05Z (SWO).

4. Discussion:

- MIAMI WEATHER BUREAU BULLETIN: "The storm is forecast to remain nearly stationary during the day with little change in size or intensity. Gale winds up to 65 mph in the heavier squalls are occurring near the center while winds from 25 to 45 mph extend outward some 300 miles from the center. The storm is seven days old and during this time has moved in every possible direction with the center remaining within an area which could roughly be called a circle with radius of less than 250 miles. The circulation of the storm has been cutoff from the general circulation of the atmosphere from its position. While cutoff lows are not new certainly one as strong as this is indeed unusual for this area and since it has remained so long in such a relatively small area."
- Reanalysis: On December 3rd, the tropical cyclone turned to the east and later to the northeast. Synoptic observations indicate that the hurricane weakened to a tropical storm at 00Z on the 3rd. At 1817Z on the 3rd, TIROS VI captured another image of the tropical cyclone showing a sheared system with most of the convection over the northern and eastern quadrants.

December 4:

1. Maps:

- HWM analyzes a closed low pressure of at most 995 mb at 34.5N, 73.0W with a stationary front to the north at 12Z.
- Microfilm shows a closed low pressure of at most 993 mb at 34.0N, 73.5W at 12Z.

2. Ship highlights:

- 35 kt WSW and 1002 mb at 32.6N, 74.2W at 00Z (COADS).
- 35 kt NE and 997 mb at 33.4N, 74.5W at 06Z (COADS).
- 45 kt NE and 994 mb at 34.7N, 73.6W at 12Z (COADS).
- 50 kt NW and 998 mb at 34.8N, 74.8W at 18Z (COADS).
- 25 kt E and 995 mb at 35.7N, 72.2W at 18Z (COADS).

3. Discussion:

- WASHINGTON WEATHER BUREAU BULLETIN: "The Atlantic storm continues to move slowly toward the north-northeast and at 5 pm was centered about 150 miles east of Cape Hatteras. Highest winds are estimated 55 mph near the center and winds of 30 mph or higher extend out 200 miles from the center with rough seas and squalls. Seas as high as 30 feet have been reported near the center today."
- Reanalysis: An approaching frontal boundary on December 4th caused the tropical storm to increase in forward speed to the northeast as it began to lose its tropical characteristics late in the day. Ship data at 18Z on the 4th showed an increase in the temperature gradient between the eastern and western quadrants as the system moved away from the Gulf Stream and into cooler waters of the northwest Atlantic.

December 5:

1. Maps:

- HWM analyzes a closed low pressure of at most 995 mb at 36.2N, 71.2W with a stationary front to the northeast at 12Z.
- Microfilm shows a closed low pressure of at most 990 mb at 34.0N, 73.5W at 12Z.

2. Ship highlights:

- 45 kt NE and 992 mb at 36.9N, 72.5W at 00Z (COADS).
- 70 kt SW and 987 mb at 34.9N, 71.1W at 00Z (COADS).
- 45 kt N and 1010 mb at 33.1N, 77.1W at 12Z (COADS).
- 80 kt SW and 990 mb at 34.9N, 71.2W at 12Z (COADS).
- 70 kt WNW and 1000 mb at 34.7N, 71.9W at 18Z (COADS).
- 50 kt WSW and 978 mb at 36.5N, 68.7W at 18Z (COADS).

3. Discussion:

- WASHINGTON WEATHER BUREAU BULLETIN: "At 5 pm EST the Atlantic storm was centered about 240 miles south-southeast of Cape Cod moving north-northeast about 15 mph. This storm is forecast to continue moving north-northeast at about 15 mph tonight and pass close to the east of Cape Cod after midnight. Strongest winds are 45 to 65 mph near the storm center and winds 25 to 45 mph extend about 300 miles to the north and 200 miles in other quadrants. The storm is expected to maintain about the same intensity and spread out over a larger area during the next 24 hours."
- Reanalysis: Transition to an extratropical cyclone is analyzed at 00Z on December 5th based upon synoptic observations showing a strong temperature gradient. A ship at 06Z on the 5th showed 70 kt SW, 80 kt SW at 12Z, and 70 kt WNW at 18Z, but based upon nearby ship observations it is analyzed that this ship has a high wind bias. Thus, the extratropical cyclone is analyzed to have regained hurricane intensity at 06Z on the 5th, reaching a tertiary peak in intensity at 12Z on this day of 70 kt. TIROS V captured an image of the extratropical cyclone at 1832Z on the 5th showing a large system over the northwest Atlantic.

December 6:

1. Maps:

- HWM analyzes an extratropical cyclone over the Mid-Atlantic (system appears to be dissipated) at 12Z.
- Microfilm shows a closed low pressure of at most 993 mb at 39.0N, 65.0W with a frontal boundary to the east at 12Z.

2. Ship highlights:

- 40 kt SW and 1005 mb at 33.8N, 64.2W at 00Z (COADS).
- 35 kt SSE and 979 mb at 38.8N, 64.7W at 06Z (micro).
- 40 kt E and 1000 mb at 40.6N, 68.8W at 12Z (COADS).
- 45 kt E and 1014 mb at 44.5N, 62.5W at 18Z (COADS).

3. Discussion/Reanalysis: The extratropical cyclone weakened on December 6th. Synoptic observations indicate that it became elongated and weakened into a trough before being absorbed by a larger extratropical cyclone over the Northeast of the United States. The last position is analyzed at 06Z on the 6th. There is no proper analog to compare to this system, but the Yankee Hurricane of 1935 had a similar development and unusual southward track that enabled it to attain tropical cyclone status.

December 7:

1. Maps:

- HWM and microfilm analyze an extratropical cyclone over the Great Lakes (system appears to be dissipated) at 12Z.

2. Discussion:

- CLIMO: "An unusually persistent low pressure storm whose center remained off the North Carolina coast from the night of November 25th until December 5th caused very heavy beach erosion and widespread minor wind damage. Sections of protective sand dunes several hundred feet in length were washed flat and beaches were cut back as much as 50 feet in width in some areas. Several buildings were destroyed and many damaged when undermined by the pounding seas; sand thus carried away was deposited in other areas, burying streets and highways in several feet of sand. Small boats tied up in port were badly battered by the long siege of onshore winds and waves, and one ship sank."
- MWL (Volume 7, Number 2, March 1963, Page 50): "A well-developed low pressure system of extratropical origin lay off the coast of the southeastern states from November 26 to December 5, its center meandering between latitudes 28°N and 35°N and between longitudes 70°W and 75°W during the entire period. The intensity of the storm varied considerably from day to day, but at weakest it was an active closed low pressure circulation and at strongest it was the equal of a minor hurricane. The center of the storm remained offshore at all times, but the prolonged pounding of the coast with winds between north and east and high seas and tides caused severe erosion along the coast from Virginia southward to central Florida. Rainfall amounts were generally light except for locally heavy amounts along the immediate coast of North Carolina and Georgia. Whole gale winds off Hampton Roads blew the Chesapeake Lightship off station early in the storm, and a huge dredge used on the Chesapeake Bridge-Tunnel Project broke loose and was driven aground off Little Creek. Farther south along the Virginia coast much of the sand which had been replaced at great expense in resort areas since the March 1962 storm was washed away again. Very extensive erosion also occurred along the Outer Banks of North Carolina. The 700-ft. wide inlet cut through Hatteras Island north of Buxton by the March storm was widened by an additional estimated 1,000 ft., and the bridge which had been built across it was destroyed. A state-owned ferry sank in Pamlico Sound, a loaded tanker was severely damaged, and small boats along the coast were battered. Some minor shallow flooding occurred at high tides. At Carolina Beach south of Wilmington about a 1,000-ft. length of beach was cut back as much as 50 ft. in width, and sections of dunes 500 ft. or more in length were reported washed flat in a number of areas. Numerous beach cottages were undermined, and several of them fell into the ocean and were washed up as debris. Shoreline erosion of a less severe nature extended southward along the South Carolina and Georgia coast. A fishing trawler based at Charleston was lost during the storm but the crew was subsequently rescued. A schooner valued at $35,000 was also lost off the South Carolina coast. Sections along the Florida coast also experienced severe erosion mostly from Cape Canaveral northward with many seawalls, docks, and piers sustaining damage. No lives were reported lost and damage estimates are rather incomplete though probably not exceeding $10,000,000."
- MWL (Volume 7, Number 2, March 1963, Page 63): "An unusual storm developed southeast of Cape Hatteras on the 26th. A warm HIGH had rapidly been developing over New England and a dynamically sympathetic LOW formed about 200 mi. southeast of Cape Hatteras at about the same time. This LOW at first moved southwestward to about 250 mi. east of the central Florida coast on the 28th accompanied by whole gale winds. The storm then drifted northward describing a couple of minor loops to the southeast of Hatteras before moving northeastward out of the area on December 3. This storm, though considered an extratropical LOW cut off from the westerlies aloft, exhibited many characteristics of a tropical cyclone while meandering over the warm Gulf Stream south of Hatteras. Even when finally moving northward off the coast on December 4 and 5 it was imbedded in a mid-tropospheric ridge with

no associated fronts and with core temperatures being quite warm. Extensive beach erosion and minor flooding at high tides were experienced mainly from the central Florida coast northward to Hampton Roads. Highest winds along the coast were recorded at cooperative hurricane reporting stations along the North Carolina coast south of Cape Lookout on the 26th. Oak Island reported a gust from the north-northeast of 77 kt. and Sneads Ferry 70 kt. Precipitation generally was not excessive over land and confined to the immediate coast. Fog and haze, associated with the persistent high pressure cell centered over New England during the end of November and into the first week of December, was bothersome to shipping in the Great Lakes and in the ports along the upper Atlantic coast. The 6,471-ton freighter SARAH BOWATER and the 10,730-ton tanker CHEMICAL TRANSPORTER collided in fog in New York harbor on December 4. No injuries were reported, and damage to both vessels was about 12 ft."

Sources: Evidence for these alterations comes from the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Surface Weather Observations, Local and State Climatological Data, Atlas of Cloud Vortex Patterns, Weather Bureau Bulletins and Mariners Weather Log. This disturbance was in Jack Beven and David Roth's List of Suspects.

1962 Additional Notes

1) February 24 – March 3: Historical Weather Maps show an extratropical cyclone exiting the United States on February 24th. The disturbance moved eastward and became occluded on February 27th producing gales. After meandering over the north Atlantic for a couple of days, an approaching frontal boundary absorbed the non-tropical cyclone on March 4th. Therefore, because the system did not acquire tropical characteristics, it is not added to HURDAT. This disturbance was in Jack Beven's List of Suspects.

Day	Latitude	Longitude	Status
February 24	40N	75W	Extratropical
February 25	41N	51W	Extratropical
February 26	46N	44W	Extratropical
February 27	40N	47W	Occluded
February 28	38N	39W	Occluded
March 1	41N	42W	Occluded
March 2	43N	48W	Occluded
March 3	42N	41W	Occluded
March 4			Absorbed

2) April 28 – May 3: Historical Weather Maps and Microfilm indicate that a trough of low pressure developed north of Puerto Rico late on the April 28th or early on the 29th. The disturbance moved northward developing a closed low-level circulation on April 30th. The system turned to the northeast on May 1st becoming better defined at the surface. A gale of 35 kt was reported at 12Z and 18Z on the 1st in the southwest quadrant, about 200 nm from the center, but both likely have a high bias compared to the surrounding ship data. On May 2nd, the disturbance continued moving eastward and weakened due to an approaching frontal system, becoming absorbed the next day. Therefore, because there is not enough evidence to support upgrading this system to a tropical storm, it is not added to HURDAT. This disturbance was in Jack Beven and David Roth's List of Suspects.

Day	Latitude	Longitude	Status
April 28	15N-25N	68W	Trough
April 29	15N-25N	65W	Trough

April 30	25N	65W	Tropical Depression
May 1	29N	65W	Tropical Storm?
May 2	29N	61W	Tropical Storm?
May 3			Absorbed

3) May 11-22: Historical Weather Maps shows an extratropical cyclone exiting the United States on May 11th and moving to the southeast. On May 15th, the disturbance became an occluded cyclone while producing gale-force winds over 300 nm away from the center. The system moved little over the next couple of days while filling as a non-tropical cyclone. On May 19th, the disturbance began to move eastward and synoptic observations indicate that it dissipated around May 22nd. Therefore, because the system did not acquire tropical characteristics, it is not added to HURDAT. This disturbance was in Jack Beven and David Roth's List of Suspects.

Day	Latitude	Longitude	Status
May 11	37N	82W	Extratropical
May 12	34N	70W	Extratropical
May 13	33N	60W	Extratropical
May 14	36N	56W	Extratropical
May 15	36N	57W	Occluded
May 16	32N	62W	Occluded
May 17	32N	60W	Occluded
May 18	33N	63W	Occluded
May 19	34N	59W	Occluded
May 20	35N	53W	Occluded
May 21	34N	47W	Occluded
May 22	37N	44W	Dissipated

4) June 5-7: Historical Weather Maps indicate that a small, non-frontal low pressure system developed between the Bahamas and Bermuda on June 5th. The disturbance moved northeastward and dissipated on June 7th. No gale-force winds were associated with this disturbance based on the synoptic data in Microfilm, COADS and MWL. Therefore, because the system did not produce tropical storm force winds, it is not added to HURDAT. This disturbance was in Jack Beven's List of Suspects.

Day	Latitude	Longitude	Status
June 5	29N	71W	Tropical Depression?
June 6	31N	68W	Tropical Depression?
June 7			Dissipated

5) July 14-20: Microfilm shows a tropical wave east of the Lesser Antilles on July 14th moving westward. Synoptic observations indicate that the disturbance became better organized as it crossed the Windward Islands but no gales were reported. The disturbance continued westward entering the Gulf of Mexico on July 19th and dissipated two days later. Therefore, because the system did not produce tropical storm force winds and did not have a closed circulation, it is not added to HURDAT. This disturbance was in Jack Beven's List of Suspects.

Day	Latitude	Longitude	Status
July 14	8N-15N	47W	Tropical Wave
July 15	9N-17N	54W	Tropical Wave
July 16	12N-20N	62W	Tropical Wave
July 17	12N-20N	71W	Tropical Wave
July 18	15N-25N	80W	Tropical Wave
July 19	16N-25N	87W	Tropical Wave
July 20	20N-30N	95W	Tropical Wave
July 21			Dissipated

6) August 23-25: Microfilm indicates that a trough of low pressure developed northeast of the Leeward Islands around August 23rd. A non-frontal, low pressure formed on August 24th and a ship reported 40 kt in the southeast quadrant, close to the center. An approaching frontal boundary caused the system to move to the northeast, absorbing it on August 25th. Therefore, because there is not enough evidence to support upgrading this system to a tropical storm, it is not added to HURDAT. This disturbance was in Jack Beven's List of Suspects.

Day	Latitude	Longitude	Status
August 23	23N-32N	56W	Trough
August 24	31N	56W	Tropical Storm?
August 25			Absorbed

7) August 25-30: Historical Weather Maps and Microfilm show that the southern portion of the tropical wave that produced Hurricane Alma continued westward into the Gulf of Mexico. The disturbance became better organized on the Bay of Campeche and a tropical depression likely formed on August 27th. The system moved northward and a ship reported 55 kt, but it appears to have a very high bias, so it's disregarded. Late on the 28th and on the 29th, an oil rig over the northwestern Gulf of Mexico reported 35 kt, but this is an elevated site, thus the winds at the surface are likely below gale-force. TIROS V captured an image of the system at 16Z on the 29th. In the picture, the system is inland over eastern Texas and looks very well-organized with a large area of convection. At the same time, surface observations show a weak reflection with winds below tropical storm force. The depression produced severe weather across eastern Texas and western Louisiana, including very heavy rains and tornadoes. However, no land based station reported tropical storm force winds. The system dissipated on the 30th. Therefore, because there is not enough evidence to support upgrading this system to a tropical storm, it is not added to HURDAT. This disturbance was in Jack Beven's List of Suspects.

Day	Latitude	Longitude	Status
August 25	20N-27N	89W-92W	Tropical Wave
August 26	20N-28N	89W-95W	Tropical Wave
August 27	22N	94W	Tropical Depression
August 28	26N	95W	Tropical Depression
August 29	30N	95W	Tropical Depression - Inland
August 30			Dissipated

8) September 19-24: Historical Weather Maps and Microfilm indicates that a tropical wave and frontal boundary interacted in the eastern Gulf of Mexico. A trough of low pressure developed on September 19th and intensified into a tropical depression on the 20th. The system continued to interact with the stationary frontal boundary to the north producing very heavy rains over the Florida peninsula. The depression moved erratically over the next couple of days before dissipating on the 24th over the water. No gales or low pressures were associated with this system based on the ship data in the Microfilm, COADS and MWL. Therefore, because the system did not produce tropical storm force winds, it is not added to HURDAT. This disturbance was in Ryan Truchelut's List of Suspects.

Day	Latitude	Longitude	Status
September 19	20N-27N	85W-90W	Trough
September 20	27N	86W	Tropical Depression
September 21	25N	85W	Tropical Depression
September 22	28N	85W	Tropical Depression
September 23	28N	85W	Tropical Depression
September 24			Dissipated

9) September 20-24: A frontal boundary extended from the northeast Atlantic into the Iberian Peninsula on September 19th. Synoptic data indicate that an extratropical low pressure gradually organized on September 20th off the Portugal coast and moved southwestward. Gales were reported on the 20th about 300 nm north of the center. The system occluded on the 22nd. On thi date, ships near the center show that the temperature gradient is uniform and the strongest winds are about 100 nm north of the center. A ship reported 40 kt ENE and 1008 mb at 18Z on the 21st. On September 22nd, the system continued on a southwest course maintaining its intensity. At 1318Z on the 22nd, a TIROS V captured an image of the system showing an area of convection around the center. On September 23rd, the westward movement of the system came to a halt as a frontal boundary approached from the west. Gales and low pressures were also reported on the 23rd by ships near the center. On September 24th, the small system turned to the southeast and is analyzed to have weakened below gale force early in the day. At 12Z on the 24th, TIROS VI captured another image of the tropical cyclone showing a sheared circulation with most of the convection northeast of the center. Surface observations at 18Z on the 24th indicate that the system had weakened into a trough over the northeast Atlantic.

Day	Latitude	Longitude	Status
September 21	38N	17W	Extratropical
September 22	36N	20W	Occluded
September 23	35N	23W	Occluded
September 24	34N	18W	Occluded

10) September 28 - October 5: Historical Weather Maps and Microfilm show that a tropical wave entered the Caribbean Sea on September 28th. The disturbance moved westward and became better organized over the central Caribbean. TIROS V captured an image of the disturbance on October 1st at 12Z showing a large area of convection with some signs of organization. Another satellite image was captured at 1410Z on October 2nd, showing some banding in the northern quadrant of the circulation. The system was investigated by aircraft reconnaissance on the 2nd and 3rd, but observations do not suggest that it had reached tropical storm intensity. The system moved westward, making landfall over northern Nicaragua on October 3rd. Another satellite image captured at 1348Z on the 4th indicates that although the system was interacting with land, it remained organized with a large area of convection. The system moved into southern Mexico on October 5th and weakened into a tropical wave. No gales or low pressures were associated with this system based on the synoptic data in Microfilm, COADS and MWL. Therefore, because the system did not produce tropical storm force winds, it is not added to HURDAT.

Day	Latitude	Longitude	Status
September 28	13N-16N	58W-66W	Tropical Wave
September 29	12N-17N	67-69W	Tropical Wave
September 30	12N-17N	72W	Tropical Wave
October 1	14N	75W	Tropical Depression?
October 2	14N	80W	Tropical Depression?
October 3	15N	84W	Tropical Depression?
October 4	16N	89W	Tropical Depression?
October 5	16N	94W	Tropical Wave

11) October 14-15: Microfilm indicates that a tropical wave was located southwest of the Cape Verde Islands on October 14th. Bulletins were issued on this system as a tropical depression, mistakenly available in the Storm Wallets of 1963 as TD8. The system moved westward, and gradually weakening and later dissipating over the central Atlantic. No gales or low pressures were associated with this system according to Microfilm, COADS and MWL. Therefore, because the system did not produce tropical storm force winds, it is not added to HURDAT. This disturbance was in Jack Beven's List of Suspects.

Day	Latitude	Longitude	Status
October 14	13N	29W	Tropical Depression?

October 15	13N	34W	Tropical Depression?
October 16			Absorbed

12) November 12-15: Historical Weather Maps shows that an extratropical cyclone developed along the tail-end of a frontal boundary on November 12th. The disturbance moved slowly northward becoming an occluded cyclone on the 13th while producing gales far north of the center. On the 14th, TIROS VI captured an image at 1308Z showing a large non-tropical cyclone. The disturbance was absorbed a day later. Therefore, because the system did not acquire tropical characteristics, it is not added to HURDAT.

Day	Latitude	Longitude	Status
November 12	30N	40W	Extratropical
November 13	33N	40W	Occluded
November 14	34N	37W	Occluded
November 15			Absorbed

13) November 25-30: Historical Weather Maps indicates that an extratropical cyclone developed on November 25th. The disturbance moved westward becoming an occluded cyclone the next day and gale-force winds were reported on the 27th about 200 nm north of the center. The disturbance was absorbed by a larger extratropical cyclone on the 30th. Therefore, because the system did not acquire tropical characteristics, it is not added to HURDAT. This disturbance was in Jack Beven's List of Suspects.

Day	Latitude	Longitude	Status
November 25	40N	15W	Extratropical
November 26	38N	15W	Occluded
November 27	38N	20W	Occluded
November 28	40N	22W	Occluded
November 29	40N	25W	Occluded
November 30			Absorbed

14) December 9-14: Historical Weather Maps shows an extratropical cyclone developing on December 9th along the tail-end of a frontal boundary. The disturbance moved southwestward becoming an occluded cyclone the next day with gales reported over 200 nm north of the elongated center. The system became better organized on December 11th with gales and a prominent decrease in the pressure near the center. Nevertheless, the ship coverage south of 30N is sparse over the eastern Atlantic and it cannot be established if the disturbance had a closed low-level circulation. The system continued to the southwest over the next couple of days gradually losing strength and dissipating on December 14th. Therefore, because it cannot be shown that a closed low-level circulation was present, it is not added to HURDAT. This disturbance was in David Roth's List of Suspects.

Day	Latitude	Longitude	Status
December 9	33N	28W	Extratropical
December 10	31N	36W	Occluded
December 11	30N	40W	Tropical Storm?
December 12	24N	45W	Tropical Storm?
December 13	18N	50W	Tropical Depression?
December 14			Dissipated

1963 Atlantic Hurricane Database Reanalysis – Sandy Delgado and Chris Landsea

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

Hurricane Arlene [July 31 - August 12, 1963] – AL011963

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42665 07/31/1963 M=12  1 SNBR= 924 ARLENE      XING=0 SSS=0
42665 07/31/1963 M=15  1 SNBR= 924 ARLENE      XING=0 SSS=0
                    **

42670 07/31*  0   0   0    0*  0   0   0    0*  0   0   0    0*110 394  25    0*
42675 08/01*110 409  25    0*111 422  25    0*112 435  25    0*113 448  30    0*
42675 08/01*110 409  25    0*111 422  25    0*112 435  25    0*114 448  30    0*
                                                              ***

42680 08/02*115 460  40    0*124 474  50    0*133 487  70    0*143 499  90  987*
42680 08/02*118 461  40    0*124 474  50    0*133 487  55    0*143 499  60  987*
            *** ***                                 **                 **

42685 08/03*149 508  80  996*152 523  65    0*155 539  65 1000*159 553  65  988*
42685 08/03*149 511  55  996*152 524  50    0*155 539  45 1000*159 553  45    0*
                ***  **          ***  **                 **                 **

42690 08/04*163 567  50    0*167 580  45    0*174 592  30 1007*182 603  30    0*
42690 08/04*163 567  40    0*170 580  40    0*179 594  35 1005*190 607  30    0*
                     **      ***      **      *** ***  ** **** *** ***

42695 08/05*191 614  30    0*200 625  25    0*210 636  25 1011*220 646  25    0*
42695 08/05*200 620  30    0*207 632  25    0*214 642  25 1009*220 652  25    0*
            *** ***          *** ***          *** ***     ****      ***

42700 08/06*228 656  25    0*235 667  25    0*240 680  25 1012*244 688  30    0*
42700 08/06D228 662  25    0D235 671  25    0D240 680  25 1012D245 688  30    0*
            *    ***          *    ***          *                 ****

42705 08/07*250 695  30    0*254 701  30    0*260 703  30    0*265 704  30    0*
42705 08/07*250 695  30    0*257 701  30    0*264 703  30    0*270 704  35    0*
                           ***              ***              ***      **

42710 08/08*273 705  55    0*280 701  60    0*285 697  65  981*288 691  65  981*
42710 08/08*275 704  45    0*279 703  55    0*283 699  65  992*287 693  75  981*
            *** ***  **      *** ***  **      *** ***      *** *** ***  **

42715 08/09*293 685  65    0*300 676  70    0*313 662  75  979*328 640  90  974*
42715 08/09*293 685  75    0*300 676  80    0*313 662  90  979*328 640 100  970*
                     **                **                 **                ***  ***

42720 08/10*345 615  90  969*364 590  90    0*380 561  85  985*400 540  80    0*
42720 08/10*347 615 100  969*364 590  95    0*382 563  85  985*400 540  75    0*
            ***      ***                **      *** ***                      **

42725 08/11E425 520  65    0E448 501  65    0*  0   0   0    0*  0   0   0    0*
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42725 08/11*420 516  65    0E435 490  55    0E444 458  50    0E452 425  45    0*
           *    ***          *** ***  **      *** ***  **      *** ***  **
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(August 12th is new to HURDAT)

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42727 08/12E452 400  45    0E450 375  40    0E440 350  35    0E430 310  35    0*
42727 08/13E410 250  30    0E390 210  30    0E370 170  30    0E350 160  30    0*
42727 08/14E340 160  25    0*  0   0   0    0*  0   0   0    0*  0   0   0    0*
42730 HR
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Hurricane Landfall

08/09 1530Z 32.3N 64.8W 95 kt Bermuda – 975 mb

Significant Revisions:

- Intensity is significantly reduced on the 2nd, 3rd, and 9th based upon aircraft reconnaissance.
- Added a disturbance stage on August 6th.
- Intensity is significantly boosted on the 9th based upon aircraft reconnaissance.
- Upgraded to a major hurricane on the 10th
- Position substantially adjusted southeastward on the 11th based upon ship observations.
- Added 66 hours to the life cycle as an extratropical cyclone.

Daily Summary:

July 30:

1. Maps and old HURDAT:

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

July 31:

1. Maps and old HURDAT:

- HWM analyzes a spot low pressure at 10.8N, 38.8W at 12Z.
- HURDAT lists a 25 kt tropical depression at 11.0N, 39.4W at 18Z (first position).
- Microfilm does not show an organized system on this date.

2. Discussion:

- MWR: "A cloud mass first detected in the mid-Atlantic by the TlROS VI satellite at 1505 GMT July 31, was undoubtedly Arlene in her embryonic tropical depression stage."
- ATSR: "Hurricane ARLENE began formation in the tropical Atlantic near 11N 39W. An area of unusual cloudiness detected by TIROS VI at 1505Z on 31 July was beyond the range of reconnaissance aircraft."
- Reanalysis: Hurricane Arlene developed from a tropical wave that left the African coast around July 27th. The disturbance moved westward across the far eastern Atlantic where the ship data is sparse. Time of genesis is

uncertain and it is retained from the original HURDAT at 18Z on July 31st as a 25 kt tropical depression. At 18Z on the 31st, microfilm shows a nephanalysis of a TIROS satellite image (though the image itself is not available) that captured the system, indicating a large area of convection around the estimated position.

August 1:

1. Maps and old HURDAT:

- HWM analyzes a closed low pressure of at most 1005 mb at 11.1N, 43.8W at 12Z.
- HURDAT lists a 25 kt tropical depression at 11.2N, 43.5W at 12Z.
- Microfilm shows a tropical wave at 45W at 12Z.

2. Discussion:

- The tropical depression continued moving westward on August 1st and another nephanalysis of a satellite image was analyzed at 18Z on this date but only captured the eastern half of the system.

August 2:

1. Maps and old HURDAT:

- HWM analyzes a hurricane of at most 1000 mb at 13.5N, 48.5W at 12Z.
- HURDAT lists a 70 kt hurricane at 13.3N, 48.7W at 12Z.
- Microfilm shows a closed low pressure of at most 1008 mb at 12.5N, 49.5W at 12Z.

2. Aircraft highlights:

- Penetration center fix extrapolated a central pressure of 987 mb, estimated surface winds of 85 kt and an eye diameter of 18 nm at 14.2N, 49.8W at 1642Z (ATSR).
- Penetration center fix estimated flight level winds of 54 kt at 14.8N, 50.7W at 2338Z (ATSR).

3. Discussion:

- MWR: "Too far away then for immediate air reconnaissance, the Navy as a fully developed hurricane at 1642 GMT located it August 2 at 14.2° N., 49.8° W. During the preceding night the *Mormactrader* passed very close to Arlene. Although a complete ship's log is not available, an examination of her excellent 6-hourly reports indicates that the cyclone had just reached tropical storm intensity. It is estimated that Arlene intensified from storm to Hurricane force within 12 hr., a rather rapid development."
- ATSR: "It was determined that a normal westerly movement would bring the cloud mass within striking distance of the reconnaissance aircraft on 2 August. Departing Roosevelt Roads at first light, a Navy reconnaissance aircraft investigated the area and by 1642Z had located fully developed Hurricane ARLENE at 14.2N 49.8W. The first warning on Hurricane ARLENE was issued at 021800Z. Maximum winds were 85 knots."
- Reanalysis: A ship moved across the tropical cyclone early on the 2nd, showing a distinctive shift in the winds, and it is the first confirmation that a closed low-level circulation was present. The first reconnaissance aircraft to investigate Arlene on the 2nd measured a central pressure of 987

mb by extrapolation to surface, estimated surface winds of 85 kt and an eye diameter of 18 nm at 1642Z. A central pressure of 987 mb suggests maximum surface winds of 68 kt from the Brown et al. south of 25N pressure-wind relationship. An eye diameter of 18 nm suggests an RMW of about 15 nm and the climatological value is 14 nm. A composite of TIROS satellite images labeled as 1446Z shows a rather ragged appears to Arlene, not resembling a "fully developed hurricane". However, it is not certain that this exact time represents the one picture showing Arlene in the composite, nor are the latitude/longitude lines drawn on the imagery certain. Based on a blend of the pressure-wind relationship and the ragged appearance in satellite, an intensity of 60 kt is selected at 18Z on the 2nd, down from 90 kt originally in HURDAT, a major intensity change. (Some central pressures values were present in the original HURDAT between August 2nd at 18Z and August 10th at 12Z. Some of these were in the wrong time slots or not accurate. Thus, based on actual observations, some were retained, others removed and new central pressure values added. Detailed information on these changes can be found in the table at the end.)

August 3:

1. Maps and old HURDAT:

- HWM analyzes a hurricane of at most 1000 mb at 15.8N, 53.8W at 12Z.
- HURDAT lists a 65 kt hurricane at 15.5N, 53.9W at 12Z.
- Microfilm shows a closed low pressure of at most 1011 mb at 15.0N, 52.5W at 12Z.

2. Aircraft highlights:

- Penetration center fix measured a central pressure of 996 mb, estimated flight level winds of 82 kt and an eye diameter of 12 nm at 14.9N, 50.9W at 01Z (ATSR).
- Penetration center fix measured a central pressure of 1000 mb and estimated surface winds of 55 kt at 15.6N, 54.7W at 14Z (WALLET).
- Penetration center fix measured a central pressure of 988 mb, estimated surface winds of 110 kt and an eye diameter of 25 nm at 16.1N, 55.4W at 1803Z (ATSR).

3. Discussion:

- MWR: "Three different flights, which penetrated the cyclone during the next 26-hr period, reported hurricane-force winds. Based upon the surface pressures taken from the dropsondes, various pressure-wind graphs would support most of the Hurricane-force winds reported by the aircraft. There is no doubt it was a well-developed hurricane, and was so described by the plane's meteorologist, yet rapid deterioration of the eye structure as well as a reduction of winds took place during the night of August 3-4 in an area where this rarely occurs…"
- ATSR: "Subsequent reconnaissance flights throughout 2 and 3 august indicated that ARLENE was maintaining hurricane intensity and moving northwestward."
- Reanalysis: The next penetration center fix measured a central pressure of 996 mb, estimated surface winds of 82 kt and an eye diameter of 12 nm at 01Z on August 3rd. A central pressure of 996 mb suggests maximum surface winds of 55 kt from the weakening subset of the south of 25N pressure-wind relationship. An eye diameter of 12 nm suggests an RMW of about 10 nm and

the climatological value is 14 nm. An intensity of 55 kt is selected at 00Z on the 3rd, down from 80 kt originally in HURDAT, a major intensity change. The next reconnaissance aircraft reached Arlene late on the 3rd and the measurements obtained show some irregularities. At 14Z on the 3rd, a center penetration fix measured a central pressure of 1000 mb based upon a low-level penetration and estimated surface winds of 55 kt. Four hours later, at 1803Z on the 3rd, a center penetration fix measured a central pressure of 988 mb, estimated surface winds of 110 kt and an eye diameter of 25 nm. However, the 988 mb is based upon a dropsonde, for which the details were never logged. Moreover, the available flight-level measurements are not supportive of such a deep central pressure. Because of the inconsistencies, the 988 mb value is not used as a central pressure. However, the 1000 mb central pressure – already in HURDAT at 12Z – is retained. The central pressure of 1000 mb from 14Z suggests maximum surface winds of 47 kt from the south of 25N pressure-wind relationship. An intensity of 45 kt is assessed at 12Z, a major reduction from 65 kt originally in HURDAT. These revisions indicate that Arlene likely did not achieve hurricane status during the early portion of its lifecycle. It is suggested that the extreme winds estimated by the aircraft crew may have been a transient event, not indicative of the intensity of the system.

August 4:

1. Maps and old HURDAT:

- HWM analyzes a tropical storm of at most 1010 mb at 17.6N, 59.0W at 12Z.
- HURDAT lists a 30 kt tropical depression at 17.4N, 59.2W at 12Z.
- Microfilm shows a closed low pressure of at most 1005 mb at 18.6N, 60.4W at 12Z.

2. Aircraft highlights:

- Radar center fix estimated an eye diameter of 23 nm at 15.6N, 55.8W at 0248Z (WALLET).
- Radar center fix measured a peripheral pressure of 1004 mb and estimated surface winds of 60 kt at 15.6N, 57.9W at 0630Z (WALLET).
- "No eye or spiral bands obsd. No circulation obsd. Max obsd sfc wind 45 kt. Min SLP 1007 mb" around 12-17Z (ATSR).
- "No definite pattern or closed circulation in evidence. Max obsd sfc wind 25 kt apparently association with isolated squalls. Min observed pressure 1009 mb" around 19-23Z (ATSR).

3. Discussion:

- MWR: "and by midday of the 4th Arlene was, at most, a tropical depression."
- ATSR: "However, during the night of 3 August, ARLENE rapidly weakened and by 041600Z was a moderate tropical depression."
- Reanalysis: On August 4th, Arlene continued to gradually weaken. Transition to a tropical depression is analyzed at 18Z on the 4th, six hours later than originally shown in HURDAT. A 1752Z TIROS satellite image composite showed a partly exposed low-level center. Reconnaissance aircraft investigating Arlene late on the 4th were not able to locate a center.

August 5:

1. Maps and old HURDAT:

- HWM analyzes a closed low pressure of at most 1010 mb at 20.8N, 63.7W at 12Z.
- HURDAT lists a 25 kt tropical depression at 21.0N, 63.6W at 12Z.
- Microfilm shows a closed low pressure of at most 1011 mb at 21.5N, 64.8W at 12Z.

2. Ship highlights:

- 40 kt SW at 22.5N, 64.0W at 18Z (micro, likely high bias).

3. Aircraft highlights:

- Max estimated surface winds 45 kt and min observed pressure 1011 mb, but no center identified between 10-15Z (ATSR).

4. Discussion:

- ATSR: "Further weakening occurred and by 050400Z ARLENE's winds were less than 25 knots. The reason for this weakening was not fully understood at the time, but post-analyses indicate that troughing at 200 mbs in the storm area had a "damping" effect on the storm's outflow. During the period 5-7 August, ARLENE remained a weak tropical depression, moving northwestward to a point approximately 550 miles east of the southern tip of Florida."
- Reanalysis: Synoptic observations late on the 4th and on August 5th indicate that Arlene may have weakened to a sharp trough. But a reconnaissance mission around 12Z on the 5th shows that Arlene still had a closed circulation, thus it is retained as a tropical depression late on the 4th through late on the 5th. A ship reported 40 kt SW at 18Z on the 5th but appears to have a high bias compared to the nearby ship observations.

August 6:

1. Maps and old HURDAT:

- HWM analyzes a closed low pressure of at most 1015 mb at 23.8N, 68.8W at 12Z.
- HURDAT lists a 25 kt tropical depression at 24.0N, 68.0W at 12Z.
- Microfilm shows a closed low pressure of at most 1014 mb at 23.8N, 68.3W at 12Z.

2. Aircraft highlights:

- "Max obsd sfc wind 20 kt. Min obsd SLP 1012 mb, Radar coverage not feasible" with no center located around 09-12Z (ATSR).

3. Discussion:

- Reanalysis: Ship data on August 6th at 00Z show that Arlene had weakened to a trough as the wind flow was easterly in the southwest quadrant. This was also confirmed by the investigative aircraft reconnaissance mission. The sharp trough continued moving west-northwest and slowed its forward speed.

August 7:

1. Maps and old HURDAT:

- HWM analyzes a closed low pressure of at most 1015 mb at 26.5N, 70.0W with a warm front to the north at 12Z.
- HURDAT lists a 30 kt tropical depression at 26.0N, 70.3W at 12Z.

- Microfilm shows a closed low pressure of at most 1014 mb at 28.0N, 69.0W with a frontal boundary to the north at 12Z.

2. Ship highlights:

- 15 kt SSE and 1005 mb at 28.9N, 69.4W at 12Z (COADS).
- 35 kt S and 1012 mb at 27.0N, 70.0W at 18Z (COADS).

3. Discussion:

- MWR: "Tropical depression intensity was maintained through August 7, mainly, it is believed, a reflection of a circulation aloft which seemed to persist throughout this degenerate stage, although at times the surface perturbation appeared to be nothing more than a disturbed area."
- Reanalysis: At 00Z on August 7th, ship observations indicate that Arlene had regained a closed circulation, thus becoming a tropical depression once again. On the 7th, Arlene reached the westernmost extent of its track and began to slowly move to the north while becoming better organized. Intensification to a tropical storm is analyzed at 18Z on the 7th, six hours earlier than HURDAT, based on a ship report of 35 kt S in the eastern quadrant.

August 8:

1. Maps and old HURDAT:

- HWM analyzes a tropical storm of at most 1005 mb at 28.5N, 69.5W with a cold front far to the northwest and a warm front to the north at 12Z.
- HURDAT lists a 65 kt hurricane at 28.5N, 69.7W at 12Z.
- Microfilm shows a closed low pressure of at most 1011 mb at 28.5N, 69.7W at 12Z.

2. Ship highlights:

- 45 kt SSW and 1009 mb at 27.4N, 70.0W at 00Z (COADS).
- 15 kt NW and 1002 mb at 27.5N, 72.8W at 06Z (COADS).
- 55 kt S and 1000 mb at 28.5N, 69.2W at 18Z (COADS).

3. Aircraft highlights:

- Penetration center fix measured a central pressure of 992 mb and estimated an eye diameter of 20 nm at 28.6N, 69.6W at 1357Z (WALLET).
- Penetration center fix measured a central pressure of 981 mb, estimated surface winds of 65 kt and an eye diameter of 22 nm at 28.8N, 69.3W at 19Z (ATSR).
- Penetration center fix estimated surface winds of 65 kt at 29.1N, 68.8W at 2230Z (WALLET).

4. Discussion:

- MWR: "Ship reports during the late evening of the 7th indicated that Arlene was once again a tropical storm and by 1357 GMT August 8, an Air Force plane penetrated the center. The eye was well defined and maximum surface winds were estimated at 75 mph. A rather unusual type of fix and a very excellent one was obtained by radar from the USS Lawrence just prior to the Air Force

plane penetration. Except for an increase in forward speed, Arlene changed little during the night and early morning hours of August 8-9."

- ATSR: "By 080400Z, however, ship reports indicated that ARLENE was reintensifying, and a tropical storm warning was issued at 080500Z. Reintensification continued and by 081600Z ARLENE was again a hurricane. By this time, she had commenced recurvature and the eye subsequently passed over Bermuda at 091600Z. Maximum winds recorded in Bermuda were gust to 84 knots."
- Reanalysis: HURDAT originally showed an unrealistic jump in intensity from 30 kt at 18Z on the 7th to 55 kt at 00Z on August 8th. A few ships reported gale-force winds and even storm-force winds, up to 55 kt on the 8th. A reconnaissance aircraft measured a central pressure of 992 mb and estimated an eye diameter of 20 nm at 1357Z on the 8th. A central pressure of 992 mb suggests maximum surface winds of 64 kt from the south of 25N pressure-wind relationship. An eye diameter of 20 nm suggests an RMW of about 15 nm and the climatological value is 20 nm. Based on a forward speed of about 7 kt, an intensity of 65 kt is selected at 12Z on the 8th, same as originally shown in HURDAT. Regaining hurricane intensity is analyzed at 12Z on the 8th, same as originally shown in HURDAT. TIROS VII captured a partial satellite image of Arlene at 1749Z on the 8th showing a well-organized area of convection with banding features. The next penetration center fix measured a central pressure of 981 mb, estimated surface winds of 65 kt and an eye diameter of 22 nm at 19Z on the 8th. A central pressure of 981 mb suggests maximum surface winds of 74 kt from the north of 25N intensifying subset of the pressure-wind relationship. An eye diameter of 22 nm suggests an RMW of about 17 nm and the climatological value is 22 nm. Based on a slow forward speed of about 6 kt, but a small RMW, an intensity of 75 kt is selected at 18Z on the 8th, up from 65 kt originally in HURDAT, a minor intensity change.

August 9:

1. Maps and old HURDAT:

- HWM analyzes a hurricane of at most 1000 mb at 31.5N, 66.4W with a cold front just to the northwest at 12Z.
- HURDAT lists a 75 kt hurricane at 31.3N, 66.2W at 12Z.
- Microfilm shows a closed low pressure of at most 1008 mb at 31.3N, 66.1W with a frontal boundary to the north at 12Z.

2. Ship highlights:

- 70 kt SW and 991 mb at 28.9N, 68.7W at 00Z (micro).
- 45 kt WSW and 1007 mb at 29.2N, 67.6W at 09Z (COADS).
- 35 kt SW and 1011 mb at 29.3N, 67.0W at 12Z (COADS).
- 35 kt S and 1011 mb at 31.4N, 62.7W at 18Z (COADS).
- 40 kt SW and 1006 mb at 32.6N, 61.9W at 21Z (micro).

3. Land highlights:

- 975 mb at Kindley Air Force Base, Bermuda near 16Z (WALLET).
- 60 kt (gusts to 85 kt) at Kindley Air Force Base, Bermuda near 16Z (WALLET).

4. Aircraft highlights:

- Radar center fix at 30.1N, 67.4W at 0611Z (WALLET).
- Penetration center fix measured a central pressure of 979 mb, estimated surface winds of 65 kt and an eye diameter of 20 nm at 30.9N, 66.8W at 1005Z (WALLET).
- Penetration center fix measured a central pressure of 982 mb, estimated surface winds of 65 kt and an eye diameter of 8 nm at 31.4N, 66.0W at 1220Z (WALLET).
- Penetration center fix measured a central pressure of 970 mb and estimated surface winds of 100 kt at 33.0N, 63.6W at 19Z (WALLET).
- Penetration center fix measured a central pressure of 969 mb, estimated surface winds of 115 kt and an eye diameter of 20-30 nm at 34.1N, 62.5W at 22Z (WALLET).

5. Discussion:

- MWR: "The eye passed over Bermuda at 1600 GMT and observers there were able to obtain an eye sounding. Temperatures in the eye, at least in the lower and middle troposphere, were quite similar to those obtained in the eye of an October hurricane at Tampa in 1944. Temperatures at higher levels in the Bermuda sounding were considerably lower than in the Tampa sounding. As observed winds aloft indicate, the radiosonde did not remain within the eye throughout its flight. There were no lives lost at Bermuda although there was $300,000 property damage. The lowest pressure was 28.78 in. or 974.5 mb, while rainfall was 2.69 in. Highest winds at Bermuda were from the east-southeast, 69 mph, with gusts to 98 mph, and tides were estimated at 4 ft. above normal."
- Tucker: "A short, sharp and vicious hurricane, whose centre passed right over the islands at noon on this Friday [9th] in August, and did a great deal of damage to trees and other vegetation…By 11.40 'Arlene's' winds were hitting the colony from the south-west at 81 knots. Travelling NE at 25 knots, 'Arlene's' eye began passing over the island shortly before noon, making a complete uncanny lull with not a zephyr stirring and people walking curiously about the streets. Following this brief calm, the storm then struck the islands from the opposite quarter and remained at top force with winds at over 90 m.p.h. till 3 P.M. Uprooted trees, smasched windows, torrential (and must needed) rain, Watford Bridge covered by waves, power and telephone lines lying in tangled masses, and the dangerous sound of tiles smashing from roof tops…There were no personal injuries whatever and not a very great deal to the sturdier houses, except for flying tiles. However, enough damage was sustained during 'Arlene's' two hour frolic over the colony to cost more than 100,000 Pounds. The insurance firms reported half that amount and that the uninsured damage plus the cost to the two public utilities – electric power and telephone – would account for the remainder."
- Reanalysis: On August 9th, Arlene increased its forward speed to the northeast and impacted the island of Bermuda. A ship reported 70 kt SW and 991 mb at 00Z on the 9th in the southern quadrant of the hurricane. At 1005Z on the 9th, a penetration center fix measured a central pressure of 979 mb, estimated surface winds of 65 kt and an eye diameter of 20 nm. A central pressure of 979 mb suggests maximum surface winds of 74 kt from the north of 25N pressure-wind relationship. An eye diameter of 20 nm suggests an RMW of about 15 nm and the climatological value is 24 nm. Based on a fast forward speed of about 22 kt and an RMW smaller than the climatological value, an

intensity of 90 kt is selected at 12Z on the 9th, up from 75 kt originally shown in HURDAT, a major intensity change. Arlene made landfall in Bermuda around 1530Z on the 9th as a small, rapidly-moving and intensifying hurricane. The Kindley Air Force Base, located in the northeastern part of the island, measured maximum sustained winds of 66 kt and with gusts to 85 kt around 16Z. A central pressure measured in Bermuda was 975 mb, which suggests maximum surface winds of 79 kt from the north of 25N pressure-wind relationship. Using the wind trace from Kindley Air Force Base, a minimum estimate of 8 nm for an RMW can be derived, indicting a quite small RMW. (If anemometer's measurements did not exactly transect the diameter of the eye, this estimate may be somewhat smaller than the actual value.) Based on a forward speed of about 25 kt and small RMW, an intensity of 95 kt is selected at the time of landfall. After leaving Bermuda, a reconnaissance aircraft investigated Arlene measuring a central pressure of 970 mb – deeper than over Bermuda - and estimated surface winds of 100 kt at 19Z on the 9th. A central pressure of 970 mb suggests maximum surface winds of 88 kt from the north of 25N intensifying subset of the pressure-wind relationship. Based upon a forward speed of about 25 kt and small RMW, an intensity of 100 kt is selected at 18Z on the 9th, up from 90 kt originally in HURDAT, a minor intensity change. An intensity of 100 kt is also the peak intensity of this tropical cyclone, up from 90 kt originally in HURDAT. This reanalysis indicates that Arlene was a major hurricane.

August 10:

1. Maps and old HURDAT:

- HWM analyzes a hurricane of at most 990 mb at 38.8N, 56.2W with a weakening cold front just to the west and a warm front to the north at 12Z.
- HURDAT lists an 85 kt hurricane at 38.0N, 56.1W at 12Z.
- Microfilm shows a closed low pressure of at most 1005 mb at 38.3N, 55.7W with an extratropical cyclone just to the northwest at 12Z.

2. Ship highlights:

- 45 kt SSW and 1010 mb at 32.7N, 60.4W at 00Z (COADS).
- 40 kt S and 1015 mb at 38.0N, 49.2W at 18Z (COADS).
- 45 kt E and 1005 mb at 45.9N, 40.6W at 21Z (COADS/micro).

3. Aircraft highlights:

- Penetration center fix at 34.8N, 61.3W at 01Z (WALLET).
- Penetration center fix measured a central pressure of 985 mb, estimated surface winds of 75 kt and an eye diameter of 15 nm at 38.6N, 55.3W at 1340Z (WALLET).
- Penetration center fix at 40.4N, 53.7W at 19Z (WALLET).

4. Discussion:

- MWR: "After leaving Bermuda, Arlene moved on a northward course and probably increased slightly in intensity for a short while, only to weaken a bit on the 10th."
- Reanalysis: At 22Z on the 9th, another penetration center fix measured a central pressure of 969 mb, estimated surface winds of 115 kt and an eye diameter of 20-30 nm. A central pressure of 969 mb suggests maximum surface winds of 86 kt from the north of 25N Brown et al. and 83 kt from the north

of 35N Landsea et al. pressure-wind relationships. An eye diameter of 20-30 nm suggests an RMW of about 15-23 nm and the climatological value is 28 nm. Based on a forward speed of 31 kt, small circulation and putting some weight on the estimated surface winds, an intensity of 100 kt is analyzed at 00Z on August 10th, up from the 90 kt originally shown in HURDAT, a minor intensity change. On the 10th, Arlene was moving northeastward ahead of a frontal boundary. The hurricane was so small synoptically, that in the microfilm the ship observations available do not even suggest that a closed circulation was present. Later on the 10th, the hurricane began to weaken. The last reconnaissance aircraft to investigate Arlene reached the tropical cyclone at 1340Z on the 10th measuring a central pressure of 985 mb, estimating surface winds of 75 kt and an eye diameter of 15 nm. A central pressure of 985 mb suggests maximum surface winds of 68 kt from the Landsea et al. north of 35N pressure-wind relationship. An eye diameter of 15 nm suggests an RMW of about 10 nm and the climatological value is 34 nm. Based on a forward speed of about 31 kt and small circulation, an intensity of 85 kt is analyzed at 12Z on the 10th, same as originally shown in HURDAT.

August 11:

1. Maps and old HURDAT:

- HWM analyzes an extratropical cyclone of at most 1005 mb at 50.0N, 50.0W with frontal boundaries extending to the southeast and southwest at 12Z.
- HURDAT lists a 65 kt extratropical cyclone at 44.8N, 50.1W at 06Z (last position).
- Microfilm shows a closed low pressure of at most 1002 mb at 39.0N, 45.4W with an extratropical cyclone to the northwest at 12Z.

2. Ship highlights:

- 40 kt SW and 1018 mb at 36.2N, 47.0W at 00Z (COADS).
- 5 kt SE and 1003 mb at 44.2N, 48.3W at 06Z (COADS).
- 35 kt SW and 1010 mb at 43.0N, 43.9W at 12Z (COADS).
- 35 kt WNW and 1008 mb at 44.5N, 45.0W at 15Z (COADS).
- 35 kt WNW and 1001 mb at 45.1N, 43.0W at 18Z (COADS).

3. Discussion:

- MWR: “During the night of August 10-11, it quickly lost tropical characteristics and merged with a polar front some 200 mi. southeast of Cape Race, Newfoundland.”
- ATSR: “After passing Bermuda, ARLENE continued on a northeasterly course and finally lost all tropical characteristics during the night of 10 August as the storm came under the influence of a cool air mass and low sea temperatures.”
- Reanalysis: Early on August 11th, Arlene passed a couple of hundred miles southeast of Newfoundland and turned to the east-northeast. Transition to an extratropical cyclone is analyzed in HURDAT at 00Z on the 11th but synoptic observations indicate that Arlene remained in the warm sector of an extratropical cyclone located to the northwest. Transition to an extratropical cyclone is analyzed at 06Z on the 11th, six hours later than originally shown in HURDAT. Weakening below hurricane intensity is analyzed at 06Z on the 11th, six hours earlier than originally shown in HURDAT.

August 12:

1. Maps and old HURDAT:

- HWM analyzes an extratropical cyclone of at most 1015 mb at 42.0N, 23.0W at 12Z.
- HURDAT does not list an organized storm on this date.
- Microfilm shows an extratropical cyclone of at most 1017 mb at 43.0N, 35.0W at 12Z.

2. Ship highlights:

- 40 kt E and 1013 mb at 46.4N, 38.9W at 00Z (COADS).
- 35 kt W and 1017 mb at 41.7N, 38.2W at 12Z (COADS).

August 13:

1. Maps and old HURDAT:

- HWM analyzes a cold front extending from Portugal to south of the Azores.
- HURDAT does not list an organized storm on this date.

2. Discussion:

- Reanalysis: Arlene continued to weaken on the 12th and 13th and synoptic observations show that it weakened into a trough after 00Z on the 14th while located between the Azores and Portugal. The last position is analyzed at 00Z on the 14th, 66 hours later than originally shown in HURDAT.

Date	Original HURDAT Central Pressure	Evidence	Changes
Aug 02 18Z	987 mb	Penetration center fix: 987 mb at 1642Z on Aug 02nd	Retained
Aug 03 00Z	996 mb	Penetration center fix: 996 mb at 01Z on Aug 03rd	Retained
Aug 03 12Z	1000 mb	Penetration center fix: 1000 mb at 14Z on Aug 03rd	Retained
Aug 03 18Z	988 mb	Penetration center fix: 988 mb at 1803Z on Aug 03rd – Inconsistent with other earlier and concurrent aircraft measurements	Removed
Aug 04 12Z	1007 mb	Ship reported 1007 mb and 20 kt	1005 mb
Aug 05 12Z	1011 mb	Dropsonde measured 1011 mb and 15 kt SW at 1Z on Aug 05th	1009 mb
Aug 06 12Z	1012 mb	Aircraft reconnaissance measured a minimum pressure of 1012 mb	Retained
Aug 08 12Z	981 mb	Penetration center fix: 992 mb at 1357Z on Aug 08th	992 mb
Aug 08 18Z	981 mb	Penetration center fix: 981 mb at 19Z on Aug 08th	Retained
Aug 09 12Z	979 mb	Penetration center fix: 979 mb at 1005Z on Aug 09th	
Aug 09 1530Z	----	Bermuda observation in eye around 16Z – 975 mb	975 mb

Aug 09 18Z	974 mb	Penetration center fix: 970 mb at 19Z on Aug 09th	970 mb
Aug 10 00Z	969 mb	Penetration center fix: 969 mb at 22Z on Aug 09th	Retained
Aug 10 12Z	985 mb	Penetration center fix: 985 mb at 1340Z on Aug 10th	Retained

Sources: the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Monthly Weather Review, Navy reconnaissance book, Mariners Weather Log, Tucker (1996), Allison & Thompson (1966) and NHC Storm Wallets.

Hurricane Beulah [August 20 – September 6, 1963] – AL021963

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42735 08/20/1963 M= 9  2 SNBR= 925 BEULAH      XING=0 SSS=0
42735 08/20/1963 M=19  2 SNBR= 925 BEULAH      XING=0 SSS=0
                    **

42740 08/20*  0   0   0    0*  0   0   0    0*137 495  30    0*143 509  30 1006*
42740 08/20*112 474  25    0*121 485  25    0*130 496  30    0*139 507  30 1006*
           *** ***  **      *** ***  **      *** ***          *** ***

42745 08/21*150 517  30    0*155 528  35    0*160 535  35    0*165 546  45 1005*
42745 08/21*147 518  30    0*154 528  35    0*160 537  40    0*165 546  45 1005*
           *** ***          ***                ***  **

42750 08/22*168 554  45    0*173 560  55    0*179 569  70  994*187 578  75    0*
42750 08/22*169 554  45    0*173 560  55    0*179 569  60  994*187 578  65    0*
           ***                                          **                 **

42755 08/23*196 583  80    0*205 588  85    0*213 591  85    0*221 592  90  962*
42755 08/23*196 583  70  991*205 588  80  977*213 591  90    0*220 592  95  963*
                    **  ***          **  ***          **      ***        **  ***

42760 08/24*226 594  95    0*231 596 105  958*237 597 105    0*241 598 100  961*
42760 08/24*226 594  95  962*231 596 105  958*237 597 100  961*243 598 100  961*
                         ***                          ***  *** ***

42765 08/25*248 600  85    0*256 602  80    0*266 603  75  985*278 604  80  976*
42765 08/25*248 600  90    0*256 602  80    0*266 603  75  972*278 604  70  976*
                    **                                     ***          **

42770 08/26*290 602  80  978*304 592  85    0*316 583  85  983*329 570  85  979*
42770 08/26*290 601  70  978*304 593  70    0*316 583  70  983*329 570  70  979*
               ***  **          ***  **                **                 **

42775 08/27*345 553  80    0*363 536  75    0*384 523  70    0*416 510  70    0*
42775 08/27*345 553  70    0*363 536  70    0*384 523  70    0*416 510  70    0*
                    **                **

42780 08/28*458 483  70    0E494 449  65    0E516 410  60    0E542 355  60    0*
42780 08/28E458 483  70    0E494 449  65    0E518 410  60    0E540 370  60    0*
           *                                   ***             *** ***
(August 29th through September 8th are new to HURDAT)
42781 08/29E550 340  55    0E560 300  55    0E564 250  55    0E567 210  55    0*
42783 08/30E570 170  55    0E572 140  55    0E572 110  55    0E560 085  55    0*
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42785 08/31E545 070  60    0E525 060  60    0E510 050  60    0E500 040  60    0*
42787 09/01E490 030  55    0E485 020  50    0E485 010  45    0E490 005  40    0*
42789 09/02E500 000  35    0E515 005  30    0E530 010  30    0E540 005  30    0*
42791 09/03E550 000  30    0E5553590  30    0E5603580  30    0E5653575  30    0*
42793 09/04E5703572  30    0E5803575  30    0E5953580  30    0E6103570  30    0*
42795 09/05E6353560  30    0E6503545  30    0E6653530  25    0E6803520  25    0*
42797 09/06E6903510  25    0E7003510  25    0E7103520  30    0E7153540  30    0*
42799 09/07E7203560  30    0E7253580  30    0E7253590  30    0E7300000  30    0*
42800 09/08E7350000  30    0E7350010  30    0E7350040  25    0E7250080  25    0*

42800 HR
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Significant Revisions:

- Several central pressures were added, mainly based upon aircraft reconnaissance.
- Intensity substantially reduced on the 26th based upon aircraft observations.
- A major alteration is to add ten days to the lifetime of this tropical cyclone.

Daily Summary:

August 16:

1. Maps and old HURDAT:

- HWM analyzes a spot low pressure at 15.6N, 44.2W at 12Z.
- HURDAT does not list an organized system on this date.
- Microfilm does not show an organized system on this date.

August 17:

1. Maps and old HURDAT:

- HWM analyzes a spot low pressure at 14.7N, 46.0W at 12Z.
- HURDAT does not list an organized system on this date.
- Microfilm shows a tropical wave at 49W at 12Z.

2. Discussion:

- MIAMI WEATHER BUREAU BULLETIN: “Special statement from the Miami Weather Bureau. A Navy reconnaissance aircraft today investigated an area of suspicion photographed by TIROS satellite yesterday some 1000 miles east of the Lesser Antilles in the central Atlantic. The flight found no evidence of a tropical disturbance or a developing circulation and reported no unusual weather in the area.”

August 18:

- HWM analyzes a spot low pressure at 14.0N, 47.5W at 12Z.
- HURDAT does not list an organized system on this date.
- Microfilm does not show an organized system on this date.

August 19:

1. Maps and old HURDAT:

- HWM analyzes a spot low pressure at 14.4N, 48.5W at 12Z.
- HURDAT does not list an organized system on this date.
- Microfilm does not show an organized system on this date.

2. Aircraft highlights:

- "Enctrd large masses of cld radar echoes with no definite patn…Unable to establish definite circulation due lack of west and south wind. Max obsd sfce wind 20 kt. Min obsd SLP 1008 mb" around 12-17Z (ATSR).

3. Discussion:

- Reanalysis: Hurricane Beulah developed from a tropical wave that left the African coast around August 11th based upon the Microfilm and Historical Weather Maps. The disturbance moved westward into an area of scarce ship data over the eastern and central Atlantic, thus the time of genesis is uncertain. Satellite imagery on 16-19 August showed a disturbance that is likely pre-Beulah. A reconnaissance aircraft investigated the tropical disturbance late on August 19th while it was located about 900 nm east of the Lesser Antilles. The aircraft did not found a closed circulation but its observations and the synoptic data at 18Z on the 19th showed that a very sharp trough was present.

August 20:

1. Maps and old HURDAT:

- HWM analyzes a closed low pressure of at most 1010 mb at 13.5N, 48.5W at 12Z.
- HURDAT lists a 30 kt tropical depression at 13.7N, 49.5W at 12Z (first position).
- Microfilm shows a closed low pressure of at most 1011 mb at 13.0N, 49.0W at 12Z.

2. Aircraft highlights:

- "Max obsd sfc wind 30 kt…Min obsd SLP 1006 mb, but no reported center around 12-1830Z (ATSR).

3. Discussion:

- MWR: "The circulation that developed into hurricane Beulah was located by aerial reconnaissance near 14°N, 51°W about midday on August 20. Maximum winds were 35 mph in squalls and the lowest observed surface pressure was 1006 mb or 29.71 in. Cloudiness and shower activity covered a large area. Surface ship reports during the preceding several days had indicated disturbed conditions over much of the area from the Cape Verdes westward to the longitude of the incipient storm. Data limitations preclude specification of the exact position of the Inter-tropical Convergence Zone during this period, but south and southwest winds of 23 to 30 m.p.h. were prevalent as much as 300 mi. to the north of the normal ITC position. Sparsity of data also makes the earlier history of the vortex obscure. Westward movement of about 11 mph would have brought a cloud mass photographed by TIROS VI near 13°N, 25°W on August 14 to the vicinity of the developing circulation. However, it is not possible to say whether this represented the nascent stages of Beulah."

- ATSR: "The circulation that developed into Hurricane BEULAH apparently formed on the Intertropical Convergence Zone during a period of abnormal northward displacement of this zone. Surface ship reports for several days had indicated disturbed weather conditions in an area east of the Antilles but no closed circulation could be found. Location of the first well-defined closed circulation was observed by reconnaissance aircraft on the 20th, about 660 miles east of the Lesser Antilles. Maximum winds were 30 knots in squalls and the lowest observed surface pressure was 1006 millibars."
- Reanalysis: The first position is analyzed at 00Z on August 20th as a 25 kt tropical depression, twelve hours earlier than originally shown in HURDAT, based upon ship data showing a weak west wind and 20 kt SW. The tropical depression moved northwestward on the 20th while slowly organizing. A reconnaissance aircraft investigated the tropical cyclone at 1830Z on the 20th measuring a central pressure of 1006 mb and estimated surface winds of 30 kt. A central pressure of 1006 mb suggests maximum sustained winds of 35 kt from the south of 25N Brown et al. pressure-wind relationship. Based ship data showing winds below-gale force, an intensity of 30 kt is selected at 18Z on the 20th, same as originally shown in HURDAT.

August 21:

1. Maps and old HURDAT:

- HWM analyzes a tropical storm of at most 1005 mb at 16.3N, 53.5W at 12Z.
- HURDAT lists a 35 kt tropical storm at 16.0N, 53.5W at 12Z.
- Microfilm shows a closed low pressure of at most 1011 mb at 16.5N, 54.0W at 12Z.

2. Ship highlights:

- 35 kt SE and 1005 mb at 16.9N, 54.3W at 12Z (micro).
- 45 kt NW and 1011 mb at 16.5N, 51.0W (may be 56.0W) at 18Z (micro).

3. Aircraft highlights:

- Penetration center fix measured a central pressure of 1005 mb and estimated surface winds of 45 kt at 16.5N, 54.5W at 1645Z (WALLET).

4. Discussion:

- MWR: "At 1200 GMT August 21, surface ships reported winds of 35 to 40 mph and when reconnaissance aircraft reached the area around noon, maximum winds were 52 mph with a minimum pressure of 1005 mb (29.68 in.) at the center near 16.5°N, 54.5°W. The storm moved toward the west-northwest at about 10 mph and slowly intensified during the next 24 hr."
- ATSR: "The wind reached tropical storm velocity at 1000Z on the 21st, and the first warning was issued at 211830Z. Anti-cyclonic flow at 200 mbs was well established at this time and steady intensification had begun."
- Reanalysis: The first gales associated with this tropical cyclone were reported on August 21st, although it seems that some of the ships in the microfilm maps were either not plotted correctly or the ships reported the wrong position. Intensification to a tropical storm is analyzed at 06Z on the 21st, same as originally shown in HURDAT, based upon ship and reconnaissance data later in the day. A reconnaissance aircraft investigated

Beulah at 1645Z on the 21st measuring a central pressure of 1005 mb and estimated surface winds of 45 kt. A central pressure of 1005 mb suggests maximum sustained winds of 37 kt from the south of 25N pressure-wind relationship. Based on a forward speed of about 10 kt and ship data also showing winds up to 45 kt, an intensity of 45 kt is selected at 18Z on the 21st, same as originally shown in HURDAT.

August 22:

1. Maps and old HURDAT:

- HWM analyzes a tropical storm of at most 1000 mb at 18.0N, 56.7W at 12Z.
- HURDAT lists a 70 kt hurricane at 17.9N, 56.9W at 12Z.
- Microfilm shows a closed low pressure of at most 1002 mb at 18.3N, 57.2W at 12Z.

2. Ship highlights:

- 30 kt W and 1003 mb at 16.6N, 55.1W at 00Z (micro).

3. Aircraft highlights:

- Penetration center fix measured a central pressure of 994 mb, estimated surface winds of 68 kt and an eye diameter of 25 nm at 18.1N, 57.4W at 1255Z (WALLET).
- Penetration center fix estimated surface winds of 55 kt and an eye diameter of 15 nm at 18.6N, 57.3W at 1635Z (WALLET/ATSR).
- Penetration center fix at 19.5N, 58.6W at 2330Z (WALLET).

4. Discussion:

- MWR: "On August 22, Navy reconnaissance reported that Beulah had increased to hurricane intensity with a well-formed eye and central pressure 994 mb or 29.35 in. Winds of 78 mph were observed just east of the center. A change to a more northwestward course, which began during the afternoon, removed any threat to the Leeward Islands. The highest swells that hit Saint Maarten, Netherlands West Indies, were 4 ft. over the open waters."
- ATSR: "Hurricane intensity was reached 26 hours later as BEULAH progressed northwestward at 10 knots, apparently carrying her own stratospheric anti-cyclone with her. Aircraft reconnaissance on the 22nd showed a well-defined eye 15 miles in diameter with six-degree Centigrade temperature rise from outside the wall cloud to the center. A change to a more northerly direction also occurred on the 22nd."
- Reanalysis: A penetration center fix occurred at 1255Z on the 22nd measuring a central pressure of 994 mb, estimated surface winds of 68 kt and an eye diameter of 25 nm. A central pressure of 994 mb suggests maximum sustained winds of 58 kt from the south of 25N pressure-wind relationship. An eye diameter of 25 nm suggests an RMW of about 20 nm and the climatological value is 15 nm. An intensity of 60 kt is selected at 12Z on the 22nd, down from 70 kt originally shown in HURDAT, a minor intensity change. TIROS VII captured an image of the tropical cyclone at 1355Z on the 22nd, available in the MWL (page 10 in January 1964). The satellite image shows a well-organized tropical cyclone with spiral bands and little to no signs of shear. This imagery appears to show a hurricane-strength cyclone, yet the aircraft observations are fairly conclusive that the system was not

yet a hurricane. Intensification to a hurricane is analyzed at 18Z on the 22nd, six hours later than originally shown in HURDAT.

August 23:

1. Maps and old HURDAT:

- HWM analyzes a hurricane of at most 995 mb at 21.7N, 59.2W at 12Z.
- HURDAT lists an 85 kt hurricane at 21.3N, 59.1W at 12Z.
- Microfilm shows a closed low pressure of at most 1011 mb at 21.0N, 59.5W at 12Z.

2. Ship highlights:

- 40 kt SE and 1011 mb at 21.1N, 56.5W at 00Z (micro).
- 40 kt ESE and 1004 mb at 22.1N, 57.5W at 06Z (micro).
- 35 kt ESE and 1008 mb at 22.6N, 56.1W at 12Z (micro).
- 40 kt SSE and 1009 mb at 21.5N, 58.5W at 18Z (micro).
- 40 kt SSW and 1002 mb at 21.1N, 58.4W at 21Z (micro).

3. Aircraft highlights:

- Penetration center fix measured a central pressure of 991 mb at 01Z (WALLET).
- Penetration center fix measured a central pressure of 977 mb, estimated surface winds of 90 kt and an eye diameter of 25 nm at 20.6N, 58.7W at 07Z (WALLET).
- Penetration center fix measured a central pressure of 979 mb at 21.8N, 59.6W at 15Z (WALLET).
- Penetration center fix measured a central pressure of 963 mb and estimated surface winds of 85 kt at 22.1N, 59.1W at 1740Z (WALLET).
- Penetration center fix measured a central pressure of 962 mb, estimated surface winds of 84 kt and an RMW of 19 nm near 21.0N, 59.0W at 2030Z (NHRP).
- Penetration center fix measured a central pressure of 962 mb, estimated surface winds of 90 kt and an eye diameter of 29 nm at 22.1N, 59.3W at 22Z (WALLET/ATSR).

4. Discussion:

- MWR: “The hurricane began to deepen more rapidly late on the 22nd and continued to intensify through the 23rd.”
- Reanalysis: On August 23rd, Beulah made its closest approach to the Leeward Islands, passing a couple of hundred miles to the northeast. Also on this date, the track of the hurricane turned to the north-northwest and the system continued to intensify. A couple of ships reported gale-force winds on the 23rd but all remained in the periphery of Beulah. The next reconnaissance aircraft to make a penetration center fix arrived at 01Z measuring a central pressure of 991 mb. This suggests an intensity of 64 kt from the Brown et al. south of 25N intensifying subset of the pressure-wind relationships. Based in part on the satellite imagery late on the 22nd, an intensity of 70 kt is analyzed at 00Z. At 07Z, aircraft reconnaissance

measured a central pressure of 977 mb, estimating surface winds of 90 kt and an eye diameter of 25 nm. A central pressure of 977 mb suggests maximum sustained winds of 82 kt from the south of 25N intensifying subset of the pressure-wind relationship. An eye diameter of 25 nm suggests an RMW of about 20 nm and the climatological value is 16 nm. An intensity of 80 kt is selected at 06Z on the 23rd, down from 85 kt originally shown in HURDAT, a minor intensity change. The next reconnaissance aircraft found that Beulah had continued to strengthen, measuring a central pressure of 963 mb and estimating surface winds of 85 kt at 1740Z on the 23rd. A few hours later, at 2030Z on the 23rd, another penetration fix estimated an eye diameter of 25 nm. A central pressure of 963 mb suggests maximum sustained winds of 99 kt from the south of 25N intensifying subset of the pressure-wind relationship. An eye diameter of 25 nm suggests an RMW of about 20 nm and the climatological value is 18 nm. Based on a slow forward speed of about 8 kt, an intensity of 95 kt is analyzed at 18Z on the 23rd, down from 100 kt originally shown in HURDAT, a minor intensity change.

August 24:

1. Maps and old HURDAT:

- HWM analyzes a hurricane of at most 990 mb at 23.7N, 59.6W at 12Z.
- HURDAT lists a 105 kt hurricane at 23.7N, 59.7W at 12Z.
- Microfilm shows a closed low pressure of at most 1008 mb at 23.0N, 60.0W at 12Z.

2. Ship highlights:

- 40 kt SE and 1008 mb at 22.8N, 56.5W at 00Z (micro).
- 45 kt SE and 1006 mb at 22.0N, 57.2W at 03Z (micro).
- 60 kt E and 998 mb at 24.2N, 58.1W at 06Z (micro).
- 50 kt NW and 993 mb at 23.1N, 60.6W at 10Z (micro).
- 60 kt SE and 996 mb at 16.9N, 58.3W at 12Z (micro).
- 45 kt SE and 989 mb at 23.7N, 59.7W at 13Z (micro).
- 40 kt SSE and 1002 mb at 23.5N, 57.2W at 19Z (micro).

3. Aircraft highlights:

- Radar center fix estimated an eye diameter of 29 nm at 22.6N, 58.1W at 0037Z (WALLET).
- Penetration center fix measured a central pressure of 958 mb and estimated an eye diameter of 20 nm at 23.0N, 59.6W at 0630Z (WALLET).
- Penetration center fix measured a central pressure of 961 mb, estimated surface winds of 96 kt and an RMW of 25 nm near 21.0N, 59.0W at 14Z (NHRP).
- Penetration center fix measured a central pressure of 961 mb, estimated surface winds of 102 kt and an eye diameter of 20 nm at 24.1N, 59.7W at 1450Z (WALLET).
- Penetration center fix measured a central pressure of 961 mb, estimated surface winds of 108 kt and an RMW of 20 nm near 21.0N, 59.0W at 1630Z (NHRP).

4. Discussion:

- MWR: "The lowest central pressure observed during the life of the storm was 958 mb. (28.29 in.) at 0630 GMT August 24. Radar showed an elliptical eye with a 20- to 30-mi. diameter. It is estimated that maximum winds at this time were about 120 m.p.h. During the late forenoon, aircraft penetrating the center indicated the beginning of a filling trend with an observed central pressure of 961 mb or 28.38 in., and maximum winds of 115 mph."
- ATSR: "Maximum intensity of 105 knots was reached on the 24th, coinciding with a minimum central pressure of 958 millibars. Rapid de-intensification began very soon after this peak, as BEULAH began to move away from the 200 mb anticyclone and weakening continued for 24 hours."
- Reanalysis: A penetration center fix at 22Z on the 23rd measured a central pressure of 962 mb, estimated surface winds of 90 kt and an eye diameter of 29 nm. An intensity of 95 kt is selected on August 24th at 00Z, down from 100 kt originally in HURDAT, a minor intensity change. On the 24th, the tropical cyclone continued to slowly move away from the Leeward Islands into the central Atlantic. Various ships reported gale-force winds and even storm-force winds, up to 60 kt. A penetration center fix measured a central pressure of 958 mb and estimated an eye diameter of 20 nm at 0630Z on the 24th. A central pressure of 958 mb suggests maximum sustained winds of 102 kt from the south of 25N intensifying subset of the pressure-wind relationship. An eye diameter of 20 nm suggests an RMW of about 15 nm and the climatological value is 18 nm. Based on a slow forward speed of about 6 kt and slightly smaller than average RMW, an intensity of 105 kt is retained in HURDAT. 105 kt is also the peak intensity of this tropical cyclone. The next penetration center fix occurred after 12Z on the 24th, measuring a central pressure of 961 mb at 1450Z and 1630Z. The peak intensity of 100 kt is analyzed for two consecutive time slots, 06Z and 12Z on the 24th. Based on the slight increase in central pressure, the intensity is decreased to 95 kt at 18Z on the 24th, down from 100 kt originally in HURDAT, a minor intensity change.

August 25:

1. Maps and old HURDAT:

- HWM analyzes a hurricane of at most 1000 mb at 26.5N, 61.0W at 12Z.
- HURDAT lists a 75 kt hurricane at 26.6N, 60.3W at 12Z.
- Microfilm shows a closed low pressure of at most 1011 mb at 27.0N, 60.0W at 12Z.

2. Ship highlights:

- 45 kt SE and 1013 mb at 23.5N, 56.5W at 00Z (micro).
- 35 kt S and 1011 mb at 22.8N, 56.7W at 06Z (COADS).

3. Aircraft highlights:

- Penetration center fix estimated flight level winds of 77 kt and an eye diameter of 30 nm at 25.6N, 60.5W at 0647Z (WALLET/ATSR).
- Penetration center fix measured a central pressure of 972 mb, estimated flight level winds of 60 kt and an eye diameter of 40 nm at 27.0N, 60.1W at 1310Z (WALLET). (Note that while the fix form extrapolates a pressure of 985 mb, the reported 700-mb height of 2929 m and temperature of 21C extrapolate to a pressure of 972 mb using today's formula.)

- Penetration center fix measured a central pressure of 976 mb, estimated surface winds of 80 kt and an eye diameter of 60 nm at 28.0N, 60.4W at 19Z (WALLET).
- Penetration center fix measured a central pressure of 978 mb at 28.5N, 60.6W at 22Z (WALLET).

4. Discussion:

- MWR: "The weakening stage, which persisted for the next 24 hr., was accompanied by an increase in the eye diameter to 60 mi. Maximum winds dropped to about 105 mph on the 25th. Beulah moved at 5 to 10 mph toward the north-northwest during the 2-day period covering the marked deepening and subsequent filling, then turned to the north and began to accelerate."
- Reanalysis: On August 25th, Beulah increased in forward speed to the north while gradually weakening. A reconnaissance aircraft investigated the hurricane at 1310Z on the 25th measuring a central pressure of 972 mb and an eye diameter of 40 nm. A central pressure of 972 mb suggests maximum sustained winds of 82 kt from the north of 25N pressure-wind relationship. An eye diameter of 40 nm suggests an RMW of about 30 nm and the climatological value is 18 nm. An intensity of 75 kt is analyzed at 12Z on the 25th, unchanged. Another penetration fix occurred at 19Z on the 25th measuring a central pressure of 976 mb, estimating surface winds of 80 kt and an eye diameter of 60 nm. A central pressure of 976 mb suggests maximum sustained winds of 77 kt from the north of 25N pressure-wind relationship. An eye diameter of 60 nm suggests an RMW of about 45 nm and the climatological value is 20 nm. An intensity of 70 kt is analyzed at 18Z on the 25th, down from 80 kt originally shown in HURDAT, a minor intensity change.

August 26:

1. Maps and old HURDAT:

- HWM analyzes a hurricane of at most 995 mb at 31.8N, 58.2W with a stationary front to the northwest at 12Z.
- HURDAT lists an 85 kt hurricane at 31.6N, 58.3W at 12Z.
- Microfilm shows a closed low pressure of at most 1002 mb at 31.8N, 58.2W with a frontal boundary to the northwest at 12Z.

2. Ship highlights:

- 45 kt NNW and 1004 mb at 31.9N, 60.4W at 1245Z (micro).
- 35 kt SW and 1015 mb at 26.2N, 57.5W at 18Z (micro).

3. Aircraft highlights:

- Radar center fix at 28.9N, 60.4W at 0010Z (WALLET).
- Radar center fix at 29.8N, 59.6W at 05Z (WALLET).
- Penetration center fix measured a central pressure of 983 mb, estimated surface winds of 70 kt and an eye diameter of 50 nm at 32.1N, 57.8W at 1345Z (WALLET).
- Penetration center fix measured a central pressure of 979 mb, estimated surface winds of 90 kt and an eye diameter of 80 nm at 33.1N, 56.8W at 19Z (WALLET).

4. Discussion:

- MWR: "By the 26th, forward speed had increased to 23 mph or more toward the northeast."
- ATSR: "By the 26th, BEULAH came under the influence of a trough in the westerlies and began to accelerate toward the northeast."
- Reanalysis: Another reconnaissance aircraft penetration center fix occurred at 22Z on the 25th and measured a central pressure of 978 mb. An intensity of 75 kt is analyzed at 00Z on August 24th, down from 80 kt in HURDAT, a minor intensity change. Ships remained in the periphery of the hurricane and the highest winds reported on the 25th were 45 kt. On the 26th, Beulah turned to the northeast ahead of a frontal boundary. A penetration center fix occurred at 1345Z on the 26th measuring a central pressure of 983 mb, estimated surface winds of 70 kt and an eye diameter of 50 nm. A central pressure of 983 mb suggests maximum sustained winds of 69 kt and 66 kt from the north of 25N and weakening subset of the pressure-wind relationship, respectively. An eye diameter of 50 nm suggests an RMW of about 40 nm and the climatological value is 21 nm. Based on a fast forward speed of about 18 kt, but large circulation, and continuity an intensity of 70 kt is analyzed at 12Z on the 26th, down from 85 kt originally shown in HURDAT, a minor intensity change. The final penetration fix measured a central pressure of 979 mb, estimated surface winds of 90 kt and an eye diameter of 80 nm at 19Z on the 26th. A central pressure of 979 mb suggests maximum sustained winds of 74 kt from the north of 25N pressure-wind relationship. An eye diameter of 80 nm suggests an RMW of about 60 nm and the climatological value is 22 nm. Based on a fast forward speed of about 18 kt and large circulation, an intensity of 70 kt is analyzed at 18Z on the 26th, down from 85 kt originally shown in HURDAT, a major intensity change.

August 27:

1. Maps and old HURDAT:

- HWM analyzes a hurricane of at most 990 mb at 38.8N, 52.2W with a weakening front just to the northwest at 12Z.
- HURDAT lists a 70 kt hurricane at 38.4N, 52.3W at 12Z.
- Microfilm shows a closed low pressure of at most 993 mb at 39.2N, 53.2W with a frontal boundary very close to the west at 12Z.

2. Ship highlights:

- 35 kt NE and 1017 mb at 27.2N, 58.0W at 00Z (COADS).
- 40 kt SE and 1001 mb at 33.9N, 52.3W at 06Z (micro).
- 55 E and 985 mb at 40.3N, 53.0W at 12Z (COADS).
- 60 kt SSW and 988 mb at 40.5N, 50.4W at 15Z (micro).
- 65 kt S and 1002 mb at 42.0N, 46.5W at 18Z (COADS).
- 45 kt WSW and 1001 mb at 41.7N, 49.7W at 21Z (COADS).
- 50 kt NNW and 989 mb at 44.2N, 49.7W at 23Z (COADS).

3. Aircraft highlights:

- 50 kt WNW at 38.0N 53.5W at 12Z (micro). (Other observations taken, but no vortex message available.)

4. Discussion:

- MWR: "Under the influence of an upper trough off the United States east coast, the hurricane continued to accelerate and late on the 27th passed some 250 mi. east of Newfoundland, moving on a north-northeastward course at about 40 mph."
- ATSR: "On the 27th, she passed some 250 miles east of Newfoundland, moving north-northeasterly at about 35 knots."

August 28:

1. Maps and old HURDAT:

- HWM analyzes a tropical storm of at most 980 mb at 51.7N, 40.3W with a warm front just to the north and a cold front to the south at 12Z.
- HURDAT lists a 60 kt extratropical cyclone at 51.6N, 41.0W at 12Z.
- Microfilm shows an extratropical cyclone of at most 996 mb at 51.7N, 39.8W at 12Z.

2. Ship highlights:

- 70 kt E and 975 mb at 46.5N, 48.0W at 00Z (micro).
- 65 kt SW and 987 mb at 47.5N, 43.5W at 06Z (COADS).
- 60 kt SSW and 1009 mb at 47.7N, 39.2W at 12Z (COADS).
- 55 kt SW at 50.0N, 40.9W at 18Z (COADS).

3. Discussion:

- MWR: "By 0400 GMT August 28, it was considered extratropical, a cold front having entered the circulation."
- ATSR: "By 0400Z on the 28th, she was considered extratropical, a cool air mass having entered the circulation."
- Reanalysis: Synoptic observations early on the 28th indicated that Beulah was becoming embedded within the approaching frontal boundary. On August 28th, Beulah passed a couple of hundred miles east of Newfoundland and ships near the center reported winds up to 70 kt. Transition to an extratropical cyclone is analyzed at 00Z on the 28th based upon ship data showing a substantial temperature gradient across the circulation, which is six hours earlier than that originally. On this date, the system turned to the east-northeast passing south of Greenland. Weakening below hurricane intensity is analyzed at 12Z on the 28th, same as originally shown in HURDAT.

August 29:

1. Maps and old HURDAT:

- HWM analyzes an extratropical cyclone of at most 990 mb at 52.5N, 23.0W at 12Z.
- HURDAT does not list an organized storm on this date.
- Microfilm shows that the system has moved off the map.

2. Ship highlights:

- 50 kt W and 1004 mb at 52.7N, 35.5W at 00Z (COADS).

- 45 kt W and 1002 mb at 52.6N, 26.5W at 06Z (COADS).
- 50 kt W and 1008 mb at 52.6N, 27.8W at 12Z (COADS).
- 5 kt W and 1003 mb at 53.1N, 21.0W at 18Z (COADS).

August 30:

1. Maps and old HURDAT:

- HWM analyzes an extratropical cyclone of at most 985 mb at 51.0N, 11.0W at 12Z.

2. Ship highlights:

- 50 kt W and 1006 mb at 53.2N, 21.5W at 00Z (COADS).
- 50 kt W and 991 mb at 54.4N, 17.6W at 06Z (COADS).
- 50 kt W and 997 mb at 54.3N, 18.0W at 12Z (COADS).
- 50 kt NW and 1005 mb at 54.2N, 19.0W at 18Z (COADS).

3. Discussion:

- MWR: "However, maximum winds remained 70 mph or higher and when the low center reached the British Isles, on August 30, it was still accompanied by gales. There was no loss of life or property damage attributable to hurricane Beulah."
- Reanalysis: Late on August 29th and early on August 30th, Beulah passed south of Iceland. Late on the 30th, the extratropical cyclone approached northern Ireland and turned to the southeast.

August 31:

1. Maps and old HURDAT:

- HWM analyzes an extratropical cyclone of at most 995 mb at 51.5N, 5.0W at 12Z.

2. Ship highlights:

- 50 kt W at 50.7N, 10.2W at 00Z (COADS).
- 60 kt NW and 1010 mb at 49.9N, 14.5W at 06Z (COADS).
- 60 kt NW and 1016 mb at 50.0N, 15.3W at 12Z (COADS).
- 45 kt WNW and 1009 mb at 46.7N, 10.3W at 18Z (COADS).

3. Discussion:

- Reanalysis: On August 31st, Beulah crossed northern Ireland and southwest Wales en route to France. Ship data indicates that it was still producing winds up to 60 kt.

September 1:

1. Maps and old HURDAT:

- HWM analyzes an extratropical cyclone of at most 1000 mb at 49.0N, 0.5W at 12Z.

2. Ship highlights:

- 40 kt NNW at 51.0N, 12.5W at 00Z (COADS).

- 35 kt NW and 1003 mb at 46.8N, 6.2W at 06Z (COADS).

3. Discussion:

- Reanalysis: On September 1st, the extratropical cyclone moved over northwest France, later turning to the north and crossing into England on September 2nd.

September 2:

1. Maps and old HURDAT:

- HWM analyzes an extratropical cyclone of at most 1010 mb at 53.0N, 0.0W at 12Z.

2. Discussion:

- Reanalysis: Synoptic observations indicate that Beulah weakened below gale-force at 06Z on the 2nd.

September 3:

1. Maps and old HURDAT:

- HWM analyzes an extratropical cyclone of at most 1005 mb at 58.0N, 2.0E at 12Z.

2. Ship highlights:

- 10 kt SE and 1004 mb at 56.5N, 3.0E at 12Z (COADS).

September 4:

1. Maps and old HURDAT:

- HWM analyzes an extratropical cyclone of at most 1005 mb at 58.0N, 2.0E at 12Z.

2. Ship highlights:

- 15 kt NNE and 1000 mb at 59.3N, 0.1W at 12Z (COADS).

3. Discussion:

- Reanalysis: Early on September 3rd, ship data show that the weak cyclone moved into the North Sea and traveled northeastward passing west of Norway on September 4th.

September 5:

1. Maps and old HURDAT:

- HWM analyzes an extratropical cyclone of at most 1005 mb at 66.0N, 5.0E at 12Z.

2. Ship highlights:

- 10 kt NE and 1000 mb at 67.9N, 8.8E at 12Z (COADS).

September 6:

1. Maps and old HURDAT:

- HWM analyzes an extratropical cyclone of at most 1005 mb at 71.0N, 8.0E at 12Z.

2. Ship highlights:

- 25 kt NE and 1000 mb at 70.3N, 1.5W at 12Z (COADS).

September 7:

1. Maps and old HURDAT:

- HWM analyzes an extratropical cyclone of at most 980 mb at 62.0N, 26.0E (Beulah's extratropical cyclone appears to have been absorbed) at 12Z.

2. Discussion:

- Reanalysis: This system finally dissipated after 18Z on September 8th. The last position is analyzed at 18Z on the 8th, 10 days later than originally shown in HURDAT.

Date	Original HURDAT Central Pressure	Evidence	Changes
Aug 20 18Z	1006 mb	Penetration center fix: 1006 mb at 1830Z on Aug 20th	Retained
Aug 21 18Z	1005 mb	Penetration center fix: 1005 mb at 1645Z on Aug 21st	
Aug 22 12Z	994 mb	Penetration center fix: 994 mb at 1255Z on Aug 22nd	
Aug 23 00Z		Penetration center fix: 991 mb at 01Z on Aug 23rd	991 mb
Aug 23 06Z		Penetration center fix: 977 mb at 07Z on Aug 23rd	977 mb
Aug 23 18Z	962 mb	Penetration center fix: 963 mb at 1740Z on Aug 23rd	963 mb
Aug 24 00Z		Penetration center fix: 962 mb at 22Z on Aug 23rd	962 mb
Aug 24 06Z	958 mb	Penetration center fix: 958 mb at 0630Z on Aug 24th	Retained
Aug 24 12Z		Penetration center fix: 961 mb at 14Z on Aug 24th	961 mb
Aug 24 18Z	961 mb	Penetration center fix: 961 mb at 1630Z on Aug 24th	Retained
Aug 25 12Z	985 mb	Penetration center fix: 972 mb at 1310Z on Aug 25th	972 mb
Aug 25 18Z	976 mb	Penetration center fix: 976 mb at 19Z on Aug 25th	Retained
Aug 26 00Z	978 mb	Penetration center fix: 978 mb at 22Z on Aug 25th	
Aug 26 12Z	983 mb	Penetration center fix: 983 mb at 1345Z on Aug 26th	
Aug 26 18Z	979 mb	Penetration center fix: 979 mb at 19Z on Aug 26th	

Sources: the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Monthly Weather Review, Navy reconnaissance book, Mariners Weather Log, National Hurricane Research Project (NHRP), Allison & Thompson (1966) and NHC Storm Wallets.

Unnamed Hurricane [September 9-14, 1963] – AL031963

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42790 09/10/1963 M= 6  3 SNBR= 926 NOT NAMED   XING=0 SSS=0
42790 09/09/1963 M= 6  3 SNBR= 926 NOT NAMED   XING=0 SSS=0
         **

(September 9th is new to HURDAT)
42793 09/09*  0   0   0    0*  0   0   0    0*255 675  25    0*271 673  25    0*
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                                *** ***  **      *** ***  **      *** ***  **

42795 09/10*  0   0   0     0*305 664  25     0*320 661  25 1007*329 639  25     0*
42795 09/10*287 670  25     0*303 664  25     0*319 655  30 1007*333 641  35  1003*
           *** ***  **       ***              *** ***  **      *** ***  **  ****

42800 09/11*338 618  25     0*348 597  35     0*358 576  35 1004*365 558  35     0*
42800 09/11*346 623  35     0*358 600  40     0*364 576  50    0*369 553  60   996*
           *** ***  **       *** ***  **       ***       **    * *** ***  **   ***

42805 09/12*370 542  35     0*371 526  45     0*372 513  50     0*379 510  50  992*
42805 09/12*374 538  65     0*377 529  70     0*379 522  70     0*383 514  65  990*
           *** ***  **       *** ***  **       *** ***  **      *** ***  **   ***

42810 09/13*388 517  50     0*397 510  50     0*410 497  50     0*432 478  50     0*
42810 09/13*390 505  60     0*402 494  55     0*416 481  50     0*435 466  50     0*
           *** ***  **       *** ***  **       *** ***             *** ***

42815 09/14*457 446  50     0*478 399  50  995*498 352  50     0E515 306  50     0*
42815 09/14*457 438  50     0*478 399  50    0*498 352  50     0*  0   0   0     0*
              ***                           *                   *  *   *   *

(September 15th has been removed)
42820 09/15E530 261  50     0E549 220  50     0*  0   0   0     0*  0   0   0     0*
42820 09/15*  0   0   0     0*  0   0   0     0*  0   0   0     0*  0   0   0     0*
           *  *   *   *      *  *   *   *

42825 TS
42825 HR
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Significant Revisions:

- Intensity substantially boosted on the 11th and 12th based upon ship observations.
- A major alteration is to indicate that the tropical cyclone reached hurricane intensity.
- Positions are substantially shifted east-northeastward on the 13th based upon ship observations.
- No extratropical transition is now shown for this system.

Daily Summary:

September 8:

1. Maps and old HURDAT:

- HWM analyzes a trough of low pressure extended from 20N-30N, 66W with a stationary front far to the northwest at 12Z.
- HURDAT does not list an organized system on this date.
- Microfilm shows a tropical wave or trough extended from 19N-28N, 66W at 12Z.

2. Discussion:

- MWR: "Each year several storms occur which are not entirely tropical in character. Tropical cyclones derive their energy from latent heat of condensation while extratropical cyclones depend upon proper positioning of

cold and warm air masses; i.e., cold air sinks and spreads under warm air causing air motion. At times "half-breed" cyclones develop over tropical oceans and tap both energy sources. In these cases it is difficult to decide whether a tropical cyclone name should be assigned to the Low. The Unnamed Storm in September was of this type, as was the late May-early June storm. It was not until a critical ship log was received after the hurricane season that the decision could be made to include the September storm in the official list. Ship reports indicated a weak circulation north of Puerto Rico on September 8."

- Reanalysis: A tropical wave or trough of low pressure was located north of Puerto Rico on September 8th based upon Microfilm and Historical Weather Maps. The disturbance moved northward and became better organized.

September 9:

1. Maps and old HURDAT:

- HWM analyzes a spot low pressure at 28.0N, 67.0W and another spot low at 25.7N, 74.2W with a cold front to the northwest at 12Z.
- HURDAT does not list an organized system on this date.
- Microfilm shows a closed low pressure of at most 1011 mb at 25.7N, 67.3W at 12Z.

2. Discussion:

- Reanalysis: A 25 kt tropical depression is analyzed to have developed at 12Z on September 9th based on synoptic data in the microfilm maps, 18 hours earlier than originally shown in HURDAT. A satellite imagery composite for 1645Z showing organized convection with the system at that time as supports an earlier genesis.

September 10:

1. Maps and old HURDAT:

- HWM analyzes a closed low pressure of at most 1010 mb at 32.0N, 66.0W with a weakening cold front to the west at 12Z.
- HURDAT lists a 25 kt tropical depression at 32.0N, 66.1W at 12Z.
- Microfilm shows a closed low pressure of at most 1011 mb at 32.0N, 66.7W with another low pressure to the west and a frontal boundary to the north at 12Z.

2. Ship highlights:

- 15 kt N and 1005 mb at 33.4N, 64.3W at 18Z (COADS).

3. Discussion:

- MWR: "The depression drifted slowly northward passing over Bermuda during the afternoon of the 10th. The pressure on Bermuda dropped to 1007 mb, or 29.74 in, and winds increased to 25 mph."
- Reanalysis: The tropical depression turned to the northeast on September 10th ahead of an approaching frontal boundary. A central pressure of 1007 mb is present in HURDAT at 12Z on the 10th and has been retained based on the report of 15 kt SE and 1009 mb by Bermuda at 12Z on the 10th. Around 14Z on the 10th, the tropical depression passed about 10 nm west of Bermuda. At 18Z on the 10th, a ship reported 15 kt N and 1005 mb, suggesting a central

pressure of 1003 mb, which has been added to HURDAT. A central pressure of 1003 mb suggests maximum sustained winds of 38 kt from the north of 25N Brown et al. pressure-wind relationship. Based upon a forward speed of about 21 kt but relatively low environmental pressures (1010 mb OCI) at this latitude, an intensity of 35 kt is selected at 18Z on the 10th, up from 25 kt originally in HURDAT, a minor intensity change. Intensification to a tropical storm is analyzed at 18Z on the 10th, twelve hours earlier than originally shown in HURDAT.

September 11:

1. Maps and old HURDAT:

- HWM analyzes a closed low pressure of at most 1005 mb at 36.5N, 57.5W with a cold front just to the west at 12Z.
- HURDAT lists a 35 kt tropical storm at 35.8N, 57.6W at 12Z.
- Microfilm shows a closed low pressure of at most 1011 mb at 37.5N, 58.0W with a frontal boundary extending to the southwest at 12Z.

2. Ship highlights:

- 35 kt SSE and 1001 mb at 36.6N, 57.4W at 12Z (COADS).
- 40 kt N and 1011 mb at 36.4N, 60.7W at 12Z (COADS).
- 50 kt SSE and 1001 mb at 37.0N, 55.0W at 18Z (COADS).
- 25 kt WNW and 999 mb at 37.0N, 55.5W at 18Z (COADS).
- 5 kt SW and 1000 mb at 37.0N, 54.6W at 21Z (COADS).

3. Discussion:

- MWR: “Tropical storm intensity was reached shortly before sunrise on the 11th.”
- Reanalysis: The tropical storm continued to the northeast on September 11th and rapidly intensified. The first gales were reported at 12Z on the 11th. At this time, microfilm shows a frontal boundary extending from the center to the southwest and another frontal boundary to the north, but HWM indicates that the small tropical cyclone was still ahead of the frontal boundary and in the warm sector. Synoptic observations are in better agreement with HWM and show that there is no temperature gradient across the circulation, thus it was still a tropical cyclone. A central pressure of 1004 mb is present in HURDAT at 12Z on the 11th and has been removed due to a ship report of 35 kt SSE and 1001 mb, suggesting a central pressure lower than what appears in HURDAT. A ship reported 50 kt SE and 1001 and another registered 25 kt NW and 999 mb. The latter ship observation indicates a central pressure of 996 mb, which has been added to HURDAT at 18Z on the 11th. A central pressure of 996 mb suggests maximum sustained winds of 55 kt from the north of 35N Landsea et al. pressure-wind relationship. Due to a forward speed of about 26 kt and normal environmental pressures (1014 mb OCI), an intensity of 60 kt is selected at 18Z on the 11th, up from 35 kt originally in HURDAT, a major intensity change.

September 12:

1. Maps and old HURDAT:

- HWM analyzes a tropical storm of at most 1010 mb at 37.5N, 51.5W with a weakening stationary front just to the west and a warm front to the northeast at 12Z.
- HURDAT lists a 50 kt tropical storm at 37.2N, 51.3W at 12Z.
- Microfilm shows a closed low pressure of at most 1008 mb at 37.0N, 52.5W with a frontal boundary extending through the center at 12Z.

2. Ship highlights:

- 45 kt N and 1012 mb at 36.8N, 54.8W at 00Z (COADS).
- 10 kt W and 998 mb at 37.4N, 52.5W at 06Z (COADS).
- 70 kt S and 996 mb at 37.4N, 52.2W at 09Z (COADS).
- 50 kt S and 1008 mb at 37.0N, 52.0W at 12Z (COADS).
- 15 kt SE and 992 mb at 38.5N, 50.9W at 18Z (micro).
- 45 kt SSE and 1000 mb at 38.0N, 51.6W at 15Z (COADS).
- 45 kt NW and 1005 mb at 37.9N, 52.3W at 18Z (COADS).

3. Discussion:

- MWR: "Maximum intensity occurred on the 12th when the Freiburg experienced 78 mph winds, 27-ft. seas, and a pressure of 995 mb, or 29.39 in. The center remained small and tightly knit as the storm accelerated rapidly northeastward ahead of a cold front."
- Reanalysis: On September 12th, the tropical cyclone decreased in forward speed and kept intensifying. Intensification to a hurricane is analyzed at 00Z on the 12th, a major change to HURDAT, which originally indicated that the tropical cyclone had peaked as a tropical storm. An intensity of 65 kt is selected at 00Z on the 12th based upon ship data later in the day, up from 35 kt originally in HURDAT, a major intensity change. A ship named "Freiburg" reported 70 kt S and 996 mb at 09Z on the 12th. Based on this data, a peak intensity of 70 kt is analyzed at 06Z and 12Z on the 12th, up from 45 kt and 50 kt, respectively, originally in HURDAT, major intensity changes. Originally HURDAT showed a peak intensity of 50 kt from September 12th at 12Z to September 14th at 12Z. Note that the satellite imagery composite for 1428Z supports this upgrade to hurricane intensity as well. At 18Z on the 12th, a ship reported 15 kt SE and 992 mb, suggesting a central pressure of 990 mb, which has been added to HURDAT replacing the existing 992 mb. A central pressure of 990 mb suggests maximum sustained winds of 63 kt from the north of 35N pressure-wind relationship. Based on a slow forward speed of 7 kt and also the earlier 70 kt ship report, an intensity of 65 kt is selected at 18Z on the 12th, up from 50 kt originally in HURDAT, a major intensity change.

September 13:

1. Maps and old HURDAT:

- HWM analyzes a tropical storm of at most 1005 mb at 41.4N, 49.4W with a warm front just to the northeast at 12Z.
- HURDAT lists a 50 kt tropical storm at 41.0N, 49.7W at 12Z.
- Microfilm shows a closed low pressure of at most 1011 mb at 40.8N, 48.3W with a frontal boundary extending through the center at 12Z.

2. Ship highlights:

- 35 kt N and 1014 mb at 43.1N, 45.7W at 12Z (COADS).
- 35 kt W and 1013 mb at 42.1N, 48.4W at 18Z (COADS).

3. Discussion:

- Reanalysis: On September 13th, the hurricane weakened and passed a couple hundred miles southeast of Newfoundland, Canada.

September 14:

1. Maps and old HURDAT:

- HWM analyzes a tropical storm of at most 1005 mb at 50.3N, 35.2W with a cold front just to the west at 12Z.
- HURDAT lists a 50 kt tropical storm at 49.8N, 35.2W at 12Z.
- Microfilm shows an extratropical cyclone of at most 1005 mb at 53.0N, 38.0W at 12Z.

2. Ship highlights:

- 40 kt SSW and 1016 mb at 44.0N, 41.0W at 00Z (COADS).
- 45 kt SW and 1017 mb at 44.0N, 41.0W at 03Z (COADS).
- 35 kt SSW and 1016 mb at 44.5N, 39.6W at 06Z (COADS).
- 40 kt SW and 997 mb at 48.6N, 35.3W at 12Z (COADS).

3. Discussion:

- MWR: "Tropical characteristics were lost on September 14."
- Reanalysis: A central pressure of 995 mb appears in HURDAT at 12Z on the 14th, and has been removed due to a ship reporting 40 kt SW and 997 mb, indicating a lower central pressure. Ship data late on September 14th indicate that the small system was absorbed by a larger extratropical cyclone to its north. The last position is analyzed at 12Z on the 14th, 18 hours earlier than originally shown in HURDAT.

September 15:

1. Maps and old HURDAT:

- HWM analyzes an extratropical cyclone of at most 1015 mb at 52.0N, 27.0W at 12Z.
- HURDAT lists a 50 kt extratropical cyclone at 54.9N, 22.0W at 06Z (last position).
- Microfilm shows a closed low pressure at 54.5N, 18.0W at 12Z (system exiting the map boundaries).

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

Tropical Storm Cindy [September 16-20, 1963] – AL041963

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42830 09/16/1963 M= 5  4 SNBR= 927 CINDY       XING=1 SSS=1

42835 09/16*  0   0   0    0*  0   0   0    0*267 937  40    0*273 939  60    0*
42835 09/16*  0   0   0    0*  0   0   0    0*267 937  40    0*273 938  50    0*
                                                                ***  **

42840 09/17*280 939  70  996*287 941  65    0*294 944  65    0*298 944  65  997*
42840 09/17*280 939  55  996*287 941  55    0*294 943  55  997*298 945  50  996*
                     **                ** ***  **  ***     ***  **  ***
42845 09/18*300 946  65    0*301 949  35    0*301 952  30    0*299 956  25    0*
42845 09/18*300 947  40    0*301 949  35    0*301 952  30    0*299 956  25    0*
                ***  **

42850 09/19*295 960  25    0*292 964  25    0*287 970  25    0*284 974  25    0*
42850 09/19*297 960  25    0*294 965  25    0*290 970  25    0*284 975  25    0*
           ***              *** ***          ***                ***

42855 09/20*278 981  25    0*  0   0   0    0*  0   0   0    0*  0   0   0    0*
42855 09/20*276 981  25    0*  0   0   0    0*  0   0   0    0*  0   0   0    0*
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42860 HRCTX1
42860 TS
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U.S. Tropical Storm Landfall

09/17 14Z 29.6N 94.3W 55 kt TX - 997 mb

Significant Revisions:

- Intensity substantially reduced on the 16th and 17th based upon aircraft reconnaissance data.
- Downgrade introduced for the system from a hurricane to a tropical storm.

Daily Summary:

September 13:

1. Maps and old HURDAT:

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

September 14:

1. Maps and old HURDAT:

- HWM analyzes does not analyze an organized system at 12Z.
- HURDAT does not list an organized system on this date.
- Microfilm shows a spot low at 20.1N, 94.6W at 12Z.

2. Discussion:

- MWR: “Weather conditions had been highly disturbed in the southwestern Gulf on the 14th and 15th.”

- Reanalysis: A tropical wave or trough of low pressure was located over the western Gulf of Mexico on September 14th based upon the microfilm maps.

September 15:

1. Maps and old HURDAT:

- HWM analyzes a spot low pressure at 24.2N, 92.8W at 12Z.
- HURDAT does not list an organized system on this date.
- Microfilm shows a spot low at 21.5N, 97.0W at 12Z.

2. Ship highlights:

- 25 kt SE and 1004 mb at 21.0N, 92.4W at 12Z (micro).

3. Discussion:

- Reanalysis: An area of low pressure developed in the Bay of Campeche on September 15th and moved northward becoming better organized. Two ships reported low pressures (1004 mb and 1002 mb) at 12Z on the 15th but subsequent observations from the ships indicate that there likely was a low bias of a few millibars in the measurements.

September 16:

1. Maps and old HURDAT:

- HWM analyzes a tropical storm of at most 1005 mb at 26.8N, 93.8W at 12Z.
- HURDAT lists a 40 kt tropical storm at 26.7N, 93.7W at 12Z (first position).
- Microfilm shows a trough of low pressure over the western Gulf of Mexico at 12Z.

2. Ship highlights:

- 45 kt SE and 1009 mb at 27.1N, 93.2W at 15Z (micro, *Sabine*).
- 50 kt W and 1008 mb (999 mb in MWL) at 27.2N, 94.0W at 18Z (COADS, *Sabine*).
- 65 kt at 20Z (MWR, *Sabine*).
- 45 kt E and 1005 mb at 28.2N, 93.5W at 21Z (micro).

3. Aircraft highlights:

- Penetration center fix measured a central pressure of 996 mb, estimated surface winds of 55 kt and an eye diameter of 30 nm at 27.9N, 93.9W at 2325Z (ATSR).

4. Radar highlights:

- Galveston radar center fix at 27.8N, 94.0W at 2047Z (WALLET).
- Galveston radar center fix at 28.1N, 93.7W at 2345Z (WALLET).

5. Discussion:

- MWR: “Cindy, the first hurricane in the Gulf of Mexico in two years, formed in a trough of low pressure located about 200 mi. east-northeast of Brownsville, Tex., in the morning of September 16. Ship reports received around noon CST, indicated that the circulation was of tropical storm strength and was intensifying rapidly. By 2:00 p.m. the central eye was developed sufficiently to be located about 200 mi. east of Corpus Christi by

the WSR-57 radar at Galveston. At the same hour, a report from the *SS Sabine* near the storm center indicated hurricane force winds, although there is some question whether the wind velocity recorder was read carefully, Cindy moved northward at an average speed of 8 mph during the afternoon and night of the 16th, remaining relatively small in area and with no further increase in intensity, although most of the circulation was still over the warm Gulf waters."

- ATSR: "CINDY apparently formed on the trailing edge of a surface quasi-stationary front elongated east-west through the Northern Gulf of Mexico. A trough of low pressure at the upper levels was located in the Western Gulf. Hurricane CINDY, the third and most short-lived storm of the 1963 season, formed over the western Gulf of Mexico approximately 225 miles east of Brownsville, Texas. On the morning of 16 September, several ships reported winds and pressure which indicated the possible development of a tropical storm. Later ship reports indicated that a circulation had formed and was rapidly intensifying. Based on this information, the first of five numbered warnings was issued at 1900Z on the 16th. Warnings two, three, and four placed her in the category of a hurricane."

- MWL: "Hurricane Cindy, the first in the Gulf of Mexico in two years, formed about 200 mi. east-northeast of Brownsville, Tex., on the morning of September 16. Ship reports received around 1800 GMT, indicated that the circulation was of tropical storm force and intensifying rapidly. Two hours later a report from the SABINE near the storm center indicated hurricane force winds. Cindy moved slowly northward toward the Texas coast, remaining relatively small in area and with no further increase in intensity."

- Reanalysis: The disturbance first noted over the southwestern Gulf of Mexico on September 14th moved northward and formed into a tropical cyclone on the 16th in the northwestern Gulf. The first position is analyzed at 12Z as a 40 kt tropical storm, same as originally shown in HURDAT. The time of genesis is uncertain because surface observations over the southwest Gulf of Mexico were sparse, but measurements from South Texas and ships early on the 16th suggests that genesis may have occurred as early as late on the 15th or early on the 16th. The first gale was reported by the ship SS SABINE at 15Z on the 16th, indicating 45 kt SE and 1009 mb. At 18Z on the 16th, SS SABINE reported 50 kt W and 999 mb. The MWR says that two hours after this report, 20Z, the SS SABINE reported hurricane-force winds but MWR questions the accuracy of the report. Nonetheless, this report was originally used by the forecasters to operationally upgrade the tropical cyclone to a hurricane. The hurricane-force wind report was not found on COADS, microfilm or MWL, even though other observations from this ship were present in all three sources.

September 17:

1. Maps and old HURDAT:

- HWM analyzes a closed low pressure of at most 1000 mb at 29.5N, 94.5W at 12Z.

- HURDAT lists a 65 kt hurricane at 29.4N, 94.4W at 12Z.

- Microfilm shows a closed low pressure of at most 1008 mb at 29.5N, 94.5W at 12Z.

2. Ship highlights:

- 50 kt NE and 1009 mb at 27.4N, 95.1W at 00Z (COADS).

- 50 kt SE at 28.9N, 92.8W at 06Z (COADS).

3. Land highlights:

- 45 kt (fastest mile, gusts to 65 kt) at Galveston, TX at 0815Z (WALLET).
- 1000 mb (min pressure) at Galveston, TX at 1129Z (WALLET).
- 997 mb (min pressure) at High Island, TX at 16Z (WALLET).
- 996 mb (min pressure) at Anahuac, TX at 2027-2045Z (WALLET).

4. Radar highlights:

- Lake Charles radar center fix estimated an eye diameter of 30 nm at 28.4N, 93.6W at 0119Z (WALLET).
- Galveston radar center fix at 28.8N, 94.0W at 0645Z (WALLET).
- Galveston radar center fix at 29.6N, 94.4W at 1245Z (WALLET).

5. Discussion:

- MWR: "Winds and tides along the coast from the Galveston area eastward increased during the evening, with winds reaching maximum values during the early morning hours of the 17th. Over the Gulf, highest sustained winds were estimated at 80 mph and highest gusts on the coast were 80 mph, measured near the eastern tip of Galveston Island. The Weather Bureau Office at Galveston recorded a fastest mile at the rate of 50 mph, and a peak gust of 74 mph on the 17th. In the Port Arthur area, the highest gusts were from 40 to 50 mph, while in Louisiana gusts were estimated as high as 60 mph at Grand Chenier and 45 mph at Cameron, but were generally in the 25 to 35 mph range. The central eye of Cindy, some 20 mi in diameter, moved on shore around High Island, about midway between Galveston and Port Arthur. The Corps of Engineers there reported "light winds and near calm" between 7:30 and 11:00 a.m., CST, on the 17th and a low barometer reading of 29.44 in. (997 mb.) at 10:00 am. A slightly lower pressure, 29.41 in. (996 mb.), was recorded inland at Anahuac between 2:27 and 2:45 pm."
- ATSR: "From her source area, CINDY moved on a northward course, reaching the shoreline on the 17th between Galveston and Port Arthur, Texas. Upon reaching shore, CINDY slowed considerably and began drifting westward, then finally southwestward until dissipation occurred just southwest of Houston, Texas. The highest winds accompanying CINDY were estimated to be near 80 knots while she was still over open waters, and 55-65 knots [likely gusts] while over land. Minimum pressure recorded was 996 millibars. CINDY, although a relatively small, short-lived storm, had captured several distinctions for the 1963 season. She was the only storm to originate in the Gulf of Mexico, and she was the only storm to hit the United States mainland. Winds accounted for little damage, but excessive precipitation and the slow movement caused damaged by heavy flooding. Since CINDY developed near land, the abnormal high tide which is generally associated with hurricanes was absent."
- Reanalysis: A few hours later, at 2325Z on the 16th, a reconnaissance aircraft made a center penetration measuring a central pressure of 996 mb, estimating surface winds of 55 kt and an eye diameter of 30 nm. A central pressure of 996 mb suggests maximum sustained winds of 50 kt from the north

of 25N Brown et al. pressure-wind relationship. An eye diameter of 30 nm suggests an RMW of about 25 nm and the climatological value is 23 nm. Based upon the reliable ship data showing winds up to 50 kt, an intensity of 55 kt is analyzed at 00Z on September 17th, down from 70 kt originally in HURDAT, a major intensity change. 55 kt is also the peak intensity of this tropical cyclone, down from 70 kt originally in HURDAT, a major intensity change. It is analyzed that Cindy did not reach hurricane intensity as previously shown in HURDAT. A central pressure of 996 mb was present in HURDAT at 00Z on the 17th and has been retained. Cindy moved slowly northward on the 17th making landfall around 14Z near High Island, Texas, as a 55 kt tropical storm. High Island, TX, reported near calm conditions and a minimum pressure of 997 mb, which has been added as a central pressure at landfall and to the 12Z time slot on the 17th. A radar image captured by the Galveston radar at 0950Z on the 17th shows a well-organized tropical cyclone with spiral bands over the eastern and northern quadrants. The highest sustained winds on land were 45 kt and gusts to 65 kt at Galveston, Texas, at 0815Z on the 17th. The slow-moving tropical storm remained close to the large Galveston Bay and a few hours after landfall, Anahuac, Texas, reported a minimum pressure of 996 mb. The minimum pressure was registered around 2030Z, thus it is used to replace the existing central pressure of 997 mb in HURDAT at 18Z on the 17th.

September 18:

1. Maps and old HURDAT:

- HWM analyzes a closed low pressure of at most 1005 mb at 30.5N, 95.3W at 12Z.
- HURDAT lists a 30 kt tropical depression at 30.1N, 95.2W at 12Z.
- Microfilm shows a closed low pressure of at most 1011 mb at 29.8N, 95.5W at 12Z.

2. Radar highlights:

- Lake Charles radar center fix at 29.8N, 94.5W at 0115Z (WALLET).
- Lake Charles radar center fix at 30.1N, 94.9W at 0545Z (WALLET).

3. Discussion:

- MWR: “The storm center became almost stationary for about 18 hr. shortly after moving inland, then drifted very slowly westward and southwestward with slowly decreasing intensity through the Texas Coastal Plain on September 18 and 19. This unusually slow movement during the decay of the storm resulted in an extended period of heavy rainfall in its northeastern sector over extreme southeastern Texas and southwestern Louisiana. Storm rainfall totals were 15 to 20 in. in portions of Jefferson, Newton, and Orange Counties, Texas and Calcasieu and Vermilion Parishes, Louisiana. The heaviest rain occurred at Deweyville, in southern Newton County: a 3-day total of 23.50 in., including 20.60 in. in 24 hr. between 7 am CST, observations on September 17 and 18.”
- Reanalysis: On September 18th, Cindy turned to the west and southwest and weakened over southeast Texas. At 00Z on the 18th, an intensity of 40 kt is analyzed, down from 65 kt originally shown in HURDAT, a major intensity change. HURDAT originally unrealistically maintained Cindy as a hurricane

for 10 hours after the small tropical cyclone made landfall at barely hurricane intensity. Weakening to a tropical depression is analyzed at 12Z on the 18th, same as originally shown in HURDAT.

September 19:

1. Maps and old HURDAT:

- HWM analyzes a closed low pressure of at most 1010 mb at 29.5N, 97.0W at 12Z.
- HURDAT lists a 25 kt tropical depression at 28.7N, 97.0W at 12Z.
- Microfilm shows a closed low pressure of at most 1011 mb at 29.0N, 96.5W at 12Z.

2. Discussion:

- Reanalysis: Synoptic observations indicate that Cindy retained a closed low-level circulation on September 19th while moving southwest over South Texas.

September 20:

1. Maps and old HURDAT:

- HWM and microfilm do not analyze an organized system at 12Z.
- HURDAT lists a 25 kt tropical depression at 27.8N, 98.1W at 00Z (last position).

2. Discussion:

- MWR: "Property damage from wind was minor, consisting of roof damage to beach homes. Only minor flooding and some slight damage occurred from tides, but several roads were impassable for short periods, and waves destroyed several piers and caused some damage to boats."
- Reanalysis: The system finally dissipated after 00Z on September 20th. The last position is analyzed at 00Z on the 20th, same as 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, Surface Weather Observations, Mexican Surface Observations and NHC Storm Wallets.

Hurricane Debra [September 19-24, 1963] – AL051963

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42865 09/19/1963 M= 6  5 SNBR= 928 DEBRA       XING=0 SSS=0

42870 09/19*  0   0   0    0*144 383  25    0*150 398  25 1011*157 412  30    0*
42870 09/19*  0   0   0    0*140 383  25    0*148 398  25    0*156 412  30    0*
                                                          *

42875 09/20*164 426  30    0*172 440  25    0*179 453  25    0*188 467  30 1008*
42875 09/20*164 426  40    0*172 440  45    0*180 453  50    0*189 467  50    0*
                     **                **                **                **    *

42880 09/21*199 479  35    0*209 485  40    0*219 488  50    0*230 489  65 1000*
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42880 09/21*199 479  50     0*210 485  50     0*221 488  55     0*231 489  65 1000*
                     **       ***       **       ***       **       ***

42885 09/22*238 489  65     0*246 488  65     0*253 487  65 1002*260 485  65  999*
42885 09/22*238 489  65     0*246 488  65     0*253 487  65 1002*258 485  60  999*
                                                            ***       **

42890 09/23*266 482  65     0*273 479  55     0*280 477  50     0*288 475  45  999*
42890 09/23*265 482  60     0*272 479  55     0*280 477  50     0*288 475  50  999*
           ***       **       ***                                          **

42895 09/24*302 475  40     0*317 479  35     0*334 484  35 1011E354 480  30    0*
42895 09/24*302 478  40     0*317 481  35     0*334 484  35 1011*354 480  30    0*
               ***               ***                          *

42900 HR
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Significant Revisions:

- Substantial boost to intensity on 20th and 21st based upon ship observations.
- Removed the extratropical transition for this system.

Daily Summary:

September 17:

1. Maps and old HURDAT:

- HWM analyzes a spot low pressure at 12.0N, 27.0W at 12Z.
- HURDAT does not list an organized system on this date.
- Microfilm does not show an organized system on this date.

2. Discussion:

- Reanalysis: Tropical Storm Debra developed from a tropical wave that entered the eastern Atlantic Ocean around September 15th. Data over this part of the basin is sparse, thus the time of genesis is uncertain. The HWM show a spot low pressure near 13N, 17W on September 17th while the disturbance was located southwest of the Cape Verde Islands. TIROS VII captured an image of the tropical system at 13Z on the 17th showing a large area of organized cloudiness with a center near 13N, 43W. This position is about 10-15 degrees too far to the west based on ship and reconnaissance data over the next couple of days and may either reflect bad navigation of the satellite picture or there was a second wave in the vicinity.

September 18:

1. Maps and old HURDAT:

- HWM analyzes a closed low pressure of at most 1010 mb at 13.8N, 33.8W at 12Z.
- HURDAT does not list an organized system on this date.
- Microfilm does not show an organized system on this date.

September 19:

1. Maps and old HURDAT:

- HWM analyzes a closed low pressure of at most 1010 mb at 15.0N, 39.7W at 12Z.
- HURDAT lists a 25 kt tropical depression at 15.0N, 39.8W at 12Z.
- Microfilm does not show an organized system at 12Z.

2. Satellite highlights:

- TIROS center fix at 17.5N, 41.5W at 1205Z (WALLET).

3. Discussion:

- MWR: "Hurricane Debra formed in the mid-tropical Atlantic and moved on a course well removed from any land areas. The first evidence of the circulation which later developed into Debra came from a ship report and a TIROS picture early on September 19."
- ATSR: "The first appearance of the disturbed area which was to develop into Hurricane DEBRA was reported at 190600Z by a ship near 14N 38W that encountered an overcast sky, light winds and a surface pressure several millibars below normal. A TIROS photograph at 191200Z indicated a possible vortex in the disturbed area, and a ship near 16N 40W reported winds easterly 25 knots and increasing, overcast skies and steady rain. DEBRA's course, from early development on the 19th until the storm was absorbed by a large extratropical low on the 24th, was predominately northerly. While at storm intensity, DEBRA was never well organized. The eye was poorly defined, and the wall cloud contained large open areas."
- Reanalysis: The disturbance moved westward and became better organized. Another satellite image was captured on September 19th at 1205Z near 18N, 42W showing a well-organized system. Once again, the position appears to be misplaced, but this time, by about 150 nm too far to the northwest based on ship data at the time the satellite image was taken. Due to the rudimentary technology of the day, it has been noticed with other satellite images of tropical cyclones over the open Atlantic Ocean that their estimated position has also been off by a few degrees. The first position is analyzed at 06Z on the 19th as a 25 kt tropical depression, same as originally shown in HURDAT. However, given the satellite presentation, the system may have been stronger. (A few central pressure values were present in the original HURDAT between September 19th at 12Z and September 24th at 12Z. Some of these were obviously based upon observations of peripheral pressures and not central pressures. Thus, based on actual observations, some were retained and some were removed. Detailed information on these changes can be found in the table at the end.)

September 20:

1. Maps and old HURDAT:

- HWM analyzes a closed low pressure of at most 1010 mb at 17.5N, 45.5W at 12Z.
- HURDAT lists a 25 kt tropical depression at 17.9N, 45.3W at 12Z.
- Microfilm does not show an organized system at 12Z.

2. Ship highlights:

- 40 kt E and 1011 mb at 18.6N, 39.1W at 00Z (micro).
- 50 kt E and 1013 mb at 19.6N, 47.3W at 12Z (micro).

3. Satellite highlights:

- TIROS center fix at 17.0N, 44.0W at 1225Z (WALLET).

4. Aircraft highlights:

- Radar center fix at 19.3N, 47.2W and 25 kt W at 1654Z (ATSR).

5. Discussion:

- MWR: "A reconnaissance aircraft was dispatched to investigate on the 20th and reached the southeast quadrant of the storm before being forced to return because of fuel limitation. The plane reported a radar eye and observed 30 mph west winds at the surface 20 mi. south of the center."
- ATSR: "A Navy weather reconnaissance aircraft departed Roosevelt Roads, Puerto Rico, at 201420Z, and, upon reaching the area at 202030Z, reported a developing eye near 19.3N 47.2W with westerly winds of 25 knots."
- Reanalysis: Debra moved to the northwest and slowly intensified. The first gale associated with Debra was reported on September 20th at 00Z by a ship, 40 kt E and 1011 mb. At 12Z on the 20th, another ship reported 50 kt E and 1013 mb. The first reconnaissance aircraft to investigate Debra reached the system at 1420Z on the 20th making a radar fix and estimating 25 kt westerly winds in the southern quadrant before departing due to fuel limitations. Based upon the 50 kt reported by the ship at 12Z on the 20th, the report of an eye visible in radar images by the reconnaissance aircraft, and westerly winds of 25 kt in the southern quadrant, an intensity of 50 kt is selected at 12Z on the 20th, up from 25 kt originally in HURDAT, a major intensity change. 50 kt is also analyzed at 18Z on the 20th, up from 30 kt originally in HURDAT, a major intensity change.

September 21:

1. Maps and old HURDAT:

- HWM analyzes a tropical storm of at most 1005 mb at 21.8N, 48.8W at 12Z.
- HURDAT lists a 50 kt tropical storm at 21.9N, 48.8W at 12Z.
- Microfilm shows a closed low pressure of at most 1005 mb at 22.7N, 48.6W at 12Z.

2. Ship highlights:

- 35 kt E and 1007 mb at 24.0N, 47.0W at 12Z (micro).
- 35 kt E and 1014 mb at 24.5N, 47.7W at 18Z (COADS).
- 55 kt ENE and 1007 mb at 24.0N, 48.3W at 21Z (COADS).

3. Aircraft highlights:

- Penetration center fix measured a central pressure of 1001 mb, estimated surface winds of 65 kt and an eye diameter of 5 nm at 23.0N, 49.0W at 1654Z (WALLET/ATSR).

4. Satellite highlights:

- TIROS center fix at 21.5N, 46.3W at 1332Z (WALLET).

5. Discussion:

- MWR: "The next day, September 21, a second reconnaissance aircraft found 75 mph winds and a central pressure of about 1000 mb or 29.53 in. Debra was at best barely a minimal hurricane for no more than 24 hr."
- ATSR: "DEBRA continued to intensity and by 211654Z the second reconnaissance aircraft found winds of 65 knots. A hurricane warning was issued at 211830Z, naming the storm."
- Reanalysis: On September 21st, Debra turned to the north over the central Atlantic. At 12Z on the 21st, a ship reported 35 kt E and 1007 mb in the northeast quadrant of the tropical cyclone. At 1654Z on the 21st, a reconnaissance aircraft measured a central pressure of 1001 mb, estimated surface winds of 65 kt and an eye diameter of 5 nm. MWR indicates that the central pressure measured in this mission was 1000 mb, which was already in HURDAT and it has been retained. A central pressure of 1000 mb suggests maximum surface winds of 47 kt from the south of 25N Brown et al. pressure-wind relationship. An eye diameter of 5 nm suggests an RMW of less than 5 nm and the climatological value is 19 nm. Based upon a forward speed of 10 kt, a tiny RMW and a ship report of 55 kt at 21Z on the 21st, a 65 kt intensity is maintained at 18Z on the 21st. 65 kt is also the peak intensity of this tropical cyclone, unchanged. It is noted, however, that the satellite images on the 21st do not obviously support hurricane strength.

September 22:

1. Maps and old HURDAT:

- HWM analyzes a hurricane of at most 1000 mb at 25.5N, 48.5W at 12Z.
- HURDAT lists a 65 kt hurricane at 25.3N, 48.7W at 12Z.
- Microfilm shows a closed low pressure of at most 1002 mb at 25.5N, 48.5W at 12Z.

2. Ship highlights:

- 45 kt NE at 26.0N, 49.0W at 06Z (micro).
- 35 kt SE and 1007 mb at 27.0N, 45.8W at 12Z (micro).
- 50 kt SE at 26.0N, 45.8W at 18Z (micro).

3. Aircraft highlights:

- Penetration center fix measured a central pressure of 1002 mb, estimated surface winds of 45 kt and an eye diameter of 5 nm at 25.5N, 48.8W at 1350Z (WALLET/ATSR).
- Penetration center fix measured a central pressure of 999 mb, estimated surface winds of 65 kt and an eye diameter of 50 nm at 25.8N, 48.2W at 1830Z (WALLET).

4. Discussion:

- MWR: "The storm continued northward slowly on the 22nd with little change in intensity."

- ATSR: "During the 18-hour period of hurricane intensity, DEBRA became better organized; however, the subsequent decrease in intensity after 221200Z brought rapid deterioration in organization."
- Reanalysis: On September 22nd, Debra continued to move northward at a slower forward speed. A couple of ships reported winds of tropical storm force on this day. The next reconnaissance aircraft to make a penetration fix occurred at 1350Z on the 22nd measuring a central pressure of 1002 mb, estimating surface winds of 45 kt and an eye diameter of 5 nm. A central pressure of 1002 mb suggests maximum surface winds of 40 kt and 43 kt from the north of 25N and south of 25N pressure-wind relationships, respectively. An eye diameter of 5 nm suggests an RMW of less than 5 nm and the climatological value is 20 nm. Based upon a tiny RMW and a ship report of 50 kt at 18Z on the 22nd, an intensity of 55 kt is analyzed at 12Z on the 22nd, down from 65 kt originally shown in HURDAT, a minor intensity change. Another penetration fix occurred at 1830Z on the 22nd measuring a central pressure of 999 mb, estimating surface winds of 50 kt and an eye diameter of 50 nm. An eye diameter of 50 nm suggests an RMW of about 35 nm and the climatological value is 20 nm. A central pressure of 999 mb suggests maximum surface winds of 45 kt and 49 kt from the north of 25N and the south of 25N pressure-wind relationships, respectively. Based upon the ship report of 50 kt and a couple other ship reports of 40 kt at 18Z on the 22nd but a much broader inner core, an intensity of 60 kt is analyzed at 18Z on the 22nd, down from 65 kt originally in HURDAT, a minor intensity change.

September 23:

1. Maps and old HURDAT:

- HWM analyzes a tropical storm of at most 1010 mb at 28.0N, 47.6W with a cold front to the northwest at 12Z.
- HURDAT lists a 50 kt tropical storm at 28.0N, 47.7W at 12Z.
- Microfilm shows a closed low pressure of at most 1011 mb at 28.8N, 47.4W at 12Z.

2. Ship highlights:

- 40 kt SE and 1015 mb at 25.2N, 45.8W at 00Z (micro).

3. Aircraft highlights:

- Penetration center fix at 28.5N, 47.6W at 1355Z (WALLET).
- Penetration center fix measured a central pressure of 999 mb, estimated surface winds of 50 kt and an eye diameter of 30 nm at 28.9N, 47.5W at 19Z (WALLET).

4. Satellite highlights:

- TIROS center fix at 28.4N, 47.6W at 1316Z (WALLET).

5. Discussion:

- MWR: "…then weakened and began accelerating on the 23rd."
- Reanalysis: On September 23rd, Debra continued northward over the open Atlantic. A reconnaissance aircraft investigated the tropical storm at 19Z on the 23rd measuring a central pressure of 999 mb, estimating surface winds of 50 kt and an eye diameter of 30 nm. An eye diameter of 30 nm suggests an RMW of about 25 nm and the climatological value is also 23 nm. A central pressure of 999 mb suggests maximum surface winds of 45 kt from the north of

25N pressure-wind relationship. Based upon an eye diameter close to climatology and a forward speed of about 8 kt, an intensity of 50 kt is analyzed at 18Z on the 23rd, up from 45 kt originally in HURDAT, a minor intensity change.

September 24:

1. Maps and old HURDAT:

- HWM analyzes a tropical storm of at most 1010 mb at 33.5N, 48.0W with a cold front just to the west at 12Z.
- HURDAT lists a 35 kt tropical storm at 33.4N, 48.4W at 12Z.
- Microfilm shows a closed low pressure of at most 1008 mb at 33.0N, 48.5W with a frontal boundary to the west at 12Z.

2. Ship highlights:

- 35 kt S and 1009 mb at 38.7N, 46.9W at 12Z (COADS).

3. Discussion:

- MWR: "It was finally absorbed by an extratropical Low on the 24th. There was no loss of life or property damage associated with Debra."
- Reanalysis: On September 24th, a frontal boundary approached Debra from the west. Debra gradually weakened during the day and dissipated after 18Z. As dissipation occurred before merging with the oncoming frontal boundary, no extratropical transition is now shown in HURDAT.

September 25:

1. Maps and old HURDAT:

- HWM analyzes a stationary front over the North Atlantic at 12Z.
- HURDAT does not list an organized system on this date.
- Microfilm shows a spot low at 34.0N, 53.0W at 12Z.

Date	Original HURDAT Central Pressure	Evidence	Changes
Sep 19 12Z	1011 mb	25 kt E and 1010 mb reported by a ship near 16N, 40W	Removed
Sep 20 18Z	1008 mb	Peripheral pressure from an aircraft making a radar fix	
Sep 21 18Z	1000 mb	Penetration center fix: 1001 mb at 1654Z on Sep 21st	Retained
Sep 22 12Z	1002 mb	Penetration center fix: 1002 mb at 1350Z on Sep 22nd	
Sep 22 18Z	999 mb	Penetration center fix: 999 mb at 1830Z on Sep 22nd	
Sep 23 18Z	999 mb	Penetration center fix: 999 mb at 19Z on Sep 23rd	
Sep 24 12Z	1011 mb	Circulation not closed, thus it has been removed	Removed

Sources: the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Monthly Weather Review, Navy reconnaissance book, Mariners Weather Log, Allison & Thompson (1966) and NHC Storm Wallets.

Hurricane Edith [September 23-29, 1963] – AL061963

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42905 09/23/1963 M= 7  6 SNBR= 929 EDITH       XING=0 SSS=0

42910 09/23*  0   0   0    0*  0   0   0    0*110 520  25    0*115 530  25    0*
42910 09/23*  0   0   0    0*  0   0   0    0*112 515  25    0*117 525  30    0*
                                              *** ***         *** ***  **

42915 09/24*121 540  30 1005*125 553  30    0*129 565  35 1004*132 582  65 1000*
42915 09/24*122 537  35 1005*125 550  40    0*128 565  50 1004*132 581  65    0*
           *** ***  **          ***  **      ***       **          ***       *

42920 09/25*137 596  85    0*139 606  75    0*144 616  85  993*147 627  85  990*
42920 09/25*136 595  85    0*139 607  85    0*143 618  80  993*147 629  80  990*
           *** ***             ***  **      *** ***  **          ***  **

42925 09/26*150 641  65    0*153 654  65  998*158 669  65 1000*168 673  65 1000*
42925 09/26*150 641  70    0*153 654  60  998*158 666  55 1000*168 673  55 1000*
                   **             **          ***  **                 **

42930 09/27*178 675  65    0*181 690  65  996*187 693  65    0*195 699  65  999*
42930 09/27*177 679  65  992*181 687  60  996*186 694  55    0*194 701  50  999*
           *** ***     ***     ***  **      *** ***  **      *** ***  **

42935 09/28*202 705  40    0*207 709  35    0*213 715  35    0*218 720  35    0*
42935 09/28*200 705  45    0*205 709  40    0*211 715  40    0*218 722  35    0*
           ***      **      ***      **      ***       **          ***

42940 09/29*226 723  30    0*231 720  30    0*  0   0   0    0*  0   0   0    0*
42940 09/29*226 728  30    0*234 725  30    0L242 715  30    0L250 705  30    0*
               ***         *** ***         **** ***         **** ***

42945 HR

Hurricane Landfall
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09/25 07Z 14.0N 60.9W 85 kt St. Lucia

Tropical Storm Landfall
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09/27 10Z 18.4N 69.1W 60 kt Dominican Republic
09/28 18Z 21.8N 72.2W 35 kt Turks and Caicos Islands
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Significant Revisions:

- Intensity substantially increased on the 24th based upon aircraft reconnaissace
- Intensity substantially reduced on the 27th based upon aircraft reconnaissance
- A remnant low status is indicated for 12 and 18Z on the 29th based upon satellite imagery. This is the earliest such usage of "remnant low" in HURDAT.

Daily Summary:

September 22:

1. Maps and old HURDAT:

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

2. Discussion:

- MWR: "Existence of a disturbance was first suspected when the Dutch tanker Acteon reported a south wind of 28 mph. and surface pressure of 1010.1 mb. (29.83 in.) as it moved southward through the inter-tropical Convergence Zone on September 22."
- Reanalysis: The disturbance that spawned Edith was a tropical wave that left the African coast around September 16th. The system moved westward and slowly became better organized. TIROS satellite imagery from 1110Z on the 21st and 1235Z on the 22nd show what looks like a well-organized system. On September 22nd, surface observations east of the Lesser Antilles indicated that a sharp trough was occurring, but it was ambiguous if the system had become a tropical cyclone.

September 23:

1. Maps and old HURDAT:

- HWM analyzes a closed low pressure of at most 1010 mb at 11.0N, 52.0W at 12Z.
- HURDAT lists a 25 kt tropical depression at 11.0N, 52.0W at 12Z.
- Microfilm shows a closed low pressure of at most 1008 mb at 11.0N, 51.8W at 12Z.

2. Aircraft highlights:

- Penetration center fix measured a central pressure of 1005 mb and estimated surface winds of 25 kt at 12.3N, 52.8W at 22Z (micro, MWR).

3. Satellite highlights: TIROS center fix at 11.0N, 52.5W at 1156Z (WALLET).

4. Discussion:

- MWR: "Photographs taken by TIROS VII at 1156 GMT September 23, showed a vortex and extensive circulation area centered near 11' N., 52' W. A reconnaissance aircraft reached the area late that afternoon and found winds of 29 mph and a surface pressure of 1005 mb (29.68 in.), but could see no definite spiral band pattern on radar."
- ATSR: "EDITH's discovery can be attributed primarily to photographs taken by TIROS VII on the 23rd of September at 1156Z. These photographs showed an abnormal mass of cloudiness with a possible vortex near 11N 52W. On the afternoon of the 23rd, a Navy reconnaissance plane was dispatched to the area and found winds of 25 knots and a surface pressure of 1005 millibars. This data prompted the issuance of a tropical depression warning by the Fleet Weather Facility, Miami."
- Reanalysis: The first position is analyzed at 12Z on September 23rd as a 25 kt tropical depression, same as originally shown in HURDAT. Time of genesis is uncertain due to the sparse observations over the central Atlantic and may have occurred substantially earlier. A TIROS satellite image at 1156Z on

the 23rd prompted the sending of an aircraft reconnaissance mission, which confirmed the presence of a tropical depression.

September 24:

1. Maps and old HURDAT:

- HWM analyzes a tropical storm of at most 1005 mb at 13.0N, 56.0W at 12Z.
- HURDAT lists a 35 kt tropical storm at 12.9N, 56.5W at 12Z.
- Microfilm shows a closed low pressure of at most 1011 mb at 12.0N, 58.0W at 12Z.

2. Ship highlights:

- 15 kt S and 1004 mb at 12.7N, 57.2W at 12Z (micro).
- 60 kt E and 1004 mb at 13.7N, 57.6W at 18Z (WALLET).

3. Aircraft highlights:

- Penetration center fix measured a central pressure of 1004 mb, estimated surface winds of 60 kt and an eye diameter of 50 nm at 12.8N, 56.6W at 1315Z (WALLET).
- Penetration center fix measured a central pressure of 1000 mb, estimated surface winds of 70 kt and an eye diameter of 30 nm at 13.4N, 58.4W at 18Z (WALLET).

4. Satellite highlights: TIROS center fix at 12.0N, 55.5W at 1217Z (WALLET).

5. Discussion:

- MWR: "Hurricane Edith formed in the Atlantic east of the Lesser Antilles on September 24. Early morning reconnaissance on the 24th found winds of 70 mph, and a short time later Edith was reported to be of hurricane intensity with 80 mph winds. This location was some 120 mi. east of Barbados. Lowest pressure computed in Edith was 978 mb, or 28.88 in., on September 24."
- ATSR: "Subsequent reconnaissance flights indicated a gradual intensification to tropical storm status and the first of 20 numbered warnings was issued at 1600Z on the 24th. Warning number two indicated that EDITH had rapidly intensified to hurricane strength."
- Reanalysis: The first reconnaissance aircraft to investigate the tropical depression arrived at late on the 23rd making a center penetration at 22Z and measuring a central pressure of 1005 mb and estimating surface winds of 25 kt. A central pressure of 1005 mb suggests maximum surface winds of 37 kt from the south of 25N Brown et al. pressure-wind relationship. Based on a forward speed of 13 kt, an intensity of 35 kt is analyzed at 00Z on September 24th, up from 30 kt originally in HURDAT, a minor intensity change. Intensification to a tropical storm is analyzed at 00Z on the 24th, twelve hours earlier than originally shown in HURDAT. (Central pressures values were present for many of the times in the original HURDAT between September 24nd at 18Z and September 27th at 18Z. All the original central pressure values were retained and one added. Detailed information on these changes can be found in the table at the end.) Edith intensified on the 24th based on ship and reconnaissance data. The next reconnaissance aircraft made a center penetration at 1315Z on the 24th measuring a central pressure of 1004 mb, estimating surface winds of 60 kt and an eye diameter of 50 nm. A

central pressure of 1004 mb suggests maximum surface winds of 39 kt from the south of 25N pressure-wind relationship. An eye diameter of 50 nm suggests an RMW of about 40 nm and the climatological value is 13 nm. Based on a forward speed of 17 kt, a ship report of 60 kt at 18Z on the 24th and putting some weight on the visual estimate, an intensity of 50 kt is selected at 12Z on the 24th, up from 35 kt originally in HURDAT, a major intensity change. At 18Z on the 24th, another reconnaissance aircraft measured a central pressure of 1000 mb, estimated surface winds of 70 kt and an eye diameter of 30 nm. MWR and the Storm Wallets have the measurement of 1000 mb as 978 mb but the ATSR book clearly indicates that the measurement was 1000 mb. The 978 mb central pressure report is simply erroneous, given the earlier 1004 mb at 1315Z on the 24th and the subsequent 993 mb at 1318Z on the 25th. Additionally, the estimated peak winds are also not consistent with a 978 mb pressure. However, a ship also at 18Z reported 60 kt wind with 1004 mb, which would suggest 998 mb or less central pressure. Because of these inconsistencies, the existing 1000 mb central pressure is removed. Based upon the 60 kt ship report, the existing 65 kt in HURDAT is retained at 18Z. The original HURDAT showed a dramatic 30 kt 6 hr increase in intensity from 35 kt at 12Z on the 24th to 65 kt at 18Z on the 24th but based on the data available, this rapid increase in intensity does not appear to have occurred. Note that the TIROS satellite image for 1217Z also does not seem to support a hurricane strength system at that time.

September 25:

1. Maps and old HURDAT:

- HWM analyzes a hurricane of at most 1000 mb at 14.4N, 61.3W at 12Z.
- HURDAT lists an 85 kt hurricane at 14.4N, 61.6W at 12Z.
- Microfilm shows a closed low pressure of at most 1008 mb at 14.0N, 61.5W at 12Z.

2. Ship highlights:

- 20 kt NNW and 1004 mb at 14.0N, 62.0W at 06Z (micro).
- 40 kt NE and 1004 mb at 14.1N, 62.0W at 12Z (micro).

3. Land highlights:

- 15 kt WSW and 1004 mb at Barbados at 00Z (micro).
- 60 kt N at St. Lucia at 06Z (micro).
- Calm at Port Castries, St. Lucia between 07-0815Z (WALLET).
- 995 mb (min pressure) at Fort-de-France, Martinique at 08Z (WALLET).
- 85 kt (direct reading) [likely gusts] at Caravelle, Martinique at 0750Z (WALLET).
- 55 kt at Le Lamentin, Martinique at 08Z (WALLET).
- Greater than 100 kt (115 kt registered before anemometer was blocked) [likely gusts] at Fort-de-France, Martinique between 0810Z and 10Z (WALLET).
- 35 kt SE and 1008 mb at Guadeloupe at 12Z (micro).

4. Aircraft highlights:

- Radar center fix at 14.2N, 59.8W at 02Z (WALLET).
- Penetration center fix measured a central pressure of 993 mb, estimated surface winds of 90 kt and an eye diameter of 14-18 nm eye diameter at 14.3N, 61.7W at 1318Z (WALLET).
- Penetration center fix measured a central pressure of 990 mb and estimated surface winds of 90 kt at 14.7N, 62.8W at 1848Z (WALLET).
- Penetration center fix estimated an eye diameter of 40 nm at 14.9N, 63.9W at 2330Z (ATSR).

5. Discussion:

- MWR: "Edith passed over the north portion of St. Lucia between midnight and daybreak on the 25th and was at her maximum intensity at about this time. Edith was weakened considerably by the mountains of the Lesser Antilles and was barely of hurricane intensity thereafter as it moved across the northeastern Caribbean and the Dominican Republic. Martinique was heavily damaged, to the extent of $40 million, with 10 persons killed and 50 injured. Storm tides of 8 ft. above normal were noted. Fort de France reported a minimum pressure of 995 mb, or 29.33 in., with maximum winds of 127 mph. Damage on Dominica was $2,611,600 and winds reached 80 mph in gusts. There was no loss of life there... Tides there were 8 to 10 ft. above normal and Port Castries reported a dead calm beginning at 2 a.m. (EST) which lasted 75 min. Maximum winds were 90 mph. There was no loss of life, but damage totaled $3,465,000. On Barbados, winds reached 60 to 65 mph in squalls on the northern tip of the island and damage was estimated at $145,000."
- Reanalysis: On September 25th, Edith crossed the Lesser Antilles into the eastern Caribbean Sea. It is noted that the Navy plane in Edith near 00Z likely missed the center. The plane reported a 700-mb height of 2979 m and temperature of 12C near 13.7N 58.6W at 0030Z. This extrapolates to a pressure of near 990 mb. However, this is about 60 n mi from the 00Z best track position, and the flight-level winds at the measurement position were 46 kt. These data suggests that the pressure was below 990 mb at the time. A central pressure of less than 990 mb suggests maximum surface winds of at least 64 kt from the south of 25N pressure-wind relationship. The 85 kt intensity originally in HURDAT is retained, which is also the peak intensity of Edith. Edith made landfall in northern Saint Lucia around 07Z on the 25th. Calm conditions were reported between 07Z and 0815Z at Port Castries, the capital of Saint Lucia, indicating the passage of the eye of the hurricane. The two stations on Martinique about 35 n mi north of the center reported 995 mb with simultaneous hurricane conditions, suggest a central pressure substantially lower than 993-995 mb. In Saint Lucia, the strongest sustained winds appear to have been 60 kt reported in the microfilm at 06Z on the 25th. The island of Martinique, about 20 nm north of Saint Lucia, reported gusts up to 115 kt and a minimum pressure of 995 mb. Intensity at 06Z and landfall at 07Z is assessed at 85 kt, which is higher from the 75 kt shown by HURDAT originally at 06Z. It is of note that the reported wind gusts of 100-115 kt on Martinique would also support an intensity higher than 75 kt, with the caveat that the terrain of the island may have enhanced those winds. At 1318Z on the 25th, a reconnaissance aircraft measured a central pressure of 993 mb, estimated surface winds of 90 kt and an eye diameter 14-18 nm. A central pressure of 993 mb suggests maximum surface winds of 59 kt from the south of 25N pressure-wind relationship. An eye

diameter of 14-18 nm suggests an RMW of about 11-14 nm and the climatological value is 13 nm. Based upon a forward speed of 12 kt, observations in the Lesser Antilles and putting some weight on the visual estimate, an intensity of 80 kt is selected at 12Z on the 25th, down from 85 kt originally in HURDAT, a minor intensity change. At 1848Z on the 25th, another penetration center fix measured a central pressure of 990 mb and estimated surface winds of 90 kt. A central pressure of 990 mb suggests maximum surface winds of 64 kt from the south of 25N pressure-wind relationship. Based on a forward speed of 12 kt and putting some weight on the visual estimate, an intensity of 80 kt is analyzed at 18Z on the 25th, down from 85 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 16.0N, 66.8W at 12Z.
- HURDAT lists a 65 kt hurricane at 15.8N, 66.9W at 12Z.
- Microfilm shows a closed low pressure of at most 1011 mb at 15.5N, 67.0W at 12Z.

2. Ship highlights:

- 35 kt NE and 1008 mb at 15.0N, 65.2W at 00Z (COADS).

3. Aircraft highlights:

- Penetration center fix estimated an eye diameter of 40 nm with 1002 mb surface pressure from dropsonde at 15.1N, 64.2W at 0105Z (ATSR). (It is unclear if this drop was in the cyclone's center and the value is not very consistent with previous and subsequent center pressures. Therefore, this value is not treated as a central pressure.)
- Penetration center fix measured a central pressure of 998 mb, estimated flight level winds of 60 kt and an eye diameter of 25 nm eye diameter at 15.3N, 65.5W at 0704Z (WALLET).
- Penetration center fix measured a central pressure of 1000 mb, estimated surface winds of 45 kt and an eye diameter of 80 nm at 15.8N, 67.1W at 13Z (WALLET).
- Penetration center fix measured a central pressure of 1000 mb and estimated an eye diameter of 12 nm eye diameter at 17.2N, 67.5W at 1945Z (WALLET).

4. Discussion:

- MWR: "The hurricane then moved on a general west-northwestward course to a point some 120 mi. south of Puerto Rico…50 to 60 mph winds along the south and southwestern coasts of Puerto Rico, together with heavy rains, caused $400,000 damage there."
- ATSR: "Hurricane EDITH moved on a general west-northwest course to a point some 120 miles south of Puerto Rico."
- Reanalysis: On September 26th, Edith moved generally northwestward and weakened. A ship reported 35 kt at 00Z on the 26th, the only synoptic gale-force winds associated with Edith on this date. A reconnaissance aircraft investigated the tropical cyclone early on the 26th making a penetration center fix at 0704Z and measuring a central pressure of 998 mb and estimating an eye diameter of 25 nm. A central pressure of 998 mb suggests maximum surface winds of 51 kt from the south of 25N pressure-wind

relationship. An eye diameter of 25 nm suggests an RMW of about 20 nm and the climatological value is 13 nm. Based upon a forward speed of 14 kt, an intensity of 60 kt is analyzed at 06Z on the 26th, down from 65 kt originally shown in HURDAT, a minor intensity change. Another penetration center fix occurred at 13Z on the 26th measuring a central pressure of 1000 mb, estimating surface winds of 45 kt and an eye diameter of 80 nm. A central pressure of 1000 mb suggests maximum surface winds of 47 kt from the south of 25N pressure-wind relationship. An eye diameter of 80 nm suggests an RMW of about 60 nm and the climatological value is 14 nm. Based upon a forward speed of 12 kt, an intensity of 55 kt is selected at 12Z on the 26th, down from 65 kt originally in HURDAT, a minor intensity change. The next penetration center fix occurred at 1945Z on the 26th also measuring a central pressure of 1000 mb. An intensity of 55 kt is selected at 18Z on the 26th, down from 65 kt originally in HURDAT, a minor intensity change.

September 27:

1. Maps and old HURDAT:

- HWM analyzes a tropical storm of at most 1010 mb at 19.0N, 69.0W at 12Z.
- HURDAT lists a 65 kt hurricane at 18.7N, 69.3W at 12Z.
- Microfilm shows a closed low pressure of at most 1008 mb at 19.0N, 69.5W at 12Z.

2. Ship highlights:

- 35 kt E and 1010 mb at 17.9N, 68.2W at 00Z (COADS).
- 60 kt E and 1009 mb at 18.7N, 67.6W at 06Z (COADS).
- 40 kt SSE at 19.5N, 68.9W at 12Z (micro).
- 35 kt SSE and 1012 mb at 19.4N, 67.6W at 15Z (micro).
- 35 kt S and 1009 mb at 19.6N, 68.5W at 18Z (COADS).

3. Aircraft highlights:

- Penetration center fix measured a central pressure of 992 mb and estimated an eye diameter of 20 nm at 17.9N, 68.0W at 01Z (ATSR). (Vortex message sent indicated 996 mb, but dropsonde surface pressure gave 992 mb which is consistent with drop’s 850 mb height/temperature. 992 mb used as central pressure.)
- Penetration center fix measured a central pressure of 996 mb at 17.8N, 68.7W at 0829Z (WALLET).
- Radar center fix at 18.9N, 69.3W at 1236Z (WALLET).
- Radar center fix calculated a central pressure of 999 mb and estimated surface winds of 40 kt at 19.5N, 70.3W at 1850Z (WALLET).

4. Land highlights:

- 20 kt NW and 1005 mb at Puerto Plata, Dominican Republic at 18Z (micro).

5. Satellite highlights: TIROS center fix at 18.5N, 69.5W at 1243Z (WALLET).

6. Discussion:

- MWR: "and then turned to a more northwestward course passing over the eastern portion of the Dominican Republic before dissipating as it moved out north of Hispaniola. In the Dominican Republic damage was minor…"
- ATSR: "…then turned to a more northwesterly course, passing over the eastern portion of Hispaniola."
- Reanalysis: On September 27th, Edith maintained a northwestward course impacting Hispaniola. The first reconnaissance aircraft to investigate the tropical cyclone on the 27th made a penetration center fix at 01Z measuring a central pressure of 992 mb and an eye diameter of 20 nm. A central pressure of 992 mb suggests maximum surface winds of 59 kt from the south of 25N pressure-wind relationship. An eye diameter of 20 nm suggests an RMW of about 15 nm and the climatological value is 14 nm. Based upon a forward speed of about 11 kt and a ship report of 60 kt at 06Z on the 27th, an intensity of 65 kt is selected at 00Z on the 27th, same as originally shown in HURDAT. Another penetration center fix measured a central pressure of 996 mb at 0829Z on the 27th and an intensity of 60 kt is selected at 06Z on the 27th, down from 65 kt originally in HURDAT, a minor intensity change. Landfall in southeastern Dominican Republic is analyzed around 10Z on the 27th as a 60 kt tropical storm. TIROS captured an image of the tropical storm at 1243Z on the 27th showing a large area of convection over the Dominican Republic with no hints of an eye. Around 19Z on the 27th, Edith reached the Atlantic Ocean after emerging north of Hispaniola. A reconnaissance aircraft measured a central pressure of 999 mb and estimated surface winds of 40 kt at 1850Z on the 27th. A central pressure of 999 mb suggests maximum surface winds of 49 kt from the south of 25N pressure-wind relationship. Based upon a forward speed of about 12 kt, an intensity of 50 kt is analyzed at 18Z on the 27th, down from 65 kt originally in HURDAT, a minor intensity change.

September 28:

1. Maps and old HURDAT:

- HWM analyzes a tropical storm of at most 1005 mb at 21.5N, 71.8W with a warm front to the north at 12Z.
- HURDAT lists a 35 kt tropical storm at 18.7N, 69.3W at 12Z.
- Microfilm shows a closed low pressure of at most 1008 mb at 19.0N, 69.5W with a frontal boundary to the north at 12Z.

2. Ship highlights:

- 35 kt S and 1006 mb at 20.0N, 69.8W at 00Z (COADS).
- 35 kt S and 1006 mb at 20.2N, 70.8W at 03Z (micro).
- 20 kt NE and 1005 mb at 20.3N, 71.4W at 06Z (COADS).
- 40 kt NE and 1005 mb at 21.5N, 72.4W at 12Z (micro).

3. Land highlights:

- 15 kt NW and 1005 mb at Puerto Plata, Dominican Republic at 00Z (micro).
- 20 kt ESE and 1005 mb at Grand Turk at 09Z (micro).
- 20 kt E and 1004 mb at South Caicos at 18Z (micro).

4. Discussion:

- ATSR: "Gradual dissipation occurred after EDITH passed over Hispaniola and the final numbered warning was issued at 2200Z on the 28th."
- Reanalysis: On September 28th, Edith continued northwestward and further weakened. Gale-force winds were reported by ships at 00Z and 12Z on the 28th. The center of Edith crossed the Turks and Caicos at 18Z on the 28th as a 35 kt tropical storm.

September 29:

1. Maps and old HURDAT:

- HWM analyzes a spot low at 23.0N, 71.8W with a dissipating warm front to the northeast at 12Z.
- HURDAT lists a 30 kt tropical depression at 23.1N, 72.0W at 06Z (final position).
- Microfilm shows a closed low pressure of at most 1008 mb at 24.5N, 71.5W with a frontal boundary to the northeast at 12Z.

2. Ship highlights:

- 35 kt S and 1012 mb at 25.1N, 68.3W at 18Z (COADS – appears to have a high bias compared with nearby ships).

3. Satellite highlights:

- TIROS center fix at 23.0N, 71.5W at 1229Z (WALLET).

4. Aircraft highlights:

- "Max obsvd sfc wind 20 kt", no center position indicated around 12-17Z (ATSR).

5. Discussion:

- Reanalysis: On September 29th, a frontal boundary north of the Bahamas caused Edith to turn to the northeast. Weakening to a tropical depression is analyzed at 00Z on the 29th, same as originally shown in HURDAT. The last position originally in HURDAT was at 06Z on the 29th but synoptic observations and a TIROS image at 1229Z indicate that the system was still had a closed circulation, but no deep convection. Thus Edith is indicated to be a remnant low for 12 and 18Z. Synoptic observations after 18Z on the 29th indicate that Edith weakened into a trough of low pressure and was likely absorbed by a developing extratropical cyclone off the East Coast of the United States on September 30th. Thus, the last position is analyzed at 18Z on the 29th, twelve hours later than originally shown in HURDAT.

September 30:

1. Maps and old HURDAT:

- HWM analyzes frontal boundaries over the western Atlantic at 12Z.
- HURDAT does not list an organized system on this date.
- Microfilm shows an extratropical cyclone of at most 1002 mb at 37.0N, 69.0W at 12Z (Edith appears to have been absorbed).

Date	Original HURDAT Central Pressure	Evidence	Changes

Sep 24 00Z	1005 mb	Penetration center fix: 987 mb at 1642Z on Aug 02nd	Retained
Sep 24 12Z	1004 mb	Penetration center fix: 1004 mb at 1315Z on Sep 24th	
Sep 24 18Z	1000 mb	Contradictory information available for central pressure, but unlikely to be 1000 mb	Removed
Sep 25 12Z	993 mb	Penetration center fix: 993 mb at 1318Z on Sep 25th	
Sep 25 18Z	990 mb	Penetration center fix: 990 mb at 1848Z on Sep 25th	Retained
Sep 26 06Z	998 mb	Penetration center fix: 998 mb at 0704Z on Sep 26th	
Sep 26 12Z	1000 mb	Penetration center fix: 1000 mb at 13Z on Sep 26th	
Sep 26 18Z	1000 mb	Penetration center fix: 1000 mb at 1945Z on Sep 26th	
Sep 27 00Z		Penetration center fix: 992 mb at 01Z on Sep 27th	992 mb
Sep 27 06Z	996 mb	Penetration center fix: 996 mb at 0829Z on Sep 27th	Retained
Sep 27 18Z	999 mb	Penetration center fix: 999 mb at 1850Z on Sep 27th	

Sources: the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Monthly Weather Review, Navy reconnaissance book, Mariners Weather Log, Allison & Thompson (1966) and NHC Storm Wallets.

Hurricane Flora [September 26 – October 13, 1963] – AL071963

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42950 09/26/1963 M=18  7 SNBR= 930 FLORA       XING=0 SSS=0
42950 09/28/1963 M=16  7 SNBR= 930 FLORA       XING=0 SSS=0
         **        **

(The 26th and 27th are removed from HURDAT.)
42955 09/26*  0   0   0    0*  0   0   0    0* 80 330  25    0* 81 348  25    0*
42960 09/27* 82 365  25    0* 83 383  30    0* 85 400  30    0* 87 416  30    0*
                                             ***              ***

42965 09/28* 88 432  30    0* 90 447  30    0* 92 463  30    0* 95 479  30    0*
42965 09/28*  0   0   0    0*  0   0   0    0* 92 463  30    0* 95 479  30    0*
            ** ***  **       ** ***  **

42970 09/29* 98 495  30    0* 99 511  30    0*100 528  40 1000*101 544  55    0*
42970 09/29* 97 495  30    0* 99 511  30    0*100 528  40    0*101 544  55    0*
            **                                            *

42975 09/30*103 560  70    0*104 576  85    0*107 591 100  994*112 607 105  978*
42975 09/30*103 560  70    0*104 576  75    0*107 591  70  994*112 607  90  974*
                           **                **                **  ***

42980 10/01*116 620 110  981*120 633 110  981*125 648 115  974*130 660 115  975*
42980 10/01*116 620  90  975*120 633  90    0*125 647  90    0*130 660  95  967*
                   ***  ***          ***    *     ***  ***    *          ***  ***

42985 10/02*136 673 120  970*141 683 120    0*146 692 120  968*151 700 120  968*
42985 10/02*136 673 100    0*142 683 105  956*147 692 105    0*151 700 105  957*
                   ***    * ***     ***  *** ***     ***    *          ***  ***
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42990 10/03*155 706 120    0*159 714 125    0*165 720 125  940*171 725 125  944*
42990 10/03*155 707 110    0*159 714 120    0*165 720 125    0*172 725 130  933*
                *** ***             ***                       * ***      ***  ***

42995 10/04*180 731 125  944*191 742 105  995*193 745 105  970*203 749 105  970*
42995 10/04*181 729 130    0*188 738 105    0*194 744 105  970*200 749 105  973*
            *** *** ***    * *** ***        * *** ***          ***          ***

43000 10/05*208 759 110    0*208 765 110    0*208 768 105  985*205 770 100    0*
43000 10/05*206 757 100    0*207 764  85    0*205 766  75    0*203 767  70    0*
            *** *** ***      *** ***  **      *** ***  **    * *** ***  **

43005 10/06*204 774 100    0*203 776  95    0*202 779  90  985*205 781  85    0*
43005 10/06*204 771  75    0*204 776  85    0*204 778  85    0*205 780  85    0*
                ***  **      ***      **      *** ***  **   *       ***

43010 10/07*206 783  85    0*207 782  80    0*208 781  80  986*210 780  75    0*
43010 10/07*207 781  85    0*209 781  75    0*211 781  70    0*213 780  60    0*
            *** ***          *** ***  **      ***      **    * ***      **

43015 10/08*213 777  75    0*212 770  75  989*211 762  70  990*215 754  75  990*
43015 10/08*213 778  60    0*211 770  55    0*211 762  50    0*213 754  65    0*
                ***  **      ***      **    *           **    * ***      **    *

43020 10/09*217 744  75  983*223 728  75    0*235 716  80  975*250 700  85  965*
43020 10/09*217 743  75  983*223 729  85  977*233 716  95  966*246 700  95  965*
                ***              ***  **  *** ***      **  *** ***      **

43025 10/10*260 683  95  965*271 665  95  969*281 649 100  969*299 622 100  972*
43025 10/10*258 683  95  965*269 665  95    0*280 648  90  969*299 624  90  972*
            ***              ***      **    * *** ***  **            ***  **

43030 10/11*322 598  95    0*343 583  90  970*362 570  85  963*383 560  80  963*
43030 10/11*322 598  90  968*342 583  90  970*362 570  90  963*381 560  90    0*
                     **  ***                          **      ***      **    *

43035 10/12*401 540  80    0*420 520  75    0*435 498  75  985E452 475  75    0*
43035 10/12E398 550  90    0E415 540  85    0E430 512  80    0E445 475  75    0*
            **** ***  **     **** ***  **     **** ***  **    * ***

43040 10/13E470 450  70    0E492 428  70    0E515 410  70    0*  0   0   0    0*
43040 10/13E460 445  70    0E490 440  70    0E530 430  70    0*545 405  70    0*
            *** ***          ***              *** ***          *** ***  **

(The 14th through the 17th are new.)
43040 10/14E570 390  70    0E605 370  65    0E625 330  65    0E640 300  60    0*
43040 10/15E650 310  55    0E645 320  50    0E640 320  45    0E638 320  40    0*
43040 10/16E636 315  35    0E635 315  35    0E633 315  35    0E631 315  35    0*
43040 10/17E630 325  35    0E628 335  35    0E626 345  35    0E628 335  30    0*

43045 HR

Hurricane Landfall
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09/30 18Z 11.2N 60.7W  90 kt Tobago
10/04 01Z 18.2N 73.0W 130 kt Haiti
10/04 18Z 20.0N 74.9W 105 kt Cuba
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10/07 00Z 20.7N 78.1W 85 kt Cuba
10/09 06Z 22.3N 72.8W 85 kt Mayaguana, Bahamas

Significant Revisions:

- Genesis is delayed by two days based upon satellite imagery.
- Several central pressures added/modified based upon aircraft reconnaissance.
- Many central pressures removed from 12Z HURDAT, as these were analyses and not based upon specific observations.
- Intensity substantially reduced on the 30th, 1st, 2nd, 5th, 6th, 7th, and 8th based upon aircraft reconnaissance.
- Intensity substantially boosted on the 9th based upon aircraft reconnaissance.
- Positions substantially adjusted west-southwest on the 12th.
- Four additional days added to end of track as extratropical cyclone

Daily Summary:

September 25:

1. Maps and old HURDAT:

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

2. Discussion:

- Reanalysis: The tropical wave that developed into Hurricane Flora entered the eastern Atlantic late on September 23th or early on September 24th according to the Historical Weather Maps, and moved westward slowly becoming better organized.

September 26:

1. Maps and old HURDAT:

- HWM and microfilm do not show an organized system at 12Z.
- HURDAT lists a 25 kt tropical depression at 8.0N, 33.0W at 12Z.

2. Satellite highlights:

- TIROS center fix at 11.5N 35.0W at 0940Z (MWR).

3. Discusion:

- MWR: “At 8:50 am, EST, on September 26, the National Hurricane Center in Miami received an advisory from the Weather Bureau's National Weather Satellite Center stating that TIROS VII at 4:40 am., EST, had sighted a poorly organized vortex at approximately 11.5 N., 35.0 W., with a central overcast area about 4 degrees in diameter with some banding to the north and east. Actually the TIROS satellite had sighted a complex cloud system with two principal areas of cloud concentration. The northern center mentioned in the advisory was probably associated with an upper-level vortex, and Flora eventually developed from the second cloud mass located at about 8.0 N., 32.5 W., which was associated with a very weak depression in the Intertropical Convergence Zone (ITC).”

- ATSR: "The incipient stage of Hurricane FLORA is believed to have been observed by satellite as early as 26 September when photographs showed a cloud mass in the mid-Atlantic near 38W."
- Reanalysis: The disturbance was first detected in a TIROS VII satellite image on September 26th over the central Atlantic. However, the satellite image at 0950Z shows a rather unimpressive system near the existing HURDAT location (8N 33W) and a much better organized looking system (labelled as Flora) near 12N 39W. The navigation of the satellite pictures is extremely uncertain over the open ocean. Thus it is quite possible that the more organized system is indeed Flora and that it is close to the original HURDAT position. However, because of more definitive satellite imagery on the 27th (see discussion on the 27th), genesis is delayed by two days from 12Z on the 26th to 12Z on the 28th. (Central pressures values for many of the six hour periods were present in the original HURDAT between September 29th at 12Z and October 12th at 12Z. Some of these were obviously analyses that were added in, not based upon actual observations. Thus, based on actual observations, some were retained and new central pressure values added. Detailed information on these changes can be found in the table at the end.)

September 27:

1. Maps and old HURDAT:

- HWM analyzes a closed low pressure of at most 1010 mb at 8.0N, 40.2W at 12Z.
- HURDAT lists a 30 kt tropical depression at 8.5N, 40.0W at 12Z.
- Microfilm shows a tropical wave along longitude 40W at 12Z.

2. Discussion:

- MWR: "On the next day, September 27, TIROS VII photographed the same complex cloud system, which retained rather remarkable resemblance to that of the day before. The center of the southern cloud mass had moved to 8.0 N., 40.0 W. The cloud mass had grown somewhat in size but there were still no indications of spiral bands and apparently it was still associated with an ordinary depression in the ITC."
- ATSR: "On the following day a photograph from the satellite, again, indicated an area of unsettled conditions near 8N 40W."
- Reanalysis: The satellite image at 1014Z with the system labelled as Flora looks unimpressive to the point that it likely was not a tropical cyclone. Genesis is thus delayed until 12Z on the 28th.

September 28:

1. Maps and old HURDAT:

- HWM analyzes a closed low pressure of at most 1010 mb at 9.0N, 46.5W at 12Z.
- HURDAT lists a 30 kt tropical depression at 9.2N, 46.3W at 12Z.
- Microfilm shows a tropical wave along longitude 46W at 12Z.

2. Discussion:

- Reanalysis: Based upon sparsely available observations and continuity with the 29th, genesis is analyzed to have occurred around 12Z. This is two days later than originally indicated by HURDAT.

September 29:

1. Maps and old HURDAT:

- HWM analyzes a tropical storm of at most 1005 mb at 9.8N, 52.6W at 12Z.
- HURDAT lists a 40 kt tropical storm at 10.0N, 52.8W at 12Z.
- Microfilm does not show an organized storm at 12Z.

2. Ship highlights:

- 1000 mb at 2230Z (MWR).

3. Discussion:

- MWR: "TIROS was not in a position to photograph the cloud system on September 28 and 29 and there were not sufficient ship reports to indicate the existence of a circulation. However, on the 29th, the San Juan Hurricane Center requested surface observations from all ships in the area, and a Navy hurricane reconnaissance flight was arranged for daybreak on September 30. A series of ship reports began to arrive early in the morning, September 30. A much delayed weather observation from the Sinon arrived around 3:30 am EST. The report stated that the barometer at 5:30 pm the afternoon before had dipped to 1000 mb (29.54 in.) with a wind shift from northwest to southwest, but nothing was said about the strength of the winds."
- Reanalysis: On September 29th around 2230Z, a ship passed near the center of the tropical cyclone measuring a peripheral pressure of 1000 mb. A peripheral pressure of 1000 mb suggests maximum surface winds greater than 47 kt from the south of 25N Brown et al. pressure-wind relationship. Because the ship is at an unknown distance from the center of Flora, the intensities at 18Z on the 29th (55 kt) and 00Z on the 30th (70 kt) are retained.

September 30:

1. Maps and old HURDAT:

- HWM analyzes a hurricane of at most 1000 mb at 10.8N, 59.1W at 12Z.
- HURDAT lists a 100 kt hurricane at 10.7N, 59.1W at 12Z.
- Microfilm shows a closed low pressure of at most 1005 mb at 10.7N, 59.2W at 12Z.

2. Ship highlights:

- 35 kt NE and 1007 mb at 10.9N, 58.3W at 06Z (COADS).
- 45 kt SSE at 10.4N, 59.1W at 10Z (micro).
- 35 kt NE at 12.0N, 62.0W at 18Z (micro).

3. Land highlights:

- 2 kt W and 974 mb (uncorrected) at Crown Point, Tobago at 1840Z (WALLET).

4. Aircraft highlights:

- Penetration center fix measured a central pressure of 994 mb, estimated surface winds of 110 kt and an eye diameter of 25 nm at 10.8N, 59.8W at 1407Z (WALLET).
- Radar center fix with peripheral pressure of 986 mb at 11.1N, 60.2W at 1630Z (WALLET).

- Penetration center fix measured a central pressure of 975 mb, estimated surface winds of 130 kt and an eye diameter of 10 nm at 11.4N, 61.5W at 2110Z (WALLET).

5. Discussion:

- MWR: "The SS Del Alba forwarded all observation made at 1:00 a.m., EST, which arrived around 4:30 am., indicating winds from the northeast of 35 kt., and a barometer reading of 1006.8 mb with a fall of 5 mb in the past 3 hr. At 10:00 am, EST, much too late for adequate warning to Tobago, the Del Alba sent in a complete report as follows: "PASSED THROUGH STORM AREA COMMENCING 4 PM ON THE 29TH-PASSED NORTH OF CENTER 2 AM ON THE 30TH-ESTIMATED POSITION AT 6 AM 11.0 57.5- WINDS FROM THE NORTHWEST AT 4 PM TO NORTHEAST 28 MPH AT 10 PM TO EAST 40 MPH AT 2 AM-PRESENT POSITION AT 10 AM 10.9N 56.3W WIND EASTSOUTHEAST TO SOUTHEAST 16 MPH BAROMETER 29.94 INCHES RISING SOUTHEAST SEAS ROUGH WITH MODERATE HEAVY SWELL-HAVE PASSED STORM." At 9:07 am, EST, the hurricane hunter plane reached the center of the storm, found a circular eye well defined, central pressure 994 mb, surface winds in excess of hurricane force, and the wall cloud around the eye 8 mi. wide. This observation indicated that hurricane Flora was the most concentrated and best organized tropical cyclone of the past two years. The San Juan Weather Bureau office issued a bulletin at 9 am, and the first formal hurricane advisory on Flora at 11 am, EST. The eye of hurricane Flora passed over Tobago at 1:40 pm, EST, with lowest pressure 28.77 in, 974 mb (uncorrected) and maximum sustained winds 90 to 100 mph. Seventeen people were killed and crop and property damage was around $30 million. On Trinidad, maximum winds were estimated at about 55 mph in extreme gusts from the southwest. There was only minor damage over most of Trinidad due to the protection afforded by the mountain range along the north coast. However, when the wind shifted to the southwest, many small boats in the harbor, which is an open roadstead to the west, were sunk. The large vessels had put out to sea. At Northwest Point on the northern slope of the mountains, the marine reporting station estimated winds up to 70 mph with torrential rains. An amateur radio operator about 10 mi. east of Northwest Point and on the slope about ½ mi. from the shore, estimated the winds at 65 mph in gusts and zero visibility due to the heavy driving rain."
- ATSR: "However, it wasn't until the night of 29 September that ships began reporting heavy seas, falling pressures and westerly winds, which prompted a disturbance warning to be issued by Fleet Weather Facility, Miami the following morning at 301100Z. A Navy reconnaissance aircraft from Roosevelt Roads was dispatched into the area the morning of the 30th. The aircraft found the circulation approximately 120 miles to the easy of Trinidad. The disturbance had intensified into a well-developed hurricane with a well-defined wall cloud and central pressure of 994 mbs. Warning number one on Hurricane FLORA was issued at 301600Z."
- Reanalysis: On September 30th, Flora rapidly intensified while approaching and later impacting the Windward Islands. At 1407Z on the 30th, a reconnaissance aircraft reached Flora measuring a central pressure of 994 mb, estimated surface winds of 110 kt, and an eye diameter of 25 nm. A central pressure of 994 mb suggests maximum surface winds of 58 kt from the south of 25N pressure-wind relationship. An eye diameter of 25 nm suggests

an RMW of about 20 nm and the climatological value is 11 nm. Based upon a forward speed of about 17 kt, small size of the circulation (ROCI about 120 nm) and putting some weight on the visual estimate, an intensity of 70 kt is analyzed at 12Z on the 30th, down from 100 kt originally in HURDAT, a major intensity change. Intensification to a hurricane is analyzed at 00Z on the 30th, same as in HURDAT. Around 18Z on the 30th, the center of Flora made landfall in Tobago and a central pressure of 974 mb was measured. (Though the barometer was noted as "uncorrected", Crown Point's elevation is 10 m, so adjusting to sea level would not be a significant uncertainty.) A central pressure of 974 mb suggests maximum surface winds of 86 kt from the south of 25N intensifying subset pressure-wind relationship. Due to the forward speed of about 15 kt and small circulation, an intensity of 90 kt is analyzed at 18Z on the 30th, down from 105 kt originally in HURDAT, a minor intensity change.

October 1:

1. Maps and old HURDAT:

- HWM analyzes a hurricane of at most 1000 mb at 12.8N, 64.8W at 12Z.
- HURDAT lists a 115 kt hurricane at 12.5N, 64.8W at 12Z.
- Microfilm shows a closed low pressure of at most 1008 mb at 13.0N, 65.5W at 12Z.

2. Ship highlights:

- 35 kt E and 1013 mb at 14.2N, 66.4W at 18Z (micro).

3. Aircraft highlights:

- Radar center fix at 11.6N, 62.3W at 01Z (WALLET).
- Radar center fix measured a peripheral pressure of 981 mb and estimated an eye diameter of 13-20 nm at 12.2N, 63.8W at 07Z (WALLET).
- Penetration center fix measured a central pressure of 974 mb, estimated surface winds of 120 kt and an eye diameter of 13 nm at 13.1N, 65.9W at 16Z (WALLET/ATSR).
- Penetration center fix measured a central pressure of 967 mb, estimated surface winds of 120 kt and an eye diameter of 13 nm at 13.2N, 66.2W at 19Z (WALLET). (Dropsonde reported 967 mb at surface, while with 700 mb height/temperature suggest 974 mb.)
- Penetration center fix measured a central pressure of 970 mb and estimated eye diameter of 11 nm at 13.5N, 66.7W at 2110Z (WALLET).

4. Discussion:

- MWR: "On Grenada damage was minor but six people lost their lives by drowning. After leaving the southern Windwards, hurricane Flora moved on a fairly smooth and regular track toward the southwestern Haitian peninsula gradually acquiring a more northward component."
- Reanalysis: On October 1st, Flora was located over the eastern Caribbean Sea moving west-northwest and became slightly more intense late in the day. Reconnaissance aircrafts made made penetration center fixes at 16Z, 19Z and 2110Z measuring a central pressure of 974 mb, 967 mb and 970 mb,

respectively. An intensity of 90 kt is analyzed at 00Z, 06Z, and 12Z and 95 kt at 18Z, down from 110 kt at 00Z and 06Z and down from 115 kt at 12Z and 18Z as originally shown in HURDAT. Ship data over the southeastern Caribbean Sea is sparse and only one ship reported gale-force winds on the 1st.

October 2:

1. Maps and old HURDAT:

- HWM analyzes a hurricane of at most 1000 mb at 14.8N, 69.2W at 12Z.
- HURDAT lists a 120 kt hurricane at 14.6N, 69.2W at 12Z.
- Microfilm shows a closed low pressure of at most 1008 mb at 14.5N, 69.0W at 12Z.

2. Ship highlights:

- 40 kt NE and 1012 mb at 17.4N, 69.8W at 12Z (COADS).
- 50 kt ESE and 1008 mb at 15.2N, 68.6W at 18Z (COADS/MWL).

3. Aircraft highlights:

- Penetration center fix at 13.5N, 67.1W at 02Z (ATSR).
- Penetration center fix measured a central pressure of 956 mb (from 700 mb height/temperature), estimated flight level winds of 145 kt and an eye diameter of 11 nm at 14.4N, 68.3W at 0710Z (WALLET). (Direct pressure from dropsonde is 964 mb, which may not have landed in the center of the hurricane.)
- Radar center fix measured a pressure of 968 mb, estimated surface winds of 130 kt and an eye diameter of 11 nm at 14.8N, 69.6W at 1342Z (WALLET). (It appears that this reading was taken close to the center, but likely was not a central preassure due to earlier and subsequent observations suggesting that it was biased high.)
- Penetration center fix measured a central pressure of 957 mb from dropsonde, estimated surface winds of 120 kt and an eye diameter of 16 nm at 15.1N, 70.1W at 1946Z (WALLET).

4. Discussion:

- Reanalysis: On the 2nd, Flora continued west-northwestward passing north of the ABC Islands. At 0710Z on the 2nd, a penetration center fix measured a central pressure of 956 mb and an eye diameter of 11 nm. A central pressure of 956 mb suggests maximum surface winds of 105 kt from the south of 25N pressure-wind relationship. An eye diameter of 11 nm suggests an RMW of about 8 nm and the climatological value is 11 nm. Based upon a forward speed of about 11 kt and an RMW near the climatological value, an intensity of 105 kt is analyzed at 06Z on the 2nd, down from 120 kt originally in HURDAT, a major intensity change. The next penetration center fix at 1946Z on the 2nd, measured a central pressure of 960 mb, estimated surface winds of 120 kt and an eye diameter of 16 nm. A central pressure of 960 mb suggests maximum surface winds of 100 kt from the south of 25N pressure-wind relationship. An eye diameter of 16 nm suggests an RMW of about 12 nm and the climatological value is also 12 nm. Based upon a forward speed of about 7 kt and an RMW close to the climatological value, an intensity of 105 kt is analyzed at 18Z on the 2nd, down from 120 kt originally in HURDAT, a major intensity change. Intensification to a major hurricane is analyzed at 06Z, 42 hours later than

originally shown in HURDAT. A few ships reported gale-force winds on the 2nd, and also a storm-force wind report of 50 kt at 18Z.

October 3:

1. Maps and old HURDAT:

- HWM analyzes a hurricane of at most 1000 mb at 16.8N, 72.0W at 12Z.
- HURDAT lists a 125 kt hurricane at 16.5N, 72.0W at 12Z.
- Microfilm shows a closed low pressure of at most 1008 mb at 15.0N, 72.0W at 12Z.

2. Ship highlights:

- 35 kt E and 1011 mb at 16.7N, 68.5W at 00Z (COADS).
- 45 kt ESE and 1004 mb at 16.1N, 68.9W at 06Z (COADS).
- 35 kt SE and 1005 mb at 15.2N, 69.4W at 12Z (COADS).

3. Land highlights:

- 1001 mb at Barahona, Dominican Republic at 21Z (WALLET).
- 42 kt (gusts to 55 kt) at Port-au-Prince, Haiti at 23Z (WALLET).

4. Aircraft highlights:

- Radar center fix measured a peripheral pressure of 963 mb, estimated surface winds of 140 kt and an eye diameter of 16 nm at 15.5N, 70.8W at 0046Z (WALLET).
- Radar center fix measured a peripheral pressure of 954 mb, estimated flight level winds of 140 kt and an eye diameter of 15 nm at 15.9N, 71.6W at 0617Z (WALLET).
- Penetration center fix estimated surface winds of 110 kt and an eye diameter of 18 nm at 16.6N, 72.2W at 1342Z (WALLET).
- Penetration center fix measured a central pressure of 936 mb, estimated surface winds of 130 kt, an eye diameter of 15 nm, and 7.5-15 nm RMW (averaging about 10 nm) at 16.8N, 72.4W at 1620Z (WALLET/NHRP).
- Penetration center fix measured a pressure of 936 mb (with flight-level winds of 35 kt) at 1708Z (NHRP). (This suggests a central pressure of 933 mb.)
- Penetration center fix estimated surface winds of 143 kt and an eye diameter of 12 nm at 17.2N, 72.6W at 1838Z (WALLET).

5. Discussion:

- MWR: "Flora intensified slowly until it began to deepen rapidly on October 3. At 11:2O am. EST, the Navy reconnaissance plane reported a central pressure of 936 mb, or 27.64 in. Flight level winds of 167 mph were measured on the 2nd and about the same on the 3rd. Probably some further intensification continued on the 3rd until the center reached the coastline around 8 pm, EST. At this time it was estimated sustained winds on the surface were around 140 mph with gusts 180-200 mph. Thus at this time, Flora was comparable to hurricane Donna when it crossed the Florida Keys in 1960 and Carla when it reached the Texas coast in 1961."

- Reanalysis: On October 3rd, Flora continued to slow its forward speed and turned to the northwest while gaining in strength. At 0617Z on the 3rd, a reconnaissance aircraft measured a peripheral pressure of 954 mb and an eye diameter of 15 nm. A peripheral pressure of 954 mb suggests maximum surface winds greater than 107 kt from the south of 25N pressure-wind relationship. An eye diameter of 15 nm suggests an RMW of about 10 nm and the climatological value is 11 nm. Based upon a forward speed of about 8 kt and an RMW close to the climatological value, an intensity of 115 kt is analyzed at 06Z on the 3rd, down from 125 kt originally in HURDAT, a minor intensity change. At 1620Z on the 3rd, a NHRP research penetration center fix measured a central pressure of 936 mb, estimated surface winds of 130 kt, and an explicit RMW of about 10 nm. At 1708Z, the plane again report surface pressure of 936 mb, but with 35 kt flight-level winds, suggesting about a 933 mb central pressure. A central pressure of 933 mb suggests maximum surface winds of 130 kt from the south of 25N intensifying subset pressure-wind relationship. Based upon a somewhat slow forward speed of about 8 kt but a small RMW, an intensity of 130 kt is analyzed at 18Z on the 3rd, slightly higher than originally shown in HURDAT. 130 kt is also the peak intensity of Hurricane Flora, 5 kt higher than originally shown in HURDAT.

October 4:

1. Maps and old HURDAT:

- HWM analyzes a hurricane of at most 995 mb at 19.7N, 74.3W at 12Z.
- HURDAT lists a 105 kt hurricane at 19.3N, 74.5W at 12Z.
- Microfilm shows a closed low pressure of at most 1005 mb at 19.0N, 75.0W at 12Z.

2. Ship highlights:

- 20 kt NW and 1004 mb at 17.2N, 74.5W at 06Z (COADS).
- 65 kt NW and 988 mb at 18Z (micro).

3. Land highlights:

- calm for 15 minutes at Fonds des Negres, Haiti starting at 0245Z (WALLET).
- calm for an 1 hour, 10 minutes at Ause a Veau, Haiti starting at 04Z (WALLET).
- 978 mb (min pressure) at Port-au-Prince, Haiti at 0430Z (WALLET).
- 55 kt NE and 1006 mb at Punta de Maisi, Cuba at 06Z (CUBA).
- 50 kt E and 1005 mb at Punta de Maisi, Cuba at 12Z (CUBA).
- 83 kt ESE at Punta de Maisi, Cuba at 16Z-18Z (WALLET).
- 70 kt E and 1000 mb at Punta de Maisi, Cuba at 18Z (micro).
- 30 kt NW and 995 mb at Guantanamo Bay, Cuba at 18Z (micro).

4. Aircraft highlights:

- Radar center fix estimated an eye diameter of 12 nm at 18.4N, 73.3W at 01Z (WALLET).
- Radar center fix measured a peripheral pressure of 995 mb, estimated surface winds of 80 kt and an eye diameter of 8-12 nm at 19.1N, 74.0W at 05Z (WALLET).

- Penetration center fix measured a central pressure of 970 mb, estimated surface winds of 110 kt and an eye diameter of 17 nm at 19.3N, 74.6W at 1231Z (WALLET). (A dropsonde, mentioned in the vortex message but otherwise undocumented, apparently measured 958 mb. However, this value is suspicious given the other aircraft observations.)
- Penetration center fix measured a central pressure of 973 mb, estimated surface winds of 100 kt and an eye diameter of 20 nm at 19.5N, 74.8W at 1540Z (WALLET).

5. Discussion:

- MWR: "The vortex entered the Haitian south coast at Cotes de Fer and calms were noted at Fond des Negres and Anse a Veau. Winds of 102 mph were noted at Cotes de Fer at 7 pm, EST October 3 and 120 mph at the Army base near Durez. The total rainfall at Miragoane during the period when western Haiti was under the influence of Flora probably exceeded 75 in. On October 6-8 when Miragoane was under the principal rain band feeding into Flora, the rain gage at the Reynolds Haitian Mines, Inc., which holds 19 in., was observed overflowing three times and was emptied. Thus at least 57 in. fell during this 3-day period. This does not include rainfall during the passage of the center nearby on October 3 and 4, or some rain which fell on the 5th. Destruction over the mountainous terrain of the Haitian peninsula ranged from severe to complete. Flash floods washed away sections of many towns and landslides buried others. The height of the storm surge on the south shore is unknown but could easily have been 12 ft. or more. Crops were totally destroyed. About 3,500 bodies were counted and several thousand persons are missing. Of the missing, normally about half are eventually found to be casualties and half turn up sooner or later in some other locality. Therefore, an estimate of 5,000 deaths appears reasonable. Property and crop damage is estimated at $125 million with some reliable figures as high as $180 million. In the Dominican Republic, preliminary information indicates that damage, mostly from floods but to some extent from wind, to agriculture, livestock, communication lines, etc., is estimated at $60 million. There was also considerable damage to bridges and roads. In the western section of the Republic 10,000 km^2 were inundated. The known loss of life is 29 but is estimated in excess of 400. Floods were the most extensive of record, and several months after the storm roads were still impassable and communication channels in many western sections unrestored. As Flora entered Cuba about 30 mi. east of Guantanamo Bay late on the forenoon of October 4, a warm High at sea level was located over Lake Huron."
- ATSR: "The hurricane reached maximum intensity on 4 October just prior to passing over the southwestern peninsula of Haiti. Later information from Haiti indicated that winds of 135 knots with gusts to 175 knots occurred as FLORA passed over the peninsula. Minimum pressure of 936 mbs was reported by aircraft. Reconnaissance aircraft from Airborne Early Warning Squadron FOUR maintained almost constant surveillance during FLORA's passage through the Caribbean. The meteorological information provided to the hurricane forecasters resulted in accurate tracking of the storm's path and assisted in the prediction of the expansive wind fields which eventually devastated portions of Haiti."

- Reanalysis: Hurricane Flora made landfall in southwestern Haiti around 01Z on October 4th as a 130 kt hurricane, based upon the last (1708Z on the 3rd) aircraft reconnaissance into the hurricane. The intensity at landfall may have been substantially higher than analyzed since the hurricane was intensifying as it was moving toward Hispaniola and the last center penetration occurred about eight hours before landfall. Calm conditions were experienced at Fonds des Negres, Haiti, for about 15 minutes and at Aude a Veau, Haiti, for over one hour. The hurricane crossed the Tiburon Peninsula of Haiti in about two hours and continued northwestward toward eastern Cuba. A reconnaissance aircraft made a center penetration fix at 1231Z on the 4th and measured a central pressure of 970 mb, estimated surface winds of 110 kt and an eye diameter of 17 nm. A central pressure of 970 mb suggests maximum surface winds of 90 kt from the south of 25N pressure-wind relationship. An eye diameter of 17 nm suggests an RMW of about 13 nm and the climatological value is 14 nm. Due to some weighting of the visual surface winds and the synoptic observations over eastern Cuba later in the day and at 00Z on October 5th, an intensity of 105 kt is analyzed at 12Z on the 4th, same as originally shown in HURDAT. Flora made landfall in Cuba around 18Z on the 4th as a 105 kt hurricane, category 3 impact. The Storm Wallets indicate that Punta de Maisi, Cuba's easternmost point, experienced sustained winds of 83 kt between 16Z and 18Z on the 4th. The landfall point in Cuba agrees with that assessed by the Meteorological Service of Cuba and is slightly west and about two hours later from that originally shown in HURDAT.

October 5:

1. Maps and old HURDAT:

- HWM analyzes a hurricane of at most 1000 mb at 21.8N, 76.7W with a weakening front far to the north at 12Z.
- HURDAT lists a 105 kt hurricane at 20.8N, 76.8W at 12Z.
- Microfilm shows a closed low pressure of at most 999 mb at 20.4N, 76.5W at 12Z.

2. Ship highlights:

- 45 kt SE and 1008 mb at 21.9N, 73.0W at 00Z (micro).
- 25 kt SW and 1004 mb at 18.9N, 76.0W at 06Z (COADS).
- 35 kt SE and 1008 mb at 19.8N, 75.1W at 12Z (COADS).
- 45 kt SE and 1003 mb at 19.2N, 75.2W at 15Z (COADS).
- 40 kt SE and 1008 mb at 19.3N, 75.2W at 18Z (COADS).

3. Land highlights:

- 95 kt E (max winds) and 995 mb at Punta Lucrecia, Cuba at 00Z (CUBA).
- 60 kt ESE and 1003 mb at Punta Lucrecia, Cuba at 06Z (micro).
- 60 kt SE and 1001 mb at Santiago de Cuba, Cuba at 12Z (micro).
- 60 kt SSE and 1003 mb at Santiago de Cuba, Cuba at 18Z (CUBA).
- 75 kt at Camagüey, Cuba at 21Z-22Z (WALLET).

4. Discussion:

- Reanalysis: Over eastern Cuba, Flora changed course and began to move slowly westward on the 5th. Minor track changes were introduced on this date to be consistent with the assessment from the Meteorological Service of Cuba. At 00Z on the 5th, Punta Lucrecia, Cuba, reported 95 kt E and 995 mb. In an email communication with Maritza Ballester, it was confirmed that this was indeed a sustained wind measurement and not a gust. Maritza also mentions that the station is very close to the coast at a height of 4 meters. This 95 kt measurement six hours after landfall in Cuba is consistent with a 105 kt intensity at landfall. Note that category 3 at landfall in Cuba is higher than the assessment of Perez et al. of the intensity of Flora at landfall in Cuba as category 2 in the Saffir-Simpson scale. Maritza comments that the Cuban landfall intensity analysis of 90 kt was estimated from a gust measurement of 110 kt and data from the last aircraft reconnaissance investigation before landfall. After approaching the northern coast of Cuba near Punta Lucrecia around 00Z on the 5th, Flora turned to the southwest and moved toward the Gulf of Guacanayabo, emerging over the Caribbean around 22Z. Note that the Meteorological Service of Cuba indicated a tight counter-clockwise loop over six hours between 12 and 18Z. Such a detail, while likely real, is not portrayed in the six hourly time steps in HURDAT. Because Flora closely approached the Atlantic Ocean around 00Z and the RMW likely was back over water, the Kaplan and DeMaria model was run starting with 100 kt at 00Z for 06Z, 12Z and 18Z on the 5th, yielding 72 kt, 54 kt and 51 kt, respectively. On the 5th, 60 kt were registered at 06Z at Punta Lucrecia, 55 kt at Punta Lucrecia and 60 kt at Santiago de Cuba at 12Z and 50 kt at Punta Lucrecia and 55 kt at Santiago de Cuba at 18Z. An intensity of 85 kt is selected for 06Z, 75 kt at 12Z and 70 kt at 18Z on the 5th (down from 110 kt at 06Z, 105 kt at 12Z and 100 kt at 18Z on the 5th, respectively, originally in HURDAT), major intensity changes. The observations from Santiago de Cuba appear to have a high bias and this is not the first time to note this issue, similar situation occurred during the reanalysis of Tropical Storm Gerda, 1961. Maritza mentioned in the email that currently the station is at a height of 45 meters but she was not sure if in 1963 it was at the same elevation.

October 6:

1. Maps and old HURDAT:

- HWM analyzes a hurricane of at most 995 mb at 20.5N, 78.2W with a warm front far to the northeast at 12Z.
- HURDAT lists a 90 kt hurricane at 20.2N, 77.9W at 12Z.
- Microfilm shows a closed low pressure of at most 990 mb at 20.5N, 77.7W at 12Z.

2. Ship highlights:

- 40 kt SSW and 1008 mb at 18.5N, 75.6W at 00Z (micro).
- 35 kt E and 1012 mb at 23.8N, 74.6W at 06Z (COADS).
- 40 kt ENE and 1013 mb at 25.0N, 75.2W at 12Z (COADS).
- 45 kt ENE and 1014 mb at 26.1N, 75.6W at 18Z (COADS).

3. Land highlights:

- 75 kt SE and 1003 mb at Santiago de Cuba, Cuba at 00Z (CUBA).

- 80 kt NE (gusts to 100 kt) and 1002 mb at Camagüey, Cuba at 06Z (micro).
- 50 kt NE and 1000 mb at Camagüey, Cuba at 12Z (micro).
- 60 kt SE and 1003 mb at Santiago de Cuba, Cuba at 18Z (CUBA).

4. Aircraft highlights:

- Radar center fix at 20.3N, 78.0W at 11Z (WALLET).
- Radar center fix at 20.5N, 78.3W at 1835Z (WALLET).

5. Discussion:

- ATSR: "The initial track of Hurricane FLORA was predominately influenced by the easterlies as FLORA passed over the island of Tobago in the Southern Windwards, across the Caribbean and into Eastern Cuba. At this point, lacking sufficient tropospheric steering, FLORA stalled for more than four days over Cuba."
- Reanalysis: Minor track changes were introduced on this date to be consistent with the assessment from the Meteorological Service of Cuba. At 00Z on October 6th, Santiago de Cuba reported 75 kt and at this time the hurricane was about 100 nm to the northwest. The analyzed intensities at 06Z, 12Z and 18Z on the 5th were above that suggested by Kaplan-DeMaria due to a report of 80 kt by Camagüey, Cuba, at 06Z on October 6th. Maritza commented that Camagüey is currently at a height of 119 meters but was not sure about the station's altitude in 1963. Nevertheless, it does appear suspicious. On the 6th, Flora moved slowly over the Gulf of Guacanayabo and some gradual intensification is shown. Observations near the center were sparse on this day but the system likely regained some of its strength over the warm waters of the gulf. Reconnaissance aircrafts investigated the hurricane around 12Z and 18Z but only radar center fixes were obtained. Synoptic observations indicate that the circulation of Flora expanded after crossing eastern Cuba. The ROCI had expanded to about 330 nm by 18Z on the 6th, compared to about 120 nm on the 1st. A couple of ships reported gale-force winds on the 6th.

October 7:

1. Maps and old HURDAT:

- HWM analyzes a hurricane of at most 985 mb at 21.0N, 78.5W with a stationary front far to the northeast at 12Z.
- HURDAT lists an 80 kt hurricane at 20.8N, 78.1W at 12Z.
- Microfilm shows a closed low pressure of at most 990 mb at 20.8N, 78.2W at 12Z.

2. Ship highlights:

- 40 kt S and 1003 mb at 17.3N, 74.9W at 00Z (COADS).
- 35 kt S and 1003 mb at 18.2N, 76.3W at 06Z (COADS).
- 35 kt SE and 1001 mb at 18.4N, 75.3W at 12Z (COADS).
- 45 kt ENE and 1014 mb at 26.1N, 75.6W at 18Z (MWL).

3. Land highlights:

- 55 kt SE and 1003 mb at Santiago de Cuba, Cuba at 00Z (CUBA).

- 55 kt SE and 1004 mb at Santiago de Cuba, Cuba at 06Z (CUBA).
- 70 kt SE and 1002 mb at Santiago de Cuba, Cuba at 12Z (CUBA).
- 35 kt SW and 996 mb at Cabo Cruz, Cuba at 18Z (CUBA).
- 35 kt NE at Caibarien, Cuba at 21Z-22Z (WALLET).

4. Aircraft highlights:

- Radar center fix near 21.0N, 78.0W at 1115Z (WALLET).
- Radar center fix estimated a peripheral pressure of 986 mb and surface winds of 55 kt at 21.1N, 78.1W at 1315Z (WALLET/ATSR).

5. Discussion:

- MWR: "During October 7 and 8 Flora moved slowly eastward to east-northeastward almost directly over the same portion of eastern Cuba it had traversed two days before."
- Reanalysis: On October 7th, Flora moved slowly northward making landfall in Camagüey at 00Z as an 85 kt hurricane, just a few miles to the west of Santa Cruz del Sur. Minor track changes were introduced on this date to be consistent with the assessment from the Meteorological Service of Cuba. A few ships reported gale-force winds on the 7th. After making landfall, Flora moved northward before turning eastward over eastern Cuba and weakened. The Kaplan and DeMaria model was run for 06Z, 12Z, and 18Z on the 7th and 00Z, 06Z, and 12Z on the 8th, yielding 61, 50, 40, 38, 38, and 40 kt, respectively. The highest recorded winds were 70 kt and 60 kt at Santiago de Cuba at 12Z and 18Z on the 7th, respectively, and 55 kt and 60 kt at Santiago de Cuba at 00Z and 06Z on the 8th, respectively. An intensity of 75 kt is selected at 06Z, 70 kt at 12Z, 60 kt at 18Z, 60 kt at 00Z on the 8th, 55 kt at 06Z, and 50 kt at 12Z. The changes at 18Z on the 7th and 00Z-12Z on the 8th were major downward revisions. The original HURDAT did not show Flora weakening to a tropical storm.

October 8:

1. Maps and old HURDAT:

- HWM analyzes a hurricane of at most 985 mb at 21.5N, 76.2W at 12Z.
- HURDAT lists a 70 kt hurricane at 21.1N, 76.2W at 12Z.
- Microfilm shows a closed low pressure of at most 993 mb at 21.1N, 76.2W at 12Z.

2. Ship highlights:

- 35 kt NE and 1005 mb at 22.2N, 73.4W at 00Z (COADS).
- 35 kt S and 1000 mb at 18.9N, 74.9W at 06Z (COADS).
- 35 kt SE and 1000 mb at 20.6N, 73.9W at 12Z (COADS/micro).
- 60 kt E and 994 mb at 22.4N, 74.4W at 18Z (COADS/MWL).
- 55 kt NNE and 991 mb at 21.5N, 76.1W at 20Z (MWL).

3. Land highlights:

- 35 kt NE and 1009 mb at North Eleuthera, Bahamas at 00Z (micro).

- 60 kt S (possible high bias) and 999 mb at Santiago de Cuba, Cuba at 06Z (micro).
- 35 kt SE and 1000 mb at Punta de Maisi, Cuba at 12Z (micro).
- 80 kt S at Punta de Maisi, Cuba at 17Z (WALLET).

4. Aircraft highlights:

- Penetration center fix measured a central pressure of 983 mb and estimated surface winds of 100 kt at 21.5N, 75.0W at 2215Z (WALLET).

5. Discussion:

- MWR: "By October 8, another active short wave was morning into the long-wave trough position off the east coast and accelerating the southwesterly flow in the area of the hurricane. Thus Flora began to follow a more normal northeastward course at a gradually increasing forward speed into higher latitudes."
- ATSR: "Recurvature to the northeast and acceleration occurred on 8 October as FLORA left the North Cuban coast and emerged into the Atlantic after passing Mayaguana Island in the Southeastern Bahamas."
- Reanalysis: Flora entered the Atlantic Ocean after 12Z on the 8th near the city of Gibara, Holguín, Cuba. Minor track changes were introduced on this date to be consistent with the assessment from the Meteorological Service of Cuba. The tropical cyclone immediately began to intensify and it is analyzed to have regained hurricane intensity at 18Z on the 8th. A ship reported 60 kt E and 994 mb at 18Z and another registered 55 kt NNE and 991 mb at 20Z.

October 9:

1. Maps and old HURDAT:

- HWM analyzes a hurricane of at most 985 mb at 23.5N, 71.2W with a weakening warm front to the northeast at 12Z.
- HURDAT lists an 80 kt hurricane at 23.5N, 71.6W at 12Z.
- Microfilm shows a closed low pressure of at most 996 mb at 23.8N, 71.3W at 12Z.

2. Ship highlights:

- 45 kt S and 998 mb at 19.7N, 73.7W at 00Z (micro).
- 40 kt ESE and 998 mb at 24.0N, 72.1W at 06Z (micro).
- 50 kt S and 998 mb at 21.7N, 68.7W at 12Z (micro).
- 35 kt SSE and 1006 mb at 24.6N, 66.5W at 15Z (COADS).
- 55 kt NNE and 1003 mb at 26.8N, 67.3W at 18Z (MWL).

3. Land highlights:

- 40 kt SSW and 989 mb at Matthew Town, Bahamas at 00Z (micro).
- 977 mb at Mayaguana, Bahamas at 0545Z (WALLET).
- 35 kt SE and 998 mb at Grand Turk at 06Z (micro).
- 40 kt SW and 999 mb at Grand Turk at 12Z (micro).

4. Aircraft highlights:

- Penetration center fix measured a central pressure of 966 mb (from 700 mb height/temperature), estimated surface winds of 80 kt at 23.4N, 71.6W at 1315Z (WALLET).
- Penetration center fix measured a central pressure of 965 mb, estimated surface winds of 130 kt and an eye diameter of 70 nm at 25.0N, 69.5W at 19Z (WALLET).
- Penetration center fix measured a central pressure of 965 mb, doppler estimated surface winds of 105 kt and an eye diameter of 40 nm at 25.7N, 68.4W at 2321Z (WALLET). (Dropsonde reported 972 mb at surface consistent with 850 mb height/temperature, but 700 mb height/temperature consistent more with 965 mb. Drop may have landed outside of hurricane's center. 965 mb used as central pressure.)

5. Discussion:

- MWR: "Hurricane Flora passed through the southeastern Bahamas on the night of October 8. On Inagua, Flora was described as the "worst hurricane ever experienced there within living memory." Winds were estimated at 75 to 80 m.p.h. Two wharves were destroyed, the sea wall was damaged, and there was extensive damage to crops, roofs, and roads. The eye passed over Mayaguana shortly after midnight with maximum winds at 1:30 a.m. EST of 83 m.p.h. The sea wall was washed away and crop destruction was total. There was extensive damage to roofs and communication lines. One person was drowned. Exuma, Long, Acklins, Crooked Islands, and Long Cay reported some damage to roads and property and crop damage ranged from moderate to total."
- Reanalysis: At 2215Z on the 8th, a reconnaissance aircraft made a penetration center fix measuring a central pressure of 983 mb and estimated surface winds of 100 kt. A central pressure of 983 mb suggests maximum surface winds of 74 kt from the south of 25N pressure-wind relationship. Based on a forward speed of about 11 kt, an intensity of 75 kt is analyzed at 00Z on October 9th, same as originally shown in HURDAT. On the 9th, Flora continued to move away from Cuba impacting the eastern Bahamas as it gained in forward speed to the northeast. The hurricane made landfall in Mayaguana, Bahamas, around 06Z on the 9th, where a central pressure of 977 mb was measured in the eye. A central pressure of 977 mb suggests maximum surface winds of 81 kt from the south of 25N pressure-wind relationship. Due to a forward speed of about 17 kt, an intensity of 85 kt is analyzed at 06Z on the 9th, up from 75 kt originally in HURDAT, a minor intensity change. At 19Z on the 9th, another penetration center fix measured a central pressure of 965 mb, estimated surface winds of 130 kt and an eye diameter of 70 nm. A central pressure of 965 mb suggests maximum surface winds of 86 kt from the south of 25N and 90 kt from the north of 25N pressure-wind relationship. An eye diameter of 70 nm suggests an RMW of about 55 nm and the climatological value is 19 nm. Due to a forward speed of about 23 kt and some weighting of the estimated surface winds, an intensity of 95 kt is selected at 18Z on the 9th, up from 85 kt originally in HURDAT, a mminor intensity change.

October 10:

1. Maps and old HURDAT:

- HWM analyzes a hurricane of at most 985 mb at 28.4N, 64.9W with a weakening stationary front to the northeast at 12Z.
- HURDAT lists a 100 kt hurricane at 28.1N, 64.9W at 12Z.

- Microfilm shows a closed low pressure of at most 999 mb at 27.5N, 64.8W with a frontal boundary to the northwest at 12Z.

2. Ship highlights:

- 75 kt SE and 990 mb at 25.5N, 68.0W at 00Z (micro).
- 60 kt WNW and 1003 mb at 25.3N, 67.7W at 06Z (micro).
- 75 kt S and 983 mb at 27.0N, 64.3W at 12Z (COADS).
- 50 kt S and 1002 mb at 27.6N, 60.0W at 18Z (COADS).
- 35 kt N and 1022 mb at 35.8N, 74.4W at 21Z (COADS).
- 50 kt E and 998 mb at 33.9N, 61.0W at 23Z (COADS).

3. Aircraft highlights:

- Radar center fix estimated a peripheral pressure of 968 mb at 26.3N, 67.2W at 0109Z (WALLET).
- Penetration center fix measured a central pressure of 969 mb, estimated surface winds of 120 kt and an eye diameter of 70 nm at 27.8N, 64.4W at 1307Z (WALLET).
- Penetration center fix measured a central pressure of 972 mb and estimated flight level winds of 85 kt with RMW measured ranging from 35 to 50 nm (average around 40 nm) at 30.3N, 61.8W at 19Z (WALLET).
- Penetration center fix measured a central pressure of 968 mb, estimated surface winds of 122 kt and an eye diameter of 50 nm at 31.4N, 60.5W at 2220Z (WALLET).

4. Discussion:

- Reanalysis: A final penetration fix on the 9th measured a central pressure of 965 mb at 2321Z, thus an intensity of 95 kt is also analyzed at 00Z on October 10th, unchanged in HURDAT. A couple of ships recorded tropical storm force winds on the 9th, up to 55 kt. On the 10th, Flora continued to move rapidly to the northeast over the western Atlantic. A few ships reported hurricane-force winds on the 10th, including 75 kt SE and 990 mb at 00Z. At 1307Z on the 10th, a penetration center fix measured a central pressure of 969 mb, estimated surface winds of 120 kt and an eye diameter of 70 nm. A central pressure of 969 mb suggests maximum surface winds of 86 kt from the north of 25N pressure-wind relationship. An eye diameter of 70 nm suggests an RMW of about 55 nm and the climatological value is 24 nm. (This is similar to the NHRP explicit RMW measurements later in the day of about 40 nm.) Due to a forward speed of about 31 kt but large size, an intensity of 90 kt is selected at 12Z on the 10th, down from 100 kt originally in HURDAT, a minor intensity change. Weakening below major hurricane intensity is analyzed at 12Z on the 10th, twelve hours earlier than originally shown in HURDAT. Another penetration center fix measured a central pressure of 972 mb at 19Z on the 10th. A central pressure of 972 mb suggests maximum surface winds of 82 kt from the north of 25N pressure-wind relationship. Due to a forward speed of about 35 kt but large size, an intensity of 90 kt is selected at 18Z on the 10th, down from 100 kt originally in HURDAT, a minor intensity change.

October 11:

1. Maps and old HURDAT:

- HWM analyzes a hurricane of at most 985 mb at 36.7N, 56.9W with a frontal boundary just to the west at 12Z.
- HURDAT lists an 85 kt hurricane at 36.2N, 57.0W at 12Z.
- Microfilm shows a closed low pressure of at most 999 mb at 36.5N, 57.0W with a frontal boundary to the west and another to the southwest at 12Z.

2. Ship highlights:

- 40 kt WSW and 1006 mb at 27.0N, 60.0W at 00Z (COADS).
- 40 kt N and 999 mb at 33.7N, 62.3W at 06Z (MWL).
- 60 kt ESE and 1001 mb at 40.1N, 56.3W at 12Z (COADS).
- 70 kt NE and 990 mb at 40.1N, 57.2W at 15Z (COADS).
- 70 kt SE and 961 mb at 38.3N, 55.6W at 18Z (COADS/micro).
- 100 kt NE at 40.2N, 55.3W at 18Z (micro).
- 70 kt N and 978 mb at 40.1N, 57.2W at 21Z (COADS).

3. Aircraft highlights:

- Radar center fix at 32.6N, 59.7W at 0106Z (WALLET).
- Penetration center fix measured a central pressure of 963 mb, estimated flight level winds of 80 kt and an eye diameter of 80 nm at 36.9N, 56.8W at 1315Z (WALLET).
- Penetration center fix estimated flight level winds of 75 kt at 38.6N, 56.0W at 1915Z (WALLET).

4. Discussion:

- Reanalysis: At 2220Z on the 10th, a penetration center fix measured a central pressure of 968 mb, estimated surface winds of 122 kt and an eye diameter of 50 nm. A central pressure of 968 mb suggests maximum surface winds of 87 kt from the north of 25N pressure-wind relationship. An eye diameter of 50 nm suggests an RMW of about 40 nm and the climatological value is 24 nm. Due to a forward speed of about 35 kt but large size, an intensity of 90 kt is selected at 00Z on October 11th, down slightly from HURDAT. At 1315Z on the 11th, a penetration center fix measured a central pressure of 963 mb and an eye diameter of 80 nm. A central pressure of 963 mb suggests maximum surface winds of 88 kt from the Landsea et al. north of 35N pressure-wind relationship. An eye diameter of 80 nm suggests an RMW of about 60 nm and the climatological value is 29 nm. Due to a forward speed of about 21 kt but large RMW, an intensity of 90 kt is selected at 12Z on the 11th, up from 85 kt originally in HURDAT, a minor intensity change. A couple of ships reported tropical storm force winds on the 11th and even a few experienced hurricane-force winds, including 100 kt at 18Z, although the two ships that reported 100 kt appears to have a high wind bias in comparison with nearby ships.

October 12:

1. Maps and old HURDAT:

- HWM analyzes a hurricane of at most 980 mb at 43.7N, 50.0W with a warm front to the northeast and a cold front to the south and an extratropical cyclone at 50.0 N, 66.0W at 12Z.

- HURDAT lists a 75 kt hurricane at 43.5N, 49.8W at 12Z.
- Microfilm shows an extratropical cyclone of at most 993 mb at 43.0N, 51.0W at 12Z.

2. Ship highlights:

- 75 kt NE and 988 mb at 42.4N, 54.3W at 00Z (COADS/MWL).
- 100 kt NW and 983 mb at 39.6N, 56.3W at 00Z (micro).
- 80 kt E at 43.2N, 52.0W at 03Z (micro).
- 70 kt NW and 983 mb at 41.1N, 56.3W at 06Z (COADS).
- 60 kt N and 982 mb at 42.5N, 52.8W at 12Z (COADS/micro).
- 60 kt WSW and 999 mb at 40.4N, 49.1W at 18Z (COADS).
- 50 kt SW and 1001 mb at 41.5N, 45.3W at 21Z (COADS).

3. Discussion:

- ATSR: "FLORA passed southeast of Newfoundland on the 12th, and soon became extratropical after coming under the influence of a cool air mass. The last of 49 warnings was transmitted at 121600Z."
- Reanalysis: Hurricane Flora began to lose its tropical characteristics late on the 11th as a frontal boundary approached from the west and the tropical cyclone moved into the mid-latitudes. Synoptic observations indicate that the transition into an extratropical cyclone occurred around 00Z on the 12th as the temperature gradient became more pronounced between the eastern and western quadrants and frontogenesis occurred. Transition into an extratropical cyclone is analyzed 18 hours earlier than originally shown in HURDAT. On October 12th, extratropical Flora began to interact with an extratropical cyclone to the northwest as both cyclones moved to the northeast. Flora remained a very powerful extratropical cyclone on the 12th as ships continued to report hurricane-force winds up to 75 kt, but the system was gradually weakening.

October 13:

1. Maps and old HURDAT:

- HWM analyzes a hurricane of at most 970 mb at 51.5N, 41.8W at 12Z.
- HURDAT lists a 70 kt extratropical cyclone at 51.5N, 41.0W at 12Z (last position).
- Microfilm shows an extratropical cyclone of at most 969 mb at 53.5N, 43.5W at 12Z.

2. Ship highlights:

- 70 kt SW and 995 mb at 44.1N, 44.5W at 00Z (COADS).
- 50 kt WSW and 1009 mb at 44.1N, 41.0W at 06Z (COADS).
- 50 kt ENE and 987 mb at 55.2N, 41.2W at 12Z (COADS).
- 35 kt NNE and 969 mb at 53.4N, 44.1W at 12Z (COADS).
- 65 kt N and 971 mb at 55.1N, 43.2W at 18Z (COADS).

3. Discussion:

- MWR: "However, for portions of five days, completely boxed in by the high-pressure areas to the west, the north, and the east, the hurricane meandered back and forth over eastern Cuba with winds of hurricane or near hurricane force and torrential rain. Members of the staff of the National Observatory at Havana jointly with personnel of the National Academy of Sciences (Cuba) carefully surveyed the hurricane area and on the basis of the survey and hourly observations during the storm, determined the track as shown in figure 2. Although Flora had not completely regained its former intensity by the time it entered Cuba, nevertheless winds of 70 to 100 mph lashed eastern Cuba for 100 hr. or more."
- Reanalysis: The original HURDAT showed Flora dissipating after 12Z on the 3rd (as a 70 kt extratropical cyclone). However, the system continued toward the northeast late on the 13th and the 14th as a strong extratropical cyclone. From the 15th to the 17th, the system stalled and gradually weakened before being absorbed by a stronger extratropical low to its east after 18Z on the 17th.

Date	Original HURDAT Central Pressure	Evidence	Changes
Sep 29 12Z	1000 mb	Ship report around 2230Z on the 29th and does not suggest it was a central pressure measurement	Removed
Sep 30 12Z	994 mb	Penetration center fix: 994 mb at 1407Z on Sep 30th	Retained
Sep 30 18Z	978 mb	Tobago: 2 kt W and 974 mb at 1840Z on Sep 30th	974 mb
Oct 01 00Z	981 mb	Penetration center fix: 975 mb at 2110Z on Sep 30th	975 mb
Oct 01 06Z	981 mb	Peripheral pressure at 07Z on Oct 1st	Removed
Oct 01 12Z	974 mb	Penetration center fix at 16Z on Oct 1st, closer to the 18Z time slot than 12Z	
Oct 01 18Z	975 mb	Penetration center fix: 967 mb at 19Z on Oct 1st	967 mb
Oct 02 00Z	970 mb	Penetration center fix: 970 mb at 22Z on Oct 1st, however, given earlier and subsequent central pressures, this appears to be biased high	Removed
Oct 02 06Z		Penetration center fix: 956 mb at 0710Z on Oct 2nd	956 mb
Oct 02 12Z	968 mb	Penetration center fix: 968 mb at 1342Z on Oct 2nd, however, given earlier and subsequent central pressures, this appears to be biased high	Removed
Oct 02 18Z	968 mb	Penetration center fix: 957 mb at 1946Z on Oct 2nd	957 mb
Oct 03 12Z	940 mb	No central pressure was reported by the reconnaissance aircraft around 12Z on Oct 3rd	Removed
Oct 03 18Z	944 mb	Penetration center fix: 936 mb at 1708Z on Oct 3rd with 35 kt flight level winds	933 mb
Oct 04 00Z	944 mb	Only radar center fixes were made around 00Z on Oct 4th near the time of landfall	Removed
Oct 04 06Z	995 mb	Peripheral pressure at 05Z on Oct 4th	

Oct 04 12Z	970 mb	Penetration center fix: 970 mb at 1231Z on Oct 4th	Retained
Oct 04 18Z	970 mb	Penetration center fix: 973 mb at 1540Z on Oct 4th	973 mb
Oct 05 12Z	985 mb	Between October 5th and October 8th, the center of Flora meandered over eastern Cuba and the nearby waters of the Caribbean Sea. The reconnaissance aircraft observations were radar center fixes and the synoptic data available is not sufficient to estimate the central pressure during these time slots	Removed
Oct 06 12Z	985 mb		
Oct 07 12Z	986 mb		
Oct 08 06Z	989 mb		
Oct 08 12Z	990 mb		
Oct 08 18Z	990 mb	Ship: 55 kt NE and 991 mb at 20Z on Oct 18th	
Oct 09 00Z	983 mb	Penetration center fix: 983 mb at 2215Z on Oct 8th	Retained
Oct 09 06Z		Penetration center fix: 977 mb at 0545Z on Oct 9th	977 mb
Oct 09 12Z	975 mb	Penetration center fix: 966 mb at 1315Z on Oct 9th	966 mb
Oct 09 18Z	965 mb	Penetration center fix: 965 mb at 19Z on Oct 9th	Retained
Oct 10 00Z	965 mb	Penetration center fix: 965 mb at 2321Z on Oct 9th	
Oct 10 06Z	969 mb	No reconnaissance aircraft was present around 06Z on Oct 10th, nor there was a ship observation near the center	Removed
Oct 10 12Z	969 mb	Penetration center fix: 969 mb at 1307Z on Oct 10th	Retained
Oct 10 18Z	972 mb	Penetration center fix: 972 mb at 19Z on Oct 10th	
Oct 11 00Z		Penetration center fix: 968 mb at 2220Z on Oct 10th	968 mb
Oct 11 06Z	970 mb	No reconnaissance aircraft was present around 06Z on Oct 11th but appears reasonable	Retained
Oct 11 12Z	963 mb	Penetration center fix: 963 mb at 1315Z on Oct 11th	
Oct 11 18Z	963 mb	Synoptic data suggests a lower central pressure	Removed
Oct 12 12Z	985 mb		

Sources: the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Monthly Weather Review, Navy reconnaissance book, Mariners Weather Log, Cuban surface maps (CUBA), National Hurricane Research Project (NHRP), Advisories Perez et al., correspondence with Maritza Ballester from the Cuban Meteorological Institute and NHC Storm Wallets.

Hurricane Ginny [October 17-30, 1963] – AL081963

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43050 10/16/1963 M=15  8 SNBR= 931 GINNY       XING=0 SSS=0
43050 10/17/1963 M=14  8 SNBR= 931 GINNY       XING=0 SSS=0
          **        **

(October 16th has been removed from HURDAT)
43055 10/16*  0   0   0    0*  0   0   0    0*210 720  20    0*218 719  20    0*
43055 10/16*  0   0   0    0*  0   0   0    0*  0   0   0    0*  0   0   0    0*
                                             *   *   *        *   *   *
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43060 10/17*225 718  20    0*233 717  20    0*240 716  20    0*248 715  20    0*
43060 10/17*  0   0   0    0*  0   0   0    0*  0   0   0    0*255 720  20    0*
              *   *   *        *   *   *        *   *   *      *** ***

43065 10/18*255 714  20    0*263 713  25    0*270 712  30    0*278 712  30    0*
43065 10/18*260 717  20    0*265 714  25    0*270 712  30    0*278 712  30    0*
            *** ***          *** ***

43070 10/19*285 712  30    0*295 713  30    0*308 718  35 1000*322 726  45    0*
43070 10/19*285 712  30    0*295 713  35    0*308 718  45    0*320 726  55  992*
                                      **               **    *          **  ***

43075 10/20*334 735  55    0*336 743  60    0*335 750  65  983*338 755  70    0*
43075 10/20*328 735  60  989*334 743  60    0*335 750  65  983*337 755  70    0*
            ***      **  *** ***                               ***

43080 10/21*340 755  75    0*342 750  75    0*340 745  75    0*336 742  75    0*
43080 10/21*340 755  75    0*342 750  80    0*340 746  80    0*336 742  80    0*
                                      **          ***  **               **

43085 10/22*330 740  70    0*322 744  70    0*315 748  70    0*308 753  70  989*
43085 10/22*330 740  75    0*322 744  70    0*315 748  65    0*308 753  65  989*
                     **                                **               **

43090 10/23*303 760  65  987*296 769  60  988*289 777  60  995*288 782  65  990*
43090 10/23*302 760  65  991*296 769  65  988*290 777  65  990*288 782  65  990*
                         ***          **      ***      **  ***

43095 10/24*288 785  65  988*290 790  65    0*294 796  65  990*298 797  70  987*
43095 10/24*288 786  70  988*290 790  70    0*293 795  70  990*297 797  70  985*
                ***  **               **      *** ***  **      ***          ***

43100 10/25*303 796  75  982*311 797  85    0*318 796  90  976*321 790  90  985*
43100 10/25*304 797  75  982*311 797  80    0*318 796  80  976*321 790  70  985*
            *** ***                   **               **               **

43105 10/26*324 781  85    0*332 773  80  988*332 769  80  986*329 765  75  978*
43105 10/26*325 782  70  985*331 775  70  983*332 769  70  986*330 765  75  978*
            *** ***  **  *** *** ***  **  ***          **      ***

43110 10/27*330 760  70  979*329 759  70  980*329 753  70  972*327 746  75  975*
43110 10/27*329 762  75  979*329 759  80  972*329 754  80    0*327 746  80  975*
            *** ***  **               **  ***     ***  **    *          **

43115 10/28*326 734  75    0*332 729  80    0*339 723  80  968*351 715  85  963*
43115 10/28*327 737  85  970*332 730  85    0*339 723  90  968*351 715  95  963*
            *** ***  **  ***     ***  **               **               **

43120 10/29*363 703  95    0*378 688  95    0*408 672  95  958E440 660  90    0*
43120 10/29*363 703  95    0*381 688  95    0*408 672  95  948*440 657  90  948*
                             ***                           ****    ***      ***

43125 10/30E470 640  80    0E490 630  80    0*  0   0   0    0*  0   0   0    0*
43125 10/30E470 640  70    0E490 630  50    0*  0   0   0    0*  0   0   0    0*
                     **               **

43130 HR
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U.S. Tropical Storm Impact

09/26 06Z 33.1N 76.9W 55 kt North Carolina
09/29 06Z 38.1N 68.8W 35 kt Massachusetts

Internation Landfall

09/29 1730Z 43.8N 65.8W 90 kt 948 mb Canada

Significant Revisions:

- Genesis indicated to have occurred 30 hours later.
- Intensity substantially reduced on the 25th and 26th based upon aircraft reconnaissance.
- Intensity substantially reduced on the 30th based upon ship observations.
- Ginny explicitly shown to be a hurricane at landfall in Canada (previously it was ambiguous in HURDAT).

Daily Summary:

October 15:

1. Maps and old HURDAT:

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

2. Ship highlights: 45 kt ESE at 28.7N, 71.1W at 18Z (micro).

October 16:

1. Maps and old HURDAT:

- HWM analyzes a closed low pressure of at most 1010 mb at 21.0N, 72.0W at 12Z.
- HURDAT lists a 20 kt tropical depression at 21.0N, 72.0W at 12Z (first position).
- Microfilm shows a closed low pressure of at most 1011 mb at 22.0N, 72.0W at 12Z.

2. Discussion:

- MWR: "The depression which grew into hurricane Ginny developed in the southeastern Bahamas during October 16. Although there was a weak surface circulation at this time, there was a marked trough, surface and aloft, extending northeastward toward Bermuda, which represented a fracture from a polar trough. Consequently the trough was cold and the air mass baroclinic."
- Reanalysis: Ginny originated from a tropical wave that entered the Caribbean Sea on October 14th. The disturbance moved westward over the Greater Antilles becoming better organized north of Hispaniola on October 16th. It is noted that while a circulation is evident in the microfilm map for 12Z on the 16th, subsequent maps show more of a trough than a closed circulation.

October 17:

1. Maps and old HURDAT:

- HWM analyzes a closed low pressure of at most 1010 mb at 24.0N, 72.0W at 12Z.
- HURDAT lists a 20 kt tropical depression at 24.0N, 71.6W at 12Z.
- Microfilm shows a closed low pressure of at most 1011 mb at 27.0N, 69.0W at 12Z.

2. Discussion:

- Reanalysis: Based upon synoptic observations, the low-level circulation became better defined on October 17th while drifting northward and a 20 kt tropical depression is analyzed to have developed at 18Z on the 17th, 30 hours later than originally shown in HURDAT. Observations on the 16th and early on the 17th indicate that the disturbance was a sharp trough over the eastern Bahamas, thus genesis was delayed from the original HURDAT. (Central pressures values for many six hour period were present in the original HURDAT between October 19th at 12Z and October 29st at 18Z. Some of these were obviously analyses that were added in, not based upon actual observations. Thus, based on actual observations, some were retained and new central pressure values added. Detailed information on these changes can be found in the table at the end.)

October 18:

1. Maps and old HURDAT:

- HWM analyzes a closed low pressure of at most 1010 mb at 27.0N, 72.0W with a stationary front to the north at 12Z.
- HURDAT lists a 30 kt tropical depression at 27.0N, 71.2W at 12Z.
- Microfilm shows a trough of low pressure north of the eastern Bahamas at 12Z.

2. Discussion:

- ATSR: "The first sustained closed circulation appeared on the 18th, after the center of lowest pressure had moved north-northeast for the two days remaining under the trough line aloft. Lowest surface pressure at this time was estimated to be 1008 mbs. Slow intensification began and the system had all indications of remaining a cold core extratropical circulation."
- Reanalysis: On October 18th, the tropical depression moved northward and slowly intensified. Synoptic observations indicate that the tropical cyclone had a large circulation, radius of OCI about 240 nm, and it was interacting with a stationary boundary over the western Atlantic, and thus this system had some subtropical characteristics during the first few days of its existence. However, without satellite imagery available on this date, the subtropical designation cannot be used.

October 19:

1. Maps and old HURDAT:

- HWM analyzes a tropical storm of at most 1000 mb at 30.9N, 71.4W with a warm front to the northeast at 12Z.
- HURDAT lists a 35 kt tropical storm at 30.8N, 71.8W at 12Z.

- Microfilm shows a closed low pressure of at most 1011 mb at 29.0N, 73.0W with a frontal boundary extended to the northeast at 12Z.

2. Ship highlights:

- 35 kt NE and 1015 mb at 32.6N, 74.3W at 00Z (COADS).
- 35 kt NE and 1011 mb at 31.1N, 74.7W at 03Z (COADS).
- 35 kt NE and 1015 mb at 34.5N, 71.8W at 09Z (COADS).
- 40 kt NE and 1009 mb at 33.0N, 73.0W at 12Z (COADS).
- 993 mb at 32.0N, 72.5W at 18Z (micro).
- 50 kt NNE and 1007 mb at 32.6N, 73.8W at 18Z (COADS).
- 40 kt E and 1007 mb at 34.0N, 71.0W at 21Z (COADS).

3. Aircraft highlights:

- Estimated surface winds of 60 kt and a "cyclonic circulation" diameter of 80 nm near 31.0N, 73.0W around 20Z. 994 mb surface pressure with flight-level winds of 20 kt and estimated surface winds of 25 kt at 21Z (ATSR).

4. Discussion:

- MWR: "In reality, the depression was not tropical and neither was the storm, which developed later on the 19th. There was no warm core."
- ATSR: "Intensification accelerated on the 19th as the circulation became closed through the 200 mb level and cold advection had increased in the upper tropospheric levels. Storm velocity of 48 knots was attained this day. The first reconnaissance flight was dispatched this date from Naval Air Station, Jacksonville to investigate an area in the vicinity of 31N 73W. A cyclonic circulation 80 miles in diameter was observed; however, no radar eye or warm core was discernible."
- Reanalysis: At 00Z on October 19th, gales were reported about 300 nm northwest of the center but the observations were outside the outermost closed isobar and therefore, not considered part of the circulation and were instead due to the large scale synoptic pressure gradients. Ginny turned to the northwest on the 19th and quickly strengthened. Intensification to a tropical storm is analyzed at 06Z on the 19th, six hours earlier than originally shown in HURDAT. A couple of ships reported gale-force winds on the 19th, including storm-force winds of 50 kt N at 18Z. The 21Z aircraft report indicates a central pressure of 992 mb (close to the 993 mb from the ship with no wind report). This central pressure suggests intensity of 56 kt from the Brown et al. north of 25N pressure-wind relationship. An intensity of 55 kt is analyzed at 18Z, up from 45 kt originally in HURDAT, a minor intensity change.

October 20:

1. Maps and old HURDAT:

- HWM analyzes a hurricane of at most 985 mb at 33.8N, 75.0W with a warm front to the northeast at 12Z.
- HURDAT lists a 65 kt hurricane at 33.5N, 75.0W at 12Z.

- Microfilm shows a closed low pressure of at most 996 mb at 33.5N, 75.2W at 12Z.

2. Ship highlights:

- 55 kt NE and 1011 mb at 33.8N, 75.6W at 00Z (COADS).
- 30 kt SE and 992 mb at 32.6N, 72.8W at 00Z (COADS/micro).
- 55 kt SSW and 994 mb at 31.7N, 72.6W at 03Z (micro).
- 45 kt ENE and 996 mb at 32.6N, 75.5W at 06Z (COADS).
- 55 kt NNW and 994 mb at 32.8N, 75.8W at 09Z (micro).
- 55 kt NNE and 1005 mb at 33.9N, 75.9W at 12Z (COADS).
- 35 kt E and 988 mb at 33.9N, 75.2W at 12Z (COADS).
- 60 kt NE and 999 mb at 34.1N, 75.6W at 15Z (micro).
- 70 kt NE and 990 mb at 34.0N, 75.1W at 18Z (micro).
- 75 kt S and 999 mb at 33.8N, 74.0W at 21Z (micro).
- 60 kt SE and 983 mb at 34.0N, 75.2W at 21Z (micro).
- 65 kt NNE and 991 mb at 34.2N, 75.8W at 21Z (MWL).

3. Discussion:

- ATSR: "A high pressure area had become well established over the middle Atlantic states through the lower half of the troposphere as GINNY progressed along her northerly track. This caused a tightening of the gradient in the northern semi-circle with accompanying winds of hurricane velocity, on the 20th. At this time, GINNY was 120 miles south-southeast of Cape Hatteras and in all respects appeared to be a well-developed "Hatteras Low," which is well known along the Atlantic seaboard for its extensive precipitation, high winds and angry seas."
- Reanalysis: On October 20th, Ginny turned to the west and slowed its forward speed. A ship reported 30 kt SE and 992 mb at 00Z on the 20th, suggesting a central pressure of 989 mb. A central pressure of 989 mb suggests maximum surface winds of 61 kt from the north of 25N Brown et al. pressure-wind relationship. Based on a forward speed of 16 kt, an intensity of 60 kt is analyzed at 00Z on the 20th, up from 55 knots originally shown in HURDAT, a minor intensity change. Also on the 20th, numerous ships reported tropical storm force winds and even hurricane-force winds at 18Z. An existing 983 mb central pressure was in HURDAT at 12Z, which is consistent with a ship with 988 mb and 35 kt. 983 mb suggests an intensity of 69 kt from the north of 25N pressure-wind relationship. The 65 kt intensity at this time is retained. Based on the synoptic data available, intensification to a hurricane is analyzed at 12Z on the 20th, same as originally shown in HURDAT.

October 21:

1. Maps and old HURDAT:

- HWM analyzes a hurricane of at most 995 mb at 34.5N, 74.5W with a cold front to the north at 12Z.
- HURDAT lists a 75 kt hurricane at 34.0N, 74.5W at 12Z.

- Microfilm shows a closed low pressure of at most 1002 mb at 34.0N, 74.5W at 12Z.

2. Ship highlights:

- 75 kt S and 999 mb at 33.8N, 74.2W at 00Z (COADS).
- 60 kt ESE and 1000 mb at 35.0N, 74.8W at 03Z (micro).
- 80 kt N and 1000 mb at 34.3N, 76.1W at 06Z (COADS/MWL).
- 55 kt NE and 1003 mb at 33.4N, 77.4W at 09Z (micro).
- 60 kt N and 1002 mb at 34.5N, 75.8W at 12Z (COADS).
- 50 kt N and 1003 mb at 34.8N, 75.5W at 15Z (MWL).
- 55 kt NNW and 1007 mb at 34.3N, 76.1W at 18Z (COADS).
- 80 kt SW and 999 mb at 33.6N, 76.4W at 21Z (MWL).

3. Aircraft highlights:

- Radar center fix measured a peripheral pressure of 1005 mb and estimated surface winds of 60 kt at 33.5N, 76.2W at 1125Z (ATSR).

4. Radar highlights:

- Cape Hatteras radar center fix at 34.2N, 75.1W at 0644Z (WALLET).
- Cape Hatteras radar center fix at 33.8N, 74.1W at 1742Z (WALLET).
- Cape Hatteras radar center fix at 33.6N, 74.2W at 2343Z (WALLET).

5. Discussion:

- ATSR: "On the 21st, Hurricane GINNY had come to a virtual stand-still over the warmer waters of the Gulf Stream off the coast of Hatteras. This temporary respite in such a favored location was undoubtedly the beginning of its transition from cold to warm core. Additionally, anticyclonic flow at the 200 mb level was observed moving in from the west. On the 21st, reconnaissance flights out of NAS Jacksonville were diverted to search for and later maintain overhead contact with a disabled naval vessel which had become adrift near the center of GINNY. This limited the reconnaissance during the transition from extratropical to tropical."
- Reanalysis: On October 21st, Ginny made a clock-wise loop off the North Carolina coast. The hurricane continued to intensify on the 21st and reached a first peak of 80 kt at 06Z through 18Z, up from 75 kt originally in HURDAT, a minor intensity change. This is based upon ships at 06Z and 18Z reporting 80 kt.

October 22:

1. Maps and old HURDAT:

- HWM analyzes a hurricane of at most 1000 mb at 31.5N, 74.8W with a weakening front to the north at 12Z.
- HURDAT lists a 70 kt hurricane at 31.5N, 74.8W at 12Z.
- Microfilm shows a closed low pressure of at most 1008 mb at 32.0N, 75.0W with a frontal boundary to the north at 12Z.

2. Ship highlights:

- 60 kt W and 1003 mb at 32.3N, 74.4W at 00Z (COADS).
- 65 kt NNW and 1005 mb at 33.4N, 76.4W at 03Z (micro).
- 60 kt W and 990 mb at 32.4N, 74.8W at 06Z (COADS).
- 55 kt NNW and 999 mb at 31.9N, 75.6W at 09Z (micro).
- 60 kt ENE and 1007 mb at 32.6N, 75.5W at 12Z (COADS).
- 60 kt S and 1007 mb at 30.6N, 73.6W at 15Z (COADS).
- 50 kt W and 1000 mb at 30.6N, 75.1W at 18Z (micro).
- 55 kt SE and 1000 mb at 31.0N, 74.5W at 21Z (micro).

3. Aircraft highlights:

- Penetration center fix measured a central pressure of 989 mb, estimated surface winds of 55 kt and an eye diameter of 80 nm at 30.8N, 75.2W at 1620Z (WALLET).
- Penetration center fix measured a central pressure of 992 mb, estimated surface winds of 50 kt and an eye diameter of 60 nm at 30.1N, 76.2W at 2252Z (WALLET).

4. Radar highlights:

- Cape Hatteras radar center fix at 33.1N, 74.6W at 0345Z (WALLET).

5. Discussion:

- MWR: "Even though hurricane-force winds were observed on the 20th, it was not until the morning of the 22nd that aircraft reconnaissance found a thermal structure that was more like a hurricane, rather than the late-season, hybrid type of the previous days. An eye of 20-mi. diameter had formed on the morning of the 22nd; however, definition was reported poor."
- ATSR: "By the 22nd, GINNY had completed a clockwise loop off Hatteras and had begun to accelerate toward the southwest. At the same time, she was moving away from the Gulf Stream."
- Reanalysis: On October 22nd, the hurricane turned to the south and later southwest while gradually weakening. A reconnaissance aircraft made a penetration center fix at 1620Z on the 22nd measuring a central pressure of 989 mb, estimating surface winds of 55 kt and an eye diameter of 80 nm. A central pressure of 989 mb suggests maximum surface winds of 61 kt from the north of 25N pressure-wind relationship. An eye diameter of 80 nm suggests an RMW of 60 nm and the climatological value is 25 nm. At 1815Z on the 22nd, TIROS VII captured an image of Ginny showing a large area of convection with a poorly-defined eye and banding features. Based upon a forward speed of about 9 kt and the TIROS satellite image, an intensity of 65 kt is analyzed at 18Z on the 22nd, down from 70 kt originally in HURDAT, a minor intensity change.

October 23:

1. Maps and old HURDAT:

- HWM analyzes a tropical storm of at most 1005 mb at 29.0N, 77.7W at 12Z.
- HURDAT lists a 60 kt tropical storm at 28.9N, 77.7W at 12Z.

- Microfilm shows a closed low pressure of at most 1005 mb at 29.0N, 77.0W at 12Z.

2. Ship highlights:

- 50 kt SE and 1011 mb at 29.7N, 73.3W at 00Z (micro).
- 50 kt NNE and 1017 mb at 33.2N, 77.7W at 03Z (MWL).
- 45 kt NE and 1013 mb at 31.6N, 77.4W at 06Z (COADS).
- 45 kt S and 1010 mb at 27.8N, 74.6W at 09Z (micro).
- 40 kt N and 1008 mb at 29.0N, 79.2W at 12Z (COADS).
- 45 kt N and 1018 mb at 30.7N, 80.7W at 15Z (micro).
- 45 kt NE and 1020 mb at 33.7N, 74.1W at 18Z (COADS).
- 55 kt NNE and 1008 mb at 29.5N, 79.5W at 21Z (micro).

3. Aircraft highlights:

- Penetration center fix measured a central pressure of 987 mb and an eye diameter of 45 nm at 30.1N, 76.0W at 0055Z (WALLET). (However, the 700-mb data given in the ATSR extrapolates to a pressure of 991 mb using today's formulas, and a dropsonde in the ATSR that appears to be from this fix reported 993 mb. 991 mb used as central pressure.)
- Penetration center fix measured a central pressure of 988 mb and estimated an eye diameter of 45 nm at 29.7N, 76.8W at 04Z (WALLET). (The 700-mb data given in the ATSR extrapolates to a pressure of 994 mb using today's formulas, and a dropsonde in the ATSR that appears to be from this fix reported 994 mb. 994 mb used as central pressure.)
- Penetration center fix measured a central pressure of 995 mb, estimated surface winds of 55 kt and an eye diameter of 40 nm at 28.9N, 77.8W at 13Z (WALLET).
- Penetration center fix measured a central pressure of 990 mb and estimated an eye diameter of 40 nm at 28.8N, 77.8W at 1445Z (WALLET).
- Penetration center fix measured a central pressure of 990 mb, estimated surface winds of 45 kt and an eye diameter of 40 nm at 28.8N, 78.3W at 18Z (WALLET).
- Penetration center fix measured a central pressure of 988 mb, estimated surface winds of 60 kt and an eye diameter of 38 nm at 28.8N, 78.4W at 2145Z (WALLET).

4. Radar highlights:

- Patrick AFB radar center fix at 28.7N, 77.9W at 1320Z (WALLET).
- Patrick AFB radar center fix at 28.8N, 77.7W at 18Z (WALLET).

5. Discussion:

- MWR: "During the 23rd, some weakening of the hurricane occurred and there was probably a period of 10 hr. when the tropical cyclone was only of storm intensity. Ginny quickly returned to hurricane force and there were only minor variations in intensity during the remainder of its life history although very slow intensification took place from this time until landfall was made on Nova Scotia on the 29th."

- Reanalysis: On October 23rd, Ginny continued on a southwestward track with no appreciable change in intensity. A few reconnaissance aircrafts made penetration center fixes throughout the day and the central pressure of the tropical cyclone fluctuated around 990-995 mb. The intensity is analyzed at 65 kt at every time slot on the 23rd, same as originally shown in HURDAT at 00Z and 18Z, and up from 60 kt at 06Z and 12Z, which are minor changes in intensity. Numerous ships reported gale and storm-force winds on the 23rd.

October 24:

1. Maps and old HURDAT:

- HWM analyzes a hurricane of at most 1000 mb at 29.6N, 79.6W with a cold front to the northeast at 12Z.
- HURDAT lists a 65 kt hurricane at 29.4N, 79.6W at 12Z.
- Microfilm shows a closed low pressure of at most 999 mb at 29.5N, 79.5W at 12Z.

2. Ship highlights:

- 75 kt ENE and 999 mb at 29.4N, 78.0W at 00Z (micro).
- 65 kt NE and 1007 mb at 29.3N, 79.1W at 03Z (micro).
- 50 kt ENE and 1010 mb at 30.5N, 79.9W at 06Z (COADS).
- 65 kt NE and 1000 mb at 29.6N, 78.8W at 09Z (micro).
- 65 kt ESE and 999 mb at 29.6N, 78.6W at 12Z (micro).
- 65 kt E and 1002 mb at 29.5N, 78.4W at 15Z (micro).
- 15 kt E and 987 mb at 29.8N, 79.7W at 18Z (micro).
- 65 kt SE and 1002 mb at 29.8N, 79.7W at 18Z (micro).
- 55 kt SSW and 1001 mb at 29.4N, 79.2W at 20Z (COADS).

3. Aircraft highlights:

- Penetration center fix estimated an eye diameter of 35 nm at 28.8N, 78.5W at 0130Z (WALLET).
- Penetration center fix estimated flight level winds of 50 kt and an eye diameter of 35 nm at 29.1N, 79.0W at 07Z (ATSR).
- Penetration center fix measured a central pressure of 990 mb, estimated surface winds of 75 kt and an eye diameter of 30 nm at 29.5N, 79.7W at 14Z (WALLET).
- Penetration center fix measured a central pressure of 987 mb, estimated surface winds of 85 kt and an eye diameter of 44 nm at 29.7N, 79.8W at 17Z (WALLET).
- Penetration center fix measured a central pressure of 982 mb, estimated surface winds of 75 kt and an eye diameter of 40 nm at 30.0N, 79.7W at 2215Z (WALLET).

4. Radar highlights:

- Daytona Beach radar center fix at 29.0N, 78.4W at 0020Z (WALLET).

- Daytona Beach radar center fix at 29.3N, 79.0W and an eye diameter of 40 nm at 0615Z (WALLET).
- Daytona Beach radar center fix at 29.6N, 79.5W and an eye diameter of 42 nm at 1215Z (WALLET).
- Daytona Beach radar center fix at 29.8N, 79.7W and an eye diameter of 44 nm at 1745Z (WALLET).

5. Discussion:

- Reanalysis: On October 24th, Ginny made its closest approach to Florida, passing about 75 nm east of Daytona Beach, before turning to the north. The radar images from Daytona Beach showed a well-defined eyewall about 40 nm in diameter. The hurricane slightly intensified on the 24th based upon data from the reconnaissance aircraft and ship observations. Various ships reported tropical storm force winds and a couple even experienced hurricane-force winds. At 18Z on the 24th, a ship reported 15 kt E and 987 mb, indicating a central pressure of 985 mb. A central pressure of 985 mb suggests maximum surface winds of 69 kt from the north of 25N intensifying subset pressure-wind relationship. A reconnaissance aircraft investigating Ginny estimated surface winds of 85 kt and an eye diameter of 44 nm at 17Z. An eye diameter of 44 nm suggests an RMW of about 33 nm and the climatological value is 24. An intensity of 70 kt is selected at 18Z on the 24th, same as originally shown in HURDAT.

October 25:

1. Maps and old HURDAT:

- HWM analyzes a hurricane of at most 1005 mb at 32.0N, 79.5W with a warm front to the east at 12Z.
- HURDAT lists a 90 kt hurricane at 31.8N, 79.6W at 12Z.
- Microfilm shows a closed low pressure of at most 1002 mb at 31.5N, 79.0W at 12Z.

2. Ship highlights:

- 65 kt S and 1007 mb at 30.3N, 78.5W at 00Z (COADS).
- 50 kt SE and 1012 mb at 31.8N, 78.2W at 06Z (micro).
- 45 kt E and 1007 mb at 32.4N, 78.4W at 12Z (COADS).
- 35 kt SE and 1009 mb at 31.1N, 77.8W at 15Z (micro).
- 40 kt SSW and 1004 mb at 31.0N, 78.4W at 18Z (micro).

3. Aircraft highlight:

- Radar center fix at 30.1N, 79.6W at 00Z (WALLET).
- Penetration center fix measured a central pressure of 976 mb, estimated surface winds of 80 kt and an eye diameter of 30 nm at 31.8N, 79.6W at 12Z (WALLET).
- Penetration center fix measured a central pressure of 985 mb and an eye diameter of 30 nm at 32.1N, 79.0W at 1859Z (WALLET).
- Penetration center fix measured a central pressure of 987 mb, estimated surface winds of 95 kt and an eye diameter of 30 nm at 32.2N, 78.5W at 22Z (WALLET/ATSR).

4. Radar highlights:

- Charleston radar center fix at 30.3N, 79.5W and an eye diameter of 23 nm at 0015Z (WALLET).
- Daytona Beach center fix at 31.1N, 79.8W and an eye diameter of 30 nm at 0545Z (WALLET).
- Charleston radar center fix at 31.8N, 79.4W and an eye diameter of 32 nm at 1222Z (WALLET).
- Charleston radar center fix at 32.1N, 79.1W and an eye diameter of 18 nm at 1818Z (WALLET).

5. Discussion:

- Reanalysis: On October 25th, Ginny moved slowly to the north and late on the day turned to the northeast passing about 60 nm southeast of South Carolina. A penetration center fix occurred at 2215Z on the 24th measuring a central pressure of 982 mb, estimating surface winds of 75 kt and an eye diameter of 40 nm. A central pressure of 982 mb suggests maximum surface winds of 73 kt from the north of 25N intensifying subset pressure-wind relationship. An eye diameter of 40 nm suggests an RMW of about 30 nm and the climatological value is 23 nm. An intensity of 75 kt is selected at 00Z on the 25th, same as originally shown in HURDAT. The next penetration center fix measured a central pressure of 976 mb, estimated surface winds of 80 kt and an eye diameter of 30 nm. A central pressure of 976 mb suggests maximum surface winds of 81 kt from the north of 25N intensifying subset pressure-wind relationship. An eye diameter of 30 nm suggests an RMW of about 23 nm and the climatological value is 24 nm. An intensity of 80 kt is selected at 12Z on the 25th, down from 90 kt originally in HURDAT, a minor intensity change. 80 kt is a second peak in intensity as reconnaissance data indicated that Ginny began to weaken late on the 25th. TIROS VII captured an image of the hurricane at 1741Z on the 25th showing a large area of convection with some banding features. A penetration center fix measured a central pressure of 985 mb and an eye diameter of 30 nm at 1859Z on the 25th. A central pressure of 985 mb suggests maximum surface winds of 63 kt from the north of 25N weakening subset pressure-wind relationship. An eye diameter of 30 nm suggests an RMW of about 23 nm and the climatological value is 24 nm. Based upon a forward speed of about 5 kt and satellite image, an intensity of 70 kt is analyzed at 18Z on the 25th, down from 90 kt originally in HURDAT, a major intensity change.

October 26:

1. Maps and old HURDAT:

- HWM analyzes a hurricane of at most 1000 mb at 33.5N, 76.5W with a warm front to the east at 12Z.
- HURDAT lists an 80 kt hurricane at 33.2N, 76.9W at 12Z.
- Microfilm shows a closed low pressure of at most 1005 mb at 33.0N, 77.0W at 12Z.

2. Ship highlights:

- 35 kt W and 1000 mb at 32.0N, 78.8W at 00Z (COADS).
- 45 kt SW and 1012 mb at 31.2N, 75.7W at 06Z (COADS).
- 60 kt S and 990 mb at 31.4N, 76.7W at 12Z (COADS).

- 60 kt NW and 1002 mb at 32.5N, 77.5W at 18Z (COADS).

3. Aircraft highlights:

- Penetration center fix measured a central pressure of 985 mb, estimated flight level winds of 53 kt, and an eye diameter of 20 nm at 32.4N, 78.0W at 01Z (WALLET).
- Penetration center fix measured a central pressure of 983 mb, estimated flight level winds of 55 kt and an eye diameter of 21 nm at 33.1N, 77.4W at 0559Z (WALLET/ATSR).
- Penetration center fix measured a central pressure of 986 mb, estimated surface winds of 90 kt and an eye diameter of 25 nm at 33.2N, 76.9W at 12Z (WALLET).
- Penetration center fix measured a central pressure of 978 mb, estimated surface winds of 80 kt and an eye diameter of 16 nm at 32.9N, 76.4W at 19Z (WALLET).

4. Radar highlights:

- Charleston radar center fix at 32.5N, 77.9W and an eye diameter of 24 nm at 0015Z (WALLET).
- Charleston radar center fix at 33.1N, 77.3W at 0540Z (WALLET).
- Charleston radar center fix at 33.3N, 77.0W and an eye diameter of 30-50 nm at 1244Z (WALLET).
- Hatteras radar center fix at 33.2N, 76.1W at 1745Z (WALLET).

5. MWR: "Highest wind at any land station was 70 mph, with gusts to 100, reported at Cape Fear at the Oak Island, NC, observation point when the center took a temporary odd turn toward the North Carolina coast."

6. NC State Climatologist: "Reports from other than First-Order stations were received erratically, but most reports gave winds at less than 50 miles per hour at all times. The exception was Oak Island Life Boat Station, which gave consistently higher winds than any other point. These reports indicated sustained winds as high as 70 miles per hour, with one gusts to 100 mph reported on the 260255E report. On some of the Oak Island reports winds were marked "estimated" and it is believed that many of the speeds were overestimated. Lowest pressure at Oak Island, the lowest reported other than that at Hatteras, was given as 29.62 inches from about 260400-260600E."

7. Reanalysis: On October 26th, Ginny moved generally northeastward at a slow forward speed and made its closest approach to North Carolina, passing about 50 nm southeast of Cape Fear. Around 06Z on the 26th, Oak Island, North Carolina, experienced tropical storm force winds up to 60 kt according to the NC State Climatologist. The report also states that some of the wind reports were estimates and some may have been overestimated. The Schwerdt et al. parametric hurricane wind model suggests that the highest sustained winds that impacted North Carolina, especially in the Cape Fear area, reached 55 kt. Thus, Ginny is analyzed as a tropical storm impact for North Carolina. A penetration center fix at 0559Z on the 26th measuring a central pressure of 983 mb and estimating an eye diameter of 21 nm. A central pressure of 983 mb suggests maximum surface winds of 69 kt from the north of 25N pressure-wind relationship. An eye diameter of 21 nm suggests an RMW of about 15 nm and the climatological value is 26 nm. Based upon an RMW smaller than the climatological value but slow forward speed of about 6 kt, an

intensity of 70 kt is analyzed at 06Z on the 26th, down from 80 kt originally shown in HURDAT, a minor intensity change. A couple of ships reported gale and storm-force winds on the 26th, up to 60 kt at 12Z and 18Z. Another penetration center fix occurred at 19Z on the 26th measuring a central pressure of 978 mb, estimated surface winds of 80 kt and an eye diameter of 16 nm. A central pressure of 978 mb suggests maximum surface winds of 75 kt and 78 kt from the north of 25N and the intensifying subset pressure-wind relationship, respectively. An eye diameter of 16 nm suggests an RMW of about 12 nm and the climatological value is 26 nm. Based upon an RMW smaller than the climatological value but slow forward speed of about 6 kt, an intensity of 75 kt is analyzed at 18Z on the 26th, same as originally shown in HURDAT.

October 27:

1. Maps and old HURDAT:

- HWM analyzes a hurricane of at most 995 mb at 33.1N, 75.0W with a warm front to the northeast at 12Z.
- HURDAT lists a 70 kt hurricane at 32.9N, 75.3W at 12Z.
- Microfilm shows a closed low pressure of at most 1002 mb at 33.0N, 75.0W at 12Z.

2. Ship highlights:

- 60 kt E and 999 mb at 33.6N, 75.3W at 00Z (COADS).
- 50 kt W and 1004 mb at 31.5N, 75.9W at 06Z (COADS).
- 45 kt WNW and 1006 mb at 31.4N, 76.1W at 12Z (COADS).
- 45 kt NNE and 1009 mb at 33.7N, 77.0W at 15Z (micro).
- 50 kt NW and 1006 mb at 32.0N, 76.7W at 18Z (COADS).
- 55 kt SSE and 989 mb at 32.3N, 73.5W at 20Z (MWL).

3. Aircraft highlights:

- Penetration center fix measured a central pressure of 979 mb, estimated surface winds of 75 kt and an eye diameter of 28 nm at 32.9N, 76.3W at 0157Z (WALLET).
- Penetration center fix measured a central pressure of 972 mb, estimated surface winds of 85 kt and an eye diameter of 22 nm at 33.0N, 75.8W at 0645Z (WALLET/ATSR). (980 mb pressure entered in fix log, but was referring to drop a few hours earlier. 972 mb based upon concurrent drop in eye.)
- Penetration center fix at 32.9N, 75.3W at 13Z (WALLET).
- Penetration center fix measured a central pressure of 975 mb, estimated surface winds of 90 kt and an eye diameter of 30 nm at 32.6N, 74.5W at 19Z (WALLET).

4. Radar highlights:

- Hatteras radar center fix at 33.1N, 76.0W at 0045Z (WALLET).
- Hatteras radar center fix at 32.9N, 75.5W at 0545Z (WALLET).
- Hatteras radar center fix at 32.8N, 74.8W at 1215Z (WALLET).

- Hatteras radar center fix at 32.8N, 74.4W at 1744Z (WALLET).
- Hatteras radar center fix at 32.8N, 73.4W at 2345Z (WALLET).

5. Discussion:

- Reanalysis: On October 27th, Ginny continued slowly moving to the east and finished a large clockwise loop off the southeast coast of the United States. At 0157Z on the 27th, a penetration center fix measured a central pressure of 979 mb, thus the intensity at 00Z on the 27th is analyzed at 75 kt, up from 70 kt originally in HURDAT, minor intensity changes. At 0645Z on the 27th, a reconnaissance aircraft measured a central pressure of 972 mb, a 22 nm eye diameter, and estimated surface winds of 85 kt. A central pressure of 972 mb suggests maximum surface winds of 82 kt from the north of 25N pressure-wind relationship. An intensity of 80 kt is analyzed at 06Z on the 27th, up from 70 kt originally in HURDAT, a minor intensity change. At 1646Z on the 27th, TIROS VII captured an image of Ginny showing a well-organized eye surrounded by a large area of convection and banding features. At 19Z on the 27th, a penetration center fix measured a central pressure of 975 mb, estimated surface winds of 90 kt and an eye diameter of 30 nm. A central pressure of 975 mb suggests maximum surface winds of 79 kt from the north of 25N pressure-wind relationship. An eye diameter of 30 nm suggests an RMW of about 25 nm and the climatological value is 26 nm. Based on a forward speed of about 10 kt and the satellite image, an intensity of 80 kt is analyzed at 18Z on the 27th, up from 75 kt originally in HURDAT, a minor intensity change.

October 28:

1. Maps and old HURDAT:

- HWM analyzes a hurricane of at most 990 mb at 34.1N, 72.5W with a cold front to the north at 12Z.
- HURDAT lists an 80 kt hurricane at 33.9N, 72.3W at 12Z.
- Microfilm shows a closed low pressure of at most 1008 mb at 33.9N, 72.3W with a frontal boundary to the northwest at 12Z.

2. Ship highlights:

- 55 kt SSE and 989 mb at 32.3N, 73.5W at 00Z (COADS).
- 50 kt WNW and 997 mb at 31.9N, 74.0W at 03Z (micro).
- 40 kt WNW and 1001 mb at 31.6N, 74.4W at 06Z (COADS).
- 40 kt SE and 999 mb at 34.1N, 70.0W at 12Z (micro).
- 50 kt E and 988 mb at 34.0N, 71.0W at 18Z (COADS).
- 50 kt S and 999 mb at 35.5N, 68.0W at 21Z (micro).

3. Aircraft highlights:

- Penetration center fix measured a central pressure of 970 mb and estimated an eye diameter of 40 nm at 32.8N, 73.3W at 0130Z (WALLET).
- Penetration center fix estimated an eye diameter of 32 nm at 33.3N, 73.1W at 0722Z (WALLET).

- Penetration center fix measured a central pressure of 968 mb, estimated surface winds of 75 kt and an eye diameter of 25 nm at 34.1N, 72.1W at 13Z (WALLET).
- Penetration center fix measured a central pressure of 963 mb, estimated surface winds of 100 kt and an eye diameter of 25 nm at 35.3N, 71.4W at 19Z (WALLET).

4. Discussion:

- Reanalysis: On October 28th, Ginny turned to the northeast and began to accelerate ahead of an approaching frontal boundary. The first reconnaissance aircraft to investigate the hurricane on the 28th measured a central pressure of 970 mb and estimated an eye diameter of 40 nm at 0130Z. A central pressure of 970 mb suggests maximum surface winds of 84 kt from the north of 25N pressure-wind relationship. An eye diameter of 40 nm suggests an RMW of about 30 nm and the climatological value is 26 nm. Based upon a forward speed of 8 kt, an intensity of 85 kt is analyzed at 00Z on the 28th. At 13Z on the 28th, another penetration center fix measured a central pressure of 968 mb, estimated surface winds of 75 kt and an eye diameter of 25 nm. A central pressure of 968 mb suggests maximum surface winds of 87 kt from the north of 25N Brown et al. pressure-wind relationship and 84 kt from the north of 35N Landsea et al. pressure-wind relationship. An eye diameter of 25 nm suggests an RMW of about 20 nm and the climatological value is 28 nm. Based on a forward speed of about 14 kt and an RMW smaller than climatology, an intensity of 90 kt is analyzed at 12Z on the 28th, up from 80 kt originally in HURDAT, a minor intensity change. At 1709Z on the 28th, TIROS VII captured an image of Ginny showing a large area of convection with a well-defined eye ahead of a frontal boundary. At 19Z on the 28th, another penetration center fix measured a central pressure of 963 mb, estimated surface winds of 100 kt and an eye diameter of 25 nm. A central pressure of 963 mb suggests maximum surface winds of 96 kt from the north of 25N pressure-wind relationship intensifying subset and 88 kt from the north of 35N pressure-wind relationship. An eye diameter of 25 nm suggests an RMW of about 20 nm and the climatological value is 27 nm. Based on a forward speed of about 14 kt and an RMW smaller than climatology, an intensity of 95 kt is analyzed at 18Z on the 28th, up from 85 kt originally in HURDAT, a minor intensity change. 95 kt is also the peak intensity of this hurricane, same as originally shown in HURDAT.

October 29:

1. Maps and old HURDAT:

- HWM analyzes a hurricane of at most 980 mb at 41.0N, 67.0W with a cold front just to the west and a warm front just to the north at 12Z.
- HURDAT lists a 95 kt hurricane at 40.8N, 67.2W at 12Z.
- Microfilm shows a closed low pressure of at most 993 mb at 41.0N, 67.0W with a frontal boundary going through the center at 12Z.

2. Ship highlights:

- 75 kt NNW and 996 mb at 36.4N, 71.5W at 00Z (micro).
- 65 kt E and 977 mb at 37.0N, 70.3W at 00Z (COADS).
- 60 kt N and 996 mb at 38.3N, 72.1W at 03Z (micro).
- 65 kt NW and 981 mb at 35.0N, 71.5W at 06Z (COADS).

- 55 kt S and 995 mb at 39.3N, 64.2W at 09Z (COADS).
- 85 kt NW and 975 mb at 39.5N, 68.0W at 12Z (MWL).
- 70 kt S and 964 mb at 41.3N, 65.8W at 15Z (micro).
- 65 kt NW and 987 mb at 43.0N, 68.5W at 18Z (micro).

3. Land highlights:

- 35 kt NNE and 997 mb at Nantucket, MA at 06Z (micro).
- 48 kt N (gusts to 66 kt) and 988 mb at Nantucket, MA at 1259Z (SWO).
- 52 kt SE (gusts to 74 kt) and 952 mb (lowest hourly pressure) at Yarmouth, Canada at 18Z (Canada).
- 57 kt S (gusts to 87 kt) and 969 mb at Greenwood, Canada at 21Z (Canada).
- 55 kt NE and 994 mb at Nantucket Lightship, MA at 23Z (SWO/MWR).

4. Aircraft highlights:

- Radar center fix at 36.9N, 71.0W at 0215Z (WALLET).
- Radar center fix at 37.9N, 68.7W at 06Z (WALLET).
- Penetration center fix measured a central pressure of 958 mb, estimated surface winds of 120 kt and an eye diameter of 25 nm at 41.4N, 66.9W at 1315Z (WALLET). (The wallet has a mention that the original 958 mb was recomputed to be 948 mb, and the latter is in better agreement with the 947 mb that would be calculated using today's formulas. 948 mb central pressure used.)
- Penetration center fix measured a central pressure of 948 mb and estimated surface winds of 120 kt at 43.1N, 66.2W at 1630Z (WALLET).

5. Discussion:

- MWR: "Later the hurricane threatened New England but gale warnings, which were in effect were ample. The fastest mile on the New England coast was 65 mph reported at Nantucket. The Coast Guard vessel Cowslip, off Portland, Maine, reported seas 30 to 40 ft. high and the anemometer broke at about 105 mph. The lowest barometer reading was 28.98 in."
- Canadian Hurricane Center: "Ginny formed near the Bahamas on October 16, 1963. Ginny became stronger upon entering the CHC Response Zone on October 29, with winds of 167 km/h, growing to winds of 176 km/h as it entered Canadian waters in the morning and then made landfall near Yarmouth, Nova Scotia, in the afternoon. Winds of 160 km/h were reported in Greenwood, Nova Scotia, and damage throughout the Maritimes was extensive. Millions of dollars worth of damage was done by the wind, rain and snow, but luckily, there were no fatalities. Ginny dissipated over Northern Quebec on October 31."
- Reanalysis: On October 29th, Ginny continued to increase in forward speed to the northeast impacting parts of New England and Atlantic Canada. At 06Z on the 29th, Nantucket, MA, registered sustained winds of 35 kt, thus Massachusetts is added as a tropical storm impact. Ginny produced sustained winds up to 48 kt in Nantucket later on as a post-tropical cyclone. The Nantucket Lightship measured 55 kt at 23Z on the 29th; the anemometer was 60 feet in height. Synoptic observations early on the 29th showed that Ginny had begun to acquire extratropical characteristics with an increase in the

temperature gradient across the circulation. Ginny was still warm-cored and remained east of the approaching cold front at 12Z on the 29th. By 18Z on the 29th, Ginny was transitioning to extratropical. Ginny made landfall in Nova Scotia, Canada around 1730Z. Ginny remained a very strong cyclone as penetration center fixes at 1315Z and 1630Z on the 29th measured central pressures of 948 mb, respectively. 948 mb central pressure suggests 98 kt from the Landsea et al. north of 35N pressure-wind relationship. Because the system was undergoing extratropical transition, an intensity of 90 kt is analyzed at both the 1730Z landfall as well as the 18Z position over Nova Scotia. This is unchanged in HURDAT at 18Z and makes Ginny a Category 2 hurricane landfall in Canada. (Previously HURDAT had shown extratropical transition at 18Z, thus the status of Ginny at landfall was ambiguous.)

October 30:

1. Maps and old HURDAT:

- HWM analyzes an extratropical cyclone of at most 985 mb at 43.0N, 65.5W at 12Z.
- HURDAT lists an 80 kt extratropical cyclone at 49.0N, 63.0W at 06Z (last position).
- Microfilm shows a closed low pressure of at most 996 mb at 45.0N, 62.0W with a large extratropical cyclone to the south at 12Z.

2. Ship highlights:

- 45 kt NW and 997 mb at 43.1N, 68.5W at 00Z (COADS).

3. Land highlights:

- 75 kt (likely gusts) (time unknown) at Saint John, Canada (Canada).
- 35 kt SW and 977 mb at Moncton, Canada at 00Z (micro).
- 40 kt WSW and 994 mb at Ile du Havre, Canada at 06Z (micro).
- 30 kt N and 991 mb at 50.1N, 64.2W at 06Z (COADS).

4. Discussion:

- MWR: "The track of Ginny was most unusual although not unique. Many hurricanes have looped and a few others have had rather long trajectories toward the southwest. The reader is referred to the "Yankee Storm" of October 30-November 8, 1935, and to hurricane Able of May 15-24, 1951. It would seem that these two storms and Ginny certainly had an affinity for the warm Gulf Stream. Operationally, aside from the erratic track, Ginny was a most difficult hurricane in that a large part of its life history was uncomfortably close to land. For eight consecutive days while Ginny was meandering off the southeastern coast, the center was within 250 n. mi. of the United States mainland and during one day the wall cloud was less than 50 mi. from the Cape Canaveral-Daytona Beach, Fla. area. Two persons apparently perished in the snow storm and there was one other fatality. Possibly four others were lost on the Tug Otho. Damage resulted from minor beach erosion and relatively small structural loss to boats, houses, autos, etc., mainly in Maine and on Cape Cod. Total damage in the United States probably did not exceed $400,000. According to reports, damage in the Canadian Maritime Provinces was confined to small boats and from minor flooding with no known deaths."

- Reanalysis: Extratropical transition was complete by 00Z on the 30th, which is six hours later than originally shown in HURDAT. A developing extratropical cyclone off the East Coast of the United States began to interact with Ginny late on the 29th and Ginny appears to have been absorbed after 06Z on October 30th. The last position is analyzed at 06Z on the 30th, same as originally shown in HURDAT.

Date	Original HURDAT Central Pressure	Evidence	Changes
Oct 19 12Z	1000 mb	No central pressure reports around 12Z and it does not appear reasonable based on the synoptic data available	Removed
Oct 19 18Z		Aircraft 994 mb pressure with 20 kt flight level winds at 21Z on Oct 19th	992 mb
Oct 20 00Z		Ship: 30 kt NE and 992 mb at 00Z on Oct 20th	989 mb
Oct 20 12Z	983 mb	No central pressure report but looks reasonable, ship report of 35 kt E and 988 mb at 12Z on Oct 20th	Retained
Oct 22 18Z	989 mb	Penetration center fix: 989 mb at 1620Z on Oct 22nd	Retained
Oct 23 00Z	987 mb	Penetration center fix: 991 mb at 0055Z on Oct 23rd	991 mb
Oct 23 06Z	988 mb	Penetration center fix: 994 mb at 04Z on Oct 23rd	994 mb
Oct 23 12Z	995 mb	Penetration center fix: 990 mb at 1445Z on Oct 23rd	990 mb
Oct 23 18Z	990 mb	Penetration center fix: 990 mb at 18Z on Oct 23rd	Retained
Oct 24 00Z	988 mb	Penetration center fix: 988 mb at 2145Z on Oct 23rd	
Oct 24 12Z	990 mb	Penetration center fix: 990 mb at 14Z on Oct 24th	
Oct 24 18Z	987 mb	Ship: 15 kt E and 987 mb at 18Z on Oct 24th	985 mb
Oct 25 00Z	982 mb	Penetration center fix: 982 mb at 2215Z on Oct 24th	Retained
Oct 25 12Z	976 mb	Penetration center fix: 976 mb at 12Z on Oct 25th	
Oct 25 18Z	985 mb	Penetration center fix: 985 mb at 1859Z on Oct 25th	
Oct 26 00Z		Penetration center fix: 985 mb at 01Z on Oct 26th	985 mb
Oct 26 06Z	988 mb	Penetration center fix: 983 mb at 0559Z on Oct 26th	983 mb
Oct 26 12Z	986 mb	Penetration center fix: 986 mb at 12Z on Oct 26th	Retained
Oct 26 18Z	978 mb	Penetration center fix: 978 mb at 19Z on Oct 26th	
Oct 27 00Z	979 mb	Penetration center fix: 979 mb at 0157Z on Oct 27th	
Oct 27 06Z	980 mb	Penetration center fix: 972 mb at 0645Z on Oct 27th	972 mb
Oct 27 12Z	972 mb	Pressure value measured closer to 06Z.	Removed
Oct 27 18Z	975 mb	Penetration center fix: 975 mb at 19Z on Oct 27th	Retained
Oct 28 00Z		Penetration center fix: 970 mb at 0130Z on Oct 28th	970 mb
Oct 28 12Z	968 mb	Penetration center fix: 968 mb at 13Z on Oct 28th	Retained
Oct 28 18Z	963 mb	Penetration center fix: 963 mb at 19Z on Oct 28th	Retained

Oct 29 12Z	958 mb	Penetration center fix: 948 mb at 1315Z on Oct 29th	948 mb
Oct 29 18Z		Penetration center fix: 948 mb at 1630Z on Oct 29th	948 mb

Sources: the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Monthly Weather Review, Navy reconnaissance book, Mariners Weather Log, Allison & Thompson (1966), the Canadian Hurricane Center, and NHC Storm Wallets.

Tropical Storm Helena [October 25-30, 1963] – AL091963

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43135 10/25/1963 M= 5  9 SNBR= 932 HELENA      XING=0 SSS=0                    L
43135 10/25/1963 M= 6  9 SNBR= 932 HELENA      XING=0 SSS=0                    L
                    *

43140 10/25*  0   0   0    0*  0   0   0    0*152 589  25    0*153 594  35 1005*
43140 10/25*  0   0   0    0*148 583  25    0*150 589  30    0*152 595  40 1005*
                             *** ***  **                **          ***  **

43145 10/26*154 601  40 1001*155 606  45    0*156 612  30    0*157 616  30    0*
43145 10/26*154 601  40    0*155 606  40    0*156 612  40 1004*157 616  40 1005*
                           *          **                **  ****          **  ****

43150 10/27*157 621  30 1006*159 622  30    0*161 623  35    0*165 621  35    0*
43150 10/27*158 619  35 1006*159 621  35    0*161 622  40    0*165 622  45 1002*
            *** ***  **          ***  **          ***  **          ***  **  ****

43155 10/28*169 619  35    0*172 614  35    0*175 610  35    0*180 605  35    0*
43155 10/28*169 620  45    0*172 614  40    0*174 609  35 1007*178 605  35    0*
               ***  **                **      *** ***     ****  ***

43160 10/29*186 601  25    0*193 600  20    0*200 600  20    0*208 599  15    0*
43160 10/29*186 601  30    0*193 595  25    0*200 588  25    0*208 580  25    0*
                    **          ***  **          ***  **          ***  **

(October 30th is new to HURDAT)
43163 10/30*215 567  25    0*223 553  25    0*230 540  25    0*  0   0   0    0*
            *** ***  **       *** ***  **       *** ***  **

43165 TS

Tropical Storm Landfall
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10/28 02Z 17.0N 61.8W 45 kt Antigua
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Significant Revisions:

1. None

Daily Summary:

October 24:

1. Maps and old HURDAT:

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

October 25:

1. Maps and old HURDAT:

- HWM analyzes a closed low pressure of at most 1010 mb at 15.2N, 59.0W at 12Z.
- HURDAT lists a 25 kt tropical depression at 15.2N, 58.9W at 12Z (first position).
- Microfilm shows a closed low pressure of at most 1011 mb at 16.3N, 59.3W at 12Z.

2. Ship highlights:

- 30 kt SSE and 1007 mb at 14.7N, 58.7W at 18Z (WALLET).
- 40 kt S and 1010 mb at 13.5N, 58.8W at 18Z (micro, WALLET).

3. Aircraft highlights:

- Penetration center fix measured a central pressure of 1005 mb and estimated surface winds of 65 kt at 15.4N, 59.6W at 2005Z (WALLET/ATSR).

4. Discussion:

- MWR: "Tropical Storm Helena developed in an easterly wave a short distance east of the Lesser Antilles on October 25. An extensive cloud mass, apparently associated with the easterly wave, was observed by the TIROS satellite near 15°N, 55°W, on the previous day. Two ships in the disturbed area during the early afternoon of October 25 reported southerly winds of 32 and 40 kt with continuous rain. A reconnaissance aircraft later in the day found similar conditions and a central pressure of 1005 mb, or 29.68 in. The system was described as ill-defined with no wall cloud but with squall bands in the eastern semicircle. The storm intensified slightly as it moved west-northwestward but later weakened to below storm force after passing between Dominica and Guadeloupe. The 5000-ft. mountains of the islands evidently disrupted the poorly organized circulation."
- ATSR: "Tropical Storm HELENA developed on an easterly wave approximately 110 miles east of the island of Dominica, in the Lesser Antilles, during the morning of 25 October. A Navy reconnaissance aircraft was dispatched on the 25th as a result of several ship reports and a TIROS photograph which had indicated a disturbed area near 15N 55W on the previous day. At 2000Z, the aircraft encountered a cyclonic circulation near 15.4N 61.3W and reported a poorly defined eye with maximum observed surface winds of 35 knots. At 252135Z, the aircraft reported a "second eye" approximately 25 miles southeast of the original eye. There were no later sightings of the second eye, and it is assumed to have dissipated."
- Reanalysis: Tropical Storm Helena developed late in October from a westward-moving easterly wave. Synoptic data east of the Lesser Antilles is sparse and the time of genesis is uncertain. Pressure reports indicate only a slight decrease (about 1 mb) in the values between October 24th at 12Z and October 25th at 12Z. The winds at Barbados did become weak westerly at 06Z on the 25th. Thus the first position is analyzed at 06Z on the 25th, six hours earlier than in HURDAT, as a 25 kt tropical depression. The TIROS VII satellite captured an image of the tropical cyclone at 1607Z on the 25th

showing a large area of convection, circular in shape, with some indications of a westerly shear pattern. Intensification to a tropical storm is analyzed at 18Z on the 25th based on a ship report of 40 kt S and 1010 mb and data from a reconnaissance aircraft. At 2005Z on the 25th, a reconnaissance aircraft made a center penetration measuring a central pressure of 1005 mb and estimated surface winds of 65 kt. A central pressure of 1005 mb suggests maximum surface winds of 37 kt from the south of 25N Brown et al. pressure-wind relationship. Based on the ship report, an intensity of 40 kt is analyzed at 18Z on the 25th, up from 35 kt originally shown in HURDAT, a minor intensity change. A central pressure of 1005 mb was present in HURDAT at 18Z on the 25th and has been retained.

October 26:

1. Maps and old HURDAT:

- HWM analyzes a closed low pressure of at most 1010 mb at 15.0N, 62.0W at 12Z.
- HURDAT lists a 30 kt tropical depression at 15.6N, 61.2W at 12Z.
- Microfilm shows a closed low pressure of at most 1005 mb at 15.7N, 61.5W at 12Z.

2. Land highlights:

- 35 kt (gusts to 40 kt) at St. Lucia at 12Z (micro).

3. Aircraft highlights:

- Penetration center fix measured a central pressure of 1005 mb at 15.3N, 61.1W at 1045Z (ATSR).
- Penetration center fix measured a central pressure of 1004 mb, estimated surface winds of 40 kt and an eye diameter of 30 nm at 15.7N, 61.3W at 1330Z (WALLET/ATSR).
- Penetration center fix measured a central pressure of 1005 mb and estimated surface winds of 30 kt at 15.7N, 61.5W at 16Z (WALLET).
- Penetration center fix measured a central pressure of 1006 mb, estimated surface winds of 31 kt and an eye diameter of 24-93 nm at 15.8N, 62.6W at 2155Z (WALLET).

4. Discussion:

- ATSR: "The storm intensified slightly as it moved west-northwest until it passed between the islands of Dominica and Guadeloupe during the early hours of the 26th when the wind reached 45 knots for brief periods. The close proximity to the two mountainous islands disrupted the circulation and weakened the storm, which had never become well organized since the formation."
- Reanalysis: On October 26th, Helena continued moving westward at a slow forward speed. A central pressure of 1001 mb was present in HURDAT at 00Z on the 26th and has been removed since no reconnaissance aircraft was investigating the tropical cyclone at this time, nor was a ship near the center. A reconnaissance aircraft investigated Helena at 1330Z on the 26th measuring a central pressure of 1004 mb and estimating surface winds of 40 kt. A central pressure of 1004 mb suggests maximum surface winds of 39 kt

from the south of 25N pressure-wind relationship. Based on the pressure-wind relationship and synoptic data, an intensity of 40 kt is selected at 12Z on the 26th, up from 30 kt originally shown in HURDAT, a minor intensity change. A central pressure of 1004 mb is added to HURDAT at 12Z on the 26th. HURDAT originally showed Helena weakening to a tropical depression at 12Z on the 26th as it passed between the islands of Guadeloupe and Dominica but data from the reconnaissance aircraft and surface observations indicate that the tropical cyclone likely maintained gale-force winds. Around 12Z on the 26th, St. Lucia reported sustained winds of 35 kt. At 16Z on the 26th, another reconnaissance aircraft made a penetration fix measuring a central pressure of 1005 mb and estimated surface winds of 30 kt. A central pressure of 1005 mb suggests maximum surface winds of 37 kt from the south of 25N pressure-wind relationship. Due to the slow forward speed of about 3 knots, an intensity of 40 kt is selected at 18Z on the 26th, up from 30 kt originally shown in HURDAT, a minor intensity change. A central pressure of 1005 mb is added to HURDAT at 18Z on the 26th. The next penetration center fix measured a central pressure of 1006 mb at 2155Z on the 26th and estimated surface winds of 31 kt. An intensity of 35 kt is selected at 00Z on October 27th, up from 30 kt originally in HURDAT, a minor intensity change. A central pressure of 1006 mb was present in HURDAT at 00Z on the 27th and has been retained.

October 27:

1. Maps and old HURDAT:

- HWM analyzes a tropical storm of at most 1005 mb at 16.5N, 62.5W at 12Z.
- HURDAT lists a 35 kt tropical storm at 16.1N, 62.3W at 12Z.
- Microfilm shows a closed low pressure of at most 1008 mb at 16.2N, 62.0W at 12Z.

2. Ship highlights:

- 40 kt SSW and 1008 mb at 15.4N, 62.5W at 18Z (micro).

3. Aircraft highlights:

- Penetration center fix measured a central pressure of 1008 mb, estimated surface winds of 55 kt and an eye diameter of 35 nm at 15.9N, 62.3W at 1247Z (WALLET/ATSR).
- Penetration center fix measured a central pressure of 1002 mb and estimated surface winds of 30-35 kt at 16.6N, 62.3W at 19Z (WALLET).

4. Discussion:

- MWR: "During the night of the 26th, Helena became almost stationary then turned northward and intensified slightly the next day. Central pressure dropped to 1002 mb (29.59 in.) and reconnaissance aircraft reported winds of 58 mph in squalls between Guadeloupe and Dominica."
- ATSR: "During the late hours of the 26th, HELENA became nearly stationary, and then began drifting north-northeastward on the 27th with slight reintensification."
- Reanalysis: On the 27th, Helena turned to the north over the extreme northeastern Caribbean Sea. Early on this day, the weak tropical storm was almost stationary about 50 nm west of Guadeloupe. A reconnaissance aircraft investigated Helena at 1247Z on the 27th and indicated a central pressure of 1008 mb and estimated surface winds of 55 kt. The central pressure value is

considered to be inaccurate based on another penetration fix later in the day, thus it is not added to HURDAT as a central pressure. TIROS VII captured an image of Helena showing a large area of cloudiness between 15N and 25N and 65W and 50W. The satellite image indicates that westerly shear was impacting the tropical cyclone. A ship reported 40 kt SSW at 18Z on the 27th. Another penetration center fix measured a central pressure of 1002 mb and estimated surface winds of 30-35 kt at 19Z on the 27th. A central pressure of 1002 mb suggests maximum surface winds of 43 kt from the south of 25N pressure-wind relationship. Based upon the ship report of 40 kt and the pressure-wind relationship, an intensity of 45 kt is analyzed at 18Z on the 27th, up from 35 kt originally in HURDAT, a minor intensity change. 45 kt is the peak intensity for Helena, unchanged, though originally this peak was shown on the 26th. A central pressure of 1002 mb is added to HURDAT at 18Z on the 27th.

October 28:

1. Maps and old HURDAT:

- HWM analyzes a tropical storm of at most 1010 mb at 18.0N, 61.0W at 12Z.
- HURDAT lists a 35 kt tropical storm at 17.5N, 61.0W at 12Z.
- Microfilm shows a closed low pressure of at most 1011 mb at 17.5N, 60.8W at 12Z.

2. Ship highlights:

- 35 kt SSW and 1009 mb at 16.2N, 60.0W at 00Z (COADS).

3. Aircraft highlights:

- Penetration center fix of 1007 mb with estimated maximum surface winds of 30 kt at 1450Z (ATSR).

4. Discussion:

- MWR: "Most of the squalliness was confined to a small area in the eastern quadrant of the storm as the center moved northeastward from the vicinity of Antigua on the night of the 27th."
- ATSR: "…by 280000Z, the storm was weakening again. Aircraft reconnaissance at 281300Z reported that the circulation was very weak and, by 281800Z, the circulation could no longer be located."
- Reanalysis: Early on the 28th, the center of Helena crossed Antigua as a 45 kt tropical storm and the system was once again over the open Atlantic Ocean. The last gale-force wind report associated with Helena occurred at 00Z on the 28th, 35 kt SW and 1008 mb. A reconnaissance aircraft investigated the tropical cyclone at 1450Z on the 28th measuring a central pressure of 1007 mb and estimated surface winds of 30 kt. A central pressure of 1007 mb suggests maximum surface winds of 32 kt from the south of 25N pressure-wind relationship. An intensity of 35 kt is selected at 12Z on the 28th, same as originally shown in HURDAT.

October 29:

1. Maps and old HURDAT:

- HWM analyzes a closed low pressure of at most 1010 mb at 20.0N, 60.0W at 12Z.
- HURDAT lists a 20 kt tropical depression at 20.0N, 20.0W at 12Z.

- Microfilm shows a closed low pressure of at most 1011 mb at 18.5N, 60.0W at 12Z.

2. Discussion:

- MWR: "During the next 24 hours the storm assumed a more northward course and gradually weakened. Reconnaissance aircraft on the 29th found only an area of squally weather with highest winds about 23 mph. Although Helena was never a well-defined storm, it caused considerable damage to small craft and roads in the Windward Islands. On Guadeloupe, five persons were reported dead, 500 homeless, and 14 seriously injured. A number of barges and fishing craft were sunk or seriously damaged. Total damage is estimated at no more than $500,000."
- ATSR: "Aircraft reconnaissance on the 29th reported scattered squalls and maximum surface winds of less than 15 knots."
- Reanalysis: Helena continued northeastward, moving away from the Leeward Islands, and it is analyzed to have weakened to a tropical depression at 00Z on October 29th, same as originally shown in HURDAT.

October 30:

1. Maps and old HURDAT:

- HWM analyzes a closed low pressure of at most 1010 mb at 24.0N, 56.5W with a cold front far to the west at 12Z.
- HURDAT does not list an organized system on this date.
- Microfilm shows a closed low pressure of at most 1011 mb at 23.5N, 54.5W at 12Z.

2. Discussion:

- Reanalysis: The last position in HURDAT originally was at 18Z on the 29th, but synoptic observations indicate that the tropical cyclone continued moving northeastward into the central Atlantic ahead of a frontal boundary. The last position is analyzed at 12Z on October 30th, 18 hours later than originally shown in HURDAT. The last position is uncertain as it is possible that Helena could have lasted about 24-30 more hours longer than analyzed as a tropical depression based on synoptic observations but the data are inconclusive.

October 31:

1. Maps and old HURDAT:

- HWM analyzes a closed low pressure of at most 1010 mb at 27.5N, 50.2W with a cold front just to the west at 12Z.
- HURDAT does not list an organized system on this date.
- Microfilm shows a closed low pressure of at most 1011 mb at 24.0N, 54.0W with a frontal boundary just to the west at 12Z.

November 1:

1. Maps and old HURDAT:

- HWM analyzes a cold front over the central Atlantic at 12Z.
- HURDAT does not list an organized system on this date.

- Microfilm shows a closed low pressure of at most 1011 mb at 24.0N, 54.0W with a frontal boundary just to the west at 12Z.

Sources: the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Monthly Weather Review, Navy reconnaissance book, Mariners Weather Log, Allison & Thompson (1966) and NHC Storm Wallets.

Unnamed Tropical Storm (New – June 2-4, 1063) – AL101963

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42125 06/01/1963 M= 3  1 SNBR= 913 NOT NAMED   XING=0 SSS=0
42125 06/01*  0   0   0    0*  0   0   0    0*260 778  30    0*265 776  30    0*
42130 06/02*273 770  35    0*285 760  35    0*298 752  40    0*311 752  40    0*
42135 06/03*325 754  45 1008*344 756  50 1000*364 759  50 1002*382 762  40 1003*
42140 06/04*392 765  30 1006*400 772  25 1010*404 784  25 1012*  0   0   0    0*
42145 TS

U.S. Tropical Storm Landfall
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06/03 08Z 35.2N 75.8W 50 kt NC (40 kt peak winds along the coast)
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Significant Revisions:

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

Daily Summary:

May 29:

1. Maps:

- HWM analyzes a closed low pressure of 1010 mb at 11.5N, 76.5W at 12Z.
- Microfilm does not show an organized system at 12Z.

2. Discussion: MWL: "A tropical disturbance, which had been tracked north-northeastward from just north of Panama on May 29."

May 30:

1. Maps:

- HWM analyzes a closed low pressure of 1010 mb at 11.0N, 78.0W at 12Z.
- Microfilm shows a spot low pressure near 13N, 78W at 12Z.

May 31:

1. Maps:

- HWM analyzes a spot low pressure of 1010 mb at 16.8N, 79.8W at 12Z.
- Microfilm shows a closed low pressure at 18.0N, 79.5W at 12Z.

2. Discussion:

- MWL: "Heavy rainfall was reported along the track of the disturbance with Santiago de Cuba receiving about 7.50 in. during a 2-day period in the incipient stage."
- Reanalysis: A tropical disturbance developed over the southern Caribbean Sea late in May and slowly moved northward. The system began to become better organized just south of Cuba late on May 31st.

June 1:

1. Maps:

- HWM analyzes a closed low pressure of 1010 mb at 26.0N, 77.0W with a weakening frontal boundary to the north at 12Z.
- Microfilm shows a closed low pressure of at most 1008 mb at 26.0N, 78.0W at 12Z.

2. Ship highlights:

- 35 kt SE and 1009 mb at 26.0N, 74.0W at 12Z (micro).
- 35 kt SE and 1012 mb at 27.2N, 74.7W at 15Z (micro).

3. Discussion:

- MWL: "Developed a closed sea level circulation over the northwestern Bahamas during the afternoon hours of June 1."
- Reanalysis: The disturbance crossed Cuba early on June 1st as a trough over into the western Bahamas. Synoptic observations indicate that a well-defined center developed around 12Z. The 500 mb analysis shows an upper-level low directly over the system, this system likely was a subtropical cyclone. However, without satellite imagery available to determine the convective structure, the system will be included in HURDAT as a tropical cyclone. A few ships reported gales over the eastern and northeastern quadrants on the 1st in its periphery due to the strong synoptic scale pressure gradient. However, peak winds directly due to this system were about 30 kt, which is used as the initial intensity.

Jun 2:

1. Maps:

- HWM analyzes a closed low pressure of 1010 mb at 30.0N, 76.0W with a warm frontal boundary to the north at 12Z.
- Microfilm shows a closed low pressure of at most 1011 mb at 30.5N, 75.0W at 12Z.

2. Ship highlights:

- 35 kt SE and 1011 mb at 28.2N, 74.5W at 00Z (COADS).
- 35 kt SE and 1010 mb at 30.7N, 73.3W at 12Z (COADS).
- 55 kt [likely high bias] ESE and 1015 mb at 31.3N, 72.7W at 12Z (COADS). (Note that a second 50-kt ship report was shown in the microfilm map. However, this appears to be the same ship as COADS, incorrectly plotted one degree too far north.)
- 40 kt ESE and 1003 mb at 33.6B, 74.6W at 18Z (COADS).

3. Aircraft highlights:

- Central pressure of 1008 mb near 32.5N, 75.5W at 2130Z (micro).

4. Discussion:

- MWL: "The tropical depression continued toward Hatteras, reaching tropical storm Intensity late the following day when information received from a Navy reconnaissance aircraft and from ship reports near the center of the cyclone indicated winds in excess of 34 kt. This unnamed tropical storm was the

first of the season in the North Atlantic region. The highest sustained wind measured in the storm was recorded aboard the ALCOA POLARIS at noon on the 2d near 31°N, 73°W when 55-kt east-southeasterly winds were encountered."

- Reanalysis: The system is upgraded to a tropical storm at 00Z, based upon a 35 kt ship observations close to the center. COADS shows two ships at 12Z on the 2nd reporting 55 kt in the northeast quadrant but MWL and microfilm indicate that it was only one ship. Furthermore, comparison with nearby ship data at 12Z on the 2nd show that the 55 kt reported is likely to have a 10-15 kt high bias. At 2130Z on the 2nd, a reconnaissance aircraft investigated the tropical storm measuring a central pressure of 1008 mb, which has been added to the 00Z time slot of June 3rd.

June 3:

1. Maps:

- HWM analyzes a closed low pressure of 1005 mb at 36.5N, 76.2W with a warm frontal boundary extending to the northeast at 12Z.
- Microfilm shows a closed low pressure of at most 1005 mb at 36.5N, 76.0W at 12Z.

2. Ship highlights:

- 40 kt SE and 1009 mb at 33.4N, 73.4W at 00Z (COADS).
- 40 kt S and 1001 mb at 33.4N, 74.2W at 03Z (MWL).
- 40 kt SSE and 1015 mb at 33.2N, 71.7W at 05Z (MWL).
- 40 kt S and 1016 mb at 36.8N, 72.5W at 12Z (COADS).

3. Land highlights:

- 40 kt ESE and 1006 mb at Diamond Shoals, NC at 06Z (micro).
- 11 kt SE and 1003 mb at Cape Hatteras, NC at 0659Z (SWO).
- 20 kt ENE and 1004 mb at NAS Oceana, VA at 1058Z (SWO).
- 40 kt ENE and 1006 mb at Chesapeake Lightship, VA at 11Z (SWO).
- 35 kt SSE and 1011 mb at Ocean City, MD at 18Z (micro/SWO).
- 14 kt ENE and 1005 mb at NAS Patuxent River, MD at 19Z (SWO).
- 12 kt ENE and 1008 mb at Baltimore, MD at 2156Z (SWO).
- 34 kt NE at Norfolk, VA (no time given) (CLIMO).

4. Discussion:

- MWL: "The cyclone crossed over the Carolina Outer Banks before noon on the 3d with a central pressure of 1004 mb and continued in a generally northwesterly direction up the Chesapeake Bay while losing intensity. At Norfolk, Virginia a new all time 24-hourly precipitation record was set with 6.87 in. collected after 0650 EST on the 2d. The fastest mile recorded at Norfolk during the storm was 39 mph registered on the 3d. Vessels encountering gale force winds off the southeastern United States coast in this tropical cyclone were mainly concentrated in the northeastern quadrant of the storm in the 5-degree square between latitudes 30° and 35°N., longitudes 70° and 75°W on the 2d and 3d. They include the ALCOA POLARIS,

ASTID ONSTAD, CHARIS, COMAYAGUA, CROWN TRADER, KENDALL FISH, RIVIERA PRIMA, and WORLD CHARITY."

- MWR: "Each year several storms occur which are not entirely tropical in character. Tropical cyclones derive their energy from latent heat of condensation while extratropical cyclones depend upon proper positioning of cold and warm air masses; i.e., cold air sinks and spreads under warm air causing air motion. At times "half-breed" cyclones develop over tropical oceans and tap both energy sources. In these cases it is difficult to decide whether a tropical cyclone name should be assigned to the Low. The Unnamed Storm in September was of this type, as was the late May-early June storm."

- Reanalysis: On the 3rd, the tropical storm continued northward and a couple of ships reported gale-force winds, mainly over the northern and eastern quadrant where the pressure-gradient was the strongest. The tropical storm made landfall around 08Z on the 3rd, just west of Cape Hatteras, NC. Cape Hatteras, NC, reported 11 kt SE and 1003 mb at 0659Z on the 3rd, suggesting a central pressure of 1002 mb. However, a few hours earlier at 03Z, a ship reported 40 kt S wind with 1001 mb, which suggests a central pressure of 997 mb. Taking a blend of the two gives 1000 mb, which has been added to the 06Z time slot. A central pressure of 1000 mb suggests maximum surface winds of 42 kt and 47 kt, from the north of 25N Brown et al. and north of 35N Landsea et al. pressure-wind relationships, respectively. Based on a forward speed of about 20 kt, an intensity of 50 kt is analyzed at 06Z on the 3rd and at landfall. 50 kt is also the peak intensity of this tropical cyclone. Diamond Shoals, NC, reported 40 kt E at 06Z on the 3rd. The fast-moving tropical storm reached the coast of North Carolina around 08Z on the 3rd as a 50 kt tropical storm. No gale-force winds were reported in the Outer Banks of North Carolina likely because the radius of maximum winds stayed offshore. However, some tropical storm force winds did occur farther north along the coast and it is analyzed that the strongest winds along the coast were about 40 kt. At 1058Z on the 3rd, Oceana, VA, a coastal station, reported 20 kt ENE and 1004 mb, suggesting a central pressure of 1002 mb, which has been added to the 12Z time slot. Late on the 3rd, the tropical storm moved farther inland and began to weaken. Ocean City, MD, reported 35 kt SSE and 1011 mb at 18Z on the 3rd. Norfolk, VA, reported 34 kt NE but the time is unknown. At 19Z on the 3rd, Patuxent River, MD, an inland station, reported 14 kt ENE and 1005 mb, suggesting a central pressure of 1003 mb, which has been added to the 18Z time slot. At 2156Z on the 3rd, Baltimore, MD, reported 12 kt ENE and 1008 mb, suggesting a central pressure of 1006 mb, which has been added to the 00Z time slot on June 4th.

June 4:

1. Maps:

- HWM analyzes a closed low pressure of 1015 mb at 40.0N, 78.0W with a weakening warm frontal boundary extending to the northeast at 12Z.

- Microfilm shows a closed low pressure of at most 1014 mb at 40.0N, 78.5W at 12Z.

2. Ship highlights:

- 9 kt ESE and 1012 mb at Harrisburg, PA at 0559Z (SWO).

- 10 kt ESE and 1014 mb at Philipsburg, PA at 1151Z (SWO).

3. Discussion:

- MWL: "Late on the 4th it dissipated over eastern Ohio."

- Reanalysis: On the 4th, the tropical cyclone turned to the northwest and west and gradually lost strength. Weakening to a tropical depression is analyzed at 00Z on the 4th. At 0559Z on the 4th, Harrisburg, PA, reported 9 kt ESE and 1012 mb, suggesting a central pressure of 1010 mb, which has been added to the 06Z time slot. At 1151Z on the 4th, Philipsburg, PA, reported 10 kt ESE and 1014 mb, suggesting a central pressure of 1012 mb, which has been added to the 12Z time slot. Synoptic observations over the Ohio Valley after 12Z on the 4th indicate that the tropical cyclone had weakened to a trough of low pressure. The last position is analyzed at 12Z on the 4th.

Sources: the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Mariners Weather Log, Surface Weather Observations, and State Climatological Data. This disturbance was in Jack Beven and David Roth's List of Suspects.

1963 Additional Notes

1. September 11: A polar orbiting satellite imagery montage at 1544Z September 11th shows both the developing stage of the unnamed hurricane as well as a possible tropical cyclone near 20N 50W as well as additional widespread convection farther southeast. No ship observations show support for either of these systems, but ship observations in this part of the Atlantic are usually quite sparse. This may be a tropical cyclone, but is not added in without additional evidence.

Day	Latitude	Longitude	Status
September 11	20N	50W	Tropical Cyclone?

2. September 23-30: Microfilm shows a tropical wave or trough of low pressure over the eastern Gulf of Mexico on September 22nd and a tropical disturbance develops over the Bay of Campeche on September 23rd and appears to have become a tropical depression later that day based upon synoptic data and an aircraft reconnaissance flight. A frontal boundary reached the northern Gulf of Mexico on the 23rd and remained stationary over the area for the next couple of days. On September 24th, the frontal boundary reached the central Gulf of Mexico generating gales over the northern gulf while the tropical depression remained almost stationary over the eastern Bay of Campeche. On September 25th, synoptic observations indicate that the tropical depression had a well-defined low-level circulation in an environment of low environmental pressures (OCI 1007 mb). The tropical cyclone moved slowly eastward on the 25th and made landfall in western Yucatan late on the day. Late on September 26th, the tropical depression moved back over the eastern Bay of Campeche. On September 27th, the tropical depression remained almost stationary. The ships near the system reported pressures below 1005 mb but no gales. On September 28th, the tropical system begins to move northeastward and the Microfilm surface analysis depicts the cyclone attached to the frontal boundary and shows a north-south elongation of the circulation. Very low environmental pressures, below 1010 mb, encompass the Gulf of Mexico. Ships reported gales in the southern quadrant of the circulation starting at 12Z on the 28th but they were about 180 nm away from the center. It is possible that the tropical depression may have become a subtropical cyclone at that point but the data is inconclusive, especially since we do not have satellite images to observe the structure of the system. On September 29th, the system continues to gain in forward speed to the northeast and became embedded within the frontal boundary. The non-tropical system continued northeastward dissipating over the western Atlantic on October 1st. Therefore, because the data available does not suggest that it was a tropical cyclone when it produced gales, it is not added to HURDAT. This disturbance was in Jack Beven's List of Suspects.

Day	Latitude	Longitude	Status
September 22	20N	89W	Tropical Wave
September 23	20N	93W	Tropical Depression
September 24	20N	91W	Tropical Depression
September 25	20N	91W	Tropical Depression
September 26	19N	91W	Tropical Depression
September 27	19N	92W	Tropical Depression
September 28	23N	91W	Subtropical Storm?
September 29	27N	85W	Extratropical
September 30	36N	74W	Extratropical
October 1			Dissipated

3. September 25 – October 3: Historical Weather Maps indicate that a extratropical cyclone developed along a stationary front on September 26th east of Florida. The system moved eastward producing gales and on September 29th it became an occluded cyclone over the central Atlantic. As the cyclone began to lose its non-tropical characteristics, the winds dropped below gale-force and the system slowly weakened until it dissipated on October 3rd over the eastern Atlantic. Therefore, because the system did not acquire tropical characteristics, it is not added to HURDAT. This disturbance was in Jack Beven's List of Suspects.

Day	Latitude	Longitude	Status
September 25	Eastern Gulf of Mexico to Western Atlantic		Stationary front
September 26	29N	77W	Extratropical
September 27	30N	70W	Extratropical
September 28	33N	57W	Extratropical
September 29	33N	51W	Occluded
September 30	30N	49W	Occluded
October 1	29N	45W	Occluded
October 2	28N	41W	Occluded
October 3			Dissipated

4. October 7-11: A tropical wave left the African coast on October 6th and synoptic data indicates that it may have reached tropical storm intensity on October 8th while it was passing south of the Cape Verde Islands. A ship reported peripheral pressure of 1005 mb on October 8th at 12Z and 45 kt E and 1006 mb at 18Z. Other ship data suggests that the gale-force winds have a high wind bias. Therefore, because there is not enough evidence to suggest that it attained tropical storm intensity, it is not added to HURDAT. This disturbance was in Ryan Truchelut's List of Suspects.

Day	Latitude	Longitude	Status
October 7	14N	21W	Tropical Depression?
October 8	14N	23W	Tropical Storm?
October 9	14N	25W	Tropical Depression?
October 10	14N	29W	Tropical Depression?
October 11			Dissipation

5. October 12-16: The Historical Weather Maps suggests that a tropical wave left the African coast on October 11th. A ship reported gale-force winds on October 12th but the data over the eastern Atlantic is sparse. Therefore, because there is only one key piece of evidence, it is not added to HURDAT. This disturbance was in Ryan Truchelut's List of Suspects.

Day	Latitude	Longitude	Status
October 12	11N	22W	Tropical Storm?
October 13	13N	22W	Tropical Depression?
October 14	14N	22W	Tropical Depression?
October 15	16N	19W	Tropical Depression?
October 16			Dissipation

6. October 23-30: The Historical Weather Maps shows a trough of low pressure between Bermuda and Bahamas. The disturbance moved to the northeast and became embedded within a frontal boundary on the 25th. Gale-force winds were reported on October 26th. On October 30th, the disturbance was absorbed by another frontal boundary. Therefore, because it did not acquire tropical characteristics, it is not added to HURDAT.

Day	Latitude	Longitude	Status
October 23	28N	65W	Trough
October 24	32N	64W	Trough
October 25	32N	64W	Extratropical
October 26	34N	54W	Extratropical
October 27	36N	43W	Extratropical
October 28	38N	33W	Extratropical
October 29	42N	14W	Extratropical
October 30			Absorbed

7. November 3-8: The Historical Weather Maps indicates that an extratropical cyclone formed in the tail-end of a frontal boundary on November 5th. The extratropical cyclone moved eastward over the next couple of days before turning to the northeast on November 8th and becoming absorbed on November 9th. Therefore, because it did not acquire tropical characteristics, it is not added to HURDAT. This disturbance was in Jack Beven's List of Suspects.

Day	Latitude	Longitude	Status
November 3	Eastern Atlantic		Cold front
November 4	30N	40W	Trough
November 5	30N	35W	Extratropical
November 6	30N	31W	Extratropical
November 7	33N	25W	Extratropical
November 8	40N	15W	Extratropical
November 9			Absorbed

Reanalysis of the 1964 Atlantic basin hurricane season
- Brenden Moses and Chris Landsea
- April 2016, Revised February 2019

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

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

Unnamed Tropical Storm [June 4-11, 1964] – AL011964

```
43170 06/02/1964 M=10  1 SNBR= 933 NOT NAMED   XING=0 SSS=0
43170 06/04/1964 M= 8  1 SNBR= 933 NOT NAMED   XING=0 SSS=0
         **         *

(The 2nd is removed from HURDAT)
43175 06/02*  0   0   0    0*  0   0   0    0*179 861  25    0*182 861  25    0*

43180 06/03*184 861  25    0*187 861  25    0*189 861  25    0*192 861  25    0*
43180 06/03*  0   0   0    0*  0   0   0    0*185 861  25    0*187 861  25    0*
                                              ***              ***

43185 06/04*194 860  25    0*196 860  25    0*198 860  25    0*207 860  25    0*
43185 06/04*190 861  25    0*195 865  25    0*201 867  25    0*207 868  30    0*
            *** ***          *** ***          *** ***               ***  **

43190 06/05*218 859  25    0*226 858  25    0*235 856  25    0*248 853  25    0*
43190 06/05*212 868  30 1007*220 866  30    0*233 861  30    0*248 854  30    0*
            *** ***  ** **** *** ***  **      *** ***  **          ***  **

43195 06/06*261 850  25    0*274 846  30    0*287 839  30    0*298 825  30    0*
43195 06/06*262 848  25    0*275 842  25    0*287 834  25    0*296 823  25    0*
            *** ***          *** ***  **          ***  **      *** ***  **

43200 06/07*307 810  30    0*316 798  30    0*325 786  35    0*332 773  35    0*
43200 06/07*303 810  30    0*310 798  40    0*318 788  50    0*326 778  50    0*
            ***              ***      **      *** ***  **      *** ***  **

43205 06/08*338 760  35    0*344 745  40    0*349 727  45    0*356 705  45    0*
43205 06/08*329 765  45    0*330 751  40 1002*333 732  40    0*342 713  45 1000*
            *** ***  **      *** ***     **** *** ***  **      *** ***     ****

43210 06/09*363 682  45    0*366 659  50    0*367 640  50    0*366 626  50    0*
43210 06/09*351 685  45    0*357 655  50    0*361 634  55  992*364 618  60    0*
            *** ***          *** ***          *** ***  **  *** *** ***  **

43215 06/10*365 614  50    0*364 601  45    0*365 589  35    0*370 577  35    0*
43215 06/10*364 608  60    0*362 599  55    0*360 592  55    0*362 585  50    0*
            *** ***  **      *** ***  **      *** ***  **      *** ***  **
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43220 06/11*377 565  35    0*384 559  35    0*390 558  35    0*396 558  35    0*
43220 06/11*370 578  45  997*380 572  40 1001*389 568  40    0*396 564  35    0*
            *** ***  **  *** *** ***  ** **** *** ***  **          ***
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43225 TS

Significant Revisions:

1. Genesis delayed by 24 hours based upon ship and land-based observations.
2. A few central pressures are added based upon ship reports.
3. Large increases in intensity on the 7th based upon ship reports.
4. Large adjustment in positions toward the south-southwest on the 8th and 9th based upon ship reports.
5. Large increases in intensity on the 10th based upon ship reports.
6. Large adjustment in positions toward the west-southwest on the 11th based upon ship reports.

Daily Summary:

May 29–June 1:

1. Maps and old HURDAT:
   - A transient low is noted on NHC Microfilm on June 1 at 18Z over Honduras, centered near 15N 87W.
2. Discussion:
   - MWR: From late May into early June, a tropical disturbance "apparently moved out of the Intertropical Convergence Zone" and emerged over the far western Caribbean Sea near British Honduras.
   - Reanalysis: Toward the end of May and into early June, a disturbance associated with the Intertropical Convergence Zone emerged over the western Caribbean Sea.

June 2:

1. Maps and old HURDAT:
   - HWM analyzes an open area of low pressure near 18N 86W with a central pressure of 1010 mb.
   - Microfilm analyzes a low, centered near 17.5N 87W, with a pressure of 1011 mb at most along the tail end of a trough that extends to Florida.
   - HURDAT lists a tropical depression at 17.9N 86.1W with winds of 25 kt.
2. Discussion:
   - MWR: "During June 2 and 3, a weak tropical depression slowly developed over the extreme western Caribbean just to the east of British Honduras and the Yucatan Peninsula."
   - Reanalysis: HURDAT lists the formation of a tropical depression from this system at 12z. However, ship and land-based observations in the region do not support the presence of a closed circulation. This remained the case for the subsequent 36 hours as the system moved slowly northward.

June 3:

1. Maps and old HURDAT:
   - HWM analyzes an open area of low pressure near 18.5N 86W with a central pressure of 1009 mb.
   - Microfilm analyzes a poorly defined low, centered near 18.5N 87W.
   - HURDAT lists a tropical depression at 18.9N 86.1W with winds of 25 kt. Discussion:

2. Discussion:
   - Reanalysis: Genesis is now shown at 12z on June 3 as a 25 kt tropical depression, delayed 24 hours from the original HURDAT.

June 4:

1. Maps and old HURDAT:
   - HWM analyzes an open area of low pressure near 19.5N 86.0W with a central pressure of 1009 mb.
   - Microfilm does not analyze a close low at 12Z.
   - HURDAT lists a tropical depression at 19.8N 86.0W with winds of 25 kt.
2. Discussion:
   - MWR: "On the 4th, the depression began drifting slowly northward and reached the extreme southeastern Gulf of Mexico by the 5th."
   - Reanalysis: The system tracked north-northwest toward the northern tip of the Yucatan Peninsula. HURDAT depicts the system as having a due north track along 86W for much of its early existence; however, observations from Mexico indicate that the depression's center was near or on the coast near Cancun around 00Z on June 5th.

June 5:

1. Maps and old HURDAT:
   - HWM analyzes an open area of low pressure near 23N 86W with a central pressure of 1008 mb.
   - Microfilm analyzes a low centered at 24N 86W.
   - HURDAT lists a tropical depression at 23.5N 85.6W with winds of 25 kt.
2. Aircraft highlights:
   - 24.6N 85.3N center fix at 1600Z. "Circular 40 nm diameter. Loosely oriented [circular] formation with some banding NE E quad. Wall cloud loose all quads. Open south" (Microfilm).
   - 24.5N 85.5W center fix at 1610Z. "Max wind observed 35kt near 24.3N 84.8W in long NNE/SSW band. NW 20 mph at 24.3N 85.8W. [Northerly] wind at 25N 86W then [easterly] at 25N 85W. Weather almost all to east of center. Lowest [pressure] observed 1009 mb. Still quite poorly organized but slightly more organization than on 4th" (Microfilm).
3. Discussion/Reanalysis: Based on a 1007 mb measurement with light east winds in Cancun at 00z on June 5, landfall intensity is estimated at 30 kt, slightly above HURDAT. The aforementioned pressure is a new addition to HURDAT at that time, as well. After clipping the Yucatan Peninsula, the depression accelerated north-northeast as it interacted with a trough over the southern Gulf of Mexico. This interaction served to weaken the system, as noted by aircraft reconnaissance which noted a "loosely oriented [circular] formation with some banding...open [to the] south." The system may have briefly become a tropical storm late on June 5 as winds of 35 kt were indicated by reconnaissance; however, based on the rapid collapse in organization, this was not implemented into HURDAT.

June 6:

1. Maps and old HURDAT:
   - HWM analyzes an area of low pressure of at most 1012 mb near 28.5N 84W.
   - Microfilm analyzes a small, possibly open, low centered near 27.5N 84.6W.
   - HURDAT lists a tropical depression at 28.7N 83.9W with winds of 30 kt.
2. Aircraft highlights: An aircraft invest mission occurred on this date as seen plotted on the microfilm analysis at 12Z. No center fix was recorded. Highest winds plotted were 15 kt and lowest pressure plotted was 1011 mb.
3. Discussion:

- MWR: "There was local flooding in western Cuba and in a few areas in the Southeastern States. Strong winds and hail associated with thunderstorm activity caused considerable damage in northeastern Florida. Damage in the Jacksonville area was estimated in excess of $300,000, and there was a local windstorm near Cross City."
- Storm Wallets: Highest gust on land was 31 kt SSW at the Jacksonville Naval Air Station at 2115Z.

June 7:

1. Maps and old HURDAT:
   - HWM analyzes an extratropical low of at most 1010 mb near 31.5N 78.5W.
   - Microfilm analyzes a developing extratropical low with a pressure of 1008 mb at most centered at 32.1N 78.9W.
   - HURDAT lists a tropical storm at 32.5N 78.6W with winds of 35 kt.
2. Ship highlights:
   - 40 kt ESE and 1012 mb at 06Z at 32.6N 77.3W;
   - 50 kt ESE at 31.5N 77.3W at 09Z (Microfilm).
   - 45 kt E and 1005 mb at 12Z at 32.9N 77.0W;
   - 35 kt E and 1011 mb at 12 Z at 31.6N 76.4W;
   - 20 kt W and 1004 mb at 18Z at 32.7N 77.9W;
   - 40 kt E and 1008 mb at 18Z at 33.7N 76.6W (All COADS except 09Z report).
3. Discussion/Reanalysis: The system emerged over the western Atlantic Ocean around 00z near Jacksonville and quickly organized. Based on ship observations, it is estimated that the depression became a tropical storm around 06z, 6 hours earlier than in HURDAT. Owing to observed 50 kt winds at 09z from a ship, a major increase in winds is shown for 12 and 18z; both are increased to 50 kt from 35 kt.

June 8:

1. Maps and old HURDAT:
   - HWM analyzes an extratropical low of at most 1004 mb near 33.5N 77.5W.
   - Microfilm analyzes a developing extratropical low with a pressure of 1005 mb at most centered at 33.5N 72.6W.
   - HURDAT lists a tropical storm at 34.9N 72.7W with winds of 45 kt.
2. Ship highlights:
   - 35 kt NW and 1005 mb at 00Z at 31.9N 77.8W;
   - 40 kt E and 1005 mb at 00Z at 33.9N 75.2W;
   - 20 kt SE and 1004 mb at 06Z at 33.1N 75.1W;
   - 35 kt SW and 1008 mb at 06Z at 30.9N 73.9W;
   - 35 kt NNW and 1009 mb at 12Z at 34.0N 76.0W;
   - 25 kt ESE and 1004 mb at 12Z at 33.3N 71.2W;
   - 15 kt SW and 1004 mb at 15Z at 34.0N 71.0W;
   - 35 kt NW and 1013 mb at 18Z at 33.6N 75.8W;
   - 35 kt NW and 1006 mb at 18Z at 33.8N 72.5W;
   - 15 kt NW and 1004 mb at 21Z at 34.0N 71.0W (All COADS).
3. Discussion/Reanalysis: The storm weakened slightly on this day as it moved generally east-northeast, paralleling the Carolinas. Major changes to the track are implemented from 06z on June 8 to 00z on June 9. Positions at these times are determined to have been significantly farther south and slightly farther west than currently stated in HURDAT, as supported by ship observations. Weakening to 40 kt for 06 and 12z is estimated based a 1004 mb measurement with 20 kt winds near the center at 06z, which yields an

approximate central pressure of 1002 mb. A central pressure of 1002 mb suggests maximum surface winds of 40 kt from the north of 25N Brown et al. pressure-wind relationship. A later measurement of 1002 mb with 15 kt SW winds near the center provided an estimated 1000 mb central pressure for 18z. A central pressure of 1000 mb suggests maximum surface winds of 44 kt from the north of 25N Brown et al. pressure-wind relationship. 45 kt retained for intensity at 18Z. It is of note that the 12Z microfilm map shows a dewpoint gradient across the cyclone from 75F southeast of the center to 60F over the Carolinas, although the gradient is not strong near the storm center. More importantly, the 500 mb maps show a shortwave trough with relatively cold temperatures near the system. It is possible that this system evolved more as a subtropical cyclone than a tropical cyclone, though without satellite imagery available such a designation is not available for use.

June 9:

1. Maps and old HURDAT:
   - HWM analyzes an extratropical cyclone with a central pressure of 995 mb near 36N 62.5W.
   - Microfilm analyzes an elongated low with a pressure of 996 mb at most centered near 36N 62.5W.
   - HURDAT lists a tropical storm at 36.7N 64.0W with winds of 50 kt.
2. Ship highlights:
   - 25 kt S and 1002 mb at 00Z at 34.0N 67.0W;
   - 20 kt SW and 999 mb at 06Z at 34.9N 65.0W;
   - 10 kt SSE and 1002 mb at 06Z at 34.5N 61.3W;
   - 35 kt NE and 1002 mb at 09Z at 38.8N 64.8W;
   - 35 kt NE and 1004 mb at 12Z at 38.8N 64.8W;
   - 25 kt SW and 995 mb at 12Z at 35.7N 62.9W;
   - 30 kt NE and 1004 mb at 15Z at 38.8N 64.8W;
   - 35 kt SW and 995 mb at 18Z at 35.9N 60.6W;
   - 25 kt SW and 1003 mb at 18Z at 35.6N 60.0W;
   - 25 kt WSW and 1005 mb at 23Z at 33.2N 60.3W (all COADS).
3. Discussion:
   - MWR: “Reaching a position some 200 nmi north of Bermuda by June 9, the storm changed to an easterly course around 10 mph under the influence of an intensifying high pressure system to the northeast. Maximum intensity was reached at this time with winds of about 60 mph reported by ships.”
   - Reanalysis: Accelerating to the east-northeast, the tropical storm appeared to take on some characteristics of an extratropical cyclone as it moved northwest of Bermuda. Indeed, the Historical Weather Map series depicts the storm as an extratropical cyclone at 12z that day. However, observations indicate that it maintained a warm-core and is thus kept as a tropical storm. Further intensification took place during the latter part of this day, with a ship near the storm’s center reporting 995 mb and 25 kt SW winds at 12z. From this it is estimated that the cyclone a central pressure is 992 mb, a new addition to HURDAT. A central pressure of 992 mb suggests maximum surface winds of 56 kt from the north of 25N Brown et al. pressure-wind relationship. Based on this, the 12z intensity was increased to 55 kt.

June 10:

1. Maps and old HURDAT:

- HWM analyzes an area of low pressure along the tail end of a stationary front with a pressure of 1004 mb at most near 36N 59W.
- Microfilm analyzes a deepening low with a pressure of 990 mb at most centered at 35.9N 59.0W. A developing warm front is noted to its northeast.
- HURDAT lists a tropical storm at 36.5N 58.9W with winds of 35 kt.

2. Ship highlights:
   - 60 kt W and 999 mb at 00Z at 35.4N 62.2W (Microfilm);
   - 40 kt NE and 1005 mb at 00Z at 40.5N 59.0W;
   - 35 kt SW and 998 mb at 00Z at 36.3N 58.4W;
   - 40 kt SW at 06Z at 34.8N 59.7W;
   - 20 kt S and 998 mb at 06Z at 36.7N 57.2W;
   - 50 kt and 989 mb at 12Z at 35.2N 59.4W;
   - 20 kt NE and 994 mb at 12Z at 36.7N 60.2W;
   - 30 kt N and 1004 mb at 18Z at 36.5N 61.5W (all COADS except the first report).
3. Discussion/Reanalysis: On this day, the system's forward speed slowed and a slight southerly deviation even took place. Observations that day indicated the system to be near hurricane-strength, with 60 kt winds measured at 00z. Of note, another ship measured 989 mb and 50 kt SW winds at 12z near the storm's center. It is possible that the system briefly reached hurricane intensity; however, based on available observations it is estimated that this unnamed system peaked as a strong tropical storm with 60 kt winds at 18z on June 9 and 00z on June 10. Later on June 10, the system turned to the north-northeast as a developing extratropical low approached from the northwest. For unknown reasons, HURDAT drops the system to a 35 kt tropical storm at 12z despite contrary observations. Winds are increased for all positions on June 10, with major increases at 12 and 18z to 55 and 50 kt, respectively.

June 11:

1. Maps and old HURDAT:
   - HWM analyzes an extratropical low with a central pressure of 1001 mb near 38.5N 55.5W.
   - Microfilm analyzes a weakening extratropical cyclone at 0600Z centered near 39.5N 60.0W that is lost within a larger extratropical cyclone by 1200Z.
   - HURDAT lists a tropical storm at 39.0N 55.8W with winds of 35 kt.
2. Ship highlights
   - 15 kt N and 999 mb at 00Z at 36.9N 58.8W;
   - 35 kt SW and 1003 mb at 00Z at 34.8N 55.4W;
   - 20 kt E and 1004 mb at 06Z at 39.7N 56.4W;
   - 30 kt SE and 1005 mb at 09Z at 39.8N 55.0W (COADS).
3. Discussion:
   - MWR: "On June 11, the storm turned northward and was soon absorbed by a large extratropical low over the Canadian Maritimes."
   - Reanalysis: This marked the final day of this system's existence as it was absorbed into the intensifying non-tropical system to its north. Major changes to the track are made on this day as observations indicate the system to have been farther west than shown in HURDAT. Central pressures of 997 and 1001 mb are added for 00 and 06z based on observations of 999 mb with 15 kt winds and 1003 mb with 15 kt winds, respectively. These central pressures indicate maximum sustained winds of

53 and 42 kt, respectively, from north of 25N Brown et al. pressure-wind relationship. Owing to decreasing environmental pressures, the 00z intensity is estimated to be 45 kt rather than 50 or 55 kt. Observations indicated that the storm maintained a non-frontal warm-core up through its absorption after 18z, thus no extratropical transition is noted.

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

Unnamed [July 28 – August 8, 1964] – AL021964

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43230 07/28/1964 M= 7  2 SNBR= 934 NOT NAMED   XING=0 SSS=0
43230 07/28/1964 M=12  2 SNBR= 934 NOT NAMED   XING=0 SSS=0
                    **

43235 07/28*  0   0   0    0*191 435  25    0*197 478  30    0*202 502  30    0*
43235 07/28*  0   0   0    0*191 460  40    0*191 485  45    0*193 508  45    0*
                             ***  **      ***  ***  **      ***  ***  **

43240 07/29*208 525  30    0*214 544  30    0*220 560  30 1006*226 576  30    0*
43240 07/29*198 528  45    0*205 543  45    0*216 558  45 1006*226 576  45    0*
           ***  ***  **      ***  ***  **      ***  ***  **                **

43245 07/30*235 592  30    0*251 604  30    0*268 610  30    0*284 611  30 1012*
43245 07/30*235 594  40 1008*248 604  40    0*268 610  40    0*284 611  35 1012*
              ***  ** **** ***       **                **                **

43250 07/31*298 608  30    0*311 602  30    0*324 591  30 1012*337 572  45    0*
43250 07/31*298 605  35    0*311 595  35    0*324 584  40 1012*337 573  45 1008*
              ***  **           ***  **          ***  **           ***     ****

43255 08/01*350 552  45    0*363 544  45    0*377 535  45    0*390 518  45    0*
43255 08/01*349 561  50    0*363 546  60    0*377 533  65    0*390 518  75    0*
           ***  ***  **           ***  **          ***  **                **

43260 08/02*403 497  45    0*420 470  45    0*442 444  45    0E470 421  45    0*
43260 08/02*403 500  75    0E420 476  70    0E442 450  60    0E470 425  55    0*
              ***  **           ***  **     *    ***  **           ***  **

43265 08/03E498 401  45    0E521 383  40    0E543 367  35    0*  0   0   0    0*
43265 08/03E498 401  55    0E521 383  55    0E543 367  55    0E565 350  55    0*
                    **                **                **     ****  ***  **

(The 4th through 9th are new to HURDAT)
43265 08/04E580 325  50    0E590 290  50    0E596 255  45    0E600 230  45    0*
43265 08/05E603 210  45    0E605 193  40    0E605 175  40    0E603 150  35    0*
43265 08/06E600 125  30    0E596 105  30    0E590  90  30    0E580  78  35    0*
43265 08/07E570  68  35    0E564  60  35    0E560  50  35    0E558  40  30    0*
43265 08/08E556  30  30    0E553  20  30    0E550  10  30    0E5503605  30    0*
43265 08/09E5453620  25    0E5403633  25    0E5353645  25    0*  0   0   0    0*

43270 TS
43270 HR
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Significant Revisions:

1. Large westward position adjustment at beginning of lifetime based upon ship observations.
2. Large upward intensity changes on the 28th and 29th based upon ship and aircraft observations.
3. Tropical storm intensity indicated three days earlier.
4. Large southward position adjustment on the 29th based upon ship and aircraft observations.
5. Large upward intensity revisions made on the 1st, 2nd, and 3rd based upon ship reports.
6. Peak intensity boosted from 45 to 75 kt based upon ship reports, now making the system a hurricane.
7. Six additional days as an extratropical cyclone added.

Daily Summaries:

July 25–27:

1. Maps and old HURDAT:

- Microfilm depicts a tropical wave near the Cape Verde Islands, extending from about 9N 26W northeast to 19N 20W at 12Z on July 25.
- HWM analyzes an area of low pressure of 1010 mb near 14N 32W at 12Z on July 26.
- Microfilm depicts a possible trough or tropical wave along 32W at 12Z on July 26.
- HWM analyzes an area of low pressure of 1010 mb near 14N 42.5W at 12Z on July 27.
- Microfilm depicts nothing of interest at 12Z on July 27.

2. Ship highlights: 15 kt SW and 1004 mb at 12.4N 17.9W at 00Z July 25 (COADS).
3. Discussion:

- MWR: "During July 27–28, ship reports indicated a perturbation in the Central Atlantic near 20N 45W, which was quite likely related to a cloud vortex viewed by TIROS near 14N 24W on July 25 and a weak surface circulation simultaneously observed in the Cape Verdes"
- Reanalysis: The first indication of this tropical cyclone was a vortex spotted on TIROS imagery near 14N 24W on July 25. Surface observations from the Cape Verde Islands and nearby ships indicated the passage of a tropical wave that day; however, no closed circulation was present. A subsequent data gap on July 26 and 27 inhibits analysis of the system during that time as it moved briskly westward over the open Atlantic.

July 28:

1. Maps and old HURDAT:

- HWM analyzes an area of low pressure of 1008 mb near 18.5N 48W at 12Z.
- Microfilm depicts a tropical wave extending from 17N 50W to 22N 48W.
- HURDAT lists a tropical depression at 19.7N 47.8W with 30 kt winds at 12Z.

2. Ship highlights:

- 40 kt NNE and 1006 mb (too low) at 20.0N 46.1W at 06Z (micro).
- 40 kt NE and 1006 mb at 20.0N 50.0W at 12Z (COADS).
- 40 kt NE and 1015 mb at 21.0N 49.2W at 18Z (COADS).

3. Aircraft highlights:

- Peak estimated surface winds of 45 kt (MWR).

4. Discussion:

- MWR: "A reconnaissance plane dispatched to the area of suspicion on the 28th reported no westerly winds although maximum surface easterly winds of 50 mph were observed near 21N 50W. The lowest sea level pressure was 1011 mb."
- Reanalysis: It was not until 00Z on this date that ships encountered the incipient storm. Around 06Z, one vessel reported NNE Force 8 winds (34-40 kt) and a 1006 mb pressure during a squall while another ship measured 35 kt E farther east. A reconnaissance aircraft flying in the system around 12Z found surface winds of 45 kt, a minimum pressure of 1011 mb, but no circulation center. Despite evidence from recon, HURDAT starts the system as a 25 kt tropical depression at 06Z. Based on the ambiguous data, initiation of the system is maintained at 06Z as originally in HURDAT. It is possible that the system remained a tropical wave at this time due to its fast motion and small size. Major changes to the intensity and position are made at the first position, however, including reclassification as a tropical storm (3.5 days earlier than originally in HURDAT). Winds are increased to 40 kt from 25 kt and the longitude is shifted 2.5 degrees west to better agree with the two ship observations.

July 29:

1. Maps and old HURDAT:

- HWM analyzes an area of low pressure of 1008 mb at most near 22N 57W at 12Z.
- Microfilm depicts an area of low pressure of 1011 mb at most near 22.1N 56.6W at 12Z.
- HURDAT lists a tropical depression at 22.0N 56.0W with 30 kt winds and a central pressure of 1006 mb at 12Z.

2. Ship highlights:

- 35 kt NE and 1013 mb at 22.2N 53.8W at 00Z (COADS).
- 35 kt ESE and 1013 mb at 21.3N 53.1W at 06Z (COADS).

3. Aircraft highlights:

- Center fix at 22.2N 56.4W with pressure of 1006 mb at 1410Z (micro/MWR).
- Center fix at 22.8N 59.0W with pressure of 1008 mb at 22Z (micro).
- Maximum estimated winds of 50 kt at 2230Z (micro).

4. Discussion:

- MWR: "[On July 29,] reconnaissance found that the pressure had dropped to 1006 mb with a small wind and pressure eye near 22.15N 56.40W; maximum surface winds of 50 mph were observed in the northwest and northeast quadrants. That afternoon a second reconnaissance flight found that no intensification had occurred. The central pressure was 2 mb higher than in the morning and the wind field was about the same"
- Reanalysis: The system began turning northwest on this date with little change in strength. Several gales were observed on the north side of the storm and serve as the basis for maintaining winds of 45 kt throughout the day, 15 kt above HURDAT. Data throughout the day was ambiguous as to whether or not a closed circulation existed, which could be the case with a rapid motion of the system. Synoptic data from ships would suggest that the system remained a tropical wave while reconnaissance reported the presence of a closed low. A recon fix at 1410Z found a central pressure of 1006 mb, indicating some deepening from the previous day. Such a central pressure being much lower than the environmental pressure gives evidence that the system likely was closed. A pressure of 1006 mb suggests maximum winds of 32 kt from the Brown et al. north of 25N pressure-wind relationship. Owing to the storm's fast motion, small size, and high environmental pressures, 45 kt is maintained as the estimated intensity.

July 30:

1. Maps and old HURDAT:

- HWM analyzes an area of low pressure of 1016 mb at most near 27N 61W at 12Z.
- Microfilm depicts indicates a circulation center near 26.5N 60.9W at 12Z.
- HURDAT lists a tropical depression at 26.8N 61.0W with 30 kt winds at 12Z.

2. Aircraft highlights:

- Wind center fix at 26.6N 61.2W around 12Z (micro).
- Wind center fix at 29.0N 61.3W at 19Z; maximum estimated surface winds of 45-55 kt (MWR).

3. Discussion:

- MWR: "On July 30 the system persisted as it turned toward the north-northwest. A squall area oriented north-northwest to south-southeast was located 60-80 mi east of a weak wind circulation wind circulation centered at 29.0N 61.3W, at 1400 EST [1900Z]. The lowest pressure was 1012 mb and the wind near the center was less than 10 kt. However, winds up to 55 to 65 mph were reported in the squall band. Rapid movement of the center (20 mph or more) contributed to the maximum winds observed, but strong basic current also tended to mask and perhaps inhibit the development of a well-defined vortical wind field."
- Reanalysis: The system turned more northerly on this date and weakened somewhat. The ambiguity of whether it had a well-defined center continued early in the day as two ships observed weak (5-10 kt) northerly winds south of the supposed circulation center at 00Z. However, aircraft reconnaissance still reported a center fix with 1008 mb around 22Z on July 29 and estimated maximum winds 50 kt. The 1008 mb is added as a central pressure for 00Z on the 30th. A pressure of 1008 mb suggests maximum winds of 28 kt from the Brown et al. pressure-wind relationship. Based on the slightly higher pressure and slight deceleration of the system, an intensity of 40 kt is chosen for 00Z, 06Z, and 12Z. Recon noted additional weakening later that day, with a 1012 mb center fix at 19Z. The highest winds observed by ships nearby were 30 kt. It is possible that the system weakened below tropical storm force by 18Z. According to the Monthly Weather Review, a squall band along the north side of the system was producing winds of 45-55; however, this is not considered representative of the storm's actual intensity.

July 31:

1. Maps and old HURDAT:

- HWM does not analyze a trough or low pressure center at 12Z with a cold front approaching from the northwest.
- Microfilm depicts a very small low pressure area of 1010 mb at most near 33.5N 58.5W at 12Z. H
- HURDAT lists a tropical depression at 32.4N 59.1W with 30 kt winds and a central pressure of 1012 mb at 12Z.

2. Aircraft highlights:

- Wind center fix at 33.1N 58.4W with a pressure of 1012 mb at 14Z (micro).
- Wind center fix at 33.6N 57.4W at 1730Z (micro).
- Wind center fix at 33.1N 56.0W with a pressure of 1008 mb at 19Z (micro).

3. Discussion:

- MWR: "On the morning of the 31st, the center was located some 300 mi east of Bermuda moving toward the northeast. There was little organization and the central pressure remained at 1012 mb, with winds of 55 to 65 mph east of the center. During the day, the pressure dropped to 1008 mb, a well-defined radar band appeared northeast of the center and winds in the western portion of the circulation increased to 25 to 30 mph. It is believed that the cyclone met the specifications of a tropical storm about midday on the 31st."

- Reanalysis: An approaching cold front imparted southwesterly flow on the system starting on this date and prompted a turn to the northeast. A clearly well-defined center is present for the first time starting around 12Z with recon finding westerly winds up to 30 kt. The system began deepening during the aircraft's flight, with fixes at 14Z and 19Z having pressure of 1012 mb and 1008 mb, the latter of which is added as a new central pressure for 18Z. Re-intensification is noted during this time with winds rising to 45 kt by 18Z. It should be noted that the operational post-storm analysis in 1964 indicated the system to have first "met the specifications of a tropical storm" (MWR p. 177) by 18Z. The intended meaning is uncertain and it is possible that this was when the system first obtained a closed circulation and became a bonafide tropical cyclone rather than intensifying from a tropical depression to tropical storm (as interpreted by the original HURDAT).

August 1:

1. Maps and old HURDAT:

- HWM analyzes a frontal low of 1012 mb at most near 38N 54W at 12Z.
- Microfilm depicts an area of low pressure of 1008 mb at most just east of an approaching frontal system at 12Z.
- HURDAT lists a tropical storm at 37.7N 53.5W with 45 kt winds at 12Z.

2. Ship highlights:

- 40 kt SW and 1012 mb at 35.8N 53.5W at 12Z (COADS).
- 40 kt NNE and 1009 mb at 40.1N 52.3W at 18Z (COADS).
- 70 kt NW and 997 mb at 39.2N 53.0W at 18Z (micro).

3. Discussion:

- MWR: "Some further intensification and better organization was noted on August 1 with ships reporting winds of 45 mph or higher; and one, apparently in a squall, reported 80mph.
- Reanalysis: Intensification continued in earnest on this date as the unnamed system continued northeast ahead of the cold front. Two vessels sailed directly into the system late on August 1 and early on August 2 and reported hurricane-force winds, providing invaluable data on the true strength of the cyclone. Based on these observations, the system is reclassified as a hurricane starting at 12Z. At 18Z, the ship GKSY reported 70 kt NW winds and 997 mb as it neared the core of the storm. This would also suggest the central pressure to have less than 990 mb. This measurement is used to obtain an estimated peak of 75 kt for 18Z and 00Z, 30 kt higher than the original HURDAT. Major increases to wind speed are introduced for 12, and 18Z on August 1 as well as 00Z and 06Z on August 2 accordingly.

August 2:

1. Maps and old HURDAT:

- HWM analyzes a deepening frontal low of 1004 mb at most near 44.5N 44.5W at 12Z.
- Microfilm depicts an area of low pressure, with a trailing frontal boundary, of 1005 mb at most near 43N 45W at 12Z.
- HURDAT lists a tropical storm at 44.2N 44.4W with 45 kt winds at 12Z.

2. Ship highlights:

- 35 kt NNE and 1009 mb at 41.9N 49.4W at 00Z (COADS).
- 65 kt SSE at 42.2N 47.0W at 06Z (COADS).
- 35 kt NNE and 1005 mb at 46.6N 44.9W at 12Z (COADS).
- 45 kt N and 1004 mb at 47.0N 44.4W at 18Z (COADS).

3. Discussion:

- MWR: "A cold front was beginning to enter the inner portion of the circulation but the center was still warm. Data were insufficient to describe the storm's subsequent history completely, but it seems likely that it did not become extratropical until late on August 2 near 47N."
- Reanalysis: Transition into an extratropical cyclone occurred by 06Z as the hurricane merged with the approaching cold front. The transition is now estimated to have taken place 12 hours earlier than HURDAT and while maintaining hurricane-force winds. The extratropical cyclone continued off to the northeast and gradually weakened, dropping below hurricane force by 12Z.

August 3:

1. Maps and old HURDAT:

- HWM analyzes an extratropical cyclone of 996 mb at most near 54N 38W at 12Z.
- Microfilm depicts an extratropical cyclone of 996 mb at most near 55N 38W at 12Z.
- HURDAT lists an extratropical storm at 54.3N 36.7W with 35 kt winds at 12Z.

2. Ship highlights:

- 25 kt NNW and 999 mb at 49.5N 42.0W at 00Z (COADS).
- 40 kt N and 995 mb at 53.8N 42.3W at 06Z (COADS).
- 993 mb at 53.4N 38.1W at 06Z (COADS).
- 50 kt WSW and 994 mb at 53.0N 39.3W at 12Z (COADS).
- 45 kt W and 1010 mb at 52.5N 39.3W at 18Z (COADS).
- 25 kt NE and 995 mb at 56.9N 38.1W at 18Z (COADS).

3. Discussion:

- MWR: "Strong gales persisted around the center as it moved southeast of Greenland on the 3rd."
- Reanalysis: Ships observed winds up to 50 kt through 18Z. A major change to intensity from 35 kt to 55 kt is made at 12Z in accordance with these observations.

August 4:

1. Maps and old HURDAT:

- HWM analyzes an extratropical cyclone of 988 mb at most near 60.5N 20W at 12Z.
- HURDAT dissipated the system after 12Z on the 3rd

2. Ship highlights:

- 35 kt WSW and 993 mb at 56.1N 33.0W at 00Z (COADS).
- 40 kt SW and 1000 mb at 56.7N 24.8W at 06Z (COADS).
- 40 kt SW and 999 mb at 56.6N 25.4W at 12Z (COADS).
- 40 kt SW and 1002 mb at 57.0N 25.0W at 18Z (COADS).

3. Discussion/Reanalysis: HURDAT erroneously weakens the cyclone and indicates dissipation after 12Z on August 3. The Historical Weather Map series and ship observations indicate that the former hurricane eventually turned eastward and passed to the south of Iceland on August 5.

August 5:

1. Maps and old HURDAT: HWM analyzes an extratropical cyclone of 1000 mb at most near 62N 13W at 12Z.
2. Ship highlights:

- 30 kt SW and 999 mb at 58.9N 19.2W at 00Z (COADS).
- 35 kt SW and 1003 mb at 58.0N 16.6W at 00Z (COADS).
- 30 kt SW and 999 mb at 59.1N 18.0W at 06Z (COADS).

- 30 kt ENE and 1000 mb at 64.9N 2.6W at 12Z (COADS).
- 30 kt NNE and 1000 mb at 62.7N 14.5W at 18Z (COADS).

August 6:

1. Maps and old HURDAT: HWM analyzes an area of low pressure of 1000 mb at most near 59N 9W at 12Z.
2. Ship highlights:

- 15 kt S and 999 mb at 59.4N 9.0W at 00Z (COADS).
- 15 kt NNW and 995 mb at 59.2N 12.0W at 06Z (COADS).
- 10 kt S and 999 mb at 58.5N 8.2W at 12Z (COADS).
- 35 kt NW and 1014 mb at 49.9N 15.2W at 18Z (COADS).

3. Discussion/Reanalysis: A brief weakening below gale-force is noted on this date based on no measurements of 35 kt winds early. The low turned southeast around this time and headed toward the United Kingdom. Ship observations indicated winds returned to gale-force by 18Z shortly before the system moved over northern Scotland.

August 7:

1. Maps and old HURDAT: HWM analyzes an area of low pressure of 1004 mb at most near 55.5N 5W at 12Z.
2. Ship highlights:

- 15 kt SSE and 998 mb at 55.4N 5.8E at 00Z (COADS).
- 35 kt SE and 1005 mb at 59.3N 4.2E at 06Z (COADS).
- 35 kt WNW and 1011 mb at 50.0N 11.1W at 12Z (COADS).

August 8:

1. Maps and old HURDAT: HWM analyzes an area of low pressure of 1008 mb at most near 55N 1W at 12Z.
2. Ship highlights:

- 15 kt ESE and 1003 mb at 53.8N 1.7E at 00Z (COADS).
- 10 kt NE and 1001 mb at 55.0N 6.0E at 06Z (COADS).
- 15 kt SE and 1002 mb at 56.0N 6.0E at 12Z (COADS).

3. Discussion/Reanalysis: The system gradually weakened on the 8th and 9th before dissipating into a trough by late on the 9th.

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

Tropical Storm Abby [August 5–8, 1964] – AL031964

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43275 08/05/1964 M= 4  3 SNBR= 935 ABBY        XING=1 SSS=0


43280 08/05*  0   0   0    0*  0   0   0    0*  0   0   0    0*270 881  25    0*
43280 08/05*  0   0   0    0*  0   0   0    0*  0   0   0    0*273 877  25    0*
                                                        *** ***

43285 08/06*270 891  25    0*270 902  25    0*271 911  25    0*273 919  25    0*
43285 08/06*278 887  25    0*282 897  25    0*285 907  25    0*285 917  25    0*
            *** ***          *** ***          *** ***          *** ***

43290 08/07*275 927  25    0*280 935  30    0*285 944  40    0*286 952  55 1000*
43290 08/07*285 926  25    0*286 935  30    0*286 944  40    0*286 952  55 1000*
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            *** ***          ***              ***

43295 08/08*288 961  55    0*289 973  25    0*288 980  25    0*287 989  25    0*
43295 08/08*288 961  50 1000*289 971  35    0*289 980  25    0*289 987  20    0*
                    ** ****     ***  **      ***              *** ***  **

43300 TS

U.S. Tropical Storm Landfall
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08/07 2030Z 28.8N 95.6W 60 kt TX
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Significant Revisions:

1. Major north-northeastward adjustment to track on August 6-7 based on ship and coastal observations

Daily Metadata:

August 5:

1. Maps and old HURDAT:
   - HWM analyzes nothing of interest
   - Microfilm depicts a depression over the northern Gulf of Mexico with a very elongated circulation
   - HURDAT lists a 25 kt tropical depression at 27.0N 88.1W at 18Z.
2. Discussion:
   a. MWR: "Formation occurred in a weak trough just off the Texas Coast. This weak trough moved out of Northern Florida into the Northeast Gulf of Mexico on the 5th. It then moved slowly westward across the northern Gulf, with no signs of development or intensification until it approached the Central Texas Coast."
   b. WBO Galveston: "The northwest Gulf had been sporadically cloudy since prior to Wednesday, August 5. On that Wednesday a series of heavy thunderstorms and a squall line moved across Chambers, Galveston, Brazoria, and Matagorda Counties. On the very next day warnings were again issued for Galveston County for similar activity moving westward from the Gulf, but this time the intensity of the activity diminished rapidly as it approached the coast. In both instances, well defined fine lines were noted on radar."

   c. Reanalysis: On August 5th, a trough of low pressure emerged over the northeastern Gulf of Mexico off the coast of Florida. Satellite imagery and ship data indicated that a depression formed by 18z on this day, unchanged from that in HURDAT originally. A weak system, the depression did not have winds in excess of 25 kt as it moved generally west-northwest. While the tropical depression was forming on the 5th, a second disturbance – a trough – was located near the Louisiana coast. This trough appears to have moved northwestward and dissipated over southeastern Texas early on the 6th, without developing into a tropical cyclone.

August 6:

1. Maps and old HURDAT:
   - HWM analyzes an open area of low pressure centered near 27.5N 89.5W, south of Louisiana and extending westward to the Texas coast at 12Z.

- Microfilm depicts a very small circulation south of the Texas/Louisiana border near 27.5N 93.0W at 12Z.
- HURDAT lists a 25 kt tropical depression at 27.1N 91.1W at 12Z.

2. Aircraft highlight: Microfilm plots of the invest mission showed strongest wind of 20 kt and pressure of 1013 mb around 16Z with no well-defined center.
3. Discussion:
    a. WBO Galveston: "On Thursday night [August 6], increasing cloudiness developed to our south and east and it was from this cloud mass that Tropical Storm Abby formed very quickly late Friday morning. The first indications of Abby occurred about 1100 [time zone unknown] when, with slight attenuation, the WSR-57 detected tropical storm characteristics."

    b. Reanalysis: Major changes to track were made to HURDAT for 06, 12, and 18z, mostly latitudinal. Data from ships and the recon invest during the day show that the positions shown in HURDAT are too far south and indicate a circulation center (though not well defined) closer to the coast of Louisiana. Interestingly, the shift northward agrees well with the original best track provided for Tropical Storm Abby in the Weather Bureau's preliminary report, which initiated the system at 18z on August 6th slightly northwest of the revised position.

August 7:

1. Maps and old HURDAT:
    - HWM analyzes a tropical storm near 29N 94.5W at 12Z.
    - Microfilm depicts Tropical Storm Abby along the immediate Texas coast at 18Z.
    - HURDAT lists a 40 kt tropical storm at 28.5N 94.4W at 12Z.
2. Land highlights:
    - 38 kt ENE and 1010 mb at Port Lavaca, Texas at 20Z (SW).
    - 40 kt SSW and 1004 mb with gusts to 55 kt at Matagorda, Texas at 23Z (SW).
3. Aircraft highlights:
    - Central pressure of 1000 mb and 75 kt surface winds in brief squalls (likely around 18z; MWR). A newspaper clipping from *The Victoria Advocate* states that recon measured 60 kt average winds and 75 kt peak sustained in the southeast quadrant.
4. Radar highlights:
    - 28.7N 95.3W at 1815z from Galveston, Texas (SW).
    - 28.9N 95.7W at 2045z from Galveston, Texas (SW).
5. Discussion:
    a. MWR: "The storm developed under the surveillance of coastal radars at Galveston, Victoria, Lake Charles, and Brownsville, all of which indicated a sudden development of spiral bands and an eye during the late afternoon of August 7. A reconnaissance plane was in the area and reported a center fix at 1115 CST [1715z]. Abby was an extremely small storm; its complete circulation was considerably less than 100 mi in diameter. It moved westward, averaging about 10 mph, and crossed the Texas coast just northeast of Matagorda about 1600 CST [2200z]. Over land, Abby gradually dissipated as it moved westward and lost its identity during the morning of the 8th southwest of San Antonio. Reconnaissance aircraft estimated the highest winds about 85 mph (probably an overestimate), in squalls, and reported a central pressure of 1000 mb (29.53 in). The highest sustained wind reported along the coast was 45 mph, with gusts to 65 mph, and the lowest

pressure was 1004 mb (29.66). These were observed by the Corps of Engineers at Matagorda. Highest tides were 2 to 4 ft msl from Matagorda to Freeport."

b. WBO Galveston: "The two unusual features of Abby were its sudden development and its very small but almost perfectly miniaturized "hurricane" characteristics. The wall cloud, spiral bands and eye were all well defined on radar, although at no time did the un-broken cloud mass exceed 100 miles in diameter. It is interesting to note that in the absence of aircraft reconnaissance and radar information, two reasonably new tools in storm detection, Abby could well have formed and approached the shore before knowledge of a tropical storm was gained."

c. WBO Austin: "Near Matagorda, what may have been a tornado unroofed a small barn, then carried the barn about 75 yards. The structure had been able to withstand the fury of Hurricane Carla in September 1961." It should be noted that no tornadoes were confirmed in relation to Abby."

d. Reanalysis: Throughout August 7th, the storm moved slowly west with an average forward speed of 7 kt. A major change to the 00z position is made as well as minor adjustments to the 06 and 12z positions to match the earlier northward changes. A reconnaissance mission into the storm around 18z on the 7th revealed a very small but well-organized cyclone with a central pressure of 1000 mb and estimated average surface winds of 60 kt with a localized peak of 75 kt. A central pressure of 1000 mb suggests maximum surface winds of 44 kt north of 25N from the Brown et al. pressure-wind relationship. At this time, environmental pressures were near average with the storm having an outermost closed isobar of ~1012 mb. However, Abby was an exceptionally small storm with radar imagery indicating the convective signature to be no more than 50 nmi in diameter. In line with this the storm had an RMW of roughly 12 nmi, derived from a radar eye diameter of 15 nmi at 0345z on August 8th, which is substantially smaller than the average of 24 nmi for a storm near 30N with a central pressure of 1000 mb. The majority of these aforementioned factors, as well as some weighting of the max surface wind estimate, led winds to be analyzed above the pressure-wind relationship value and an intensity of 55 kt is chosen for 18z, unchanged in HURDAT. After attaining these winds, Abby made landfall to the northeast of Matagorda, Texas around 2030z. Almost three hours after landfall, Matagorda's 40 kt and 1004 mb suggest a central pressure of 1000 mb. Thus it is likely that Abby continued intensifying up until landfall and then typical weakening thereafter. Thus a landfall intensity is assessed 60 kt (with no central pressure value, but it may have been near 995 mb). It is possible that Abby became a hurricane by the time it moved ashore, though due in part to a lack of direct observations near the center the peak is kept below 65 kt.

August 8:

1. Maps and old HURDAT:
   - HWM depicts nothing of interest.
   - Microfilm depicts a very small low near 29N 98W at 12Z.
   - HURDAT lists a 25 kt tropical depression at 28.8N 98.0W at 12Z.
2. Land highlights:
   - 38 kt SW at Point Comfort, Texas at 0325z (SW).
   - 34 kt SSW with gusts to 42 kt at Palacios, Texas at 0128z (SW).

3. Radar highlights:
   - 28.9N 96.1W with a 15 mi diameter eye at 0015z from Victoria, Texas (SW).
   - 28.0N 96.6W at 0245z from Victoria, Texas (SW).
4. Discussion:
   a. Reanalysis: Maintaining its due west track, Abby steadily weakened as it moved inland. Only minor changes for smoothing were made to the track and winds were adjusted at 00, 06, and 18z to depict steady decay. A value of 35 kt is chosen for 06z rather than 30 kt due to an observation of 38 kt winds at Point Comfort at 0325z. A discernable low-level circulation was lost over south-central Texas after 18z and the final position of Abby is assessed at 18z on August 8th, the same as originally shown in HURDAT.

Tropical Storm Brenda [August 8–10, 1964] – AL041964

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43305 08/07/1964 M= 4  4 SNBR= 936 BRENDA      XING=0 SSS=0
43305 08/08/1964 M= 3  4 SNBR= 936 BRENDA      XING=0 SSS=0
          *         *

(The 7th is removed from HURDAT)
43310 08/07*  0   0   0    0*  0   0   0    0*  0   0   0    0*320 690  25    0*

43315 08/08*321 676  30    0*322 662  30    0*324 649  45 1008*320 634  45    0*
43315 08/08*  0   0   0    0*330 670  30    0*324 652  45 1006*319 637  45    0*
            *** ***  **      *** ***              ***     **** *** ***

43320 08/09*314 620  45 1010*315 613  45    0*319 606  45 1008*329 601  45 1006*
43320 08/09*314 621  45    0*315 612  45    0*319 606  45 1008*328 601  45 1006*
                       ****     ***                          ***

43325 08/10*337 592  45    0*344 578  40    0*352 565  40 1010*361 555  35    0*
43325 08/10*337 592  45    0*345 580  40    0*352 565  35 1010*  0   0   0    0*
                         *** ***                    **       *** ***  **

43330 TS

Tropical Storm Landfall
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8/08 1300Z 32.3N 64.8W 45 kt Bermuda
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Significant Revisions:

1. Genesis delayed by a half day based upon ship and coastal observations.

Daily Summaries:

August 7:

1. Maps and old HURDAT:
   - HWM analyzes a stationary front west of Bermuda at 12Z.
   - Microfilm analyzes a trough extending generally northeast from 31N 74W to 38N 60W with a possible circulation marked near 32N 71W at 12Z.
   - HURDAT lists a tropical depression at 32.0N 69.0W with 25 kt winds at 18Z.

2. Discussion:

- MWR: "Post analysis of the storm indicates that it probably began its development in a minor trough of low pressure some 400 mi west of Bermuda on August 7. An airline crewmember recalled observing a low-level circular cloud formation in the vicinity of 32N, 69W at 1300 EST [18Z] on August 7, though the pattern did not then appear significantly different from many cloud formations frequently observed…Prior to the storm's passage over Bermuda, there was no evidence from available sparse ship reports or other data of the development of the storm. Not until August 8 was sufficient information available to substantiate that a tropical storm and not a frontal wave or local disturbance was responsible for the conditions observed at Bermuda."
- Reanalysis: On the 6th and 7th of August, an extratropical cyclone east of the Carolinas moved east-northeast into the central Atlantic. Tropical Storm Brenda had its origins within a dissipating frontal boundary associated with this extratropical cyclone. HURDAT indicates that genesis as a tropical depression took place at 18z, in accordance with an interview with an airline crewmember that flew by the area around that time. However, available data from the COADS database and microfilm maps shows no evidence of a closed low at that time.

August 8:

1. Maps and old HURDAT:

- HWM analyzes a tropical storm of 1012 mb at most at 32.N 64.5W at 12Z.
- Microfilm analyzes an area of low pressure of 1011 mb at most near 32.3N 65.5W at 12Z.
- HURDAT lists a tropical storm at 32.4N 64.9W with 45 kt winds and a central pressure of 1008 mb at 12Z.

2. Ship highlights:

- 40 kt SE and 1011 mb at 31.5N 62.0W at 18Z (Micro).

3. Station highlights:

- 38 kt at 1210Z (max winds, 55 kt gusts) and 1008 mb (lowest pressure) at 1300Z with E 20 kt wind at Bermuda (MWR, Storm Wallets).

4. Aircraft highlights:

- Radar center fix with estimated surface winds of 45 kt and an eye diameter of 3 nmi at 31.4N 62.1W at 2318Z (ATSR).

5. Discussion:

- MWR: "Observations from Bermuda first indicated the existence of tropical storm Brenda. During the morning of August 8, the pressure began to fall, dropping from 1018 mb at 0100 EST to 1008 mb at 0800 EST [06Z to 13Z]. Winds increased briefly to 45 m.p.h. with gusts to 65 m.p.h. as the center passed over the island. No casualties were reported. A small tornado or waterspout spawned by the storm damaged a commercial airliner and several privately-owned aircraft and was apparently responsible for winds of 92 m.p.h. measured atop a 100-ft NASA tower. Spiral bands were observed on the U.S. Air Force radar at Bermuda after the passage of the center."
- Reanalysis: Genesis does not appear to have taken place until 06z on this date, 12 hours later than HURDAT. Observations from Bermuda indicate the presence of a low-pressure circulation to the west by this time. Moving swiftly to the east-southeast, the depression reached tropical storm strength by 12z. Brenda likely passed directly over Bermuda around 13z, when a 1008 mb pressure with 20 kt wind was measured, indicating a central pressure of about 1006 mb. Sustained winds on the island briefly reached 38 kt with gusts to 55 kt. Brenda was an unusually small storm and radar imagery from reconnaissance aircraft indicated an eye diameter of 3 nmi late this date. With the presence of high environmental pressures, it is possible

that Brenda is stronger than currently listed but available data does not support such.

August 9:

1. Maps and old HURDAT:

- HWM analyzes a tropical storm near 32N 60.5W at 12Z.
- Microfilm analyzes an area of low pressure of 1011 mb at most near 32N 60.5W at 12Z.
- HURDAT lists a tropical storm at 31.9N 60.6W with 45 kt winds and a central pressure of 1008 mb at 12Z.

2. Ship highlights:

- 40 kt W and 1013 mb at 31.3N 62.3W at 00Z (COADS).

3. Aircraft highlights:

- Penetration center fix with estimated surface winds of 41 kt and a central pressure of 1008 mb at 31.9N 60.6W at 1211Z (ATSR).
- Penetration center fix with estimated surface winds of 45 kt and a central pressure of 1006 mb at 33.3N 59.8W at 2026Z (ATSR).

4. Discussion:

- MWR: "After passing over Bermuda, the storm drifted slowly east-southeastward before recurving and accelerating northeastward ahead of a cold front on the 9th...Lowest central pressure was 1006 mb on the 9th."
- Reanalysis: The storm abruptly slowed on August 9 and turned northeast, likely in response to southerly flow from a cold front to its northwest. A 1010 mb listed in HURDAT at 00z that day, though this appears erroneous and is removed as observations before and after this position show lower pressures. Reconnaissance missions throughout the day indicated slight deepening of the storm from 1008 mb at 12z to 1006 mb at 20z; maximum estimated surface winds were 41 and 45 kt, respectively.

August 10:

1. Maps and old HURDAT:

- HWM analyzes a tropical storm near 35N 57W at 12Z.
- Microfilm analyzes a small, lists a tropical storm at 35.2N 56.5W with 40 kt winds and a central pressure of 1010 mb at 12Z.

2. Ship highlights:

- 35 kt S and 1012 mb at 34.1N 57.7W at 06Z (COADS).

3. Discussion:

- MWR: "The circulation could not be tracked north of 35N where reconnaissance reported it had dissipated on August 10."
- Reanalysis: Brenda slowly weakened as it interacted with the approaching cold front on this date. Observations indicate that it either dissipated or was absorbed by the front after 12z while maintaining tropical storm-force winds, 6 hours earlier than shown in HURDAT.

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

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

1964/05L - 2014 REVISION:

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43335 08/20/1964 M=17  5 SNBR= 937 CLEO        XING=1 SSS=2
43335 08/20/1964 M=23  5 SNBR= 937 CLEO        XING=1 SSS=2
                   **

43340 08/20*  0   0   0    0*  0   0   0    0*  0   0   0    0*131 443  30 1003*
43340 08/20*  0   0   0    0*  0   0   0    0*  0   0   0    0*131 443  40 1003*
                                                                    **

43345 08/21*134 468  35    0*137 491  40 1000*141 513  65    0*144 535  70  993*
43345 08/21*133 467  40    0*137 491  45    0*141 514  55 1000*145 535  65  993*
           *** ***  **                **  ****     ***  ** **** ***      **

43350 08/22*149 557  75  993*153 578 100    0*157 597 110  970*160 619 115  962*
43350 08/22*149 557  75    0*153 577  85    0*157 597 100  970*160 616 110  962*
                          ***     ***  ***              ***          ***  ***

43355 08/23*162 634 120  955*163 650 125    0*165 666 130    0*167 680 135  950*
43355 08/23*162 634 120    0*163 650 125    0*165 666 130  938*167 680 125  945*
                                                          ***         ***  ***

43360 08/24*167 695 135  950*169 706 135    0*171 718 135    0*178 731 130    0*
43360 08/24*168 694 125    0*170 706 125    0*173 719 130    0*180 732 130    0*
           *** *** ***  *** ***     ***      *** *** ***      *** ***

43365 08/25*184 746 130    0*189 756 125    0*194 766 100    0*200 776  70    0*
43365 08/25*186 744  95    0*190 755  85    0*194 766  75    0*200 776  70    0*
           *** *** ***      *** *** ***              ***

43370 08/26*208 784  65    0*215 789  65    0*224 792  65    0*237 796  80  987*
43370 08/26*208 784  70    0*215 789  70    0*224 792  60    0*237 796  70  990*
                   **                **              **                **  ***

43375 08/27*246 796  90  984*255 799  90  968*263 802  85  971*272 806  75    0*
43375 08/27*246 797  80  984*255 800  95  968*263 802  80  971*272 805  55    0*
               ***  **          ***  **                **          ***  **

43380 08/28*278 807  60  983*284 809  60    0*295 812  55    0*302 813  50  995*
43380 08/28*279 807  45  983*286 810  45    0*295 813  55    0*302 813  55  995*
           ***       **      *** *** **          ***                    **

43385 08/29*308 813  45  999*314 813  40    0*320 814  35    0*324 816  30    0*
43385 08/29*308 813  50  999*314 813  50  999*320 814  45 1000*324 816  40    0*
                   **                **  ***          **  ****          **

43390 08/30*329 819  30    0*333 821  30    0*340 820  25    0*346 815  25    0*
43390 08/30*329 819  40    0*334 821  35 1005*340 820  30    0*346 816  25    0*
                   **      ***       **  ****          **

43395 08/31*351 811  25    0*356 803  25    0*360 795  25    0*363 783  30    0*
43395 08/31*351 811  25 1007*356 803  25 1007*360 795  25 1007*362 785  30    0*
                       ****              ****              **** *** ***

43400 09/01*365 770  30    0*363 760  35    0*358 752  40    0*353 742  45    0*
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43400 09/01*363 774   30 1005*363 764   35 1001*359 754   40  999*356 744   45     0*
            *** ***      ****     ***      **** *** ***      *** *** ***

43405 09/02*350 732   55    0*352 721   60    0*354 711   65  980*358 691   70     0*
43405 09/02*353 734   55  997*352 723   65    0*355 710   75  980*357 696   75     0*
            *** ***      ***     ***   **      *** ***   **      *** ***   **

43410 09/03*359 675   70    0*365 654   70  980*371 635   70  983*378 610   70  982*
43410 09/03*360 677   75    0*365 656   75  980*371 635   80  980*378 610   85  975*
            *** ***   **          ***   **                  **  ***           **  ***

43415 09/04*387 569   75    0*410 530   75    0*447 505   75  970*469 498   70     0*
43415 09/04*387 569   85    0*415 530   85    0E447 505   85  970E469 498   80     0*
                      **      ***       **     *          **     *          **

43420 09/05*488 495   65    0*513 488   65    0*535 480   60    0*  0   0   0     0*
43420 09/05E488 495   75    0E510 490   65    0E528 483   60    0E541 469  55     0*
            *         **     **** ***         **** ***         **** ***  **

(The 6th through 11th are new to HURDAT)
43340 09/06E550 455   50    0E553 448   50    0E555 440   50    0E553 432   50     0*
43340 09/07E550 425   45    0E547 418   45    0E544 410   40    0E541 404   40     0*
43340 09/08E536 397   40    0E532 392   40    0E528 387   35    0E525 385   35     0*
43340 09/09E525 385   30    0E530 375   30    0E535 365   30    0E545 355   30     0*
43340 09/10E550 340   30    0E550 320   30    0E560 300   30    0E565 275   30     0*
43340 09/11E565 260   25    0*  0   0   0     0*  0   0   0     0*  0   0   0     0*

43425 HRCFL2
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Hurricane Landfalls

8/22 17Z 15.9N 61.3W 110 kt Marie Galante
8/22 18Z 16.0N 61.6W 110 kt Basse-Terre, Guadeloupe
8/24 20Z 18.2N 73.7W 130 kt Haiti
8/25 17Z 19.9N 77.4W 70 kt Cuba
8/26 07Z 21.6N 79.0W 70 kt Cuba

U.S. Hurricane Landfall

Aug 27th – 08Z – 25.8N 80.1W – 95 kt – Category 2 – 968 mb – 10 nmi RMW – CFL2

U.S. Tropical Storm Landfall

8/29 0400Z 31.2N 81.3W 50 kt 999 mb Brunswick, GA

Significant Revisions:

1. System is now started as a tropical storm; however, the precise time of genesis is unclear and likely prior to the start of HURDAT.
2. Some significant reductions in intensity during the hurricane's first rapid intensification phase on August 22.

3. Landfall in the Tiburon Peninsula of Haiti on August 24 is now indicated to have made a direct hit.
4. Major reductions to maximum winds on August 25 after clearing Haiti.
5. Tropical storm period over the Southeast extended by 18 hours.
6. Intensity significantly boosted late on the 3rd based upon reconnaissance data.
7. Extratropical transition now indicated starting at 12z on September 5 (no extratropical transition phase was previously indicated).
8. Six days as an extratropical cyclone are added to HURDAT.

Daily Metadata:

August 15-19:

1. Maps and old HURDAT:
   - Sources depict nothing of interest during this time
2. Discussion:
   a. MWR: "The disturbance in which Cleo later formed appears to have moved off the African coast south of Dakar as a 1010-mb low accompanied by continuous rain and thundershowers, on August 15. Later, a TIROS VII photograph (unavailable at the time of this reanalysis) at 1044 EST [1544z] August 18 showed a cloud mass covering the region from 7 to 12 N, 32 to 37 W, centered at 10N, 34W. At 1300 EST [1800z] on the same date, the German Ship *Lichtenstein* reported a light east wind, continuous rain, and a pressure of 1008.9 mb (29.79 in) at 12N, 33.5W. From this area, the disturbance moved west-northwestward about 16 mph until located by reconnaissance aircraft on the 20th."

   b. Reanalysis: This long-lived and powerful hurricane was purported to have first begun as a tropical wave that emerged off the West African coast on August 15. Later images on August 18 from TIROS VII indicated some development of a system, with it being referred to as a "depression" on the 18Z microfilm surface analysis. A German vessel encountered a system around that time on the 18th and reported light east winds along with a pressure of approximately 1009 mb at 12N 33.5W. The system could not be classified as a tropical depression at this time due to a lack of additional data in the vicinity to confirm whether or not a closed circulation existed. However, it appears unlikely that Cleo originated from either of these systems as suggested in the Monthly Weather Review. The backwards extrapolated positions from the first definitive location and translational speed late on the 20th suggest positions substantially farther east than what is suggested on the 15th and 18th. It is possible instead that Cleo originated from the next tropical wave that emerged from the coast.

August 20:

1. Maps and old HURDAT:
   - HURDAT lists a 30 kt tropical depression at 13.1N 44.3W at 18Z.
   - HWM analyzes an area of low pressure around 13.5N 42.5W at 12Z.

- Microfilm analyzes a low pressure center near 13N 44.5W at 12Z.

2. Aircraft highlights:
   - Penetration center fix with estimated surface winds of 30 kt, estimated wind center diameter of 5 nmi, and a measured pressure of 1003 mb at 13.0N 44.4W at 1835Z (ATSR).
3. Discussion:
   a. MWR: "At 0100 EST [0600z] on the 20th, a ship report (name unknown) indicated the existence of a circulation. A Navy reconnaissance plane that afternoon found a tropical cyclone at 13.2N, 44.5W, in a very early stage of development with minimum pressure of 1006 mb (29.71 in.) and a few squalls up to 35 mph."

   b. Reanalysis: The disturbance continued generally west-northwest and was later located by reconnaissance aircraft on August 20. The aircraft made a penetration fix at 1835Z with a central pressure of 1003 mb. A pressure of 1003 mb suggests maximum winds of 40 kt from the south of 25N Brown et al. pressure-wind relationship. Based on this, it is estimated that Cleo became a tropical storm by 18Z on the 20th; however, genesis as a tropical cyclone is unknown and likely occurred at least 12 hours earlier. The 40 kt intensity chosen for the start of Cleo is a 10 kt increase from the original HURDAT. (Genesis was considered to be moved up to 06Z based on the ship with SW 20 kt and 1010 mb. However, the ship's latitude (and possibly longitude) is not reasonable. The aircraft reconnaissance's latitude near 18Z was 13.0N and a day later (21st 18Z) was near 14.7N. The ship early on the 20th suggests a center of 14.5-15.0N, which would be about two degrees too far north. Thus because of this big discrepancy on the location of the ship, Cleo's best track is started at the time of arrival of the aircraft reconnaissance.

August 21:

1. Maps and old HURDAT:
   - HURDAT lists a 65 kt hurricane at 14.1N 51.3W at 12Z.
   - HWM analyzes a tropical storm of at most 1010 mb at 14.0N 51.5W at 12Z.
   - Microfilm analyzes an area of low pressure centered near 13.2N 51.0W at 12Z.
2. Ship highlights:
   - 35 kt ENE and 1012 mb at 16.2N 52.8W at 18Z (COADS).
3. Aircraft highlights:
   - Penetration center fix with estimated surface winds of 60 kt, an eye diameter of 23 nmi, and a measured pressure of 1000 mb at 14.1N 51.4W at 13Z (ATSR/SW).
   - Penetration center fix with estimated surface winds of 80 kt, an eye diameter of 18 nmi, and a measured pressure of 993 mb at 14.7N 53.9W at 1918Z (ATSR/SW).
4. Discussion:

a. MWR: “The next day, the central pressure had deepened to 993 mb (29.32 in) and winds had reached hurricane force. The hurricane steadily intensified during the next several days as it moved west-northwestward at 20 to 25 mph, an unusually rapid motion for low latitudes.”

b. Reanalysis: Embarking on a swift west-northwest track owing to deep easterly flow, Cleo quickly strengthened. Reconnaissance on August 21 found central pressures of 1000 and 993 mb at 13Z and 1918Z, respectively. These pressures suggest maximum winds of 42 kt and 60 kt south of 25N from the south of 25N Brown et al. pressure-wind relationship. Owing to the fast forward speed of Cleo, the 12Z and 18Z intensities are estimated to have been slightly higher than the suggested values at 55 and 65 kt respectively. The 1000 mb pressure was moved to the 12Z slot in HURDAT after erroneously being placed in the 06Z slot. Based on their observations, it is estimated that Cleo attained hurricane-status around 18Z with 65 kt winds, six hours later than originally shown in HURDAT. Only minor adjustments to Cleo’s intensity were made on this day.

August 22:

1. Maps and old HURDAT:
   - HURDAT lists a 110 kt hurricane with a 970 mb pressure at 15.7N 59.7W at 12Z.
   - HWM analyzes a hurricane of at most 1005 mb at 16.0N 59.7W at 12Z.
   - Microfilm analyzes a hurricane centered near 15.6N 59.7W at 12Z.
2. Ship highlights:
   - 35 kt E and 1009 mb at 15.7N 55.9W at 00Z (COADS).
   - 35 kt SSE and 1008 mb at 15.2N 56.5W at 06Z (COADS).
   - 35 kt E and 1014 mb at 19.1N 60.7W at 15Z (COADS).
3. Land highlights:
   - 38 kt (gusts to 70 kt, max winds) at Raizet Airport, Guadeloupe (time unknown, likely around 18Z when Cleo moved over Guadeloupe; MWR).
4. Aircraft highlights:
   - Penetration center fix with estimated surface winds of 65 kt and an eye diameter of 16 nmi at 14.9N 56.5W at 0059Z (ATSR/SW).
   - Radar center fix with 11,000 ft winds of 65 kt and an eye diameter of 16 nmi at 15.4N 57.9W at 0645Z (ATSR/SW).
   - Penetration center fix with flight level winds of 98 kt and an eye diameter of 7 nmi at 15.8N 60.8W at 1257Z (ATSR/SW).
   - Penetration center fix with flight level winds of 103 kt, an eye diameter of 6 nmi, and an observed surface pressure of 960 mb at 16.0N 62.1W at 19Z (ATSR/SW).
   - Penetration center fix with estimated surface winds of 104 kt and an observed surface pressure of 965 mb at 16.0N 62.3W at 1949Z (SW).
5. Discussion:
   a. MWR: “Hurricane Cleo reached Guadeloupe early in the afternoon of August 22. The center crossed the island of Marie Galante at

1137 EST [1637z] and the southern tip of Basseterre at 1240 EST [1740z]. At Raizet Airport, about 15 mi north of the eye, minimum pressure of 1003 mb (29.62 in) and the highest wind 44 mph, with gusts to 81. In the French West Indies, Cleo caused 14 deaths and 40 injuries; destruction of the banana crop and 1,000 homes; and extensive damage to roofs, roads, and communication lines."

b. Reanalysis: Rapid intensification ensued on August 22 with the formation of a 16 nmi diameter eye by 07Z, which later contracted to a miniscule 7 nmi by 13Z according to aircraft reconnaissance radar. The 970 mb pressure listed at 12Z in HURDAT suggests maximum winds of 91 kt from the intensifying subset of the south of 25N Brown et al. pressure-wind relationship. The intensity is adjusted to 100 kt from 110 kt based on the storm's fast motion and small size. A smoother intensification process is implemented into the early half of August 22, resulting in a major change at 06Z from 100 kt originally in HURDAT to 85 kt. The center of Cleo roared into Guadeloupe late on the 22nd, passing directly over the nearby Marie Galante around 17Z before making landfall on the island proper at 18Z. Measurements from recon at this time indicated pressures between 960 and 965 mb, in agreement with the 962 mb already in HURDAT. A central pressure of 962 mb suggests an intensity of 99 kt from the south of 25N Brown et al. pressure-wind relationship. (The intensifying subset for this central pressure south of 25N is 100 kt.) Taking into account Cleo's forward speed of roughly 18 kt and its tiny size, having an RMW of ~5 nmi, an intensity of 110 kt is chosen for both landfalls and the 18Z position (down from 115 kt originally). Category 3 conditions are likely to have occurred on Guadeloupe proper, where tremendous damage was incurred. The small size of Cleo is dramatically reflected by observations on the island with Raizet Airport, only 15 mi north of Cleo's eye, reporting peak gusts of only 38 kt according to the Monthly Weather Review.

August 23:

1. Maps and old HURDAT:
   - HURDAT lists a 130 kt hurricane at 16.5N 66.6W at 12Z.
   - HWM analyzes a hurricane of at most 1008 mb at 16.9N 66.2W at 12Z.
   - Microfilm analyzes a hurricane near 16.5N 66.5W at 12Z.
2. Ship highlights:
   - 45 kt E and 1011 mb at 17.3N 62.8W at 00Z (COADS).
   - 35 kt SE and 1011 mb at 16.6N 66.3W at 18Z (COADS).
3. Aircraft highlights:
   - Radar center fix with flight level winds of 115 kt and an eye diameter of 8 nmi at 16.2N 63.9W at 0115Z (ATSR/SW).
   - Radar center fix with an eye diameter of 6 nmi at 16.3N 65.1W at 0554Z (ATSR/SW).

- Penetration center fix estimated surface winds of 120 kt, an eye diameter of 10 nmi, and measured surface pressure of 938 mb at 16.1N 66.7W at 1141Z (ATSR/SW).
- Penetration center fix with flight-level winds of 128 kt, an eye diameter of 8 nmi, and extrapolated surface pressure of 950 mb at 16.8N 68.0W at 1735Z (today's formulas give 945 mb pressure) (SW).
- Peak 700 mb flight level winds of 135 kt and radius of maximum wind of 7.5 nmi at 19Z (Shea and Gray/MWR).
- Penetration center fix with flight-level winds of 139 kt and an eye diameter of 10 nmi at 16.8N 68.8W at 2050Z (ATSR/SW).

4. Discussion:
   a. MWR: "The hurricane center passed about 90 mi south of St. Croix, V.I. at midnight August 23, and 83 mi south of Cabo Rojo on the southwestern tip of Puerto Rico at 1300 EST [1800z] the same day. Highest observed winds were 50 mph at Ham Bluff, St. Croix, and 52 mph at Point Tuna, Puerto Rico, although Cleo had intensified with central pressure of 950 mb (28.05 in), and winds had increased to 140 mph. The hurricane remained small and concentrated and destructive winds were confined to a small area near the eye. At flight level the Weather Bureau research aircraft measured 135 kt (152 mph) winds. A Navy hurricane hunter plane was badly damaged on this date and seven crewmen injured. It was estimated that as the plane left the eye and entered the wall cloud, the recorded wind increase by 90 mph within a distance of 1 mi."
   b. Flight accident summary: "Upon initial penetration of a storm eye (Hurricane Cleo), the port wing tip fuel tank and portion of wing were torn away by extreme updraft turbulence. While trying to exit the storm, the starboard tip tank and larger portion of wing were torn away by extreme down draft turbulence. An emergency landing was made at NAS Roosevelt Roads, PR. The aircraft was damaged beyond repair."

   c. Reanalysis: Intensification continued once over the Caribbean Sea, with the system becoming extremely intense. A Weather Bureau research aircraft into the system during the afternoon of August 23 recorded flight level winds of 135 kt (139 kt also reported) while another aircraft measured a central pressure of 938 mb at 1141Z. The aircraft estimates showed that winds near the core increased by approximately 80 kt over a single mile. This dramatic uptick in winds created dangerous turbulence ultimately damaging the aircraft, injuring the crew, and prompting an emergency landing in Puerto Rico. Following this, all recon was barred from flying into Cleo's center during its trek through the Caribbean and no direct observations of its intensity were collected. The aforementioned 938 mb reading does allow for a gauge of Cleo's strength prior to the data gap. This pressure suggests winds of 123 kt from the south of 25N Brown et al. pressure-wind relationship as well as 125 kt from the intensification subset. Although Cleo remained exceptionally small, with an RMW averaging 5-10 nmi, its forward speed

lessened. Based on these factors, the 130 kt intensity at previously in HURDAT at 12Z is retained. This is the peak intensity of Cleo. One final central pressure value of 945 mb (corrected from 950 mb originally) was obtained at 1735Z, which suggests 116 kt from the pressure-wind relationship. As it still had a tiny RMW, an intensity of 125 kt analyzed at 18Z, down some from the 135 kt originally.

August 24:

1. Maps and old HURDAT:
   - HURDAT lists a 135 kt hurricane at 17.1N 71.8W at 12Z.
   - HWM analyzes a hurricane of at most 1005 mb at 17.2 N 71.9W at 12Z.
   - Microfilm analyzes a hurricane near 17.1N 72.0W at 12Z.
2. Ship highlights:
   - 20 kt NE and 1003 mb at 17.1N 77.0W at 12Z (COADS).
   - 40 kt NE and 1012 mb at 19.0N 74.6W at 12Z (COADS).
3. Land highlights:
   - 950 mb (lowest pressure) at Camp Perrin, Haiti at 1935Z (MWR).
   - 964 mb (lowest pressure) at Les Cayes, Haiti around 21Z (MWR).
4. Aircraft highlights:
   - Radar center fix with an eye diameter of 6 nmi at 16.8N 69.8W at 01Z (ATSR/SW).
   - Radar center fix with an eye diameter of 10 nmi at 16.9N 70.9W at 07Z (ATSR/SW).
   - Radar center fix with an elliptical eye of 12 nmi N-S and 10 nmi E-W at 17.2N 72.1W (ATSR/SW).
   - Radar center fix at 18.0N 73.3W at 19Z (ATSR/SW).
5. Discussion:
   a. MWR: "No penetration was made of this dangerous hurricane on the 24th and its maximum intensity on this date is unknown. Cleo passed south of the Dominican Republic early on the 24th with its closest approach about 30 mi south of Isla Beata, just off the Barahona Peninsula at 0600 EST [1100z]. Seven lives were reported lost in the Dominican Republic. As Hurricane Cleo passed south of Haiti on August 24 it veered northward momentarily, enough to move onto the southwestern peninsula. The hurricane entered land just east of the city of Les Cayes, still a very small intense hurricane. It came and went within 90 to 115 min. Aerial surveys indicated that severe damage extended only 3.7 mi west of the center and 13.7 mi east of the center. At Les Cayes, several miles west of the center, there was no calm and the lowest pressure was 964 mb. From 1500 to 1535 LST [1900 to 1935z] the pressure fell 34 mb and by 1600 LST [2000z] had risen 37 mb. The lowest barometer reading at Camp Perrin, which is about 12.5 mi inland along the center track was 950 mb."

   "Within a short time the hurricane reached the slopes of the Massif de la Hotte. During the next few hours the movement of Cleo was obscure. Mr. Michel A. Frère, WMO representative in Haiti, believes it continues northwestward and reached the north coast of the peninsula near Roseaux (18.6N 74.0W). Evidence from

reconnaissance aircraft would indicate the greatly diffused center turned westward along the southern slopes of the mountain range and eventually passed out into the Caribbean over the western tip of the peninsula. Damage in Haiti was considerable and 192 persons were killed."
"The reason for the sharp turn of Cleo toward the southwestern peninsula of Haiti cannot be explained on the basis of available data. A short-wave trough had already passed eastward to the north of the hurricane and it was under rising heights. It may be that previous reconnaissance fixes were in error and that the correct track during the previous 12 to 18 hr was farther north than reported. However, the south shore of Hispaniola should have been on the radar scope of the plane and the reason for error, if any, is not obvious."

b. Reanalysis: Due to the aforementioned lack of direct measurements on the 24th, no clear estimate can be made of Cleo intensity. That evening, the hurricane acquired a more northerly component to its track and aimed itself at the Tiburon Peninsula of Haiti. Radar fixes from aircraft observing the system from a distance indicate that the system struck the peninsula several miles east of Les Cayes around 2030Z. The 130 kt intensity in HURDAT at 18Z is used as Cleo's landfall intensity in light of no supplemental data, which matches the 130 kt peak intensity indicated on the 23rd. The landfall position is estimated to have been farther north than depicted in HURDAT based on observations from Les Cayes and Camp Perrin, the latter of which reported 950 mb and may have been in the eye. (The 950 mb pressure about an hour after landfall about 10 nmi inland supports at least 111 kt from the south of 25N pressure-wind relationship. This is consistent with 130 kt at landfall.) A statement by the WMO representative in Haiti further supports the northward shift; he reported the center to have emerged off the northern coast of the Tiburon Peninsula near the town of Roseaux (18.6N 74.0W). An aircraft radar fix at 2325Z placed the center just west of the Peninsula. A blend of these data, with emphasis on recon, places the center just onshore at 00Z on August 25th.

August 25:

1. Maps and old HURDAT:
   - HURDAT lists a 100 kt hurricane at 19.4N 76.6W at 12Z.
   - HWM analyzes a hurricane of at most 1008 mb 19.5N 76.5W at 12Z.
   - Microfilm analyzes a hurricane near 19.5N 77.0W at 12Z.
2. Ship highlights:
   - 10 kt NE and 1004 mb at 20.5N 82.7W at 12Z (COADS).
   - 35 kt SE and 1011 mb at 18.3N 75.1W at 12Z (COADS).
   - 10 kt NE and 1005 mb at 21.4N 84.2W at 18Z (COADS).
3. Land highlights:
   - 40 kt SE and 1010 mb at Guantanamo, Cuba at 18Z (micro).

4. Aircraft highlights:
   - Radar center fix at 18.5N 74.7W at 01Z (SW).
   - Radar center fix with a partially closed eye of 12 nmi at 19.0N 75.7W at 07Z (SW).
   - Radar center fix with an eye diameter of 15 nmi at 19.2N 76.1W at 1045Z (SW).
   - Radar center fix with an elliptical, but well-defined eye of unknown diameter at 20.4N 77.6W at 1830Z (SW).
5. Discussion:
   a. MWR: "Cleo never regained its former intensity. However, as a minimal hurricane, it passed over a narrow peninsula of Cuba, east of Cabo Cruz (18.8N 77.7W), and thence moved into the Gulfo de Guacanayabo. The center remained a short distance off the southern coast of Cuba until it again re-entered the coast near longitude 79W."

   b. Reanalysis: The Kaplan and DeMaria inland decay model was run for one period starting at 20Z with 130 kt, yielding 95 kt for 00Z on August 25. The rapid weakening from 130 kt appears reasonable based on the locally high terrain of the western Tiburon Peninsula, with peaks over 2,000 m, and the tiny RMW of the hurricane. The 95 kt intensity is used for the 00Z position, a major change from the 130 kt in HURDAT. Wind speeds for the 06 and 12Z positions are adjusted downward accordingly to 85 kt and 75 kt, respectively. These are also major changes from 120 kt and 100 kt originally in HURDAT. After clearing Haiti, Cleo apparently failed to re-intensify before striking southern Cuba as a minimal hurricane late on August 25, though observations are sparse near the landfall location. A brief landfall took place over Granma Province at 17Z, with an estimated intensity of 70 kt, with Cleo emerging back over the Caribbean within two hours. An analysis of Cuban hurricanes by Perez at al. lists Cleo as a Category 1 impact for the provinces of Sancti Spiritus, Ciego de Avila, Camaguey, Las Tunas, and Granma. In light of no direct observations, this is used as the basis for maintaining Cleo as a Category 1 hurricane over the Caribbean near Cuba. This is a major reduction from HURDAT which had indicated an intensity of 100 kt in the last synoptic time (12Z) before the first Cuban landfall.

August 26:

1. Maps and old HURDAT:
   - HURDAT lists a 65 kt hurricane at 22.4N 79.2W at 12Z.
   - HWM analyzes a hurricane of at most 1008 mb at 22.0N 79.3W at 12Z.
   - Microfilm analyzes a hurricane of 1002 mb at most near 22.3N 79.2W at 12Z.
2. Land highlights:
   - 40 kt ESE and 1013 mb at Guantanamo, Cuba at 00Z (micro).
3. Aircraft highlights:
   - Radar center fix at 21.4N 79.0W at 0602Z (SW).

- Radar center fix at 22.3N 79.2W at 1300Z (SW).
- Penetration center fix at 23.8N 79.6W with 75 kt maximum surface winds, 990 mb central pressure, and 15 nmi eye diameter (SW).

4. Discussion:
   a. MWR: "Cleo probably was of slightly less than hurricane intensity during the journey across Cuba until emerging from the northern coast east of Caibarien (22.5N 79.5W) around 0700 EST [1200z] on the 26th. Winds in Júcaro, Majagua, Tamarindo, and Florencia were estimated about 60 to 70 mph, and in Jatibonico 70 to 75 mph. Damage in Cuba was not serious with apparently only one casualty."
   "Shortly after emerging from the northern coast of Cuba, Cleo regained hurricane intensity and then moved on a mildly zigzag course north-northwestward to northward toward the lowest east coast of Florida. Beginning at 1030 EST [1530z], August 26, Hurricane Cleo was under constant radar surveillance by Miami and Key West radars and later by the Tampa and Daytona Beach radars."

   b. Reanalysis: Cleo acquired a more northerly track, taking the center into central Cuba. A second landfall in the country occurred around 07Z with an intensity of 70 kt. The Kaplan and DeMaria model was run for one period starting at that time with 70 kt, yielding 55 kt for 12Z. Since the storm was just moving offshore at 12Z, the intensity for that position is estimated slightly above the model's output at 60 kt, a minor decrease from the 65 kt in HURDAT. Cleo began intensifying immediately after moving back over the ocean, as observed by research aircraft flying into the system. Still a very small hurricane, with an RMW of approximately 10 nmi, Cleo rapidly intensified during the overnight of August 26-27 as it moved over the Gulf Stream. Maximum wind speeds during this initial part of this strengthening period are adjusted downward to 70 kt at 18Z based on the 990 mb central pressure measured at 1845Z, which yields 64 kt from the Brown et al. pressure-wind relationship. The intensity is estimated to be higher than suggested due to the hurricane's very small size.

August 27:

1. Maps and old HURDAT:
   - HURDAT lists an 85 kt hurricane with a 971 mb pressure at 26.3N 80.2W at 12Z.
   - HWM analyzes a hurricane of at most 1002 mb at 26.2N 80.2W at 12Z.
   - Microfilm analyzes a hurricane of 1000 mb at most at 27.2N 81.0W at 18Z (12Z microfilm unavailable due to disruptions from the hurricane itself).
2. Ship highlights:
   - 35 kt WSW and 1003 mb at 24.6N 79.8W at 00Z (COADS).
   - 25 kt ESE and 1004 mb at 25.8N 76.8W at 00Z (COADS).
   - 40 kt SE and 1005 mb at 26.0N 79.3W at 12Z (COADS).

- 35 kt SE and 1008 mb at 27.6N 79.1W at 18Z (COADS).

3. Land highlights:
   - 95 kt N and 973 mb (estimated max, est. gust to 115 kt) at NHC office in Miami, Florida at 0730Z (MWR).
   - Gust of 110 kt at Miami Beach, Florida at 0714Z (SWO).
   - 60 kt N and 971 mb (gusts to 87 kt, max winds of 64 kt at 0745Z) at Miami International Airport 0809Z (SWO).
   - Eye passage with "absolute calm" from 0745-0815Z in Biscayne Park, Miami (SW).
   - 966 mb from 0810-0925 in North Miami, Florida (MWR/SW).
   - 75 kt ESE (max winds, gusts to 90 kt both at 1340Z) and 984 mb at West Palm Beach, Florida at 1358Z (MWR/SWO).
   - 44 kt E (max winds) at Melbourne, Florida at 2235Z (SWO).
4. Aircraft highlights:
   - Penetration center fix at 24.8N 79.6W with 984 mb central pressure with 73 kt (may be surface or flight-level) with Poorly defined eye 9 nm at 01Z (MWR, SW, but not in Shea and Gray).
   - Radar center fix at 25.8N 79.9W at 0642Z (SW).
   - Radar center fix at 27.6N 80.5W at 21Z (SW).
5. Discussion:
   a. MWR: "Throughout the afternoon and evening [26th local time], instrumented Research Flight Facility aircraft repeatedly crisscrossed through the storm, including the center, and at flight level found no winds of hurricane force in the western semicircle, and the central pressure stable at around 984 mb…At 0200 EST [0700z], the edge of the eye moved onto Key Biscayne. Cleo was the first hurricane to strike the greater Miami area with full force since October 17, 1950; and, indeed, the tracks from Cuba to the greater Miami area of the two hurricanes were very similar. The lowest barometer reading in Florida was 967.5 mb (28.57 in) in North Miami. It is estimated that maximum sustained winds were in the 100 to 110 mph range with gusts to 135 mph. It is certain that Cleo intensified very rapidly in the 3 hr between the time when the aircraft left the storm and when the eye reached Key Biscayne and several hours later passed through North Miami. In the western semicircle, winds increase from less than hurricane force to 100 mph or more and the central pressure fell about 16 mb (0.5 in). This may be explained by (a) the fact that the temperature of the shallow water between the western edge of the Gulf Stream and the coast is even higher than that of the warm Gulf Stream, 86 to 90F vs. 83F, and (b) as the portion of the hurricane circulation over land increased, the inflow toward the center also became greater with resultant increase lift and latent heat from condensation." "As the hurricane moved along the lower east coast of Florida, the eye continually expanded and contracted from a minimum diameter of 8 mi to a maximum of 16 mi. The eye consistently moved north-northwestward for a number of hours and then

northward for a number of hours. The longest central calm at any reporting point was 1 hr 25 min."

b. Preliminary Report: "At the National Hurricane Center, 3240 NW 27th Avenue, wind instruments were destroyed when peak gusts reached 110 mph. Winds increased for some 20 minutes thereafter and maximum winds were estimated as sustained 110 mph, gusts 135 mph. Lowest pressure was 973 mb or 28.74 inches at 0306E [0806z]. The Weather Bureau airport station reported peak gusts of 100 mph, and lowest pressure of 972 mb or 28.71 inches at 0308E [0808z]. Key Biscayne reported lowest pressure 28.72 inches between 0200 and 0230E [0700 and 0730z]. The wind reached the top of the scale which is 100 mph. Maximum duration of the eye was one hour 20 to 30 minutes and maximum duration of hurricane winds was estimated at two and one half hours."
"It is evident that fairly rapid intensification began as the center left the edge of the Gulf Stream after 11 p.m. [0400z] and moved over the extremely warm waters between the Gulf Stream and the mainland, and intensification continued as it moved over land and continued until it passed west of North Miami. In that area the lowest barometer 964 mb or 28.47 inches was reported. This aneroid will be calibrated within the next few days however numerous reports of readings as low as 967 mb or 28.56 inches were made in this area."

c. Supplemental landfall info: Jarrell et al.: Category 2 landfall, 968 mb; Ho et al.: 968 mb central pressure at landfall, 25.7N 80.2W landfall point, 7 nmi RMW, 9 kt speed.

d. Reanalysis: A 984 mb central pressure at 01Z suggests 72 kt intensity from the south of 25N and 68 kt from the north of 25N Brown et al. pressure-wind relationships. An intensity of 80 kt is analyzed (down from 90 kt originally) due to the small eye size reported (9 nmi diameter). Rapid intensification ensued as Cleo approached the Miami metropolitan area and the storm eventually made landfall around 08Z on August 27 in North Miami. A pressure of 968 mb was observed, and later verified, in North Miami at the time of landfall. While there was an unverified observation of 963 mb near Sunrise, this measurement was not considered accurate compared with other observations that were verified closer to the coast line. It is possible that some slight deepening occurred after landfall, but such an effect is likely to be only a millibar or two. A 968 mb pressure suggests maximum winds of 93 kt from the south of 25N intensifying subset and 91 kt from the north of 25N intensifying subset of the Brown et al. pressure-wind relationship. Accounting for the storm's very small size with an RMW of ~10 nmi, average environmental pressures, and slightly slow movement, a landfall intensity of 95 kt is chosen. This makes Cleo a Category 2 impact, same as that previously listed in HURDAT.

Continuing north-northwest, just inland along Florida's east coast, Cleo steadily weakened due to land interaction. The Kaplan and DeMaria model was run for 12Z and 18Z on August 27

and 00Z, 06Z, and 12Z on August 28. This yielded intensities of 69 kt, 52 kt, 44 kt, 39 kt, and 49 kt respectively. Maximum observed winds for these periods were 60 kt, 35 kt, 44 kt, 40 kt, and 50 kt, respectively. Wind speeds for the inland positions are adjusted to 80 kt, 55 kt, 45 kt, 45 kt, and 55 kt for the corresponding time slots. Adjustments at 18Z on August 27 and 00Z and 06Z on August 28 are major changes from HURDAT, which originally showed much slower weakening over land. Cleo moved back over the Atlantic shortly after 12Z, as determined by reconnaissance fixes, on August 28, resulting in slight re-intensification. Ship observations support this notion, with an observation of 50 kt at 12Z. Straddling the coast of northeast Florida and Georgia, Cleo gradually decelerated and weakened slowly. The center became increasingly broad and ill-defined due to prolonged interaction with land.

August 28:

1. Maps and old HURDAT:
   - HURDAT lists a 55 kt tropical storm at 29.5N 81.2W at 12Z.
   - HWM analyzes a hurricane of at most 1005 mb at 29.5N 81.0W at 12Z.
   - Microfilm analyzes a tropical storm with winds of 50 kt and a central pressure of 990 mb at 29.5N 81.0W at 12Z.
2. Ship highlights:
   - 35 kt S and 1007 mb at 26.6N 79.2W at 00Z (COADS).
   - 50 kt SE and 1009 mb at 29.2N 79.1W at 12Z (micro).
   - 35 kt SE and 1011 mb at 28.4N 78.7W at 12Z (COADS).
   - 35 kt SE and 1015 mb at 30.0N 77.8W at 18Z (COADS).
3. Land highlights:
   - 997 mb (lowest pressure) at Patrick Air Force Base, Florida at 0259Z (SWO).
   - 40 kt SSE (max winds) at Patrick Air Force Base, Florida at 0356Z (SWO).
   - 995 mb (lowest pressure) at NAS Sanford, Florida at 0758Z (SWO).
   - 35 kt (max winds, 0859Z) 996 mb (lowest pressure) at Daytona Beach, Florida between 09 and 10Z (SWO).
   - Multiple observations of near-1000mb pressures along the northeast coast of Florida (SWO).
4. Aircraft highlights:
   - Penetration center fix at 28.2N 80.7W at 0011Z (SW).
   - Radar center fix at 29.3N 81.3W at 1203Z (SW).
   - Radar center fix with 5,000 ft winds of 80 kt at 30.3N 81.7W at 1815Z (SW).
5. Discussion:
   a. MWR: "After leaving Florida between St. Augustine and Jacksonville, the center remained at sea a short time and then re-entered the coastline near Savannah without much increase in intensity. Cleo continued as a weakening tropical cyclone

through the interior of the Carolinas, passing out to sea again near Norfolk, Va., where it gave record-breaking precipitation."

b. Reanalysis: (See combined commentary for 27th and 28th above.)

August 29:

1. Maps and old HURDAT:
   - HURDAT lists a 35 kt tropical storm at 32.0N 81.4W at 12Z.
   - HWM analyzes a hurricane at 32.0N 81.5W at 12Z.
   - Microfilm analyzes a tropical storm with winds of 35 kt and a central pressure of 1002 mb at 32.0N 81.4W at 12Z.
2. Ship highlights:
   - 40 kt SE and 1011 mb at 30.7N 78.8W at 06Z (COADS).
   - 40 kt SE and 1011 mb at 31.4N 77.6W at 06Z (COADS).
3. Land highlights:
   - 1000 mb (lowest pressure) at Brunswick, Georgia between 04 and 06Z (SWO).
   - 49 kt E (fastest mile) at Charleston, South Carolina WBO at 0609Z (MWR).
   - 1001 mb (lowest pressure) at NAS Glynco, Georgia between 08 and 10Z (SWO).
   - 1003 mb (lowest pressure) at Savannah, Georgia between 09 and 11Z (SWO).
   - 36 kt SE at Charleston, South Carolina WBAS at 1635Z (MWR).
4. Aircraft highlights:
   - Penetration center fix with a measured pressure of 999 mb at 30.9N 81.2W at 0036Z (SW).
5. Discussion:
   a. Reanalysis: Observations from NAS Glynco and Brunswick in Georgia indicated the passage of Cleo's center between 04Z and 10Z on August 29. Landfall in Georgia is estimated to have occurred around 04Z with an intensity of 50 kt and pressure of 999 mb. A pressure of 999 mb suggests maximum winds of 45 kt north of 25N from the Brown et al. pressure-wind relationship; however, observations of 49 kt at Charleston right after landfall indicate that it was slightly stronger than indicated from the pressure-wind relationship.

August 30:

1. Maps and old HURDAT:
   - HURDAT lists a 25 kt tropical depression at 34.0N 82.0W at 12Z.
   - HWM analyzes an area of low pressure of at most 1010 mb at 34.0N 82.0W at 12Z with a cold front approaching from the northwest.
   - Microfilm analyzes a tropical cyclone of 1008 mb at most at 34.0N 81.0W at 12Z.
2. Discussion:
   - Reanalysis: Although no observations of gales on land were made, ships continued to report tropical storm-force winds through 00Z on August 30. A 40 kt observation was made at that time and is the

basis for extending Cleo's duration as a tropical storm over land through 06Z, 12 hours longer than originally in HURDAT.

August 31:

1. Maps and old HURDAT:
   - HURDAT lists a 25 kt tropical depression at 36.0N 79.5W at 12Z.
   - HWM analyzes an area of low pressure of 1008 mb at most near 35.5N 79.5W at 12Z with a cold front approaching from the northwest.
   - Microfilm analyzes a tropical cyclone of 1008 mb at most at 35.8N 79.2W at 12Z.
2. Discussion:
   a. MWR: "Very heavy rainfall developed from the Hampton Roads area southward over extreme southeastern Virginia during the night of August 31-September 1 as Cleo moved offshore and a cold front approached the region. Rainfall amounts at several points exceeded all-time 24 hr records. The largest reported storm total was 14.09 in at Back Bay Wildlife Refuge. At Norfolk WBAS, 10.40 in of rain fell between 1100 EST August 31 and 1100 EST September 1 [16-16z], shattering the previous 24 hr record of 6.78 in on June 2-3, 1964. Considerable flooding occurred in the Hampton Roads area with many streets blocked and roads washed out. Hundreds of homes were flooded and several areas were evacuated."

   b. Reanalysis: Though weak, Cleo remained identifiable as it moved through Georgia and the Carolinas. Observations in North Carolina indicate that the system filled to 1007 mb by August 31. Around this time, the system turned to the east and headed toward the Atlantic.

September 1:

1. Maps and old HURDAT:
   - HURDAT lists a 40 kt tropical storm at 35.8N 75.2W at 12Z.
   - HWM analyzes an area of low pressure of 1004 mb at most near 35N 75W at 12Z with a cold front near the northwestern portion of the system.
   - Microfilm analyzes a tropical storm with winds of 35 kt and a central pressure of 1004 mb at 35.8N 75.2W at 12Z.
2. Ship highlights:
   - 20 kt N and 1001 mb at 35.1N 75.3W at 12Z (COADS).
   - 35 kt SW and 1002 mb at 34.6N 74.6W at 18Z (COADS).
3. Land highlights:
   - 1002 mb (lowest pressure) at Elizabeth City, North Carolina between 08 and 10Z (SWO).
   - 1001 mb (lowest pressure) at Cape Hatteras, North Carolina between 16 and 17Z (SWO).
   - 50 kt NNW at Cape Lookout, North Carolina (34.7N 76.5W) at 21Z (micro).
4. Aircraft highlights:

- Penetration center fix with estimated surface winds of 25 kt (FL: 41 kt), an eye diameter of 67 nmi, and a measured pressure of 1003 mb at 35.5N 73.8W at 1930Z (SW).

5. Discussion:
   a. Reanalysis: Intensification began while the system was still inland over North Carolina on September 1, with Elizabeth City reporting a minimum pressure of 1002 mb around 09Z. A 1001 mb central pressure obtained from that observation yields an intensity of 42 kt north of 25N from the Brown et al. pressure-wind relationship; however, the 06Z wind speed is adjusted downward to 35 kt based on slightly lower than normal environmental pressures. Cleo turned to the east-southeast and emerged over the Atlantic before 12Z. Intensification continued throughout the day and into September 2 with ships reporting steadily decreasing pressures.

September 2:

1. Maps and old HURDAT:
   - HURDAT lists a 65 kt hurricane at 35.4N 71.1W at 12Z.
   - HWM analyzes an area of low pressure of 996 mb at most near 35N 70W at 12Z with a stationary front extending along the northwestern periphery.
   - Microfilm analyzes a hurricane with winds of 80 kt and a central pressure of 980 mb at 35.5N 70.8W at 12Z with a frontal boundary northeast of the center.
2. Ship highlights:
   - 40 kt NE and 1002 mb at 35.6N 74.0W at 00Z (COADS).
   - 20 kt S and 999 mb at 35.1N 72.9W at 00Z (COADS).
   - 35 kt SSW and 1003 mb at 33.9N 71.1W at 06Z (COADS).
   - 40 kt E and 1000 mb at 36.4N 70.9W at 09Z (COADS).
   - 35 kt SSE and 1001 mb at 36.1N 69.9W at 12Z (COADS).
   - 35 kt E and 998 mb at 36.5N 69.1W at 18Z (COADS).
   - 40 kt NE and 1009 mb at 37.5N 71.0W at 18Z (COADS).
3. Aircraft highlights:
   - Penetration center fix with estimated surface winds of 80 kt, an eye diameter of 25 nmi, and a measured pressure of 980 mb at 35.5N 70.9W at 13Z (SW).
   - Penetration center fix with estimated surface winds of 85 kt and an eye diameter of 20 nmi at 35.8N 69.5W at 1845Z (SW).
4. Discussion:
   a. Reanalysis: Recon began investigating Cleo once more starting late on September 1, though an accurate central pressure was not obtained until a fix at 13Z on September 2 with 980 mb. A pressure of 980 mb suggests maximum winds of 73 kt from the north of 25N Brown et al. pressure-wind relationship. This is used as the basis for increasing the 06Z and 12Z intensities to 65 kt and 75 kt respectively, slightly above the original HURDAT. This strengthening phase leveled out shortly thereafter for about 24 hours.

September 3:

1. Maps and old HURDAT:
   - HURDAT lists a 70 kt hurricane at 37.1N 63.5W at 12Z.
   - HWM analyzes a hurricane of 996 mb at most near 37N 63W at 12Z.
   - Microfilm analyzes a hurricane with winds of 110 kt and a central pressure of 988 mb at 37.2N 63.1W at 12Z.
2. Ship highlights:
   - 35 kt NE and 1005 mb at 36.8N 68.9W at 00Z (COADS).
   - 25 kt SSW and 994 mb at 34.6N 66.0W at 06Z (micro).
   - 40 kt NE and 1010 mb at 38.3N 67.8W at 06Z (COADS).
   - 35 kt S and 1026 mb at 35.9N 53.0W at 12Z (COADS).
   - 30 kt S and 1001 mb at 37.0W 58.5W at 18Z (COADS).
3. Aircraft highlights:
   - Penetration center fix with flight level winds of 80 kt, an eye diameter of 100 nmi (possibly an error), and a measured pressure of 986 mb at 36.0N 67.4W at 01Z (SW).
   - Penetration center fix with flight level winds of 87 kt, an eye diameter of 110 nmi (possibly an error), and a measured pressure of 980 mb at 36.6N 65.4W at 0631Z (SW).
   - Penetration center fix with estimated surface winds of 110 kt, an eye diameter of 15 nmi, and a measured pressure of 980 mb at 37.2N 63.2W at 13Z (SW).
   - Penetration center fix with estimated surface winds of 150 kt, an elliptical eye of 20-28 nmi in diameter, and a measured pressure of 975 mb (982 mb reported at time, value of 975 obtained from modern extrapolation formula) at 38.0N 60.6W at 19Z (SW).
4. Discussion/Reanalysis:

- Late on September 3, Cleo began accelerating in earnest and resumed intensification. A 19Z recon fix found a 20-28 nmi elliptical eye, yielding an RMW of approximately 20 nmi, and a central pressure of 975 mb. A pressure of 975 mb suggests maximum winds of 78 kt from the north of 35N Landsea et al. pressure-wind relationship. For a system around 38N with the aforementioned pressure, the climatological RMW is 31 nmi, indicating Cleo was smaller than average. Based on the small size of Cleo and its fast forward speed, reaching 40 kt by 06Z, an intensity of 85 kt is estimated for 18Z, a major increase from 70 kt originally in HURDAT.

September 4:

1. Maps and old HURDAT:
   - HURDAT lists a 75 kt hurricane at 44.7N 50.5W at 12Z.
   - HWM analyzes an extratropical cyclone of 980 mb at most near 44N 51W at 12Z.
   - Microfilm analyzes a tropical cyclone with a “probable” central pressure of 970 mb at 44.7N 50.5W at 12Z.
2. Ship highlights:
   - Numerous reports of gales and pressures below 1000 mb.
   - 60 kt SE and 977 mb at 45.5N 48.8W at 14Z (COADS).
   - 70 kt S and 976 mb at 45.7N 49.2W at 18Z (COADS).

- 80 kt W and 979 mb at 45.5N 50.0W at 18Z (COADS).
- 45 kt NE and 978 mb at 47.6N 51.1W at 18Z (COADS).
- 70 kt SSW and 992 mb at 47.2N 46.8W at 23Z (COADS).

3. Land highlights:
   - 20 kt NW and 990 mb at St. John's Newfoundland at 18Z (micro).
   - 15 kt N and 998 mb at Gander, Newfoundland (micro).
   - 20 kt NW and 1005 mb at Corner Brook, Newfoundland at 18Z (micro).
   - 25 kt N and 1005 mb at St. Anthony, Newfoundland at 18Z (micro).
4. Aircraft highlights:
   - Radar center fix at 38.5N 56.5W at 0025Z (SW).
   - Radar center fix at 39.0N 56.0W at 0100Z (SW).
5. Discussion:
   a. Reanalysis: Additional intensification is believed to have taken place early on September 4 owing to baroclinic forces as Cleo began transitioning to an extratropical cyclone. It is estimated that the system reached a fourth and final peak of 85 kt at 00Z and 06Z, both minor changes from 75 kt originally in HURDAT. The additional intensification following the departure of recon is based on continued acceleration of Cleo, up to 40 kt as mentioned previously, and observations from ships in the vicinity of the hurricane later that day which indicated decreasing pressures. Real-time analysis as depicted on microfilm shows an analyzed central pressure of 970 mb at 12Z, consistent with ship reports late on the 4th. A pressure of 970 mb suggests maximum winds of 82 kt from the north of 35N Landsea et al. pressure-wind relationship. Transition into a powerful extratropical cyclone, something previously absent in HURDAT, is believed to have occurred by 12Z as cool air wrapped into the circulation and defined frontal features became apparent. Though now assessed as extratropical for at 12Z, the baseline of 82 kt is used to estimate 85 kt for the two preceding synoptic times, considering that the system was undergoing extratropical transition early on this date. Several ships encountered the system during its transition, with some reporting hurricane-force winds. One vessel observed 80 kt W winds and 979 mb at 18Z on September 4 while another observed 70 kt SSW winds and a 975 mb at 23Z.

September 5:

1. Maps and old HURDAT:
   - HURDAT lists a 60 kt hurricane at 53.5N 48.0W at 12Z.
   - HWM analyzes an extratropical cyclone of 980 mb at most near 53.5N 47W at 12Z.
   - Microfilm analyzes a tropical cyclone of 988 mb at most near 53.5W 48.0W at 12Z.
2. Ship highlights:
   - Numerous reports of gales and pressures below 1000 mb.
   - 40 kt E and 978 mb at 50.0N 49.0W at 00Z (COADS).

- 55 kt SSW and 995 mb at 48.0N 46.2W at 06Z (COADS).
- 45 kt SE and 989 mb at 53.5N 44.1W at 12Z (micro).
- 35 kt NNE and 987 mb at 52.3N 50.8W at 12Z (COADS).
- 35 kt NW and 997 mb 53.8N 54.0W at 18Z (COADS).
- 25 kt SE and 981 mb at 54.8N 43.7W at 18Z (COADS).

3. Land highlights:
   - 30 kt WNW and 994 mb at St. John's Newfoundland at 00Z (micro).
   - 15 kt NNW and 994 mb at Gander, Newfoundland at 00Z (micro).
4. Discussion:
   a. Reanalysis: A northward turn took place shortly after the system became extratropical and gradual weakening ensued thereafter. Ship observations indicate that Cleo's winds subsided below hurricane-force by 12Z on September 5. The original HURDAT terminates Cleo at that time; however, it is clear that the system remained a well-defined extratropical cyclone for at least four more days.

September 6:

1. Maps and old HURDAT:
   - HWM analyzes and occluded area of low pressure of 988 mb at most near 55N 45W at 12Z.
   - Microfilm analyzes an area of low pressure of 984 mb at most near 55N 45W.
2. Ship highlights:
   - 35 kt NW and 989 mb at 53.2N 49.6W at 00Z (COADS).
   - 45 kt SSW and 992 mb at 54.0N 37.9W at 06Z (COADS).
   - 45 kt NNE and 1003 mb at 56.5N 51.0W at 12Z (COADS).
   - 35 kt SW and 990 mb at 54.6N 42.3W at 18Z (COADS).
   - 35 kt N and 1007 mb at 53.1N 46.5W at 18Z (micro).
3. Discussion/Reanalysis:

- Based on available ship observations, it appears that Cleo slowed significantly by the end of September 6 and meandered south of Greenland for several days.

September 7:

1. Maps and old HURDAT:
   - HWM analyzes an area of low pressure of 1000 mb at most near 54N 41W at 12Z.
   - Microfilm analyzes an area of low pressure of 1002 mb at most near 53.5N 41.5W.
2. Ship highlights:
   - 30 kt SE and 989 mb at 55.0N 40.1W at 00Z (COADS).
   - 35 kt SW and 1008 mb at 42.5N 51.5W at 00Z (micro).
   - 20 kt S and 997 mb at 54.9N 41.8W at 06Z (COADS).
   - Several measurements of pressures between 1000 and 1005 mb.

September 8:

1. Maps and old HURDAT:

- HWM analyzes an area of low pressure of 1004 mb at most near 54N 40W at 12Z.
- Microfilm analyzes an area of low pressure of 1005 mb at most near 54N 40W.

2. Ship highlights:
   - 20 kt SE and 1000 mb at 55.8N 31.3W at 00Z (COADS).
   - 15 kt WSW and 999 mb at 55.1N 31.6W at 03Z (COADS).
   - 15 kt NNW and 1003 mb at 54.8N 32.7W at 06Z (COADS).
   - 10 kt NNE and 1002 mb at 54.0N 42.8W at 12Z (COADS).
   - 15 kt ESE and 1003 mb at 53.1N 38.0W at 18Z (COADS).
   - 35 kt NW and 1007 mb at 50.9N 41.6W at 18Z (micro).
3. Discussion/Reanalysis:
   - Ships continued to report gales through September 8 at 18Z before Cleo began to interact with another system to its northeast.

September 9:

1. Maps and old HURDAT:
   - HWM analyzes an area of low pressure of 1004 mb at most near 53N 36W at 12Z.
   - Microfilm analyzes an area of low pressure of 1002 mb at most near 55.5N 36.5W.
2. Ship highlights:
   - 15 kt NW and 1002 mb at 45.8N 39.4W at 00Z (COADS).
   - 25 kt WNW and 1005 mb at 51.4N 41.3W at 06Z (COADS).
   - 15 kt SW and 1005 mb at 52.7N 35.5W at 12Z (COADS).
   - 10 kt SW and 1004 mb at 52.7N 35.5W at 18Z (COADS).
3. Discussion/Reanalysis:
   - The system continued moving slowly northeastward with winds less than gale force.

September 10:

1. Maps and old HURDAT:
   - HWM analyzes an open area of low pressure near 56N 30W at 12Z.
2. Discussion/Reanalysis:
   - The system continued with little change toward the east-northeast on the 10th until finally dissipating after 00Z on the 11th.

Date	Original HURDAT Central Pressure	Evidence	Changes
Aug 20 18Z	1003 mb	Penetration center fix: 1003 mb around 1835Z on Aug 20th	Retained

Aug 21 12Z		Penetration center fix: 1000 mb around 1300Z on Aug 21st	1000 mb
Aug 21 18Z	993 mb	Penetration center fix: 993 mb around 1918Z on Aug 21st	Retained
Aug 22 00Z	993 mb	Appears to have been duplicated data from the 19Z aircraft fix. Intensification continued from that time thus the 993 mb pressure is considered too high and removed.	Removed
Aug 22 12Z	970 mb	No direct mention of this central pressure is made in the reconnaissance fix log, though aircraft were flying penetration fixes in the storm at this time and it appears valid.	Retained
Aug 22 18Z	962 mb	Penetration center fix: 960 mb around 1900Z on Aug 22nd Penetration center fix: 965 mb around 1949Z on Aug 22nd Based on conflicting observations within an hour of each other, the 962 mb is kept as a blend of the two observations.	Retained
Aug 23 00Z	955 mb	No penetration center fixes were being flown by aircraft reconnaissance at this time	Removed
Aug 23 12Z		Penetration center fix: 938 mb around 1141Z on Aug 23rd	938 mb
Aug 23 18Z	950 mb	Penetration center fix: 945 mb at 1735Z	945 mb
Aug 24 00Z	950 mb	No penetration center fixes were being flown by aircraft reconnaissance at this time	Removed
Aug 26 18Z	987 mb	Penetration center fix: 990 mb at 1845Z	990 mb
Aug 27 00Z	984 mb	Penetration center fix: 984 mb at 01Z on August 27th	Retained
Aug 27 06Z	968 mb	Observed pressure of 966 mb in North Miami, FL around 08Z on Aug 27th	966 mb
Aug 27 12Z	971 mb	Although the original source data could not be found for this measurement, though it appears reasonable based on synoptic data and continued	Retained

		structural resilience of Cleo shortly after landfall.	
Aug 28 00Z	983 mb	Original source data could not be found for this measurement, though it appears reasonable and is retained.	
Aug 28 18Z	995 mb	Appears reasonable based on synoptic data	
Aug 29 00Z	999 mb	Penetration center fix: 999 mb around 0036Z on Aug 29th	
Aug 29 06Z		NAS Glynco, GA: 10 kt SW 1001 mb at 0648Z on Aug 29th	999 mb
Aug 29 12Z		Savannah, GA: 15 kt W 1003 mb at 1157Z	1000 mb
Aug 30 06Z		South Carolina: 10 kt SE 1006 mb at 06Z	1004 mb
Aug 31 00Z		North Carolina: 5 kt SSE 1008 mb at 00Z	1007 mb
Aug 31 06Z		North Carolina: 5 kt SE 1008 mb at 06Z	1007 mb
Aug 31 12Z		North Carolina: Calm 1008 mb at 12Z North Carolina: 10 kt ESE 1008 mb at 12Z A blend of these observations yields an approximate central pressure of 1007 mb.	1007 mb
Sep 1 00Z		North Carolina: 5 kt NW 1006 mb at 00Z	1005 mb
Sep 1 06Z		Elizabeth City, NC: 5 kt WSW 1002 mb at 0858Z on Sep 1st	1001 mb
Sep 1 12Z		Cape Hatteras, NC: 10 kt WSW 1001 mb at 1258Z on Sep 1st	999 mb
Sep 2 00Z		COADS: 20 kt S 999 mb at 00Z on Sep 2nd	997 mb
Sep 2 12Z	980 mb	Penetration center fix: 980 mb around 1300Z on Sep 2nd	Retained
Sep 3 06Z	980 mb	Penetration center fix: 980 mb around 0631Z on Sep 3rd	Retained

Sep 3 12Z	983 mb	Penetration center fix: 980 mb at 1330Z on Sep 3rd	980 mb
Sep 3 18Z	982 mb	Penetration center fix: 975 mb around 1900Z on Sep 3rd	975 mb
Sep 4 12Z	970 mb	Value appears reasonable based on a ship observation of 60 kt SE and 977 mb at 14Z (COADS).	Retained

Sources: the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Monthly Weather Review, Navy reconnaissance book, Mariners Weather Log, National Hurricane Research Project (NHRP), North Atlantic Tropical Cyclones, Local Climatological Data, Surface Weather Observations, Schwerdt et al. (1979), Ho et al. (1987) and Jarrell et al. (1992) and NHC Storm Wallets (both on-line and NHC w: drive).

Hurricane Dora [August 28 – September 15, 1964] – AL061964

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43430 08/28/1964 M=20  6 SNBR= 938 DORA        XING=1 SSS=2
43435 08/28*  0   0   0    0*  0   0   0    0*140 180  25    0*136 200  25    0*
43435 08/28*  0   0   0    0*  0   0   0    0*140 170  30    0*140 188  30    0*
                                             ***  **      ***  ***  **

43440 08/29*131 220  25    0*128 240  25    0*124 260  25    0*121 275  25    0*
43440 08/29*139 206  30    0*137 224  30    0*135 242  30 1007*133 261  30    0*
            ***  ***  **      ***  ***  **      ***  ***  ** **** ***  ***  **

43445 08/30*118 296  25    0*117 317  25    0*115 333  25    0*114 350  25    0*
43445 08/30*130 281  30    0*127 301  30    0*124 320  30    0*120 340  30    0*
            ***  ***  **      ***  ***  **      ***  ***  **      ***  ***  **

43450 08/31*112 370  25    0*111 390  25    0*110 410  30    0*111 425  30    0*
43450 08/31*116 360  30    0*112 380  30    0*110 400  30    0*110 419  35    0*
            ***  ***  **      ***  ***  **           ***          ***  ***  **

43455 09/01*113 440  30    0*115 455  30    0*117 470  50    0*127 487  55  998*
43455 09/01*112 437  40    0*115 454  45    0*119 470  50    0*125 485  55  998*
            ***  ***  **           ***  **      ***               ***  ***

43460 09/02*133 496  60    0*142 512  60    0*153 530  60  996*165 549  60    0*
43460 09/02*133 498  55    0*143 513  60    0*155 530  60  996*168 546  65    0*
                ***  **      ***  ***           ***               ***  ***  **

43465 09/03*178 565  80    0*182 573  85  984*187 580  90  984*196 589  90    0*
43465 09/03*177 561  70  989*182 572  75    0*187 580  75  984*196 588  80    0*
            ***  ***  **  ***      ***  **  ***           **           ***  **

43470 09/04*205 595  95  981*211 599  95  994*216 603  95  976*222 608  95  973*
43470 09/04*205 594  80  981*211 599  80  978*216 603  80  976*222 608  85  973*
                ***  **                  **  ***           **                ** 

43475 09/05*228 612  95    0*234 616  95    0*240 621 100  971*248 629 105  960*
43475 09/05*227 612  85    0*233 616  90    0*240 621  90  971*248 629 100  960*
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            ***      **      ***      **              ***              ***

43480 09/06*255 636 110    0*261 644 115  942*267 652 115    0*271 661 110  958*
43480 09/06*255 636 105    0*261 644 115  942*267 652 110    0*271 660 100  958*
                   ***                              ***          *** ***

43485 09/07*274 670 100    0*278 679  95    0*280 690  95  964*281 702  95  956*
43485 09/07*275 669  95    0*278 678  95    0*280 690  95  959*282 703  95  956*
            *** *** ***          ***                      *** *** ***

43490 09/08*282 718 100    0*285 730 100    0*286 744 100    0*286 759 100  963*
43490 09/08*283 717  95    0*285 730  95    0*286 745  90  962*286 760  90  963*
            *** *** ***              ***          *** ***  ***     *** ***

43495 09/09*288 774 100    0*290 783 100  972*294 794 100  970*297 800 100  962*
43495 09/09*288 774  85    0*291 785  80  972*294 794  80  970*297 800  90  962*
                   ***      *** *** ***              ***              ***

43500 09/10*298 807 100  964*299 814  95  966*300 824  90    0*301 831  80    0*
43500 09/10*298 806  90  964*299 813  95  966*300 821  65    0*300 829  55    0*
                *** ***          ***              ***  **      *** ***  **

43505 09/11*301 835  70    0*302 840  55    0*305 845  45    0*311 849  35    0*
43505 09/11*301 835  50    0*302 840  45  990*304 844  45    0*307 847  40    0*
                   **              **  *** *** ***            *** ***  **

43510 09/12*315 850  35    0*316 848  35    0*315 846  35    0*319 833  35    0*
43510 09/12*311 847  40  993*313 846  40  995*314 842  45  996*316 834  55  995*
            *** ***  **  *** *** ***  **  *** *** ***  **  *** *** ***  **  ***

43515 09/13*322 822  35    0*329 810  40    0*337 798  45    0*344 779  45    0*
43515 09/13*321 823  60  996*327 810  60    0E336 792  60    0E346 772  60    0*
            *** ***  **  *******      **     **** ***  **     **** ***  **

43520 09/14*356 753  50  998*369 733  50    0E380 715  55    0E406 681  55    0*
43520 09/14E356 753  60  998E369 733  60    0E385 710  60    0E404 681  60    0*
           *         **     *         **      *** ***  **      ***       **

43525 09/15E430 646  55    0E446 617  55    0E460 590  55    0E476 556  55    0*
43525 09/15E424 648  55    0E443 615  55    0E460 585  55    0E476 556  55    0*
            *** ***          *** ***              ***

43530 09/16E490 520  55    0*  0   0   0    0*  0   0   0    0*  0   0   0    0*
43530 09/16E495 530  55    0*  0   0   0    0*  0   0   0    0*  0   0   0    0*
            *** ***

43535 HRDFL2
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U.S. Hurricane Landfall

September 10th – 06Z – 29.9N 81.3W – 95 kt – Category 2 – 966 mb – 1012 mb
OCI – 325 nmi ROCI - 5 nmi RMW

Significant Revisions:

1. Major changes to track from August 28-31.

2. Intensification into a tropical storm assessed to be at least 18 hours earlier; may have occurred even earlier.
3. Major reductions to intensities on September 3, 4, 9, 10, and 11. Major increase to intensities on September 12 and 13.
4. Extratropical phase indicated 24 hours earlier.

Daily Metadata:

August 28:

1. Maps and old HURDAT:
   - HURDAT lists a 25 kt tropical depression at 14.0N 18.0W at 12Z.
   - HWM depicts nothing of interest at 12Z.
   - Microfilm analyzes an area of low pressure near 18N 17W.
2. Discussion:
   a. MWR: "A large envelope of low pressure moved through the Cape Verde area on August 28."

   b. Reanalysis: Hurricane Dora began its long, three-week journey as a tropical depression at 12Z on August 28 just off the coast of Senegal. Genesis remains unchanged from HURDAT as ship observations along the coast of Africa confirm the presence of a closed circulation at this time. One vessel measured winds of 25 kt at 18Z, serving as the basis for starting the system at 30 kt.

August 29:

1. Maps and old HURDAT:
   - HURDAT lists a 25 kt tropical depression at 12.4N 26.0W at 12Z.
   - HWM depicts a low pressure area south of Cape Verde at 12Z.
   - Microfilm indicates a low pressure system near Cape Verde at 12Z.
2. Discussion:
   a. Reanalysis: Tracking just west-southwest, the depression passed just south of the Cape Verde Islands on August 29. One ship passed close to the center around 12Z and reported 1007 mb with calm winds; this value is added as a central pressure at that time. A 1007 mb central pressure suggests maximum winds of 32 kt from the south of 25N Brown et al. pressure-wind relationship.

August 30:

1. Maps and old HURDAT:
   - HURDAT lists a 25 kt tropical depression at 11.5N 33.3W at 12Z.
   - HWM depicts a low pressure area southwest of Cape Verde at 12Z.
   - Microfilm depicts nothing of interest at 12Z.
2. Discussion:
   a. Reanalysis: Observations on August 29 also indicate the center to be significantly farther north and east than indicated by HURDAT and is the basis for the major revisions to track on August 28-31.

August 31:

1. Maps and old HURDAT:
   - HURDAT lists a 30 kt tropical depression at 11.0N 41.0W at 12Z.
   - HWM analyzes a weak low pressure system near 11.5N 41W at 12Z.
   - Microfilm analyzes a depression at 11.0N 40.0W at 12Z.
2. Satellite estimate:
   - Center fix near 11N 40W around 12Z (Micro).
3. Discussion:
   a. MWR: "On the 31st a TIROS picture located a cloud mass near 11N, 41W."

   b. Reanalysis: After clearing the Cape Verde Islands, Dora entered a data void and little information is available until around 12Z on August 31. At that time, satellite imagery from TIROS indicated a circulation center at 11N and 40W or 41W. The 1964 MWR and microfilm analyses disagree on the fix position, with HURDAT using 11N 41W as stated in the MWR. Based on the aforementioned track adjustment, the microfilm assessment appears to be accurate when a steady forward speed is accounted for. Major changes to track are made up until 12Z in order to create a smooth track between this point and the previous point near the Cape Verde Islands. Regardless of the exact position, 12Z marks the southernmost point in Dora's track. Thereafter, it began a gradual turn west-northwestward.

September 1:

6. Maps and old HURDAT:
   - HURDAT lists a 50 kt tropical storm at 11.7N 47.0W at 12Z.
   - HWM depicts a depression at 11.0N 47.0W near 12Z.
   - Microfilm analyzes a tropical storm near 12N 47W at 12Z.
7. Aircraft highlights:
   - Penetration center fix with estimated surface winds of 50 kt, an eye diameter of 20 nmi, and an observed surface pressure of 998 mb at 12.3N 48.0W at 1645Z (SW).
8. Discussion:
   a. MWR: "The following day reconnaissance aircraft located a tropical storm with a central pressure of 998 mb. The storm was enclosed in an envelope of low pressure approximately the same size as that which had moved through the Verdes. The 1008-mb isobar was about 300 mi in diameter in both locations."

   b. Reanalysis: Reconnaissance reached the storm during the evening of September 1, fixing a central pressure of 998 mb at 1645Z. A central pressure of 998 mb suggests maximum winds of 51 kt from the south of 25N Brown et al. pressure-wind relationship. Accounting for the somewhat above average forward motion (~16 kt), the 55 kt intensity at 18Z is maintained. Backtracking from this point, gradual intensification is shown. This results in Dora being classified as a tropical storm 18 hours earlier than

originally in HURDAT. However, this could be conservative due to the earlier lack of data.

September 2:

1. Maps and old HURDAT:
   - HURDAT lists a 60 kt tropical storm at 15.3N 53.0W at 12Z.
   - HWM depicts a tropical storm of at most 1000 mb near 15.5N 53W at 12Z.
   - Microfilm analyzes a tropical storm of 998 mb near 16.7N 53.2W at 12Z.
2. Ship highlights:
   - 40 kt E and 999 mb at 14.5N 49.5W at 00Z (Micro).
   - 35 kt E and 1012 mb at 17.0N 48.0W at 06Z (COADS).
   - 65 kt ENE and 1004 mb at 17.5N 54.5W at 18Z (COADS).
3. Aircraft highlights:
   - Penetration center fix with estimated surface winds of 70 kt and an observed surface pressure of 996 mb at 15.9N 53.8W at 1501Z (SW).
   - Penetration center fix with estimated surface winds of 105 kt, an eye diameter of 25 nmi, and an observed surface pressure of 989 mb at 17.5N 55.8W at 2120Z (SW). (Note that the minimum reported pressure on the fix form is 989 mb, which was apparently measured at low level. However, the minimum 700 mb height for the fix is 2873 m, which suggests substantially lower central pressure. It appear that the "2873 m" value was a typo and should instead have been "2973 m", which would have been consistent with 989 mb central pressure.)
4. Discussion:
   a. MWR: "Dora moved west-northwestward and reached hurricane force on the 2nd. It continued to intensify while gradually expanding."

   b. Reanalysis: Only minor changes are made on September 2, including intensification to hurricane intensity 6 hours earlier than HURDAT. This stems from two recon fixes, one of 996 mb at 1501Z and the other of 989 mb at 2120Z. A central pressure of 996 mb suggests maximum winds of 54 kt and 989 mb suggests maximum winds of 65 kt from the south of 25N Brown et al. pressure-wind relationship. The latter recon fix reported an eye diameter of 25 nmi, indicating an RMW of 18 nmi; this is larger than average for a 996 mb system and near-average for 989 mb. Accounting for these factors, the storm's fast movement, and lightly weighting the 105 kt surface wind estimate, Dora is analyzed at 60 kt at 12Z and 70 kt at 00Z on the 3rd.

September 3:

1. Maps and old HURDAT:
   - HURDAT lists a 90 kt hurricane at 18.7N 58.0W at 12Z.
   - HWM depicts a hurricane of at most 1000 mb near 19N 57.5W at 12Z.
   - Microfilm analyzes a hurricane of 984 mb near 18.8N 58W at 12Z.
2. Ship highlights:

- 45 kt ESE and 1010 mb at 19.6N 55.2W at 00Z (Micro).
- 50 kt E and 1008 mb at 19.8N 57.4W at 06Z (Micro).
- 50 kt NE and 1015 mb at 21.4N 60.0W at 12Z (Micro).
- 65 or 75 kt ENE and 1007 mb at 20.2N 57.0W at 12Z (Micro/COADS).
- 50 kt SE and 1006 mb at 20.1N 56.6W at 18Z (COADS).

3. Aircraft highlights:
   - Radar center fix with an estimated eye diameter of 80-100 nmi at 18.4N 57.4W at 0622Z (SW).
   - Penetration center fix with estimated surface winds of 80 kt, an eye diameter of 30 nmi, and an observed surface pressure of 984 mb at 18.4N 57.8W at 1000Z (SW).
   - Radar center fix with an eye diameter of 20 nmi at 19.8N 59.2W at 1835Z (SW).
   - Penetration center fix with estimated surface winds of 100 kt, an eye diameter of 30 nmi, and an observed surface pressure of 981 mb at 20.1N 59.0W at 2130Z (SW).
4. Discussion:
   a. Reanalysis: Turning toward a northwest track, Dora slowly intensified on September 3. Recon fixes show the central pressure falling to 984 mb by 10Z. A central pressure of 984 mb suggests maximum winds of 72 kt south of 25N from the Brown et al. pressure-wind relationship. A major reduction to intensity is implemented on this day, as HURDAT may have heavily relied on the 100 kt recon surface wind estimates. Maximum winds at 12Z are lowered by 15 kt.

September 4:

1. Maps and old HURDAT:
   - HURDAT lists a 95 kt hurricane at 21.6N 60.3W at 12Z.
   - HWM depicts a hurricane of at most 1000 mb near 22N 60W at 12Z.
   - Microfilm analyzes a hurricane of 976 mb near 21.6N 60.3W at 12Z.
2. Ship highlights:
   - 55 kt ENE and 1011 mb at 23.1N 59.0W at 00Z (COADS).
   - 45 kt SE and 1008 mb at 24.6N 58.1W at 16Z (COADS).
   - 35 kt NE and 1009 mb at 24.5N 62.2W at 18Z (COADS).
3. Aircraft highlights:
   - Penetration center fix with 11,000 ft winds of 69 kt, an eye diameter of 40 nmi, and an observed surface pressure of 978 mb at 21.2N 60.0W at 0715Z (SW). (ATSR gave 994 mb central pressure by drop surface value, but the 850 and 700 mb heights/temperatures indicate 978 mb.
   - Penetration center fix with estimated surface winds of 80 kt and an observed surface pressure of 976 mb at 21.8N 60.3W at 1300Z (SW).
   - Penetration center fix with a surface pressure of 973 mb at 18Z (SW).
   - Penetration center fix with estimated surface winds of 65 kt, an eye diameter of 25 nmi, and an observed surface pressure of 974 mb at 22.3N 60.8W at 19Z (SW).
4. Discussion:

a. Reanalysis: Similar changes are made on September 4 as Dora continued its slow intensification. Recon fixes of 981 mb, 978 mb, 976 mb, and 973 mb, were made around the 00Z, 06Z, 12Z, and 18Z synoptic times. These values yield maximum winds of 76 kt, 80 kt, 83 kt, and 86 kt, south of 25N from the Brown et al. pressure-wind relationship, respectively. Based upon these and lightly weighting the earlier and subsequent surface wind estimates, intensities at the respective time slots are analyzed to be 80 kt, 80 kt, 80 kt, and 85 kt, with the 18Z intensity also accounting for Dora's decreasing forward speed.

September 5:

1. Maps and old HURDAT:
   - HURDAT lists a 100 kt hurricane at 24.0N 62.1W at 12Z.
   - HWM depicts a hurricane of at most 1000 mb at 24N 62W at 12Z.
   - Microfilm analyzes a hurricane of 971 mb near 24N 62W at 12Z.
2. Ship highlights:
   - 40 kt NNW and 1010 mb at 21.5N 64.0W at 00Z (Micro).
   - 40 kt S and 1009 mb at 21.7N 59.0W at 12Z (COADS).
   - 35 kt S and 1009 mb at 21.0N 60.0W at 18Z (COADS).
3. Aircraft highlights:
   - Radar center fix with an eye diameter of 22 nmi at 22.8N 61.0W at 0100Z (SW).
   - Radar center fix with an eye diameter of 12 nmi at 23.5N 61.8W at 0700Z (SW).
   - Penetration center fix with estimated surface winds of 100 kt, an eye diameter of 16 nmi, and an observed surface pressure of 971 mb at 24.2N 62.2W at 13Z (ATSR/SW).
   - Penetration center fix with an eye diameter of 40 nmi, an RMW of 25 nmi, estimated surface winds of 95 kt, and an extrapolated surface pressure of 960 mb at 24.8N 62.8W at 1741Z (ATSR/SW).
4. Discussion:
   a. Reanalysis: September 5 marked a period of steady intensification that culminated with Dora reaching its peak strength on September 6. Winds throughout September 5 are adjusted downward, with major changes at 00 and 12Z, in accordance with recon fixes of 971 mb at 13Z and 960 mb at 1741Z. A pressure of 971 mb suggests maximum winds of 89 kt south of 25N from the Brown et al. pressure-wind relationship. A pressure of 960 mb suggests maximum winds of 102 kt from the south of 25N and 100 kt from the north of 25N intensifying subsets of the Brown et al. pressure-wind relationship. The storm also featured an eye diameter of 20-25 nmi, yielding an estimated RMW of 15-18 nmi which is near or slightly smaller than average. Accounting for the storm's continued slow movement, with slight weighting of the 100 kt surface wind estimate, maximum winds at 12Z and 18Z are assessed at 90 kt and 100 kt, respectively.

September 6:

1. Maps and old HURDAT:
   - HURDAT lists a 115 kt hurricane at 26.7N 65.2W at 12Z.
   - HWM depicts a hurricane of at most 1000 mb near 26.5N 65W at 12Z.
   - Microfilm analyzes a hurricane of 942 mb near 27N 65W at 12Z.
2. Ship highlights:
   - 35 kt E and 1011 mb at 29.4N 61.7W at 03Z (COADS).
3. Aircraft highlights:
   - Radar center fix with an eye diameter of 30 nmi at 25.9N 63.8W at 0315Z (SW).
   - Penetration center fix with estimated surface winds of 110 kt, an eye diameter of 20 nmi, and an observed surface pressure of 942 mb (950 mb extrapolated from height) at 26.4N 64.8W at 07Z (SW).
   - Radar center fix at 26.5N 65.2W at 1227Z (SW).
   - Penetration center fix with estimated surface winds of 115 kt, an eye diameter of 27-30 nmi, and an observed surface pressure of 958 mb at 27.1N 66.1W at 1912Z (SW).
4. Discussion:
   a. MWR: "When over 300 mi south of Bermuda, it turned on a course only slightly north of due west. It had missed the trough associated with the redeveloped hurricane Cleo. At this time Dora was a large severe hurricane with a central pressure of 942 mb (27.82 in). During this intensification there was low-level inflow."

   b. Reanalysis: Dora reached its maximum intensity around 06Z on September 6 as a Category 4 with winds of 115 kt; this peak is unchanged from HURDAT. A recon fix of 942 mb around 0700Z serves as the basis for this peak. A pressure of 942 mb suggests maximum winds of 118 kt from the intensifying subset of the north of 25N Brown et al. pressure-wind relationship; the winds are analyzed slightly below this value due the storm's slow movement. Weakening ensued almost immediately, with the pressure rising to 958 mb by 1912Z according to recon. A pressure of 958 mb suggests maximum winds of 93 kt from the weakening subset of the Brown et al. pressure-wind relationship. Accordingly, weighting lightly the 115 kt surface wind estimate, a reduction in winds from 110 kt to 100 kt is made at 18Z.

September 7:
1. Maps and old HURDAT:
   - HURDAT lists a 95 kt hurricane at 28.0N 69.0W at 12Z.
   - HWM depicts a hurricane of at most 1000 mb near 28N 68.5W at 12Z.
   - Microfilm analyzes a hurricane of 1000 mb near 27.5N 68.5W at 12Z.
2. Ship highlights:
   - 35 kt NW at 27.7N 71.1W at 06Z (COADS).
   - 45 kt WNW and 997 mb at 27.2N 69.0W at 12Z (Micro).
   - 35 kt NE and 1015 mb at 31.6N 73.7W at 18Z (COADS).
   - 35 kt SW and 999 mb at 26.1N 68.8W at 18Z (Micro).
3. Aircraft highlights:

- Radar center fix with an eye diameter of 30 nmi at 27.3N 67.2W at 0115Z (SW).
- Radar center fix with an eye diameter of 15 x 20 nmi at 27.6N 67.8W at 0554Z (SW).
- Penetration center fix with estimated surface winds of 92 kt, an eye diameter of 30 nmi, and an observed surface pressure of 964 mb at 28.0N 69.2W at 1243Z (ATSR/SW). (Note that the 700 mb data for the 964 mb fix extrapolates to a pressure of 959 mb from modern formulas. Given the earlier and subsequent fixes of central pressure near 959 mb, this value is used as the central pressure at this time.)
- Penetration center fix with estimated surface winds of 97 kt, an eye diameter of 25 nmi (poorly defined), estimated RMW of 32-50 nmi, and an observed surface pressure of 956 mb at 28.2N 70.5W at 1850Z (ATSR/SW).

4. Discussion:
   a. MWR: "Following its turn, the inflow stopped and a gradual decrease in intensity occurred for about 24 hr, central pressure rising about 22 mb."

   b. Reanalysis: Tracking just north of due west, Dora continued nearly steady state in intensity during the day. Recon reported a central pressure of 956 mb at 1850Z. This value suggests maximum winds of 99 kt from the north of 25N Brown et al. pressure-wind relationship. The recon crew also estimated the RMW at 32 to 50 nmi, significantly larger than the average of 20 nmi. An intensity of 95 kt is analyzed at 18Z.

September 8:

1. Maps and old HURDAT:
   - HURDAT lists a 100 kt hurricane at 28.6N 74.4W at 12Z.
   - HWM depicts a hurricane of at most 1000 mb near 28.5N 74.5W at 12Z.
   - Microfilm analyzes a hurricane of at most 1002 mb near 28.5N 74.5W at 12Z.
2. Ship highlights:
   - 40 kt NE and 1017 mb at 33.1N 74.0W at 00Z (COADS).
   - 40 kt NE and 1010 mb at 32.4N 75.1W at 06Z (Micro).
   - 45 kt ENE and 1010 mb at 32.6N 75.1W at 12Z (Micro).
   - 40 kt SSW at 27.0N 73.5W at 12Z (COADS).
   - 45 kt NNE and 1012 mb at 31.8N 76.6W at 18Z (COADS).
3. Land highlights:
   - 40 kt W and 1005 mb at Marsh Harbour, Bahamas, at 18Z (Micro).
4. Aircraft highlights:
   - Radar center fix with an eye diameter of 20 nmi at 28.5N 71.8W at 0120Z (SW).
   - Radar center fix with at 28.4N 73.6W at 0750Z (SW).
   - Penetration center fix with estimated surface winds of 88 kt, an eye diameter of 30-40 nmi, an estimated RMW of 33-50 nmi, and an

observed surface pressure of 962 mb at 28.6N 74.8W at 1319Z (ATSR/SW).

- Penetration center fix with flight level winds of 105 kt, an eye diameter of 40 nmi, and an observed surface pressure of 963 mb at 28.6N 76.2W at 1855Z (ATSR/SW).

5. Discussion:
   a. Reanalysis: Dora only maintained Category 3 status for 12 hours before weakening again. Maximum winds at 06Z, 12Z, and 18Z on September 8 are reduced based on recon fixes of 962 mb and 963 mb at 1319Z and 1855Z, respectively. A pressure of 962 mb suggests maximum winds of 93 kt from the north of 25N Brown et al. pressure-wind relationship. Based upon the continued large RMW of Dora at this time, intensities of 90 kt are analyzed for 12Z and 18Z.

September 9:

1. Maps and old HURDAT:
   - HURDAT lists a 100 kt hurricane at 29.4N 79.4W at 12Z.
   - HWM depicts a hurricane of at most 992 mb near 29.5N 79.0W at 12Z.
   - Microfilm analyzes a hurricane of at most 967 mb near 29.4N 79.1W at 12Z.
2. Ship highlights:
   - 50 kt NE and 1010 mb at 30.9N 80.6W at 00Z (COADS).
   - 50 kt NE and 1006 mb at 31.6N 79.6W at 06Z (COADS).
   - 50 kt W and 1002 mb at 27.4N 80.0W at 06Z (COADS).
   - 60 kt ENE and 1006 mb at 32.0N 78.9W at 12Z (COADS).
   - 55 kt E and 997 mb at 30.0N 79.5W at 13Z (Micro).
   - 60 kt E and 1008 mb at 32.1N 78.2W at 18Z (COADS).
3. Radar highlights (Daytona Beach, FL):
   - 29.1N 78.4W "Psbl center" at 0545Z (SW).
   - 29.8N 79.5W 8 nmi eye at 1145Z (SW).
   - 29.7N 80.0W at 1745Z (SW).
4. Aircraft highlights:
   - Radar center fix at 28.8N 77.6W at 0100Z (SW).
   - Penetration center fix with an eye diameter of 50 nmi and an observed surface pressure of 972 mb at 29.3N 78.6W at 07Z (SW).
   - Penetration center fix with estimated surface winds of 100 kt and an observed surface pressure of 970 mb at 29.4N 79.6W at 1247Z (SW).
   - Penetration center fix with estimated surface winds of 87 kt and an observed surface pressure of 962 mb at 29.7N 80.1W at 19Z (SW).
5. Discussion:
   a. MWR Vol. 94, No. 10: "On the morning of the 9th, radar observers at Daytona Beach noted a rapid change in both the definition of the hurricane's precipitation pattern and the radar track of the eye. This change was characterized by the wall cloud region's becoming better defined, accompanied with an erratic shift of the radar track from westward to northward. Previous to this period, radar return from precipitation echoes of the wall cloud were poorly defined if not entirely absent, thereby

necessitating the employment of logarithmic spiral overlays to fix the center. Following this abrupt change, approximately 120 nmi off the northeastern Florida coast, Dora retained its improved radar definition until landfall."

b. Reanalysis: Dora's motion became erratic on September 9 as it approached the Southeastern United States, executing three cyclonic loops accordingly to half hourly radar imagery (such small-scale details are not possible to provide in HURDAT). Another possible eyewall replacement cycle weakened the system to 972 mb, as measured by recon at 07Z; this value suggests maximum winds of 82 kt from the north of 25N Brown et al. pressure-wind relationship. The eye spanned 50 nmi at this time indicating an RMW of 37 nmi, well-above the average of 22 nmi. Winds at 00Z and 06Z are conservatively reduced to 85 kt and 80 kt, respectively; 15 kt and 20 kt major decreases from HURDAT. As the system traversed the Gulf Stream, its pressure fell by 10 mb to 962 mb in roughly 12 hours. A pressure of 962 mb, stemming from a recon fix at 19Z, suggests maximum winds of 93 kt from the north of 25N Brown et al. pressure-wind relationship. Intensification to 90 kt is indicated by 18Z, although this remains 10 kt below the original HURDAT.

September 10:

1. Maps and old HURDAT:
   - HURDAT lists a 90 kt hurricane at 30.0N 82.4W at 12Z.
   - HWM depicts a hurricane of at most 988 mb near 30.0N 82.5W at 12Z.
   - Microfilm analyzes a tropical cyclone of at most 1008 mb near 30.1N 82.3W at 12Z.
2. Ship highlights:
   - 40 kt E and 1011 mb at 32.5N 76.0W at 00Z (COADS).
   - 35 kt SSW and 1005 mb at 28.9N 78.5W at 06Z (COADS).
   - 40 kt SW and 1011 mb at 30.3N 77.6W at 12Z (COADS).
   - 35 kt SE and 1010 mb at 30.3N 79.4W at 18Z (COADS).
3. Land highlights:
   - 966 mb at 06Z in St. Augustine, FL; eye passage 0515-0630Z (MWR).
   - 71 kt N at 0048Z in Jacksonville Imeson AP, FL (MWR).
     - 40 kt NNE gusts to 74 kt at 0030Z (SWO).
     - 984 mb at 0755Z (SWO).
     - 51 kt ENE gusts to 65 kt at 0814Z (SWO).
   - 64 kt NNE (exact time unk) gust to 88 kt NNE at 0630z in Mayport, FL (SW).
   - 975 mb at 05Z in Marineland, FL (MWR).
   - 978 mb at 0755Z at Jacksonville NAS, FL (MWR).
   - 979 mb at 0955Z at Jacksonville Cecil Field, FL; eye passage ~11Z (SWO).
   - 30 kt W and 985 mb at 12Z in Gainesville, FL (SWO).
4. Radar highlights (Daytona Beach, FL):

- 29.8N 80.6W 24 nmi eye at 0015Z (SW).
- 30.0N 81.4W 8 nmi eye at 0542Z (SW).
- 29.9N 81.4W 7 nmi eye at 0612Z (SW).
- 30.0N 82.1W at 1143Z (SW).
- 30.0N 82.9W 2 nmi eye at 1745Z (SW).

5. Aircraft highlights:
   - Penetration center with estimated surface winds of 75 kt and an observed surface pressure of 964 mb at 29.8N 80.8W at 0112Z (SW).
   - Penetration center fix with estimated surface winds of 75 kt at 29.8N 81.5W at 0630Z (SW).
6. Landfall analyses:
   a. Ho et al.: 29.9N, 81.3W landfall, 961 mb, 34 nmi RMW, 7 kt speed.
   b. Jerrell et al.: Category 2 landfall 966 mb
7. Discussion:
   a. MWR: "Hurricane Dora slowed considerably before reaching land and consequently the winds and tides increased slowly...Winds exceeded hurricane force along the coast from extreme southeastern Georgia southward to Flagler County, Fla. Highest sustained winds, estimated at 125 mph from the southwest, occurred at St. Augustine, immediately following the passage of the center. The lowest pressure on land also occurred at St. Augustine, 966 mb (28.52 in), at 0100 EST on the 10th. The station was in the eye from 0015 to 0130. Sustained winds near 100 mph were reported along the coastline north of St. Augustine."

   b. Reanalysis: As the hurricane neared landfall on September 10, radar imagery from Daytona Beach indicated substantial contraction of its eye. In the 6 hours leading up to landfall, Dora's eye contracted from 24 nmi to 7 nmi, the latter value yielding an RMW of 5 nmi. The average RMW for a storm of this strength and location is 22 nmi. The tiny core of Dora moved ashore at St. Augustine, Florida, around 06Z. A station in the city reported an eye passage from 0515Z to 0630Z with a pressure of 966 mb. The landfall point of 29.9N 81.3W is a compromise between the radar-estimated landfall at 30.0N 81.3W and the recon derived landfall at 29.8N 81.3W. Since a full record of the observations at St. Augustine is unavailable, it is uncertain if 966 mb was a true minimum but due to a lack of contradictory data, the value retained as a central pressure. (It is noted that Ho et al. used the 966 mb in St. Augustine and "computed from pressure profile along or near coast" along with an RMW of 34 nmi from reconn to arrive at 961 mb central pressure. However, this value appears to be too low because of the following: 1) the land-based radar and the recon indicate that the center of Dora went directly over St. Augustine and the minimum pressure was recorded in the eye; and 2) an RMW of 34 nmi is not consistent with the much smaller values suggested by radar. Thus 961 mb is not likely to be the central pressure of

Dora at landfall.) A pressure of 966 mb suggests maximum winds of 89 kt from the north of 25N Brown et al. pressure-wind relationship. Although Dora was a large system overall, having a ROCI of 325 nmi, and slow moving, its extremely tiny core lends to the winds being assessed slightly above the pressure-wind relationship at 95 kt. This is the intensity already in HURDAT. Within hours of landfall Dora passed just 25 nmi south of Jacksonville, bringing hurricane-force winds to the city. Steady weakening ensued once the hurricane moved ashore. The Kaplan and DeMaria inland decay model was run for 12Z and 18Z on September 10, and 00Z, 06Z, and 12Z on September 11. This yielded intensities of 60 kt, 52 kt, 44 kt, 46 kt, and 34 kt respectively. Maximum observed winds for these periods were 50 kt, 35 kt, 30 kt, 35 kt, and 35 kt, respectively. Wind speeds for the inland positions are adjusted to 65 kt, 55 kt, 50 kt, 45 kt, and 45 kt for the corresponding time slots. These are major reductions for 12 and 18Z on the 10th and 00Z on the 11th. The 95 kt intensity at landfall makes Dora a high end Category 2 hurricane for northeast Florida. This is the same as originally assessed in Jarrell et al.

September 11:

1. Maps and old HURDAT:
   - HURDAT lists a 45 kt tropical storm at 30.5N 84.5W at 12Z.
   - HWM depicts a tropical storm of at most 996 mb near 30.5N 84.5W at 12Z.
   - Microfilm analyzes a tropical cyclone of at most 996 mb near 30.5N 85.0W at 12Z.
2. Ship highlights:
   - 35 kt W and 1009 mb at 27.6N 87.3W at 06Z (COADS).
   - 35 kt S and 1010 mb at 29.7N 80.5W at 12Z (COADS).
3. Land highlights:
   - 10 kt NE and 992 mb at Tallahassee Airport, FL at 0756Z (SWO).
   - 998 mb at 0730Z at Tallahassee, FL at 0730Z (MWR).
4. Discussion:
   a. Reanalysis: Steady weakening is depicted in the 36 hours following landfall, with winds decreasing to 40 kt at 18Z on September 11. (The highest winds for the land stations near the center were 10-15 kt, but tropical storm force winds were occurring over the water near the coast.)

September 12:

1. Maps and old HURDAT:
   - HURDAT lists a 35 kt tropical storm at 31.5N 84.6W at 12Z.
   - HWM depicts a tropical storm of at most 1000 mb near 31.5N 84.5W at 12Z.
   - Microfilm analyzes a tropical cyclone of at most 996 mb near 31.0N 85.0W at 12Z; a frontal feature is impinging on the circulation from the northwest.
2. Ship highlights:

- 35 kt W and 1009 mb at 27.6N 87.3W at 06Z (COADS).
- 40 kt S and 1010 mb at 28.0N 80.3W at 12Z (COADS).
- 35 kt S and 1012 mb at 28.5N 79.9W at 12Z (COADS).
- 50 kt SE and 1008 mb at 31.9N 80.8W at 18Z (Micro).
- 45 kt SSW and 1004 mb at 30.5N 81.0W at 18Z (Micro).

3. Land highlights:
   - Albany, GA (Micro).
     - 10 kt ESE and 995 mb at 00Z
     - 10 kt SE and 999 mb at 06Z
     - 10 kt ESE and 998 mb at 12Z
     - 15 kt NW and 998 mb at 18Z
   - 10 kt NE and 999 mb at Ft. Bennings, GA at 09Z (SWO).
   - 10 kt NW and 995 mb at Dothan Regional Airport, AL at 08Z (SWO)
   - 10 kt WNW and 997 mb at Fort Rucker Cairns, AL at 07Z (SWO).
4. Discussion:
   a. Reanalysis: Dora turned northward after passing close to Tallahassee and moved farther inland. The storm executed a sluggish turn to the northeast ahead of an approaching cold front over the next two days. Observations from Georgia consistently indicated that the storm's pressure was in the mid-990 mb range. The strongest winds were confined to offshore areas, particularly off the Georgia coastline. Ship observations reported steadily increasing winds in this region, possibly due to baroclinic forcing. Observations of 50 kt SE at 18Z on September 12 and 55 kt SSW at 00Z on September 13 were received, well above the 35 kt intensity originally depicted in HURDAT. Major increases to winds are made accordingly, starting at 18Z on September 12 and for the entirety of September 13. (The highest winds for the land stations near the center were 10-15 kt, but tropical storm force winds were occurring over the water near the coast.)

September 13:

1. Maps and old HURDAT:
   - HURDAT lists a 45 kt tropical storm at 33.7N 79.8W at 12Z.
   - HWM depicts an extratropical cyclone of at most 1000 mb near 33.5N 79.5W at 12Z.
   - Microfilm analyzes a frontal low of at most 1000 mb near 33.5N 79.5W at 12Z.
2. Ship highlights:
   - 55 kt SSW and 1006 mb at 30.0N 79.7W at 00Z (COADS).
   - 40 kt SW and 1009 mb at 29.4N 77.9W at 06Z (COADS).
   - 45 kt WSW and 1005 mb at 30.0N 79.6W at 12Z (COADS).
   - 45 kt SW and 1009 mb at 28.4N 78.6W at 12Z (COADS).
   - 45 kt NE and 1006 mb at 36.5N 75.0W at 18Z (COADS).
   - Multiple other observations of gale-force winds
3. Land highlights:
   - 10 kt W and 998 mb at Alma, GA at 00Z (Micro).

- 41 kt S (peak sustained wind) at Charleston, SC at 0118Z (SWO).
- 10 kt SW and 999 mb at Savannah Travis Field, GA at 08Z (SWO).
- 3 kt SW and 999 mb at Myrtle Beach, SC at 1157Z (SWO).
- 57 kt NE (peak sustained wind) at Cape Henry, VA at 1731Z (MWR).
- 13 kt NNE and 1000 mb at MCAF New River, NC at 1758Z (SWO).
- 7 kt N and 1000 mb at MCAS Cherry Point, NC at 1958Z (SWO).
- 33 kt NE, gusts to 47 kt, at Elizabeth City, NC at 2358Z (SWO).

4. Recon highlights:
   - Radar center fix at 33.9N 80.1W at 1117Z (SW).
   - Maximum estimated surface winds of 65 kt at 33.8N 78.7W at 13Z (Micro).
   - Radar center fix with estimated surface winds of 65 kt at 34.9N 78.4W at 19Z (SW).
5. Discussion:
   a. Reanalysis: During this time, the aforementioned cold front gradually merged with Dora as the former hurricane accelerated northeast over the Carolinas. Transition into an extratropical cyclone appears to have occurred around 12Z; this is 24 hours earlier than originally in HURDAT. Winds throughout the day are estimated at 60 kt; however, Dora may have become a hurricane-force extratropical low as recon estimated sustained hurricane-force winds at 13 and 19Z.

September 14:

1. Maps and old HURDAT:
   - HURDAT lists a 45 kt extratropical storm at 38.0N 71.5W at 12Z.
   - HWM depicts an extratropical cyclone of at most 1000 mb near 37.5N 71.5W at 12Z.
   - Microfilm analyzes an extratropical cyclone of at most 999 mb centered at 38.3N 71.0W at 12Z.
2. Ship highlights:
   - 50 kt NE and 1009 mb at 38.3N 74.0W at 00Z (COADS).
   - 45 kt SSW and 1007 mb at 32.5N 72.6W at 00Z (COADS).
   - 50 kt E and 1004 mb at 37.5N 74.4W at 03Z (Micro).
   - 45 kt SSW and 1008 mb at 33.0N 71.4W at 06Z (COADS).
   - 45 kt NE and 1001 mb at 39.6N 69.5W at 12Z (COADS).
   - 45 kt N and 998 mb at 40.5N 69.4W at 18Z (COADS).
   - 55 kt SW and 991 mb at 41.3N 66.1W at 22Z (COADS).
   - Numerous other gale and low pressure observations.
3. Land highlights:
   - 10 kt SW and 999 mb at Cape Hatteras, NC at 00Z (SWO).
   - 36 kt NE (peak sustained wind) at Nantucket, MA at 1633Z (MWR).
4. Recon highlights:
   - Penetration center fix with an observed surface pressure of 998 mb at 36.1N 74.6W at 0106Z (SW).
   - Penetration fix with estimated surface winds of 65 kt at 38.5N 71.8W at 1315Z (SW).

- Surface observation of 25 kt SE and 999 mb at 39.2N 70.8W at 1330Z (Micro).
- Penetration fix at 41.4N 67.2W at 1842Z (SW).

5. Discussion:
   a. Reanalysis: The extratropical system exited the Outer Banks of North Carolina early and emerged over the western Atlantic early on September 14. Several observations of storm-force winds on September 14 serve as the basis for maintaining 60 kt winds throughout the day, above the original HURDAT.

September 15:

1. Maps and old HURDAT:
   - HURDAT lists a 55 kt extratropical storm at 46.0N 59.0W at 12Z.
   - HWM depicts an extratropical cyclone of at most 988 mb near 45.5N 59.5W at 12Z.
   - Microfilm analyzes an extratropical cyclone of at most 996 mb centered at 46.0N 59.0W at 12Z.
2. Ship highlights:
   - 35 kt E and 995 mb at 43.3N 65.4W at 00Z (COADS).
   - 40 kt WSW and 1011 mb at 39.8N 61.0W at 00Z (COADS).
   - 50 kt S and 1010 mb at 38.1N 60.8W at 06Z (COADS).
   - 45 kt W and 1011 mb at 39.1N 60.1W at 12Z (COADS).
   - 50 kt NW and 1004 mb at 44.8N 59.8W at 18Z (COADS).
   - Numerous other gale and low pressure observations.
3. Land highlights:
   - Yarmouth, Nova Scotia (Micro).
     - 10 kt ENE and 1002 mb at 00Z.
     - 15 kt N and 1004 mb at 06Z.
   - 15 kt NE and 1003 mb at Halifax, Nova Scotia at 00Z (Micro).
   - 20 kt NW and 993 mb at Sydney, Nova Scotia at 12Z (Micro).
   - 10 kt SW and 996 mb on Sable Island at 12Z (Micro).
   - 30 kt ESE and 997 mb at Glovertown, Newfoundland at 18Z (Micro).
   - 5 kt ENE and 998 mb at Corner Brook, Newfoundland at 18Z (Micro).
4. Discussion:
   - Reanalysis: Ex-Dora skirted the southern coast of Nova Scotia on September 15. No gale-force winds were observed in Nova Scotia, though they may have impacted Sable Island. The storm was ultimately absorbed between 18Z on September 15 and 00Z on September 16 by a developing extratropical system to the west as it moved ashore in Newfoundland. Dissipation is now noted as 6 hours earlier than the original HURDAT.

September 16:

1. Maps and old HURDAT:
   - HURDAT lists a 55 kt extratropical storm at 49.0N 52.0W at 00Z; final position.
   - HWM depicts nothing of interest in relation to the remnants of Dora.

- Microfilm analyzes a broad low over Newfoundland with no defined center at 00Z; earlier analysis indicated a center near 49.5N 52.5W.

2. Ship highlights:
   - 35 kt SE and 1001 mb at 48.8N 49.1W at 00Z (COADS).
   - 30 kt SE and 997 mb at 51.2N 53.6W at 00Z (COADS).
3. Land highlights:
   - 15 kt SW and 996 mb at St. John's, Newfoundland at 00Z (Micro).
   - 15 kt W and 999 mb at Corner Brook,

Date	Original HURDAT Central Pressure	Evidence	Changes
Aug 29 12Z		COADS: 1007 mb at 12Z on the 29th COADS: 15 kt N and 1008 mb at 12Z on the 29th	1007 mb
Sep 1 18Z	998 mb	Penetration center fix: 998 mb around 1645Z on Sep 1st	Retained
Sep 2 12Z	996 mb	Penetration center fix: 996 mb around 1501Z on Sep 2nd	Retained
Sep 3 00Z		Penetration center fix: 989 mb around 2120Z on Sep 2nd	989 mb
Sep 3 06Z	984 mb	Duplicate pressure extending from 10Z recon fix	Removed
Sep 3 12Z	984 mb	Penetration center fix: 984 mb around 1000Z on Sep 3rd	Retained
Sep 4 00Z	981 mb	Penetration center fix: 981 mb around 2130Z on Sep 3rd	Retained
Sep 4 06Z	984 mb	Penetration center fix: 978 mb around 0715Z on Sep 4th	978 mb
Sep 4 12Z	976 mb	Penetration center fix: 976 mb around 1300Z on Sep 4th	Retained
Sep 4 18Z	973 mb	Penetration center fix: 973 mb around 1800Z on Sep 4th	Retained
Sep 5 12Z	971 mb	Penetration center fix: 971 mb around 1300Z on Sep 5th	Retained
Sep 5 18Z	960 mb	Penetration center fix: 960 mb around 1741Z on Sep 5th	Retained

Sep 6 06Z	942 mb	Penetration center fix: 942 mb around 0700Z on Sep 6th	Retained
Sep 6 18Z	958 mb	Penetration center fix: 958 mb around 1912Z on Sep 6th	Retained
Sep 7 12Z	964 mb	Penetration center fix: 959 mb around 1243Z on Sep 7th	959 mb
Sep 7 18Z	956 mb	Penetration center fix: 956 mb around 1850Z on Sep 7th	Retained
Sep 8 12Z		Penetration center fix: 962 mb around 1319Z on Sep 8th	962 mb
Sep 8 18Z	963 mb	Penetration center fix: 963 mb around 1855Z on Sep 8th	Retained
Sep 9 06Z	972 mb	Penetration center fix: 972 mb around 0700Z on Sep 9th	Retained
Sep 9 12Z	970 mb	Penetration center fix: 970 mb around 1247Z on Sep 9th	Retained
Sep 9 18Z	962 mb	Penetration center fix: 962 mb around 1900Z on Sep 9th	Retained
Sep 10 00Z	964 mb	Penetration center fix: 964 mb around 0112Z on Sep 10th	Retained
Sep 10 06Z	966 mb	St. Augustine, FL: 966 mb at 06Z during eye passage	Retained
Sep 11 06Z		Tallahassee FL: 10 kt NE and 992 mb at 0756Z	990 mb
Sep 12 00Z		Albany, GA: 10 kt ESE and 995 mb at 00Z	993 mb
Sep 12 06Z		Ft. Rucker Cairns, AL: 10 kt NW and 995 mb at 07Z	995 mb
Sep 12 12Z		Albany, GA: 10 kt ESE and 998 mb at 12Z	996 mb
Sep 12 18Z		Albany, GA: 15 kt NW and 998 mb at 18Z	995 mb
Sep 13 00Z		Alma, GA: 10 kt W and 998 mb at 00Z	996 mb
Sep 14 00Z	998 mb	Penetration center fix: 998 mb around 1330Z on Sep 14th	Retained

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43540 09/04/1964 M=13  7 SNBR= 939 ETHEL       XING=0 SSS=0
43540 09/04/1964 M=14  7 SNBR= 939 ETHEL       XING=0 SSS=0
                    **

43545 09/04*  0   0   0    0*177 354  25    0*180 370  35    0*184 384  35    0*
43545 09/04*  0   0   0    0*177 356  25    0*180 370  30    0*184 384  35    0*
                              ***                 **

43550 09/05*188 399  35    0*192 415  35    0*195 430  35    0*199 447  35 1005*
43550 09/05*188 399  35    0*192 415  35    0*195 430  35    0*199 447  35 1005*


43555 09/06*203 464  35    0*212 479  35    0*220 495  35    0*228 510  40    0*
43555 09/06*203 464  35    0*209 483  35    0*220 503  35 1008*233 523  40    0*
                           *** ***                 ***     **** *** ***

43560 09/07*235 525  45 1002*244 543  65    0*253 560  65 1007*261 575  65    0*
43560 09/07*243 538  40 1006*250 552  45    0*256 565  45    0*263 577  50    0*
           *** ***  ** **** *** ***  **      *** ***  ** **** *** ***  **

43565 09/08*269 590  65    0*273 597  65    0*275 603  70  999*276 608  75  986*
43565 09/08*269 588  50    0*272 595  50    0*274 602  55  999*275 606  65  986*
                ***  **      *** ***  **      *** ***  **      *** ***  **

43570 09/09*276 612  85    0*277 615  90  989*277 624  95  984*277 632 100    0*
43570 09/09*276 611  65    0*277 615  65  989*277 622  65  984*277 631  65    0*
                ***  **                 **          ***  **          *** ***

43575 09/10*276 640 100    0*274 648  95    0*272 656  90  976*273 660  85  977*
43575 09/10*276 640  70    0*274 648  70    0*273 654  75  976*274 658  75  977*
                   ***                 **      *** ***  **      *** ***  **

43580 09/11*274 662  80    0*278 663  80    0*282 665  75  983*289 668  75  977*
43580 09/11*275 660  75    0*278 662  70    0*282 664  70  983*288 667  75  977*
           *** ***  **          ***  **          ***  **      *** ***

43585 09/12*297 670  80    0*303 672  90    0*310 673  90  974*319 669  90  976*
43585 09/12*295 670  75    0*303 672  80    0*311 673  80  974*319 669  80  976*
           ***      **                 **      ***      **                 **

43590 09/13*329 661  90    0*340 649  85    0*355 631  85    0*370 613  80    0*
43590 09/13*329 661  80    0*341 649  85    0*355 632  90    0*370 614  90    0*
                   **      ***                 ***  **          ***  **

43595 09/14*384 594  80    0*400 572  80    0*415 548  75    0*429 519  75  969*
43595 09/14*384 594  90    0*400 572  90    0*415 548  90    0E429 519  85  969*
                   **                 **                 **      *          **  ***

43600 09/15*440 490  75    0*448 457  75    0*452 422  70    0E455 383  70    0*
43600 09/15E440 490  75    0E448 457  65    0E450 422  60    0E448 383  60    0*
           *               *          **      ****      **      ***      **

43605 09/16E458 348  70    0E459 307  70    0*  0   0   0    0*  0   0   0    0*
43605 09/16E444 348  55    0E440 315  50    0E435 290  45    0E425 275  40    0*
           ***      **      *** ***  **      **** ***  **      **** ***  **
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(The 17th is new to HURDAT)
43830 09/17E415 265 35   0E405 257 30   0E395 250 30   0* 0   0   0   0*

43610 HR

Significant Revisions:

1. Large west-northwestward adjustment to positions late on the 6th and early on the 6th based upon ship and aircraft observations.
2. Intensity reduced substantially from the 7th to the 10th based upon aircraft observations.
3. Peak intensity reduced from 100 kt (on the 9th and 10th) to 90 kt (on the 13th and 14th).
4. Intensity increased substantially on the 14th based upon aircraft observations.
5. Extratropical transition indicated one day earlier.
6. Large south-southwestward change in positions made on the 16th based upon ship observations.
7. Dissipation indicated to be a day later based upon ship observations.

Daily Summaries:

September 1:

1. Maps and old HURDAT:
   - HWM analyzes a weak area of low pressure near 14N 33W at 12Z.
   - Microfilm depicts nothing of interest at 12Z.
2. Discussion/Reanalysis: The origins of Hurricane Ethel are somewhat uncertain but the first indication of its incipient disturbance appears to be a weak low pressure system southwest of the Cape Verde Islands on this date.

September 2:

1. Maps and old HURDAT:
   - HWM analyzes a weak area of low pressure near 14N 35W at 12Z.
   - Microfilm states the presence of a tropical depression near 11N 28W at 12Z.
2. Discussion/Reanalysis: Microfilm analysis states the presence of a tropical depression near 11N 28W at 12Z; however, no data was available to verify this.

September 3:

1. Maps and old HURDAT:
   - HWM analyzes an area of low pressure of 1012 mb at most near 15.5N 36.5W at 12Z.
   - Microfilm depicts a tropical wave along an axis extending from 13N 32W to 19N 30.5W at 12Z.

September 4:

1. Maps and old HURDAT:
   - HWM analyzes an area of low pressure near 17N 40W at 12Z.
   - Microfilm depicts a tropical storm with an estimated central pressure of 1008 mb and 35 kt winds at 17.5N 38W at 12Z.
   - HURDAT lists a 35 kt tropical storm at 18N 37W at 12Z.
2. Discussion:
   - MWR: "The first evidence of the incipient stage of Ethel was a cloud mass observed by TIROS near 18N, 37W on September 4."
   - Reanalysis: The next indication of this system was a TIROS photograph (not available for the reanalysis) around 18Z on September 4, which placed the

circulation near 18N 37W. Likely based on this, HURDAT initiated the system 12 hours earlier as a tropical depression and strengthens Ethel to a tropical storm 6 hours later. Due to a lack of other evidence, this assessment is maintained in HURDAT, though the 12Z wind speed was reduced to 30 kt to show a smoother intensification process.

September 5:

1. Maps and old HURDAT:

- HWM analyzes an area of low pressure of 1008 mb at most near 19.5N 43W at 12Z.
- Microfilm depicts a 35 kt tropical storm with an estimated central pressure of 1005 mb at 20.5N 44.5W at 12Z.
- HURDAT lists a 35 kt tropical storm at 19.5N 43W at 12Z.

2. Aircraft highlights:

- Penetration center fix with a central pressure of 1005 mb at 20N 45W 1730Z (MWR/SW).

3. Discussion:

- MWR: "A reconnaissance aircraft dispatched to the suspicious area on the 5th found evidence of storm development but was unable to completely reconnoiter the area because of the extreme range from the operating base. A poorly-defined eye was located near 20N, 45W, with a central pressure of 1005 mb. Maximum observed winds were 25 mph south of the center but sea return and other radar echoes indicated much higher winds to the north."
- Reanalysis: The system traveled to the west-northwest with little change in strength on this date. Aircraft reconnaissance reached the system in the afternoon and made a fix with a central pressure of 1005 mb at 1730Z. A pressure of 1005 mb suggests maximum winds of 37 kt from the Brown et al. south of 25N pressure-wind relationship. This is used to maintain wind speeds of 35 kt throughout the day.

September 6:

1. Maps and old HURDAT:

- HWM analyzes a tropical storm of 1008 mb at most near 22N 49.5W at 12Z.
- Microfilm depicts a 45 kt tropical storm with an estimated central pressure of 1010 mb at 23.2N 50.5W at 12Z.
- HURDAT lists a 35 kt tropical storm at 22N 49.5W at 12Z.

2. Ship highlights:

- 35 kt E and 1014 mb at 26.0N 48.6W at 06z (COADS).
- 35 kt ESE and 1017 mb at 27.5N 49.6W at 15z (COADS).

3. Aircraft highlights:

- Penetration center fix with estimated winds of 45 kt and a central pressure of 1008 mb at 22.2N 50.7W at 1430Z (SW).
- Penetration center fix with estimated winds of 30 kt and a central pressure of 1006 mb at 24.2N 53.2W at 2113Z (SW).

4. Discussion:

- MWR: "Ethel moved on a course toward the west-northwest with little development during the next two days."
- Reanalysis: Some filling took place with recon reporting a central pressure of 1008 mb at 1430Z. A pressure of 1008 mb suggests maximum winds of 30 kt from the south of 25N Brown et al. pressure-wind relationship. Owing to notable acceleration of the system - possibly the result of interaction with the much larger Hurricane Dora to Ethel's west - the intensity is assessed slightly above the suggested value at 35 kt. This acceleration is a new

feature to HURDAT with a substantial longitudinal shift for 18Z on September 6 and 00Z on September 7.

September 7:

1. Maps and old HURDAT:

- HWM analyzes a tropical storm of 1008 mb at most near 25.5N 55.5W at 12Z.
- Microfilm depicts a 70 kt hurricane with an estimated central pressure of 1000 mb near 25.5N 56W at 12Z.
- HURDAT lists a 65 kt hurricane with a central pressure of 1007 mb at 25.3N 56W at 12Z.

2. Ship highlights:

- 35 kt SE and 1016 mb at 26.9N 50.5W at 00z (COADS).

3. Aircraft highlights:

- Center fix with 1006 mb at 24.6N 54.6W at 0105Z (SW).
- Radar center fix at 25.3N 56.3W at 1107Z (SW).
- Penetration center fix with a 5 nmi wind eye and maximum estimated winds of 70 kt at 25.8N 56.4W at 1357Z (SW).
- Radar center fix at 26.6N 58.4W at 1948Z (SW).

4. Discussion:

- MWR: "During this period hurricane Dora was located approximately 575 mi to the west and Ethel was moving faster than Dora; therefore forecasters considered it possible that Ethel much be absorbed in the circulation of the much larger and more intense Dora, and lose its identity. However, on September 7, a period of intensification began, establishing Ethel as a hurricane and eliminating the probability of absorption by Dora."
- Preliminary report: "Ethel and Dora seemingly presented an opportunity to observe the effect of the interaction of circulations of adjacent cyclones on their motions [the Fujiwhara effect]. However, other steering influences during this period were quite complex and data were limited so that any interaction that occurred cannot be exclusively demonstrated."
- Reanalysis: Ethel only very gradually intensified as recon reported a central pressure of 1007 mb at 0105Z. A pressure of 1002 mb suggests maximum winds of 32 kt from the south of 25N Brown et al. pressure wind-relationship. Based on the storm's forward speed, an intensity of 40 kt is chosen for 00Z. Later on, the system began decelerating and turning more to the west. A significant reduction of intensity is made at 06Z from 65 kt to 45 kt based on the aforementioned data. No further central pressures were available on this date.

September 8:

1. Maps and old HURDAT:

- HWM analyzes a hurricane of 1008 mb at most near 27.5N 60.5W at 12Z.
- Microfilm depicts an 80 kt hurricane with a central pressure of 999 mb near 28N 60W at 12Z.
- HURDAT lists a 70 kt hurricane with a central pressure of 999 mb at 27.5N 60.3W at 12Z.

2. Ship highlights:

- 45 kt ESE and 1002 mb at 29.4N 60.6W at 18Z (COADS).
- 70 kt NW and 1007 mb at 28.6N 59.9W (micro/COADS).

3. Aircraft highlights:

- Radar center fix at 27.3N 59.5W at 0800Z (SW).
- Penetration center fix with estimated winds of 80 kt, an eye diameter of 15 nmi, and a central pressure of 999 mb at 27.8N 60.5W at 1330Z (SW).

- Penetration center fix with estimated winds of 60 kt, an elliptical eye of 8 nmi by 20 nmi in diameter, and a central pressure of 986 mb at 27.8N 60.9W at 1926Z (SW).

4. Discussion/Reanalysis: No intensity observations were available early on the 8th, so the 50 kt intensity from late on the 7th is maintained, as the system began to decelerate to the southwest of Bermuda. Satellite imagery around 12Z shows Ethel as a heavily sheared system with a partially exposed circulation along the northwest side. Reconnaissance data shows notable deepening of the system that day with the pressure dropping from 999 mb (1330Z fix) to 986 mb (1926Z fix). A pressure of 986 mb suggests maximum winds of 65 kt from the north of 25N Brown et al. pressure-wind relationship. Additionally, recon reported an elliptical eye of 20 x 8 nmi, yielding an RMW of roughly 15 nmi (slightly smaller than the climatological average of 20 nmi). Based on these factors and Ethel's sluggish movement, an intensity of 65 kt is chosen for 18Z, 10 kt lower than HURDAT. A ship reporting 70 kt winds around this time also provides evidence for hurricane intensity.

September 9:

1. Maps and old HURDAT:

- HWM analyzes a hurricane of 1008 mb at most near 28N 62W at 12Z.
- Microfilm depicts a tropical cyclone of 1014 mb at most near 27.5N 61.4W at 12Z.
- HURDAT lists a 95 kt hurricane with a central pressure of 984 mb at 27.7N 62.4W at 12Z.

2. Ship highlights:

- 35 kt E and 1002 mb at 29.8N 61.7W at 00Z (COADS).
- 35 kt SSE and 1012 mb at 27.8N 59.1W at 00Z (COADS).
- 35 kt S and 1011 mb at 26.1N 61.1W at 12Z (COADS). 35 kt S and 1012 mb at 25.8N 61.9W at 18Z (COADS).

3. Aircraft highlights:

- Penetration center fix with estimated winds of 70 kt, an eye diameter of 17 nmi, and a central pressure of 989 mb at 27.5N 61.6W at 0700Z (SW).
- Penetration center fix with estimated winds of 110 kt, an elliptical eye of 12 nmi by 17 nmi in diameter, and a central pressure of 984 mb at 27.7N 61.9W at 1036Z (SW).
- Radar fix with an eye diameter of 32 nmi at 27.6N 62.5W at 1300Z (SW).
- Radar fix with an elliptical eye of 17 nmi in diameter at 27.7N 63.3W at 1900Z (SW).

4. Discussion/Reanalysis: Slight acceleration westward and intensification took place on this date. Major changes to intensity are implemented including a 35 kt drop from 100 kt to 65 kt at 18Z. A recon center fix with 989 mb was made at 0700Z; an eye diameter of 17 nmi was reported at this time. A pressure of 989 mb suggests maximum winds of 61 kt from the north of 25N Brown et al. pressure-wind relationship. An intensity of 60 kt is chosen for 06Z based on the counteracting effects of the storm's small size and slow movement. A later recon fix with 984 mb was made at 1036Z. A pressure of 984 mb suggests maximum winds of 68 kt from the north of 25N Brown et al. pressure-wind relationship. Based on this, Ethel is classified as a hurricane with 65 kt winds starting at 12Z on September 9. The intensification to hurricane status is now shown 54 hours later than originally in HURDAT.

September 10:

1. Maps and old HURDAT:

- HWM analyzes a hurricane of 1000 mb at most near 27.5N 60.5W at 12Z.
- Microfilm depicts a tropical cyclone of 1011 mb at most near 27.2N 66W at 12Z.
- HURDAT lists a 90 kt hurricane with a central pressure of 976 mb at 27.2N 65.6W at 12Z.

2. Ship highlights:

- 35 kt NW and 1013 mb at 26.4N 65.8W at 00Z (COADS).
- 35 kt S and 1009 mb at 26.5N 64.3W at 06Z (COADS).
- 40 kt S and 1013 mb at 27.4N 62.9W at 12Z (COADS).
- 35 kt E and 1016 mb at 28.5N 61.7W at 18Z (COADS).

3. Aircraft highlights:

- Radar center fix with a 20 nmi diameter eye at 27.5N 64.3W at 0055Z (SW).
- Radar center fix at 27.5N 64.8W at 0700Z (SW).
- Penetration center fix with flight level winds at 10,000 ft of 75 kt, an elliptical eye of 19 nmi by 28 nmi in diameter, and a central pressure of 976 mb at 27.1N 65.7W at 1205Z (SW).
- Penetration center fix with estimated winds of 90 kt, a 20 nmi diameter eye, and a central pressure of 977 mb at 27.7N 65.6W at 1920Z (SW).

4. Discussion:

- MWR: "The deepening persisted through the 10th when a central pressure of 977 mb and maximum observed winds of 100 mph were reported by reconnaissance aircraft. The hurricane moved very slowly westward on the 10th, then turned northward, and began to accelerate, with the center passing 100 mi west of Bermuda on the afternoon of September 12. Gusts of about 70 mph were reported in the islands during the afternoon and evening and gales continued through the night."
- Reanalysis: Slow intensification took place with the storm's motion dipping just south of due west. A center fix with 976 mb and an elliptical eye of 19 x 28 nmi, yielding an RMW of 18 nmi, was made at 1205Z. A pressure of 976 mb suggests maximum winds of 77 kt from the north of 25N Brown et al. pressure-wind relationship. An intensity of 75 kt is chosen based on these data. Major changes to wind speed are implemented for 00Z, 06Z, and 12Z based on the fix of 984 mb on the 9th and the 976 mb fix on the 10th.

September 11:

1. Maps and old HURDAT:

- HWM analyzes a hurricane of 1000 mb at most near 28N 66W at 12Z.
- Microfilm depicts a tropical cyclone of 1011 mb at most near 28N 66W at 12Z.
- HURDAT lists a 75 kt hurricane with a central pressure of 983 mb at 28.2N 66.5W at 12Z.

2. Ship highlights:

- 50 kt ENE and 1007 mb at 30.4N 65.9W at 18Z (COADS).
- 40 kt SE and 1011 mb at 30.1N 64.6W at 18Z (COADS).

3. Aircraft highlights:

- Radar center fix at 27.5N 66.1W at 0115Z (SW).
- Radar center fix at 27.7N 66.1W at 0630Z (SW).
- Penetration center fix with an 18 nmi diameter eye and a central pressure of 983 mb at 28.2N 66.4W at 1300Z (SW).
- Penetration center fix with a 12 nmi diameter eye and a central pressure of 977 mb at 28.6N 66.7W at 1630Z (SW).
- Radar center fix with a 20 nmi diameter eye at 29.1N 66.8W at 2218Z (SW).

4. Station highlights:

- (Bermuda): Radar center fix at 29.1N 66.5W at 2230Z (SW).

5. Discussion/Reanalysis: A slow turn to the north-northwest took place alongside fluctuations in intensity. Slight weakening to 70 kt at 06Z and 12Z is shown based on a recon fix of 983 mb at 1300Z.

September 12:

1. Maps and old HURDAT:

- HWM analyzes a hurricane of 996 mb at most near 31N 67W at 12Z.
- Microfilm depicts a tropical cyclone fixed at 31N 67.4W with a central pressure of 974 mb at 12Z.
- HURDAT lists a 90 kt hurricane with a central pressure of 974 mb at 31N 67.3W at 12Z.

2. Ship highlights:

- 50 kt SE and 1004 mb at 30.1N 65.2W at 00Z (COADS).
- 45 kt SSE and 1006 mb at 29.5N 65.0W at 06Z (COADS).
- 45 kt S and 1012 mb at 29.3N 65.1W at 12Z (COADS).

3. Aircraft highlights:

- Radar center fix with a 15 nmi diameter eye at 30.2N 67.5W at 0428Z (SW).
- Penetration center fix with estimated winds of 95 kt, a 30 nmi diameter eye, and a central pressure of 974 mb at 31.2N 67.3W at 1300Z (SW).
- Penetration center fix with estimated winds of 90 kt, a 20 nmi eye diameter, and a central pressure of 976 mb at 32.0N 66.9W at 1800Z (SW).

4. Station highlights:

- 40 kt S and 1007 mb at 18Z in Bermuda (Micro.).
- Gust of about 60 kt in Bermuda during the afternoon, likely between 18Z and 00Z (MWR).
- Radar center fix at 29.4N 66.5W at 0015Z (SW).
- Radar center fix at 30.4N 66.0W at 0630Z (SW).
- Radar center fix with a 44 nmi eye diameter at 31.2N 67.2W (SW).
- Radar center fix at 31.8N 66.9W at 1810Z (SW).

5. Discussion:

- *Beware the Hurricane!*: "'Ethel' was a hurricane that required careful watching. She threatened [Bermuda] for more than a week, playing a cat and mouse game in her erratic movements, and keeping Bermudians on tenterhooks with shop windows shuttered, planes grounded or flown out, boats carefully moored. Eventually the centre of this hurricane passed on September 12th with its parimetric winds, of less than hurricane force, battering the islands for some hours during the late afternoon and evening."
- Reanalysis: Re-intensification took place as represented by decreasing central pressures reported by recon late on the 11th; however, winds are still assessed below the original HURDAT for all of September 12. Around 12Z, Ethel began turning toward the northeast and approached Bermuda. Tropical storm-force winds were observed in the territory by 18Z.

September 13:

1. Maps and old HURDAT:

- HWM analyzes a hurricane of 1000 mb at most near 35.5N 63W at 12Z.
- Microfilm depicts a tropical cyclone of 1002 mb at most near 35.5N 63W at 12Z.
- HURDAT lists a 85 kt hurricane at 35.5N 63.1W at 12Z.

2. Ship highlights:

- 40 kt S and 1012 mb at 32.7N 62.7W at 06Z (COADS).
- 100 kt S at 33.2N 65.1W at 06Z (micro).
- 70 kt WSW at 33.2N 65.0W at 12Z (micro).

- 40 kt SE and 1009 mb at 37.7N 61.9W at 12Z (COADS).
- 40 kt S and 1012 mb at 35.6N 59.9W at 12Z (COADS).
- 40 kt SSE and 1014 mb at 34.8N 59.0W at 18Z (COADS).

3. Aircraft highlights:

- Radar center fix at 34.5N 64.8W at 0730Z (SW).
- Radar center fix with 10 nmi diameter eye at 37.3N 61.3W at 1910Z (SW).

4. Station highlights:

- 45 kt S and 1004 mb at 00Z in Bermuda (Micro.).
- 40 kt S and 1004 mb at 06Z in Bermuda (Micro.).
- Radar center fix with a 14 nmi diameter eye at 32.8N 66.1W at 0015Z (SW).
- Radar center fix with a 16 nmi diameter eye at 34.1N 64.9W at 0610Z (SW).
- Radar center fix with a 13 nmi diameter eye at 34.9N 63.9W at 1030Z (SW).

5. Discussion:

- MWR: "Ethel moved rapidly northeastward after passing Bermuda and maintained hurricane force during the conversion to an extratropical cyclone near 45N, 40W on September 15."
- Reanalysis: Ethel made its closest approach to Bermuda around 00Z, passing roughly 75 nmi to the northwest. Peak winds there reached 45 kt at this time with gusts to 60 kt. At 06Z, a ship located at 33.2N, 65.1W reported 100 kt S winds. Due to the vessel being 55 nmi from Ethel's center, well outside the estimated RMW, and continued hurricane-force winds at 12Z as Ethel moved even farther away, this observation is discounted. Radar data from Bermuda indicated that Ethel's eye gradually shrank to 14-16 nmi in diameter early on September 13 and further to 13 nmi by 1030Z. Based on the tightening of the eye and acceleration northeast, it is estimated that Ethel reached 85 kt intensity by 06Z, the same as originally in HURDAT. Additional intensification likely took place thereafter as recon reported an even smaller eye diameter of 10 nmi, but without making a penetration center fix. This eye size yields an approximate RMW of 8 nmi, considerably smaller than the climatological average.

September 14:

1. Maps and old HURDAT:

- HWM analyzes a hurricane of 1000 mb at most near 41.5N 55W at 12Z.
- Microfilm depicts an elongating tropical cyclone of 1008 mb at most near 41.5N 56W at 12Z.
- HURDAT lists a 75 kt hurricane at 41.5N 54.8W at 12Z.

2. Ship highlights:

- 50 kt S and 1012 mb at 37.8N 57.1W at 00Z (COADS).
- 40 kt NE and 1012 mb at 41.4N 60.9W at 00Z (COADS).
- 50 kt SW and 1011 mb at 37.8N 57.2W at 06Z (COADS).
- 40 kt NE and 1013 mb at 42.9N 60.1W at 12Z (COADS).
- 40 kt SSW and 1011 mb at 40.3N 49.8W at 18Z (COADS).
- 45 kt SSE and 990 mb at 43.0W 51.0W at 18Z (micro).
- 40 kt E and 998 mb at 41.8N 64.3W at 19Z (COADS).

3. Aircraft highlights:

- Radar center fix at 38.6N 59.3W at 0040Z (SW).
- Penetration center with estimated winds of 90 kt, a 25 nmi diameter eye, and a central pressure of 969 mb at 42.3N 52.7W at 1648Z (SW).

4. Discussion/Reanalysis: A final recon mission was flown into the system as it was transitioning into an extratropical cyclone late on this date. A center fix with 969 mb, estimated surface winds of 90 kt, and a 25 nmi eye was made at 1648Z. A pressure of 969 mb suggests maximum winds of 83 kt from

the north of 35N Landsea et al. pressure-wind relationship. Based these data, Ethel is estimated to have peaked between 18Z on September 13 and 12Z on September 14 with winds of 90 kt. Due to a lack of direct observations at this time, there is uncertainty in the accuracy of this peak and Ethel may have briefly reached Category 3 status early on September 14. Transition into an extratropical cyclone began during this time as Ethel interacted with a frontal boundary to its north. Ethel is estimated to have become fully extratropical and merged with the front by 18Z on September 14 with winds of 85 kt, 24 hours earlier than originally in HURDAT. The estimated intensity stems from the aforementioned recon fix at 1648Z. It is possible that the transition took place by 12Z, but data are ambiguous at that time.

September 15:

1. Maps and old HURDAT:
- HWM analyzes a frontal low of 996 mb at most near 45.5N 42W at 12Z.
- Microfilm depicts a frontal low of 1002 mb at most near 45N 41W at 12Z.
- HURDAT lists a 70 kt hurricane at 45.2N 42.2W at 12Z.

2. Ship highlights:
- 55 kt SW at 43.0N 48.4W at 00Z (COADS).
- 50 kt SSW and 986 mb at 44.1N 46.5W at 03Z (COADS).
- 40 kt SW and 1000 mb at 42.6N 44.1W at 06Z (COADS).
- 35 kt SSW and 999 mb at 44.0N 40.9W at 09Z (COADS).
- 50 kt SW and 1000 mb at 44.0N 41.0W at 12Z (COADS).
- 40 kt NNW and 1005 mb at 44.0N 41.0W at 18Z (COADS).
- 35 kt SSW and 998 mb at 43.5N 33.6W at 18Z (COADS).

3. Discussion/Reanalysis: Steady weakening ensued following extratropical transition, with winds subsiding below hurricane-force by 12Z. This weakening is a new feature introduced to HURDAT.

September 16:

1. Maps and old HURDAT:
- HWM analyzes an extratropical cyclone of 1004 mb at most near 43N 27.5W at 12Z.
- Microfilm depicts a broad area of low pressure west of Ireland with no defined center.
- HURDAT lists a 70 kt extratropical cyclone at 45.9N 30.7W at 06Z.

2. Ship highlights:
- 35 kt WSW and 1013 mb at 40.5N 37.1W at 00Z (COADS).
- 40 kt N and 1014 mb at 42.3N 37.4W at 06Z (COADS).
- 40 kt WNW and 1013 mb at 40.4N 33.6W at 06Z (COADS).

3. Discussion/Reanalysis: For unknown reasons, the original HURDAT erroneously maintains Ethel as a hurricane-force non-tropical system through 06Z on September 16 when it terminates the cyclone. Early on this date, Ethel began to detach from the frontal boundary and changed course to the east-southeast. The system acquired a more southerly trajectory into September 17 as it continued to diminish.

September 17:

1. Maps and old HURDAT:
- HWM analyzes a weak area of low pressure of 1020 mb at most near 40N 25.5W at 12Z.

2. Ship highlights:
- 35 kt SW and 1019 mb at 39.2N 24.2W at 00Z (COADS).

3. Discussion/Reanalysis: A final gale observation was made at 00Z and the remnant of Ethel is estimated to have weakened below gale-force at 06Z. Dissipation is shown after 12Z to the northwest of the Azores, 30 hours later than originally in HURDAT, with ship observations indicating Ethel lost a closed circulation by 18Z.

Date	Original HURDAT Central Pressure	Evidence	Changes
Sep 5 18Z	1005 mb	Penetration center fix: 1005 mb around 1730Z on Sep 5th	Retained
Sep 6 12Z		Penetration center fix: 1008 mb around 1430Z on Sep 6th	1008 mb
Sep 7 00Z	1002 mb	Penetration center fix: 1006 mb around 0105Z on Sep 7th	1006 mb
Sep 7 12Z	1007 mb	Penetration center fix: 1000 mb around 1357Z on Sep 7th	1000 mb
Sep 8 12Z	999 mb	Penetration center fix: 999 mb around 1330Z on Sep 8th	Retained
Sep 8 18Z	986 mb	Penetration center fix: 986 mb around 1926Z on Sep 8th	
Sep 9 06Z	989 mb	Penetration center fix: 989 mb around 0700Z on Sep 9th	
Sep 9 12Z	984 mb	Penetration center fix: 984 mb around 1040Z on Sep 9th	
Sep 10 12Z	976 mb	Penetration center fix: 976 mb around 1205Z on Sep 10th	
Sep 10 18Z	977 mb	Penetration center fix: 977 mb around 1920Z on Sep 10th	
Sep 11 12Z	983 mb	Penetration center fix: 983 mb around 1300Z on Sep 11th	
Sep 11 18Z	977 mb	Penetration center fix: 977 mb around 1630Z on Sep 11th	
Sep 12 12Z	974 mb	Penetration center fix: 974 mb around 1300Z on Sep 12th	
Sep 12 18Z	976 mb	Penetration center fix: 976 mb around 1800Z on Sep 12th	
Sep 14 18Z	969 mb	Penetration center fix: 969 mb around 1648Z on Sep 14th	

Sources: NHC microfilm maps (Micro.), the Historical Weather Maps series (HWM), the COADS ship database, Monthly Weather Review (MWR), Mariners Weather Log (MWL), and the NHC Storm Wallets (SW).

Tropical Storm Florence [September 5-10, 1964] – AL081964

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43615 09/05/1964 M= 6  8 SNBR= 940 FLORENCE    XING=0 SSS=0

43620 09/05*  0   0   0    0*  0   0   0    0*  0   0   0    0*163 197  20    0*
43620 09/05*  0   0   0    0*145 180  30 1004*150 189  30    0*154 200  30    0*
                             *** ***  ** **** *** ***  **      *** ***  **

43625 09/06*165 210  20    0*168 223  20    0*171 235  20    0*175 245  25    0*
43625 09/06*158 212  30    0*163 224  30    0*168 235  30 1003*175 245  30    0*
           *** ***  **      *** ***  **      *** ***  ** ****          **

43630 09/07*181 255  30    0*189 265  30    0*198 275  30    0*206 285  30    0*
43630 09/07*181 255  35    0*189 265  35    0*198 275  35    0*206 285  35    0*
                     **                **                **                **

43635 09/08*214 294  35    0*225 299  40    0*238 299  40    0*252 297  40    0*
43635 09/08*214 294  40    0*226 299  40    0*242 296  40    0*260 290  40    0*
                     **      ***             *** ***         *** ***

43640 09/09*267 293  40    0*282 287  40    0*297 282  40    0*312 277  35    0*
43640 09/09*280 283  40    0*295 277  40    0*305 275  35    0*312 275  35    0*
           *** ***          *** ***          *** ***  **          ***

43645 09/10*326 272  35    0*335 260  35    0*  0   0   0    0*  0   0   0    0*
43645 09/10*318 275  30 1007*320 275  30    0*  0   0   0    0*  0   0   0    0*
           *** ***  ** **** *** ***  **

43650 TS
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Significant Revisions:

1. Genesis indicated to be 12 hours earlier based upon ship and coastal observations.
2. Tropical storm intensity is indicated a day earlier based upon station observations.
3. A large northeastward shift in location is indicated on the 9th based upon ship observations.
4. A large southwestward shift in location is indicated on the 10th based upon ship observations and continuity with earlier positions.

Daily Summaries:

September 4:

1. Maps and old HURDAT:

- HWM analyzes a closed area of low pressure of 1008 mb at most near 14N 12W.

2. Discussion:

- MWR: "Weather conditions reported in the Cape Verdes and by nearby ships indicated that a strong perturbation on the ITC[Z] was moving westward off French West Africa on the 4th and 4th of September."

- Reanalysis: Late on September 4, a strong tropical wave emerged off the west coast of Africa.

September 5:

1. Maps and old HURDAT:

- HWM analyzes an area of low pressure of 1008 mb at most near 15N 20W.
- Microfilm analyzes a "depression" of 1008 mb at most near 15N 17W.
- HURDAT lists a tropical depression starting at 18z at 16.3N 19.7W with winds of 20 kt.

2. Ship highlights:

- 10 kt W and 1005 mb at 14.2N 17.8W at 06Z (COADS).

3. Discussion/Reanalysis: Available data indicate that the system either already had or quickly acquired a surface circulation within hours of moving offshore. Vessels traveling along the coast of Africa provided excellent data for locating a closed circulation by 06Z on September 5. Genesis as a tropical depression is noted at this time, just 40 nmi west-southwest of Dakar, Senegal, and 12 hours earlier than originally in HURDAT. A ship passing near the circulation reported 10 kt W and 1005 mb, providing a central pressure of 1004 mb. A pressure of 1004 mb suggests maximum winds of 39 kt from the south of 25N Brown et al. pressure-wind relationship. Based on the system being embedded in the low pressures of the monsoon trough and lack of notable winds from nearby ships, an intensity of 30 kt is chosen at initiation. Wind speeds at 18Z are increased from 20 kt to 30 kt based on the aforementioned data.

September 6:

1. Maps and old HURDAT:

- HWM analyzes a tropical storm of 1004 mb at most near 17N 24W.
- Microfilm analyzes a tropical storm with maximum estimated winds of 45 kt and a central pressure of 1002 mb near 17.8N 23.5W.
- HURDAT lists a tropical depression at 17.1N 23.5W with winds of 20 kt.

2. Station highlights:

- 10 kt SSW and 1004 mb at 16.8N 22.9W on Cape Verde at 12z (micro).
- 20 or 30 kt N and 1006 mb at 16.9N 25.0W on Cape Verde at 12z (micro).

3. Discussion:

- MWR: "On the morning of the morning of the 6th there was a low pressure area, estimated at 1002 mb. (29.59 in.), just north of the Cape Verdes. Although data were sparse, there was some evidence of cold air aloft over the surface Low. It appeared to be a very wet system but with highest winds probably no more than 25 m.p.h. at this time. The Low was moving northwestward at about 10 m.p.h. Some intensification occurred later although indications are that highest winds were never greater than about 50 m.p.h."
- Reanalysis: The newly formed depression tracked steadily west-northwest toward the Cape Verde Islands with no deepening taking place on September 6. Between 06Z and 12Z, the center of Florence passed just a few miles south of the island of Sal. Though a complete record of observations from the island is not available, a pressure of 1004 mb with 10 kt SSW winds was reported at 12Z. Based on this observation, a central pressure of 1003 mb is added to HURDAT at that time. A pressure of 1003 mb suggests maximum winds of 41 kt from the Brown et al. pressure-wind relationship. Again because of low environmental pressures, the intensity is assessed at 30 kt.

September 7:

1. Maps and old HURDAT:

- HWM analyzes a tropical storm of 1004 mb at most near 20.5N 28W.

- Microfilm analyzes an area of low pressure with maximum estimated winds of 45 kt and a central pressure of 1002 mb at an uncertain 19.5N 27.8W.
- HURDAT lists a tropical depression at 19.8N 27.5W with winds of 30 kt.

2. Ship highlights:

- 30 kt SSE and 1005 mb at 19.2N 24.1W at 00z (COADS).

3. Discussion/Reanalysis: After clearing the Cape Verde Islands late on September 6 and turning to the northwest, a ship of 30 kt and 1005 mb (suggesting central pressure of at most 1002 mb) at 00Z provides evidence that the system had become a 35-kt tropical storm at that time. Further data is sparse for September 7 and no clear picture on the subsequent development of Florence can be made. Based on the original strengthening trend shown in HURDAT, Florence is estimated to have attained maximum winds of 40 kt by 00Z as it began turning due north.

September 8:

1. Maps and old HURDAT:

- HWM analyzes a tropical storm of 1004 mb at most near 25N 29.5W.
- Microfilm analyzes Tropical Storm Florence with a pressure of 1011 mb at most near 23N 30W.
- HURDAT lists a tropical storm at 23.8N 29.9W with winds of 40 kt.

2. Ship highlights:

- 35 kt NE at 26.4N 28.8W at 06z (COADS).
- 35 kt SE at 26.2N 28.5W at 12z (COADS).
- 35 kt SE and 1009 mb at 27.1N 27.9W at 12z (COADS).

3. Discussion/Reanalysis: Two ships later encountered the system on this date and reported 35 kt southwesterly winds at 12Z. This serves as verification for maintaining winds of 40 kt, though the true peak of Florence will likely never be known. Acceleration to the north-northeast occurred later that day.

September 9:

1. Maps and old HURDAT:

- HWM analyzes a tropical storm of 1008 mb at most near 29N 28W.
- Microfilm analyzes a tropical cyclone with a pressure of 1011 mb at most near 31.7N 27.5W.
- HURDAT lists a tropical storm at 29.7N 28.2W with winds of 40 kt.

2. Ship highlights:

- 35 kt SE and 1013 mb at 28.6N 26.0W at 00z (COADS).
- 15 kt W and 1013 mb at 24.7N 31.6W at 00Z (COADS).

3. Discussion:

- MWR: "Florence headed in a northerly direction toward the Azores but weakened on the night of September 9-10. An Air Force tanker found only an area of squalls south of the islands during the early morning hours of September 10."
- Reanalysis: Two vessels to the northwest and northeast of the circulation assisted in locating the center at 00Z resulting in a substantial shift northeast from HURDAT. Subsequent smoothing of the track yielded substantial changes at 06Z and 12Z. According to microfilm analysis, a satellite image around 18Z on September 9 was used to estimate the center of Florence; however, this image was not available at the time of reanalysis.

September 10:

1. Maps and old HURDAT:

- HWM analyzes an open area of low pressure near 33N 23W.

- Microfilm analyzes a tropical cyclone with a pressure of 1011 mb at most near 32.8N 28.8W.
- HURDAT lists the final position of Tropical Storm Florence at 06z at 33.5N 26.0W with winds of 35 kt.

2. Discussion/Reanalysis: A central pressure of 1007 mb is added at 00Z on September 10 based on a ship observation of 20 kt SW and 1009 mb. A pressure of 1007 mb suggests maximum winds of 30 kt from the north of 25N Brown et al. pressure-wind relationship. Based on this, Florence is estimated to have weakened to a 30 kt depression at this time. What little data was available during the remainder of the day indicates that the system began to stall well to the south of the Azores. A final significant change to the track is made to remove an unrealistic northeastward acceleration and maintain a slow northward pace. Dissipation is shown after 06Z, in agreement with the original HURDAT. It should be noted that Florence likely continued as a tropical cyclone for at least another day; however, data remains ambiguous and it could not be determined if a closed center existed.

September 11:

1. Maps and old HURDAT:

- HWM analyzes an open area of low pressure near 35N 19W.

September 12:

1. Maps and old HURDAT:

- HWM analyzes an open area of low pressure near 41N 20W.

September 13:

2. Maps and old HURDAT:

- The aforementioned low pressure analyzed by HWM is absorbed by an approaching cold front by September 13.

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

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

Hurricane Gladys [September 13-25, 1964] – AL091964

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43655 09/13/1964 M=13  9 SNBR= 941 GLADYS      XING=0 SSS=0

43660 09/13*  0   0   0    0*147 443  30    0*154 460  55    0*161 474  60    0*
43660 09/13*  0   0   0    0*147 445  55    0*154 460  55    0*162 475  55    0*
                           ***  **                          ***  ***  **

43665 09/14*170 490  60    0*179 506  60    0*188 521  85  992*196 535  85  994*
43665 09/14*170 490  60  997*179 505  60    0*188 520  65  992*196 534  65  994*
                         ***     ***           ***  **          ***  **

43670 09/15*202 546  80    0*208 554  75    0*213 561  70  996*218 572  70  992*
43670 09/15*202 545  65  994*207 554  60    0*212 562  60  996*217 571  60  992*
               ***  **  *** ***      **      ***  ***  **      ***  ***  **
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43675 09/16*223 582  70    0*227 591  70    0*231 600  70   995*234 610  75    0*
43675 09/16*222 581  60    0*227 591  65    0*230 600  70   986*233 609  75    0*
           *** ***  **               **      ***              *** *** ***

43680 09/17*238 621  75 1001*242 631  85    0*246 641 120   954*250 651 125  945*
43680 09/17*237 620  75    0*242 631  85  974*245 640 105   954*250 651 115  945*
           *** ***     ****              *** *** *** ***                ***

43685 09/18*254 659 125  951*258 665 125  951*261 671 120   952*264 677 120  953*
43685 09/18*254 659 110  951*258 665 110  951*261 671 110   952*264 677 110  953*
                   ***              ***              ***                ***

43690 09/19*268 683 115  962*271 688 110  951*273 692 110   960*276 696 105  962*
43690 09/19*267 682 110  947*270 687 110  951*273 691 100   960*276 695 100  962*
           *** *** ***  *** *** ***                ***  ***           *** ***  ***

43695 09/20*279 698 100  962*284 698  95  965*290 698  95   967*294 697  90  964*
43695 09/20*279 696 100  962*284 697  95  965*289 697  85   967*294 696  85  964*
               ***              ***          ***  ***  **           ***

43700 09/21*298 696  90  964*304 696  85    0*311 698  85   980*322 704  80  977*
43700 09/21*298 695  80  964*304 695  75  969*312 697  65   980*323 702  65  977*
               ***  **          ***  **  *** *** ***  **           ***  **

43705 09/22*331 710  80  984*335 714  75  980*339 718  75   984*343 721  70  982*
43705 09/22*331 708  65  984*337 713  65  980*339 718  65   984*342 722  65  982*
               ***  **      *** *** **                **       *** ***  **

43710 09/23*348 724  75  980*355 724  75  977*365 719  75   982*377 707  70  974*
43710 09/23*348 724  70  979*356 722  75  977*364 718  75   982*377 707  80  974*
                   **  *** *** ***          ***  ***                     **


43715 09/24*392 690  65  980*409 669  65  982*428 642  65   973E447 603  60  990*
43715 09/24*392 690  75  980*409 669  75  982*428 642  75     0*447 598  70    0*
                   **                  **                ****    ***  **  ***

43720 09/25E475 549  60    0*  0   0   0    0*  0   0   0    0*  0   0   0    0*
43720 09/25E475 549  60    0*  0   0   0    0*  0   0   0    0*  0   0   0    0*

43725 HR
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U.S. Tropical Storm Impact

September 23 – 00Z 34.8N 72.4W – 40 kt - North Carolina

Significant Revisions:

1. Tropical storm intensity indicated 6 hours earlier; genesis unknown; major increase to winds at 06Z on September 13.
2. Major reduction to intensity on September 14, 15, 17, 18, 19, 20, 21, and 22 including a downgrade to tropical storm status on September 15-16.
3. Extratropical phase delayed by 6 hours

Daily Metadata:

September 8-12:

3. Maps and old HURDAT:
   - HURDAT does not list an organized storm on these days.
   - HWM depicts nothing of interest on these days.
   - Microfilm shows nothing of interest on these days.
4. Discussion:
   a. MWR: "A weak low pressure system that was first observed off the west coast of Africa on September 9 may have been the first indication of the disturbance that later developed into hurricane Gladys."

September 13:

1. Maps and old HURDAT:
   - HURDAT lists a 55 kt tropical storm at 15.4N, 46.0W at 12Z.
   - HWM analyzes hurricane of at most 1004 mb near 15.5N, 46W at 12Z.
   - Microfilm depicts Gladys near 15.5N 46W at 12Z.
2. Ship highlights:
   - 55 kt ESE and 1005 mb at 16.0N, 45.0W at 12Z (Micro).
   - 45 kt ESE and 1009 mb at 17.0N, 45.8W at 15Z (COADS).
   - 40 kt SE and 1011 mb at 15.7N, 44.9W at 15Z (COADS).
3. Aircraft highlights:
   - Penetration fix measured a central pressure of 997 mb and an eye diameter of 30 nmi at 16.6N, 48.5W at 2109Z (Storm Wallets).
4. Discussion:
   a. MWR: "On the morning of September 13, a report of 63 m.p.h. winds and heavy rain was received from the SS *Gerwi*, confirming the existence of a tropical storm near 15.5N, 46W. A reconnaissance aircraft reached the area during the afternoon but was unable to measure maximum winds because of darkness."

   b. Reanalysis: The first confirmation of Gladys existing as a tropical cyclone is around 12Z on September 13 when two ships encountered gale to storm-force winds. Reconnaissance reached the storm later that day and fixed a 997 mb center at 2109Z. A pressure of 997 mb suggests maximum winds of 53 kt from the south of 25N Brown et al. pressure-wind relationship. Based on these data, Gladys is initiated as a 55 kt tropical storm at 06Z, the same time as HURDAT but 25 kt higher; however, genesis likely took place several days earlier but cannot be confirmed due to a lack of data.

September 14:

1. Maps and old HURDAT:
   - HURDAT lists an 85 kt hurricane at 18.8N, 52.1W at 12Z.
   - HWM analyzes hurricane of at most 1000 mb near 19N, 52W at 12Z.
   - Microfilm depicts Gladys near 18.5N 51.5W at 12Z.
2. Ship highlights:
   - 35 kt SE and 1014 mb at 20.7N, 50.3W at 12Z (COADS).

3. Aircraft highlights:
   - Penetration fix measured a central pressure of 992 mb, an eye diameter of 25 nmi, and maximum estimated surface winds of 100 kt at 18.6N, 51.8W at 1038Z (Storm Wallets).
   - Penetration fix measured a central pressure of 994 mb at 19.8N, 54.0W at 2000Z (Storm Wallets).
   - Penetration fix measured a central pressure of 994 mb at 19.9N, 54.1W at 2140Z (Storm Wallets).
4. Discussion:
   a. MWR: "Early on September 14 reconnaissance aircraft found Gladys had intensified to hurricane force and was moving on a west-northwestward course at about 18 m.p.h."

   b. Reanalysis: Gladys steadily intensified as it moved briskly to the west-northwest. Recon indicated the pressure falling to 992 mb with an eye of diameter 25 nmi (near-average) by 1038Z. A pressure of 992 mb suggests maximum winds of 61 kt from the south of 25N Brown et al. pressure-wind relationship. Based on the storm's near-average size, fast motion, and slight weighting of the surface wind estimates, Gladys is estimated to have an intensity of 65 kt. This is a major decrease in maximum winds from 85 kt.

September 15:
1. Maps and old HURDAT:
   - HURDAT lists a 70 kt hurricane at 21.3N, 56.1W at 12Z.
   - HWM analyzes hurricane of at most 1000 mb near 21.5N, 56W at 12Z.
   - Microfilm depicts Gladys near 20.5N 55W at 12Z.
2. Ship highlights:
   - 45 kt SE and 1017 mb at 23.2N, 53.3W at 06Z (COADS).
   - 35 kt SSE and 997 mb at 20.0N, 54.4W at 06Z (Micro).
   - 35 kt SE at 23.3N, 54.5W at 12Z (Micro).
   - 35 kt ESE and 1012 mb at 23.2N, 56.5W at 18Z (Micro).
3. Aircraft highlights:
   - Penetration fix measured a central pressure of 996 mb, an eye diameter of 35 nmi, and maximum estimated surface winds of 50 kt at 21.1N, 55.1W at 1206Z (Storm Wallets).
   - Radar fix estimated a central pressure of 992 mb and maximum estimated surface winds of 65 kt at 21.6N, 57.4W at 1918Z (Storm Wallets).
4. Discussion:
   a. Reanalysis: A temporary reduction to tropical storm intensity is introduced to HURDAT starting at 06Z on September 15. This stems from a recon fix of 996 mb at 1206Z; a pressure of 996 mb suggests maximum winds of 54 kt from the south of 25N Brown et al. pressure-wind relationship. Winds are assessed at 65 kt, 60 kt, 60 kt, and 60 kt, for the four respective synoptic times, down from 80 kt, 75 kt, 70 kt, and 70 kt, respectively.

September 16:

1. Maps and old HURDAT:
   - HURDAT lists a 70 kt hurricane at 23.1N, 60.0W at 12Z.
   - HWM analyzes hurricane of at most 1000 mb near 23N, 60W at 12Z.
   - Microfilm depicts a low of at most 1011 mb near 22.5N 60W at 12Z.
2. Ship highlights:
   - 35 kt E and 1015 mb at 23.5N, 54.9W at 00Z (COADS).
   - 35 kt E and 1016 mb at 22.3N, 53.7W at 06Z (COADS).
   - 35 kt SE and 1014 mb at 24.8N, 56.9W at 12Z (COADS).
   - 45 kt SE and 1012 mb at 24.2N, 57.6W at 15Z (COADS).
   - 40 kt SE and 1009 mb at 23.5N, 58.0W at 18Z (COADS).
3. Aircraft highlights:
   - Penetration fix measured a central pressure of 986 mb, an eye diameter of 50 x 35 nmi, and maximum estimated surface winds of 80 kt at 22.6N, 60.0W at 1241Z (Storm Wallets). (995 mb was reported in the vortex message, but the eye dropsonde reported 986 mb surface pressure, which is consistent with the 850 and 700 mb heights/temperatures.)
4. Discussion:
   a. Reanalysis: 986 mb central pressure suggests an intensity of 70 kt from the south of 25N pressure-wind relationship. This value is retained in HURDAT at 12Z.

September 17:

1. Maps and old HURDAT:
   - HURDAT lists a 120 kt hurricane at 24.6N, 64.1W at 12Z.
   - HWM analyzes hurricane of at most 996 mb near 24.5N, 64W at 12Z.
   - Microfilm depicts Hurricane Gladys near 24.5N 64.5W at 12Z.
2. Ship highlights:
   - 35 kt WSW and 1007 mb at 22.2N, 61.4W at 00Z (COADS).
   - 35 kt SE and 1013 mb at 23.9N, 59.6W at 06Z (COADS).
   - 40 kt SE and 1015 mb at 24.0N, 59.4W at 12Z (COADS).
   - 40 kt SE and 1013 mb at 26.4N, 62.0W at 18Z (COADS).
3. Aircraft highlights:
   - Penetration fix measured a central pressure of 974 mb and an eye diameter of 30 nmi at 24.1N, 63.1W at 0703Z (Storm Wallets).
   - Penetration fix measured a central pressure of 954 mb, maximum estimated surface winds of 110 kt, and an eye diameter of 25 nmi at 24.4N, 64.3W at 1304Z (Storm Wallets).
   - Penetration fix measured a central pressure of 945 mb and maximum estimated surface winds of 109 kt at 25.0N, 65.2W at 1908Z (Storm Wallets).
4. Discussion:
   a. MWR: “Gladys continued to intensify and follow the same course, reaching maximum intensity of 945 mb, with 140 m.p.h. winds, on September 17.”

b. Reanalysis: Hurricane Gladys entered a period of rapid intensification late on September 16 and throughout September 17, as depicted by a pressure drop of 50 mb in the 30 hours ending at 18Z. A major decrease to winds is made at 12Z based a recon fix of 954 mb at 1304Z; a pressure of 954 mb suggests maximum winds of 109 kt south of 25N and 106 kt north of 25N in the intensifying subset of 25N from the Brown et al. pressure-wind relationship. Based on its near-average RMW of 18 nmi, an intensity of 105 kt is chosen for 12Z, down from 120 kt originally in HURDAT. Gladys is assessed to have peaked as a 115 kt Category 4 hurricane with a pressure of 945 mb, as measured by recon. A pressure of 945 mb suggests maximum winds of 118 kt south of 25N and 115 kt north of 25N in the intensifying subset from the south of 25N Brown et al. pressure-wind relationship.

September 18:

1. Maps and old HURDAT:
   - HURDAT lists a 120 kt hurricane at 26.1N, 67.1W at 12Z.
   - HWM analyzes hurricane of at most 992 mb near 26N, 67W at 12Z.
   - Microfilm depicts Gladys near 26.5N 67.5W at 12Z.
2. Ship highlights:
   - 35 kt NW and 1003 mb at 23.9N, 67.4W at 00Z (COADS).
   - 40 kt ESE and 1014 mb at 27.5N, 63.2W at 00Z (COADS).
   - 35 kt NW and 1011 mb at 23.5N, 70.2W at 06Z (COADS).
   - 40 kt S and 1003 mb at 24.7N, 64.9W at 06Z (COADS).
   - 35 kt SW and 1000 mb at 24.9N, 67.1W at 15Z (COADS).
   - 45 kt SW at 25.4N, 67.0W at 18Z (COADS).
   - 50 kt S at 25.8N, 66.7W at 21Z (COADS).
3. Aircraft highlights:
   - Penetration fix measured a central pressure of 951 mb, maximum estimated surface winds of 90 kt, and an eye diameter of 20 nmi at 25.5N, 66.0W at 0130Z (Storm Wallets).
   - Penetration fix measured a central pressure of 951 mb, maximum estimated surface winds of 90 kt, and an eye diameter of 25 nmi at 25.8N, 66.7W at 0711Z (Storm Wallets).
   - Penetration fix measured a central pressure of 952 mb, maximum estimated surface winds of 70 kt, and an eye diameter of 25 nmi at 26.2N, 67.2W at 1232Z (Storm Wallets).
   - Penetration fix estimated a central pressure of 953 mb, maximum estimated surface winds of 75 kt, and an eye diameter of 20 nmi at 26.3N, 67.6W at 1745Z (Storm Wallets).
4. Discussion:
   a. Reanalysis: Gladys weakened slightly from its peak by 00Z on September 18; with recon fixing a central pressure 951 mb at 0130Z. A pressure of 951 mb suggests maximum winds of 110 kt from the south of 25N and 104 kt north of 25N Brown et al. pressure-wind relationship. The pressure remained near 950 mb for the day. Accordingly, maximum winds are assessed at 110 kt for the entire day.

September 19:

1. Maps and old HURDAT:
   - HURDAT lists a 110 kt hurricane at 27.3N, 69.2W at 12Z.
   - HWM analyzes hurricane of at most 996 mb near 27.5N, 69W at 12Z.
   - Microfilm depicts Gladys at 27.3N 69.2W at 12Z.
2. Ship highlights:
   - 35 kt SSW and 1009 mb at 23.5N, 68.0W at 00Z (COADS).
   - 50 kt SSE and 1009 mb at 24.3N, 66.2W at 00Z (Micro).
   - 40 kt WSW and 1003 mb at 24.5N, 68.3W at 06Z (COADS).
   - 50 kt SE and 1004 mb at 27.8N, 67.8W at 12Z (COADS).
   - 75 kt SE and 1002 mb at 27.4N, 67.4W at 18Z (COADS).
   - 45 kt S and 1007 mb at 25.4N, 66.9W at 18Z (COADS).
3. Aircraft highlights:
   - Penetration fix measured a central pressure of 962 mb, maximum estimated surface winds of 90 kt, and an eye diameter of 20 nmi at 26.7N, 68.8W at 0100Z (Storm Wallets). (Reported central pressure appears to be erroneous. Extrapolation from heights/temps gives 947 mb.)
   - Penetration fix measured a central pressure of 951 mb, maximum estimated surface winds of 60 kt, and an eye diameter of 20 nmi at 26.9N, 68.7W at 0630Z (Storm Wallets).
   - Penetration fix measured a central pressure of 960 mb, maximum estimated surface winds of 125 kt, and an eye diameter of 20 nmi at 27.4N, 69.2W at 1300Z (Storm Wallets).
   - Penetration fix measured a central pressure of 962 mb, maximum estimated surface winds of 140 kt, and an eye diameter of 15 nmi at 27.6N, 69.7W at 1900Z (Storm Wallets).
4. Discussion:
   a. MWR: "On September 19 Gladys turned northward in response to a weak trough in the westerlies. A slow northward drift continued for almost 48 hr., until rising pressures to the north turned the hurricane's track back to the northwest."

   b. Reanalysis: On September 19, Gladys turned to the north while maintaining its slow (~6 kt) forward pace and central pressure near 950 mb. Winds at 00Z and 06Z were lowered 5 kt from the original HURDAT based on pressure-wind relationship values while accounting for its slow speed and near-average size. Later on the 19th, though the central pressure rose, the eye size shrunk and surface wind estimates increased. A recon fix of 960 mb was made at 1300Z; a pressure of 960 mb suggests maximum winds of 95 kt from the north of 25N Brown et al. pressure-wind relationship. An intensity of 100 kt is assessed at 12Z and 18Z, above the pressure-wind relationship because of the small size (RMW: 10-15 nmi, climo 20 nmi) and the extreme surface wind estimates.

September 20:

1. Maps and old HURDAT:
   - HURDAT lists a 95 kt hurricane at 29.0N, 69.8W at 12Z.
   - HWM analyzes hurricane of at most 992 mb near 28.5N, 69.5W at 12Z.
   - Microfilm depicts Gladys near 29.0N 69.5W at 12Z.
2. Ship highlights:
   - 60 kt SE and 998 mb at 27.0N, 67.8W at 00Z (COADS).
   - 60 kt S and 994 mb at 26.5N, 67.9W at 06Z (COADS).
   - 50 kt S and 996 mb at 26.0N, 68.0W at 12Z (COADS).
   - 35 kt S and 994 mb at 28.0N, 68.8W at 18Z (COADS).
   - 50 kt S and 1002 mb at 27.7N, 67.8W at 18Z (COADS).
3. Aircraft highlights:
   - Penetration fix measured a central pressure of 962 mb and an eye diameter of 15 nmi at 27.8N, 69.5W at 0100Z (Storm Wallets).
   - Penetration fix measured a central pressure of 965 mb, maximum estimated surface winds of 85 kt, and an eye diameter of 20 nmi at 28.5N, 69.7W at 0700Z (Storm Wallets).
   - Penetration fix measured a central pressure of 967 mb and maximum estimated surface winds of 75 kt at 29.0N, 69.6W at 1332Z (Storm Wallets).
   - Penetration fix measured a central pressure of 964 mb and maximum estimated surface winds of 82 kt at 29.3N, 69.6W at 1733Z (Storm Wallets).
4. Discussion:
   a. Reanalysis: The pressure filled some on this date, while the surface wind estimates dropped. A central pressure of 967 mb, fixed at 1332Z, suggests maximum winds of 88 kt from the north of 25N Brown et al. pressure-wind relationship. However, data from early on the 21st indicates that the RMW broadened to 80 nm and that the convective structure likely decayed. Intensity reduced down to 85 kt at 12 and 18Z (from 95 and 90 kt).

September 21:

1. Maps and old HURDAT:
   - HURDAT lists an 85 kt hurricane at 31.1N, 69.8W at 12Z.
   - HWM analyzes hurricane of at most 992 mb near 31.5N, 69.5W at 12Z.
   - Microfilm depicts a hurricane of at most 1008 mb near 31.5N 69.7W at 12Z.
2. Ship highlights:
   - 60 kt SSE and 999 mb at 29.3N, 66.9W at 00Z (COADS).
   - 45 kt ENE and 1008 mb at 34.0N, 71.0W at 06Z (COADS).
   - 60 kt SSE and 1001 mb at 28.9N, 66.8W at 06Z (COADS).
   - 45 kt NE and 1005 mb at 33.9N, 71.7W at 12Z (COADS).
   - 60 kt NNE at 33.0N, 73.0W at 15Z (COADS).
   - 50 kt NNE and 1001 mb at 33.2N, 72.9W at 18Z (COADS).
3. Aircraft highlights:
   - Penetration fix measured a central pressure of 964 mb at 29.7N, 69.4W at 0110Z (Storm Wallets).

- Penetration fix measured a central pressure of 969 mb and an eye diameter of 80 nmi at 30.8N, 69.9W at 0700Z (Storm Wallets).
- Penetration fix measured a central pressure of 980 mb and maximum estimated surface winds of 65 kt at 31.3N, 69.6W at 1300Z (Storm Wallets).
- Penetration fix measured a central pressure of 977 mb and maximum estimated surface winds of 65 kt at 32.5N, 70.2W at 1900Z (Storm Wallets).

4. Discussion:
   a. Reanalysis: Gladys became increasingly large on September 21, with recon reporting an eye diameter of 80 nmi at 0700Z. Despite its significant increase in size from the previous day, Gladys appears to have only slowly weakened. Winds are assessed slightly below the original HURDAT. A central pressure of 980 mb, fixed at 1300Z, suggests maximum winds of 73 kt from the north of 25N Brown et al. pressure-wind relationship. Intensity at 12Z assessed at 65 kt, down significantly from 80 kt originally.

September 22:

1. Maps and old HURDAT:
   - HURDAT lists a 75 kt hurricane at 33.9N, 71.8W at 12Z.
   - HWM analyzes hurricane of at most 988 mb near 34N, 72W at 12Z.
   - Microfilm depicts a hurricane of at most 999 mb near 34N 72W at 12Z.
2. Ship highlights:
   - Dozens of gales throughout the day, peak obs around synoptic time listed
   - 50 kt N and 1011 mb at 33.5N, 75.7W at 00Z (COADS).
   - 45 kt N and 996 mb at 33.3N, 72.3W at 06Z (COADS).
   - 60 kt N and 1000 mb at 35.2N, 74.5W at 14Z (COADS).
   - 60 kt N and 1001 mb at 34.4N, 75.3W at 18Z (COADS).
3. Aircraft highlights:
   - Penetration fix measured a central pressure of 984 mb and an eye diameter of 35 nmi at 33.3N, 71.1W at 0100Z (Storm Wallets).
   - Penetration fix measured a central pressure of 980 mb and an eye diameter of 30 nmi at 34.1N, 71.5W at 0700Z (Storm Wallets).
   - Penetration fix measured a central pressure of 984 mb, maximum estimated surface winds of 60 kt, and an eye diameter of 40 nmi at 34.0N, 71.9W at 1208Z (Storm Wallets).
   - Penetration fix measured a central pressure of 982 mb at 34.1N, 72.2W at 1900Z (Storm Wallets).
4. Discussion:
   a. Reanalysis: Gladys remained a minimal hurricane throughout September 22 as it moved slowly northwest. One major change to reflect a weaker storm was made at 00Z, lowering winds from 80 kt to 65 kt. This stems from the storm's slow movement and large size (~25 nmi RMW) coupled with a 984 mb central pressure and observations of 60 kt sustained by ships later in the day. A pressure of 984 mb suggests maximum winds of 68 kt from the

north of 25N Brown et al. pressure-wind relationship. Minor reductions (5-10 kt) were made for the remainder of the day.

September 23:

1. Maps and old HURDAT:
   - HURDAT lists a 75 kt hurricane at 36.5N, 71.9W at 12Z.
   - HWM analyzes hurricane of at most 992 mb near 36.5N, 72W at 12Z.
   - Microfilm depicts a low of at most 1002 mb near 36.2N 72W at 12Z.
2. Ship highlights:
   - Multiple gales throughout the day, peak obs around synoptic time listed
   - 55 kt SW and 996 mb at 34.3N, 74.6W at 00Z (COADS).
   - 50 kt NNW and 1000 mb at 35.1N, 74.6W at 06Z (COADS).
   - 40 kt NNW and 1008 mb at 33.1N, 73.0W at 12Z (COADS).
   - 45 kt S and 1002 mb at 37.7N, 68.0W at 18Z (COADS).
3. Land highlights:
   - 35 kt N (fastest mile) at Hatteras, NC at 0009Z (Storm Wallets).
   - 39 kt NNE (fastest mile) at Bodie Island, NC at 0100Z (Storm Wallets).
4. Aircraft highlights:
   - Penetration fix measured a central pressure of 979 mb at 34.7N, 72.6W at 0100Z (Storm Wallets).
   - Penetration fix measured a central pressure of 977 mb, maximum flight level winds of 65 kt, and an eye diameter of 20 nmi at 35.9N, 72.0W at 0700Z (Storm Wallets).
   - Penetration fix measured a central pressure of 982 mb at 36.5N, 71.6W at 1300Z (Storm Wallets).
   - Penetration fix measured a central pressure of 974 mb, maximum estimated surface winds of 70 kt, and an eye diameter of 40 nmi at 37.0N, 71.2W at 1600Z (Storm Wallets).
5. Discussion:
   a. MWR: "This course continued until the 23rd when Gladys reached its closest point to the United States, some 140 mi east of Cape Hatteras. Slow filling persisted through this period and the highest winds decreased to 85 m.p.h. As a low pressure system deepened in the Great Lakes area Gladys turned northeastward during September 23. The storm moved rapidly on this course gradually assuming extratropical characteristics."

   b. Reanalysis: Slight re-intensification took place on September 23 as Gladys began to accelerate northeast ahead of an approaching cold front. Reconnaissance fixed a pressure of 974 mb around 16Z. A pressure of 974 mb suggests maximum winds of 79 kt from the north of 35N Landsea et al. pressure-wind relationship. A later fix at 01Z on the 24th reported an eye diameter of 30 nmi, yielding an RMW of 23 nmi which is slightly below the average of 28 nmi. Accounting for the storm's smaller than average RMW,

acceleration to 17 kt, but below-average environmental pressures, an intensity of 80 kt is analyzed for 18Z.

September 24:

1. Maps and old HURDAT:
   - HURDAT lists a 75 kt hurricane at 42.8N, 64.2W at 12Z.
   - HWM analyzes hurricane of at most 984 mb near 43N, 64W at 12Z.
   - Microfilm depicts a hurricane of at most 996 mb near 42.9N 63.8W at 12Z.
2. Ship highlights:
   - 45 kt SSE and 997 mb at 39.1N, 67.5W at 00Z (COADS).
   - 50 kt S and 1015 mb at 39.0N, 65.7W at 03Z (COADS).
   - 75 kt S and 1000 mb at 38.9N, 65.6W at 06Z (COADS).
   - 35 kt WNW and 1000 mb at 42.0N, 67.0W at 12Z (COADS).
   - 50 kt S and 989 mb at 44.4N, 58.9W at 18Z (COADS).
   - 50 kt SE at 46.4N, 55.5W at 21Z (COADS).
3. Land highlights:
   - 5 kt NW and 999 mb at Nantucket, MA at 06Z (Micro).
   - 10 kt NW and 997 mb at Yarmouth, Nova Scotia at 12Z (Micro).
   - 35 kt WSW at Sable Island at 18Z (Micro).
   - 10 kt ESE and 994 mb at Sydney, Nova Scotia at 18Z (Micro).
4. Aircraft highlights:
   - Penetration fix measured a central pressure of 980 mb and an eye diameter of 30 nmi at 39.3N, 68.8W at 0100Z (Storm Wallets).
   - Penetration fix measured a central pressure of 982 mb at 40.1N, 67.5W at 0400Z (Storm Wallets).
   - Penetration fix measured a central pressure of 973 mb (uncertain) at 43.5N, 63.3W at 1500Z (Storm Wallets).
   - Penetration fix measured a central pressure of 990 mb (uncertain) at 44.7N, 61.6W at 1810Z (Storm Wallets).
5. Discussion:
   a. MWR: “During the afternoon of September 24, remnants of the storm passed through Newfoundland with no unusually strong winds.”

   b. Reanalysis: Slow weakening ensued throughout September 24 as the hurricane paralleled the southern coast of Nova Scotia. Recon fixes depict steadily rising pressures; however, synoptic data contradicts the final two fixes and render them invalid. Winds are maintained at 75 kt for 00Z, 06Z, and 12Z, mostly due to a report of 75 kt winds from a ship on the south side of the storm at 06Z. A report of 50 kt and 989 mb at 18Z serves as the basis for maintaining Gladys as a hurricane at 18Z. This observation would suggest a central pressure of 984 mb or deeper; a pressure of 984 mb suggests maximum winds of 69 kt from the north of 35N Landsea et al. pressure-wind relationship.

September 25:

1. Maps and old HURDAT:
   - HURDAT terminates Gladys as an extratropical system after 00z.
   - HWM analyzes a low pressure of at most 1004 mb near 49N, 46W at 12Z.
   - Microfilm depicts nothing of interest at 12Z.
2. Ship highlights:
   - 50 kt SSW at 46.0N, 55.0W at 00Z (COADS).
   - 40 kt WSW and 1001 mb at 45.7N, 56.7W at 00Z (COADS).
   - 40 kt SW and 998 mb at 46.5N, 53.0W at 03Z (COADS).
   - 10 kt SW and 998 mb at 47.3N, 52.6W at 06Z (COADS).
   - 30 kt SW and 1002 mb at 46.3N, 52.6W at 06Z (COADS).
3. Land highlights:
   - 10 kt SSE and 1000 mb at St. John's, Newfoundland at 00Z (Micro).
   - 10 kt SSE and 996 mb at Glovertown, Newfoundland at 00Z (Micro).
   - 30 kt W and 997 mb at St. John's, Newfoundland at 06Z (Micro).
   - 10 kt W and 997 mb at Glovertown, Newfoundland at 06Z (Micro).
4. Discussion:
   a. Reanalysis: Gladys rapidly lost its identity as it approached Newfoundland. Transition into an extratropical cyclone is assessed 6 hours later than HURDAT based on ship observations at 18Z depicting an isothermal core alongside no defined frontal features. Observations at 00Z on September 25 show a cold front extending south of Gladys' center, indicating its transition into an extratropical cyclone. Dissipation occurred as it crossed the island early on September 25 as a closed low could not identified after 00Z. Dissipation remains unchanged from HURDAT.

Date	Original HURDAT Central Pressure	Evidence	Changes
Sep 14 00Z		Penetration center fix: 997 mb around 2109Z on Sep 13th	997 mb
Sep 14 12Z	992 mb	Penetration center fix: 992 mb around 1038Z on Sep 14th	Retained
Sep 14 18Z	994 mb	Penetration center fix: 994 mb around 2000Z on Sep 14th	Retained
Sep 15 00Z		Penetration center fix: 994 mb around 2140Z on Sep 14th	994 mb
Sep 15 12Z	996 mb	Penetration center fix: 996 mb around 1206Z on Sep 15th	Retained
Sep 15 18Z	992 mb	Radar fix: 992 mb around 1918Z on Sep 15th No data to indicate this value is incorrect	Retained

Sep 16 12Z	995 mb	Penetration center fix: 995 mb around 1241Z on Sep 16th	Retained
Sep 17 00Z	1001 mb	Radar fix: 1001 mb around 0100Z on Sep 17th Preceding and following fixes indicate value is likely a peripheral pressure.	Removed
Sep 17 06Z		Penetration center fix: 974 mb around 0703Z on Sep 17th	974 mb
Sep 17 12Z	954 mb	Penetration center fix: 954 mb around 1304Z on Sep 17th	Retained
Sep 17 18Z	945 mb	Penetration center fix: 945 mb around 1908Z on Sep 17th	Retained
Sep 18 00Z	951 mb	Penetration center fix: 951 mb around 0130Z on Sep 18th	Retained
Sep 18 06Z	951 mb	Penetration center fix: 951 mb around 0711Z on Sep 18th	Retained
Sep 18 12Z	952 mb	Penetration center fix: 952 mb around 1232Z on Sep 18th	Retained
Sep 18 18Z	953 mb	Penetration center fix: 953 mb around 1745Z on Sep 18th	Retained
Sep 19 00Z	962 mb	Penetration center fix: 947 mb around 0100Z on Sep 19th	947 mb
Sep 19 06Z	951 mb	Penetration center fix: 951 mb around 0630Z on Sep 19th	Retained
Sep 19 12Z	960 mb	Penetration center fix: 960 mb around 1300Z on Sep 19th	Retained
Sep 19 18Z	962 mb	Penetration center fix: 962 mb around 1900Z on Sep 19th	Retained
Sep 20 00Z	962 mb	Penetration center fix: 962 mb around 0100Z on Sep 20th	Retained
Sep 20 06Z	965 mb	Penetration center fix: 965 mb around 0700Z on Sep 20th	Retained
Sep 20 12Z	967 mb	Penetration center fix: 967 mb around 1332Z on Sep 20th	Retained
Sep 20 18Z	964 mb	Penetration center fix: 964 mb around 1733Z on Sep 20th	Retained
Sep 21 00Z	964 mb	Penetration center fix: 964 mb around 0110Z on Sep 21st	Retained
Sep 21 06Z		Penetration center fix: 969 mb (by height) around 0700Z on Sep 21st	969 mb

Sep 21 12Z	980 mb	Penetration center fix: 980 mb around 1300Z on Sep 21st	Retained
Sep 21 18Z	977 mb	Penetration center fix: 977 mb around 1900Z on Sep 21st	Retained
Sep 22 00Z	984 mb	Penetration center fix: 984 mb around 0100Z on Sep 22nd	Retained
Sep 22 06Z	980 mb	Penetration center fix: 980 mb around 0700Z on Sep 22nd	Retained
Sep 22 12Z	984 mb	Penetration center fix: 984 mb around 1208Z on Sep 22nd	Retained
Sep 22 18Z	982 mb	Penetration center fix: 982 mb around 1900Z on Sep 22nd	Retained
Sep 23 00Z	980 mb	Penetration center fix: 979 mb around 0100Z on Sep 23rd	979 mb
Sep 23 06Z	977 mb	Penetration center fix: 977 mb around 0700Z on Sep 23rd	Retained
Sep 23 12Z	982 mb	Penetration center fix: 982 mb around 1300Z on Sep 23rd	Retained
Sep 23 18Z	974 mb	Penetration center fix: 974 mb around 1600Z on Sep 23rd	Retained
Sep 24 00Z	980 mb	Penetration center fix: 980 mb around 0100Z on Sep 24th	Retained
Sep 24 06Z	982 mb	Penetration center fix: 982 mb around 0400Z on Sep 24th	Retained
Sep 24 12Z	973 mb	Penetration center fix: 973 mb (uncertain) around 1500Z on Sep 24th Value is questionable and based on the weakening trend a sudden 9 mb deepening is unlikely; the value is removed accordingly.	Removed
Sep 24 18Z	990 mb	Penetration center fix: 990 mb (uncertain) around 1810Z on Sep 24th COADS: 50 kt S and 989 mb at 18Z Penetration appears out of place and a near-simultaneous ship report of 989 mb indicates the pressure to be below 990 mb; value is removed accordingly.	Removed

Hurricane Hilda [September 28 – October 9, 1964] – AL101964

43730 09/28/1964 M= 8 10 SNBR= 942 HILDA XING=1 SSS=3

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43730 09/28/1964 M=11 10 SNBR= 942 HILDA       XING=1 SSS=2
                    **                             *

43735 09/28*  0   0   0    0*  0   0   0    0*212 800  15    0*213 811  20    0*
43735 09/28*  0   0   0    0*  0   0   0    0*212 800  25    0*213 811  25    0*
                                                 **                 **

43740 09/29*214 821  20    0*217 832  25    0*220 842  35    0*223 853  40    0*
43740 09/29*214 821  30    0*217 832  30    0*220 842  35    0*224 852  45    0*
                     **                 **                      *** ***  **

43745 09/30*228 861  50  997*232 873  60  994*234 881  70  984*238 890  80  978*
43745 09/30*228 862  55  997*231 872  60  994*234 882  70  984*238 890  80  978*
                ***  **      *** ***           ***

43750 10/01*240 895  95  977*242 901 110  955*245 906 120  951*248 911 130  941*
43750 10/01*241 895  85  977*243 901 105  955*245 906 110  951*248 911 120  941*
           ***       **                ***              ***              ***

43755 10/02*252 914 130  942*257 917 125    0*263 917 120    0*268 917 115    0*
43755 10/02*253 915 120  942*258 917 110    0*263 917 105  956*268 916 100    0*
           *** *** ***      ***     ***              ***  ***     *** ***

43760 10/03*272 914 110  960*277 914 105  964*282 914 100  962*286 916 100  961*
43760 10/03*272 912 100  960*277 912 100  964*281 913  95  962*288 916  90  961*
                ***  ***          ***  ***     ***  *** ***      ***     ***

43765 10/04*296 916  95  959*302 912  60    0E306 906  60    0E307 893  60    0*
43765 10/04*297 915  90  959*302 913  70    0*306 906  60    0*307 893  55    0*
           ***  ***  **          ***  **     *                 *         **

43770 10/05E306 878  50    0E305 861  40    0E308 845  35    0E310 825  35    0*
43770 10/05E305 876  50    0E306 860  50    0E308 844  45    0E310 825  45    0*
           ***  ***          ***  ***  **          ***  **                 **

(The 6th and 7th are new to HURDAT)
00000 10/06E310 806  45    0E308 790  45    0E306 780  45    0E305 770  45    0*
00000 10/07E304 765  50    0E301 762  55    0E298 761  55    0*  0   0   0    0*

43775 HR LA3
43775 HR LA2
         ***
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Tropical Storm Landfall

9/29 1100Z 21.9N 84.0W 35 kt Cuba

U.S. Hurricane Landfall

October 3rd – 23Z – 29.5N 91.5W – 90 kt – Category 2 – 959 mb – 1010 mb
OCI – 35 nm RMW

Significant Revisions:

1. Major reductions to winds on October 2 based on reported aircraft pressures, eye diameter, environmental pressure, and motion.
2. Extratropical transition delayed by 12 hours based on post-storm analysis in 1968 and surface observations across the Gulf Coast.
3. Extratropical phase extended by 42 hours based on station and ship observations.

Daily Metadata:

September 26:

1. Maps and old HURDAT:
   - HURDAT does not list an organized storm on this date.
   - HWM depicts nothing of interest at 12Z.
   - Microfilm shows a tropical wave extending from 31N 73W south to 19N 72W at 12Z

September 27:

1. Maps and old HURDAT:
   - HURDAT does not list an organized storm on this date.
   - HWM analyzes a weak, open area of low pressure near 20N 80W at 12Z.
   - Microfilm indicates a developing surface trough extending from 25N 73.5W south to 20N 74.5W at 12Z.

September 28:

1. Maps and old HURDAT:
   - HURDAT lists a 15 kt tropical depression at 21.2N, 88.0W at 12Z.
   - HWM analyzes a weak, open area of low pressure near 21N 80W at 12Z.
   - Microfilm indicates a developing circulation centered near 21N 80W at 12Z.
2. Discussion:
   c. MWR: "Hilda developed in an easterly wave which was moving slowly westward through the western Caribbean Sea. On the morning of September 28, a weak cyclonic circulation formed just off the southern coast of central Cuba."

   d. Reanalysis: Hurricane Hilda originated from a tropical wave first identified north of the Greater Antilles on September 26. Tracking slowly westward, the system developed a well-defined surface trough the following day as it neared Cuba. Satellite imagery on September 28 indicates the formation of a surface low along the south-central coast of Cuba. Genesis as a tropical depression occurred by 12z on this day along the south-central coast of Cuba, unchanged from the original HURDAT. Winds are increased slightly to 25 kt in accordance with surrounding ship observations of 20-25 kt.

September 29:

1. Maps and old HURDAT:
   - HURDAT lists a 35 kt tropical storm at 22.0N, 84.2W at 12Z.

- HWM analyzes a closed low pressure of at most 1008 mb near 22N 84W at 12Z.
- Microfilm depicts a closed low pressure of at most 1005 mb near 22N 83.6W at 12Z.

2. Ship highlights:
   - 25 kt ESE and 1004 mb at 23.5N, 86.0W at 18Z (COADS).
   - 40 kt NE at 22.8N, 85.7W at 19Z (COADS).
   - 30 kt NE and 1005 mb at 23.1N, 85.9W at 21Z (COADS).
3. Aircraft highlights:
   - Penetration fix measured a central pressure of 998 mb and estimated maximum surface winds of 53 kt at 22.5N, 85.7W at 2109Z (Storm Wallets).
   - Penetration fix measured a central pressure of 997 mb, estimated maximum surface winds of 42 kt, and an eye diameter of 8 nmi at 22.8N, 86.1W at 2351Z (Storm Wallets).

4. Discussion:
   a. MWR: "The circulation became better organized and gradually intensified as it moved slowly westward. It reached storm intensity as it crossed the western tip of Cuba near Cape San Antonio."

   b. Reanalysis: Intensification was slow at first, possibly due to the system's proximity to land. The depression made landfall over the Isle of Youth around 03z on September 29 with 30 kt winds. Roughly eight hours later, the system reached tropical storm strength, 35 kt, and made a second landfall in Cuba, this time over Pinar del Río Province. Reconnaissance reached the storm after it emerged over the Gulf of Mexico, fixing a 998 mb center at 2109Z and estimating surface winds of 58 kt. A subsequent fix at 2351Z found a pressure of 997 mb. A pressure of 997 mb suggests maximum winds of 53 kt from the south of 25N Brown et al. pressure-wind relationship. These data serve as the basis for analyzing 55 kt for 00Z on September 30 (5 kt higher than HURDAT) as well as starting the system as a tropical storm at 12Z on the 29th.

September 30:

3. Maps and old HURDAT:
   - HURDAT lists a 70 kt hurricane at 23.4N, 88.1W at 12Z.
   - HWM analyzes a hurricane of at most 1000 mb near 24N 88W at 12Z.
   - Microfilm depicts a closed low with a central pressure of 984 mb near 23.5N 88W at 12Z.
4. Ship highlights:
   - 35 kt E and 1003 mb at 23.1N, 84.7W at 00Z (COADS).
   - 35 kt SE and 1008 mb at 23.0N, 85.2W at 06Z (COADS).
   - 35 kt SE and 1009 mb at 25.1N, 87.0W at 12Z (COADS).
   - 40 kt SSE and 1009 mb at 24.1N, 86.5W at 18Z (COADS).
   - 40 kt E and 1000 mb at 23.2N 85.5W at 21Z (COADS).

5. Aircraft highlights:
   - Penetration fix measured a central pressure of 994 mb, estimated maximum surface winds of 50 kt, and an eye diameter of 20 nmi at 23.4N, 87.8W at 07Z (Storm Wallets).
   - Penetration fix measured a central pressure of 984 mb and estimated maximum surface winds of 60 kt at 23.4N 88.3W at 1318Z (Storm Wallets).
   - Penetration fix measured a central pressure of 978 mb and estimated maximum surface winds of 65 kt at 23.7N 89.2W at 1758Z (Storm Wallets).
6. Discussion:
   a. MWR: "Hilda moved west-northwestward at an average speed of 9 mph for 48 hr, and intensified steadily while in the southern Gulf of Mexico. The storm reached hurricane force early on September 30 and reached maximum intensity about 350 mi south of New Orleans on October 1."

   b. Reanalysis: Hilda quickly intensified throughout September 30, reaching hurricane status by 12Z, and developing a small 10 nmi eye by 1949Z per recon. A recon fix at 1758Z provided a central pressure of 978 mb. A pressure of 978 mb suggests maximum winds of 80 kt south of 25N from the Brown et al. pressure-wind relationship. This value is retained in HURDAT. No significant changes are made on this day.

October 1:
1. Maps and old HURDAT:
   - HURDAT lists a 120 kt hurricane at 24.5N, 90.6W at 12Z.
   - HWM analyzes a hurricane of at most 996 mb near 24.5N 91W at 12Z.
   - Microfilm depicts a 948 mb hurricane with winds of 125 kt near 24.5N 90.5W at 12Z.
2. Ship highlights:
   - 45 kt SE and 1002 mb at 24.2N, 90.5W at 00Z (COADS).
   - 40 kt SE and 1004 mb at 23.3N, 87.7W at 00Z (Micro).
   - 45 kt E and 1000 mb at 26.6N, 87.6W at 06Z (COADS).
   - 35 kt SSW and 1000 mb at 23.4N, 90.2W at 12Z (COADS).
   - 45 kt E and 999 mb at 25.2N, 90.0W at 18Z (COADS).
   - 40 kt SSE and 1006 mb at 23.7N, 88.8W at 18Z (COADS).
3. Aircraft highlights:
   - Penetration fix measured a central pressure of 977 mb, estimated maximum surface winds of 80 kt, and an eye diameter of 8 nmi at 24.2N, 89.6W at 01Z (Storm Wallets).
   - Penetration fix measured a central pressure of 955 mb at 24.4N, 90.0W at 07Z (Storm wallets).
   - Penetration fix measured a central pressure of 951 mb and maximum flight-level winds of 98 kt at 24.4N, 90.7W at 1251Z (Storm Wallets).

- Penetration fix measured a central pressure of 948 mb, estimated maximum surface winds of 125 kt, and an eye diameter of 25 nmi at 24.6N, 90.9W at 1447Z (Storm Wallets).
- Penetration fix extrapolated a central pressure of 941 mb at 24.9N, 91.2W at 1901Z (Storm Wallets).

4. Discussion:
   a. MWR: "The minimum computed sea level pressure from reconnaissance aircraft [on October 1] was 941 mb (27.79 in.) and winds were estimated at 150 mph. A severe hurricane by this time, Hilda turned gradually northward on October 1."

   b. Reanalysis: Hilda's rapid intensification culminated on October 1 with the storm reaching Category 4 status by 18Z, six hours later than HURDAT. Recon fixes at 07Z, 1251Z, and 1901Z provided central pressures of 955 mb, 951 mb, and 941 mb, respectively. A pressure of 955 mb suggests maximum winds of 108 kt and 105 kt from the intensifying subsets of the south of 25N and north of 25N Brown et al. pressure-wind relationship. A pressure of 951 mb suggests maximum winds of 112 kt and 109 kt from the intensifying subsets of the south of 25N and north of 25N Brown et al. pressure-wind relationship. A pressure of 941 mb suggests maximum winds of 122 kt and 119 kt from the intensifying subsets of the south of 25N and north of 25N Brown et al. pressure-wind relationship. Recon reported an eye diameter of 25 nmi at 1447Z, which yields an RMW of about 20 nmi. This is near the climatological value of 16 nmi. A fix at 01Z on October 2 reported an eye diameter of 18 nmi, yielding a near-average RMW of about 15 nmi. Intensities throughout the day are assessed below the original HURDAT, including a major decrease at 18Z. These account for the storm's slow motion (roughly 5 knots), low environmental pressure (1008 mb OCI), and near average RMW. Winds at 00Z, 06Z, 12Z, and 18Z are reassessed at 85 kt, 105 kt, 110 kt, and 120 kt, down from 95 kt, 110 kt, 120 kt, and 130 kt, respectively. The peak winds of 120 kt are chosen in accordance with the aforementioned data both late on the 1st and early on the 2nd, a moderate decrease from the 130 kt peak originally in HURDAT,

October 2:

1. Maps and old HURDAT:
   - HURDAT lists a 120 kt hurricane at 26.3N, 91.7W at 12Z.
   - HWM analyzes a hurricane of at most 996 mb near 26N 92W at 12Z.
   - Microfilm depicts closed low pressure of at most 1005 mb near 25.5N, 91.5W at 12Z.
2. Ship highlights:
   - 25 kt E and 999 mb at 25.3N, 90.0W at 00Z (Micro).
   - 40 kt SSE and 1003 mb at 24.4N, 89.2W at 00Z (COADS).
   - 35 kt SSE and 1000 mb at 24.8N, 90.8W at 06Z (COADS).
   - 35 kt S and 999 mb at 24.8N, 91.3W at 12Z (COADS).
   - 40 kt SE and 1007 mb at 27.4N, 88.8W at 12Z (COADS).

- 45 kt NW and 1006 mb at 24.7N, 91.1W at 18Z (COADS).

3. Aircraft highlights:
   - Penetration fix measured a central pressure of 942 mb, estimated maximum surface winds of 82 kt, and an eye diameter of 18 nmi at 25.3N, 91.5W at 01Z (Storm Wallets).
   - Penetration fix estimated maximum surface winds of 93 kt and an eye diameter of 18 nmi at 25.8N, 91.7W at 06Z (Storm Wallets).
   - Penetration fix measured a central pressure of 956 mb and estimated maximum surface winds of 114 kt at 26.6N, 91.7W at 1415Z (Storm Wallets).
   - Penetration fix estimated maximum surface winds of 99 kt at 26.9N, 91.6W at 1930Z (Storm Wallets).
4. Discussion:
   a. MWR: "It moved northward at an average speed of 6 mph for the next two days and crossed the central Louisiana coast about dark on October 3. Some decrease in intensity had occurred on October 2 but Hilda was still a severe hurricane when it reached the coast."

   b. Reanalysis: Turning north, Hilda entered a weakening phase on October 2. Moderate to major reductions to wind speeds are made throughout the day based on central pressures of 942 mb and 956 mb from reconnaissance at 01Z and 1415Z, respectively. A pressure of 956 mb suggests maximum winds of 102 kt from the weakening subset of the north of 25N Brown et al. pressure-wind relationship. Hilda was maintaining a small eye during the day with an estimated RMW of about 15 nm (compared with 19 nm from the central pressure-latitude climatology) based on the eye diameter of 18 nm. Winds at 00Z, 06Z, 12Z, and 18Z are reassessed at 120 kt, 110 kt, 105 kt, and 100 kt, major reductions from the original HURDAT values of 130 kt, 125 kt, 120 kt, and 115 kt, respectively.

October 3:

1. Maps and old HURDAT:
   - HURDAT lists a 100 kt hurricane at 28.2N, 91.4W at 12Z.
   - HWM analyzes a hurricane of at most 1000 mb near 28N 91.5W at 12Z.
   - Microfilm depicts a 962 mb hurricane with 90 kt winds near 28.2N, 91.4W at 12Z.
2. Ship highlights:
   - 45 kt WSW and 1001 mb at 25.6N, 91.0W at 00Z (COADS).
   - 35 kt NW and 1003 mb at 25.7N, 92.5W at 00Z (COADS).
   - 35 kt S at 26.0N, 91.7W at 06Z (COADS).
   - 35 kt W and 1003 mb at 26.2N, 91.5W at 12Z (Micro).
   - 35 kt S and 1004 mb at 26.6N, 88.9W at 12Z (COADS).
   - 40 kt N and 1002 mb at 29.5N, 93.5W at 18Z (COADS).
3. Land highlights:
   - 1000 mb at Sabine, TX at 20Z (MWR).
   - > 105 kt at "Oil Driller" (85 nm south of Morgan City) at 05Z
   - 65 kt S and gusts to 70 kt at Buras, LA at 1540Z (MWR).

4. Aircraft highlights:
   - Penetration fix measured a central pressure of 960 mb, estimated maximum surface winds of 110 kt, and an elliptical eye diameter of 10-15 nmi at 27.2N, 91.2W at 00Z (Storm Wallets).
   - Penetration fix measured a central pressure of 964 mb, estimated maximum surface winds of 110 kt, and an eye diameter of 20 nmi at 27.7N, 91.2W at 07Z (Storm Wallets).
   - Penetration fix measured a central pressure of 962 mb and an elliptical eye diameter of 20x30 nmi at 28.1N, 91.5W at 13Z (Storm Wallets).
   - Penetration fix measured a central pressure of 961 mb and estimated maximum surface winds of 90 kt at 28.7N, 91.6W at 19Z (Storm Wallets).
   - Penetration fix measured a central pressure of 962 mb and an eye diameter of 40 nmi at 29.3N, 91.6W at 22Z (Storm Wallets).
5. Discussion:
   a. MWR: "About 100 mi south of Morgan City, winds of 120 mph were recorded on the "Oil Driller" at 23000 CST October 2 [05Z on October 3]. This was the peak that the instrument could record. During the night "substantially high winds" were apparent. The eye of the hurricane passed during the morning of October 3, when the winds dropped to 30 mph, but after the eye moved toward shore the winds again exceeded 120 mph. Huge waves, 50 ft or higher, lashed the rig for hours."

   b. Reanalysis: The storm entered a near steady state on October 3, with pressures remaining in the low 960 mb range. Central pressures of 960 mb (at 00Z) and 964 mb (at 07Z and in between these values the remained of the day) suggest maximum winds of 95 kt and 91 kt, respectively, from the north of 25N subset of the Brown et al. pressure-wind relationship. Hilda's eye fluctuated in size, growing from 10-15 nmi in the early part of the day to 40 nmi around 22Z. The former value yields an RMW of about 10 nmi while the latter yields a value of 30 nmi. Based on a pressure of about 965 mb, the average RMW for a storm in the northern Gulf of Mexico is about 18 nmi. An oilrig about 100 mi south of Morgan City, Louisiana, reported winds in excess of 105 kt around 06Z. Given that the winds remained above the 120 mph maximum value of the anemometer for a period on the order of minutes to hours, this suggests sustained winds instead of a peak gust. A newspaper article in the storm wallet states that the top deck of the platform was set at 50 ft above sea level during Hilda's passage (and was hit by waves), although it does not state the anemometer height above the deck. This suggests that this platform was less elevated than its current day counterparts. Based on the aforementioned data, major reductions to wind speeds are made at 00Z and 06Z. Winds at 00Z, 06Z, 12Z, and 18Z are reassessed at 100 kt, 100 kt, 95 kt, and 90 kt, down from 110 kt, 105 kt, 100 kt, and 100 kt, respectively. Additionally, positions ware adjusted slightly south and east in accordance with recon fixes.

October 4:

1. Maps and old HURDAT:
   - HURDAT lists a 60 kt extratropical storm at 30.6N, 90.6W at 12Z.
   - HWM analyzes a tropical storm of at most 1000 mb near 28N 91.5W at 12Z.
   - Microfilm depicts a closed low with a central pressure of 992 mb near 30.5N, 90.5W at 12Z.
2. Ship highlights:
   - 45 kt NNW and 1004 mb at 28.8N, 93.7W at 00Z (COADS).
   - 45 kt NW and 1000 mb at 28.6N, 92.9W at 00Z (COADS).
   - 40 kt SW and 1006 mb at 27.8N, 89.3W at 06Z (COADS).
   - 55 kt SW and 1004 mb at 29.2N, 88.2W at 18Z (COADS).
   - 55 kt SW and 1004 mb at 29.0N, 88.1W at 20Z (COADS).
3. Land highlights:
   - 962 mb during eye passing at Franklin, LA at 0010Z (MWR).
   - 85 kt NE at Thibodaux, LA at 04Z (MWR). – Not an official site; no anemometer height info available.
   - 981 mb minimum pressure at Baton Rouge, LA at 08Z (MWR).
   - 52 kt+ at Clinton, LA at unknown time (MWR).
   - 45 kt S, gust to 65 kt, at Gulfport, MS at 12Z (SWO).
   - 30 kt N and 994 mb at Mobile Regional Airport at 2225Z (SWO).
   - 995 mb at Mobile, AL at 2230Z (MWR).
4. Aircraft highlights:
   - Penetration fix measured flight level winds of 104 kt at 29.6N, 91.6W at 0030Z (Storm Wallets).
   - Penetration fix measured an eye diameter of 50 nmi at 29.8N, 91.6W at 0110Z (Storm Wallets).
   - Penetration fix estimated maximum surface winds of 70 kt at 29.9N, 91.6W at 0330Z (Storm Wallets).
5. Previous landfall data:
   - "959.4 mb, 961.7 measured at Franklin, LA – RMW 18 nmi – 7 kt forward speed – landfall pt 29.5N, 91.5W" (Ho et al. (1987).
   - "Oct – LA, 3 – Cat 3 – 950 mb" (Jarrell et al. (1992).
6. Discussion:
   a. MWR: "After the eye moved inland the storm gradually weakened and moved north-northeastward toward Baton Rouge. When the center approached the Baton Rouge area, the storm was forced eastward as cold air associated with strong pressure rises moved into the circulation from the northwest. Soon after the eastward turn, the winds decreased to less than hurricane force. Hilda continued to weaken as cold air moved rapidly into its circulation, and the storm became extratropical over extreme southern Mississippi. The Low continued to move eastward and moved into the Atlantic Ocean near Jacksonville, Fla. The rapid advance of cold air into the storm was manifested by abrupt wind shifts to the north and increased speeds. This sharp increase in northerly winds across Lake Pontchartrain caused large waves to break and spill over the

seawall along the New Orleans lake front. Flooding occurred between the seawall and the back levee. The high waves on the lake caused considerable damage to fishing camps and some business establishments which were built out over the water and on the lake shore. To the east of New Orleans, the strongest winds in most areas occurred after the cold front had passed rather than in the southerly flow ahead of the Low."
"Data are scarce from the hard-hit areas of south-central Louisiana. The highest wind reported was an estimated 135 mph at Franklin, LA. The lowest pressure at Franklin was 962 mb (28.40 in.) as the eye of the storm passed over…The highest tide reported was an unofficial estimate of 10 ft near Point-au-Fer. Tides were 2 to 6 ft above msl from the mouth of the Mississippi River eastward to Apalachicola, Fla. And 2 to 5 ft above msl on the extreme western Louisiana and upper Texas coasts."

b. Hawkins and Rubsam: "After more than half of the storm was over land it began to fill at an extremely rapid rate of some 2 to 4 mb./hr. This continued for some 10 to 12 hr., after which the filling decreased to about ½ of this amount...This rapid rate may be attributed, in part at least, to the cold dry air that dominated the mainland. After the oceanic heat and moisture source were effectively removed, the sharply contrasting air entered the system at low levels. With but short overwater trajectories the air was not modified sufficiently to maintain Hilda in the 960-965 mb range."

c. Reanalysis: Hilda made landfall in central Louisiana, with the hurricane's central pressure about the same as the day before with 959 mb on 00Z October 4. Coinciding the hurricane making landfall was a dramatic increase in the hurricane's eye diameter, measured at 20-30 nmi at 13Z on the 3rd and expanding to 50 nmi—yielding an RMW of 35 nmi, well above the average of 22 nmi—by 0110Z on the 4th. Slight acceleration also took place, reaching roughly 10 kts. Landfall in south-central Louisiana is assessed at 23Z on October 3, slightly earlier than in the original HURDAT, with a central pressure of 959 mb, based 962 mb observed within the eye at Franklin. A pressure of 959 mb suggests maximum winds of 96 kt from the north of 25N subset of the Brown et al. pressure-wind relationship. Given the hurricane's very large RMW, modest pace, and an OCI of 1010 mb, landfall intensity is assessed at 90 kt, making Hilda a Category 2 impact for Louisiana. This is below the original HURDAT intensity of 95 kt and a downgrade from the Category 3 impact listed. It is worth noting that peak sustained winds of 115 kt were visually estimated in Franklin, but this value is not considered reliable and was not taken into account for assessing Hilda's landfall intensity.
Once onshore, Hilda's forward motion slowed and the system turned east. A gradual transition into an extratropical cyclone ensued once the hurricane moved ashore, and an approaching cold front interacted with the system. The Kaplan and DeMaria model was run with 90 kt starting at 23Z on October 3 for 06Z, 12Z, and 18Z on

October 4. This yielded intensities of 58 kt, 46 kt, and 42 kt, respectively. Maximum observed winds at these times were 40 kt, 52 kt, and 55 kt, respectively. Based on these data, wind speeds for these times are adjusted to 70 kt, 60 kt, and 55 kt, respectively. The 06Z intensity is assessed slightly above the Kaplan DeMaria model based on the topography of southern Louisiana: low-lying marshes, which lends to slower weakening than over other terrain. Coastal stations indicate Hilda maintained tropical characteristics throughout October 4, and transition into an extratropical cyclone is now assessed at 00Z on October 5, 12 hours later than originally in HURDAT.

October 5:

1. Maps and old HURDAT:
   - HURDAT lists a 35 kt extratropical storm at 30.8N, 84.5W at 12Z.
   - HWM analyzes an extratropical cyclone of at most 1004 mb near 31N 85W at 12Z.
   - Microfilm depicts an extratropical cyclone of at most 1005 mb near 30.5N 84.5W at 12Z.
2. Ship highlights:
   - 50 kt SW and 999 mb at 29.3N, 88.0W at 00Z (Micro).
   - 45 kt SW and 1002 mb at 29.2N, 87.5W at 00Z (COADS).
   - 50 kt NW and 1007 mb at 29.2N, 87.2W at 06Z (COADS).
   - 35 kt SSW and 1010 mb at 31.0N, 76.7W at 12Z (COADS).
   - 35 kt NW and 1016 mb at 28.9N, 88.2W at 18Z (COADS).
3. Land highlights:
   - General note: Minimum pressure preceded wind shift by several hours for most locations
   - 15 kt S and 997 mb at NAS Pensacola at 2355Z on October 4 (SWO).
   - 38 kt NW, gust to 47 kt, at Pensacola WBAS at 0246Z (MWR).
   - 1002 mb and 5 kt E at Dothan, AL at 0456Z (SWO).
   - 20 kt SSW and 1000 mb at Panama City, FL at 05Z (SWO).
   - 10 kt SSW and 1001 mb at Tallahassee, FL at 09Z (SWO).
   - 20 kt S and 1005 mb at Jacksonville, FL at 11Z (SWO).
   - 5 kt SSW and 1000 mb at Valparaiso, FL at 02Z (SWO).
4. Discussion:
   a. MWR: “Hilda had little direct effect on North Carolina. However, the extremely heavy rains and local severe storms which occurred in a 24- to 36-hr period centered around October 4 may be attributed, at least in part, to Hilda, which moved into the mainstream of upper-level winds which had been flowing from the Gulf of Mexico up over the Atlantic Seaboard States for several days. The situation was brought to a climax when a cold front approaching the Appalachians from the northwest was drawn into the circulation of the dying tropical cyclone.”

   b. Hawkins and Rubsam: “As the low moved eastward just about over the middle of the Florida Panhandle, Valparaiso remained in the warm

sector of the new extratropical wave until around 03 GMT on October 5. The time section at Valparaiso suggests that the cold wedge was well entrenched by 06 GMT on the 5th and that little of the thermal structure of the hurricane remained over the station. By 12 GMT of the 5th, there was adequate evidence of a cold front between Valparaiso and Jacksonville, Fla."

c. Reanalysis: Possibly due to baroclinic forcing, Hilda maintained gale- to storm-force winds as it became extratropical along the northern Gulf Coast. Multiple ships encountered 45-50 kt winds along a cold front extending from Hilda. The storm passed very close to Pensacola, Florida, where a pressure of 997 mb, along with NE 15 kt, was observed at the Naval Air Station at 0055Z. Only minor adjustments to track are made for smoothing. Wind speeds of 50 kt, 50 kt, 45 kt, and 45 kt are chosen for the respective synoptic times on October 5, the latter three of which are slight increases from the original HURDAT.

October 6:

1. Maps and old HURDAT:
   - HURDAT does not list an organized storm on this date.
   - HWM analyzes a frontal low of at most 1012 mb near 31N 76W at 12Z.
   - Microfilm depicts a frontal low of at most 1008 mb near 30.5N 76W at 12Z.
2. Ship highlights:
   - 40 kt N and 1014 mb at 35.3N, 73.6W at 00Z (COADS).
   - 35 kt S and 1012 mb at 36.6N, 68.6W at 00Z (COADS).
   - 45 kt NNE and 1014 mb at 34.5N, 75.7W at 06Z (COADS).
   - 15 kt S and 1006 mb at 30.9N, 78.2W at 06Z (Micro).
   - 45 kt N and 1008 mb at 29.8N, 79.7W at 12Z (COADS).
   - 35 kt NNE and 1011 mb at 34.6N, 75.5W at 12Z (COADS).
   - 45 kt NW and 1014 mb at 30.3N, 80.4W at 18Z (Micro).
   - 35 kt NE and 1012 mb at 30.7N, 79.7W at 18Z (COADS).
3. Discussion:
   a. Reanalysis: For unknown reasons, the original HURDAT terminates Hilda at 18Z on October 5. However, surface and ship observations clearly indicate the system persisting for several more days over the Atlantic Ocean off the Southeastern United States. Maximum winds of 45 kt are maintained throughout October 6 based on ship observations. The extratropical system regained some strength on October 7 due to a tightening gradient between it and a high pressure over the continental United States. Maximum winds are estimated to have reached 55 kt by 06Z, based on multiple ship observations of 50 kt, and remained at this level through dissipation.

October 7:

1. Maps and old HURDAT:
   - HURDAT does not list an organized storm on this date.
   - HWM analyzes a frontal low of at most 1008 mb near 31N 76W at 12Z.
   - Microfilm depicts a frontal low of at most 1008 mb near 30.5N 76W at 12Z.
2. Ship highlights:
   - 40 kt N and 1010 mb at 29.5N, 79.7W at 00Z (COADS).
   - 35 kt NE and 1015 mb at 31.4N, 79.7W at 00Z (COADS).
   - 50 kt N at 32.0N, 79.0W at 06Z (Micro).
   - 45 kt NNE and 1014 mb at 30.1N, 79.8W at 06Z (COADS).
   - 45 kt NE and 1014 mb at 30.9N, 79.7W at 12Z (COADS).
   - 40 kt NE and 1014 mb at 35.1N, 74.9W at 12Z (COADS).
   - 50 kt NE and 1016 mb at 31.6N, 79.2W at 18Z (COADS).
   - 35 kt S and 1015 mb at 31.7N, 71.0W at 18Z (COADS).
3. Discussion:
   a. Reanalysis: Throughout October 7, the cyclone became increasingly elongated, remaining at the tail end of the cold front that pushed it east days prior. After 12Z, it is difficult to determine if a closed circulation exists and as such, dissipation is assessed at this time. This extends Hilda's track 42 hours beyond the original HURDAT, now ending at 12Z on October 7.

October 8:

1. Maps and old HURDAT:
   - HURDAT does not list an organized storm on this date.
   - HWM analyzes a frontal low of at most 1012 mb near 31N 76W at 12Z.
   - Microfilm depicts a frontal low of at most 1015 mb near 29.5N 73W at 12Z.
2. Ship highlights:
   - 50 kt N and 1017 mb at 32.2N, 78.7W at 00Z (COADS).
   - 45 kt NNE and 1015 mb at 31.6N, 78.0W at 00Z (COADS).
   - 45 kt NE and 1015 mb at 32.4N, 77.0W at 06Z (COADS).
   - 45 kt NE and 1015 mb at 33.4N, 76.1W at 12Z (COADS).
   - 35 kt NE at 30.3N, 80.1W at 18Z (COADS).

October 9:

1. Maps and old HURDAT:
   - HURDAT does not list an organized storm on this date.
   - HWM analyzes a possible open frontal low of at most 1012 mb near 32N 77W at 12Z.
   - Microfilm depicts a frontal low of at most 1015 mb near 31N 78W at 12Z.
2. Ship highlights:
   - 30 kt N and 1015 mb at 29.9N, 80.8W at 18Z (COADS).

October 10:

1. Maps and old HURDAT:

- HURDAT does not list an organized storm on this date.
- HWM analyzes a frontal system extending from 21N, 82W northeast to the Canadian Maritimes at 12Z.
- Microfilm depicts a frontal system extending from 27N, 77W northeast to the Canadian Maritimes at 12Z.

2. Ship highlights:
   - No gales or low pressures observed on this date.

Harry F. Hawkins and Daryl T. Rubsam, 1968: Hurricane Hilda, 1964. *Mon. Wea. Rev.*, **96**, 701-707 doi: http://dx.doi.org/10.1175/1520-0493(1968)096<0701:HH>2.0.CO;2

Date	Original HURDAT Central Pressure	Evidence	Changes
Sep 30 00Z	997 mb	Penetration center fix: 997 mb around 2351Z on Sep 29th	
Sep 30 06Z	994 mb	Penetration center fix: 994 mb around 0700Z	
Sep 30 12Z	984 mb	Penetration center fix: 984 mb around 1318Z	
Sep 30 18Z	978 mb	Penetration center fix: 978 mb around 1758Z	
Oct 1 00Z	977 mb	Penetration center fix: 977 mb around 0100Z	Retained
Oct 1 06Z	955 mb	Penetration center fix: 955 mb around 0700Z	
Oct 1 12Z	951 mb	Penetration center fix: 951 mb around 1251Z	
Oct 1 18Z	941 mb	Penetration center fix: 941 mb around 1901Z	
Oct 2 00Z	942 mb	Penetration center fix: 942 mb around 0100Z	
Oct 2 12Z		Penetration center fix: 956 mb around 1415Z	956 mb
Oct 3 00Z	960 mb	Penetration center fix: 960 mb around 0000Z	Retained

Oct 3 06Z	964 mb	Penetration center fix: 964 mb around 0700Z	
Oct 3 12Z	962 mb	Penetration center fix: 962 mb around 1300Z	
Oct 3 18Z	961 mb	Penetration center fix: 961 mb around 1900Z	
Oct 4 00Z	959 mb	Franklin, LA: 962 mb during eye passage at 0010Z on Oct 4th. Used by Ho et al. (1987) to obtain 959.4 mb landfall pressure. Although station obs are unavailable at the time of this reanalysis to double-check estimated central pressure, it seems plausible given slight deepening in the hours preceding landfall and the value is retained as a central pressure.	

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

"Minor" intensity changes are less than 20 kt
"Minor" position changes are less than 1 degree

Hurricane Isbell [October 9 – 16, 1964] – AL111964

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43780 10/08/1964 M=10 11 SNBR= 943 ISBELL      XING=1 SSS=2
43780 10/09/1964 M= 8 11 SNBR= 943 ISBELL      XING=1 SSS=2
         **        **

(The 8th is removed from HURDAT)
43785 10/08*  0   0   0    0*  0   0   0    0*130 800  25 1008*134 806  25    0*

43790 10/09*140 813  25    0*148 822  25    0*155 830  25 1008*163 835  25    0*
43790 10/09*  0   0   0    0*155 830  30    0*160 836  30    0*165 842  30    0*
            *** ***  **      *** ***  **      *** ***  ** **** *** ***  **

43795 10/10*170 840  25    0*176 845  25    0*180 850  25    0*184 852  25 1008*
43795 10/10*170 847  30    0*176 850  30    0*181 851  30    0*185 852  30 1008*
              ***  **          ***  **      *** ***  **      ***       **

43800 10/11*189 853  25    0*192 855  25    0*194 857  25    0*194 860  25    0*
43800 10/11*189 853  35    0*192 854  35    0*194 855  30 1009*194 855  30    0*
                  **          ***  **          ***  ** ****     ***  **

43805 10/12*193 861  25    0*192 859  30    0*192 858  30    0*194 857  30 1005*
43805 10/12*193 856  30 1005*192 856  30    0*193 854  35    0*196 852  45    0*
              ***  ** ****     ***  **      *** ***  **      *** ***  ** ****

43810 10/13*200 850  40    0*205 848  50    0*210 846  60    0*217 845  80  979*
43810 10/13*200 850  55  996*205 848  60    0*210 847  70    0*216 845  85    0*
                  **  ***          **          ***  **      ***          ***

43815 10/14*225 841  95    0*232 836 100    0*240 829 110  964*251 820 110  968*
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43815 10/14*224 841   75   979*232 836   90     0*240 829 100   964*251 820   95   968*
            ***       **   ***         ***              ***                 ***

43820 10/15*264 806 110     0*278 790 100     0*296 773  80   980*305 765  70   986*
43820 10/15*264 806  80     0*280 791  80     0*293 778  80   980*305 766  75   986*
                    ***       ***  ***  ***      ***  ***              ***  **

43825 10/16*319 761  65   990*334 762  65   994E349 764  40  1000E360 765  35    0*
43825 10/16*320 761  75   990*334 758  75     0*345 765  60   992E355 777  35    0*
            ***       **          ***  **   ******* ***  **  **** *** ***

(The 17th is removed from HURDAT)
43830 10/17E365 765  30    0*  0    0    0     0*  0    0    0     0*  0    0    0     0*

43835 HRBFL2CFL2
43835 HRBFL2CFL1
            ****
```

Hurricane Landfall

10/13 1900Z 21.7N 84.5W 85 kt Cuba

U.S. Hurricane Landfall

Oct 14th – 21Z – 25.8N 81.4W – 90 kt – Category 2 – 970 mb – 20 nmi RMW – BFL2

U.S. Tropical Storm Landfall

10/16 13Z 34.7N 76.7W 60 kt 992 mb West of Morehead City, NC

Significant Revisions:

1. Genesis delayed by 18 hours.
2. Several central pressures were added based upon aircraft observations.
3. Several central pressures were removed, as they were not based upon specific observations.
4. Intensity revised upward on 12th and 13th.
5. Intensity revised downward on 14th and 15th.
6. Intensity revised upward on 16th.
7. Tropical storm landfall added in North Carolina on the 16th.

Daily Summaries:

October 6-7:

1. Maps and old HURDAT:
   - HWM analyzes an area of low pressure of 1008 mb at most near 11N 77W at 12Z on October 6.
   - Microfilm analyzes an area of low pressure of 1008 mb at most near 11N 78W at 12Z on October 6.
   - HWM analyzes an area of low pressure of 1008 mb at most near 12N 77N at 12Z on October 7.
   - Microfilm analyzes an area of lower pressures (with no circulation) over the southwest Caribbean Sea at 12Z on October 7.
2. Discussion:
   - Reanalysis: In early October, a frontal boundary extending from former Hurricane Hilda traversed the northwestern Caribbean Sea. An area of

disturbed weather coalesced along the southern edge of the boundary as it weakened on October 6-7.

October 8:

1. Maps and old HURDAT:
   - HWM analyzes a 1008 mb low near 12.5N 80W at 12Z.
   - Microfilm analyzes a broad circulation with two possible centers over the southwestern Caribbean, but no distinct low pressure area at 12Z.
   - HURDAT lists a 25 kt tropical depression with a pressure of 1008 mb at 13.0N 80.0W at 12Z.
2. Discussion:
   - MWR: "Evidence of a new tropical disturbance appeared over the western Caribbean just south of an old diffuse frontal trough on October 7. However, it remained quite weak and poorly organized for several days and the first bulletin was not issued until October 10. It was named tropical storm Isbell at 2300 EST on October 12 [04Z October 13]."

October 9:

1. Maps and old HURDAT:
   - HWM analyzes a weak low near 15N 83W at 12Z.
   - Microfilm analyzes an area of low pressure of 1008 mb at most near 14N 80W at 12Z.
   - HURDAT lists a 25 kt tropical depression with a pressure of 1008 mb at 15.5N 83.0W at 12Z.
2. Ship highlights:
   - 35 kt NW at 16.0N 84.0W at 0819Z (Micro).
3. Discussion:
   a. Reanalysis: A broad cyclonic gyre formed on October 8; however, ship observations and *in situ* analyses show no defined circulation until 06Z on October 9. At that time, the system is initiated as a tropical depression. This is 18 hours later than originally shown in HURDAT. The ship *Rozella* encountered 35 kt NW in brief squall at 0819Z. Due to the transient nature of these winds, 30 kt is chosen as the starting intensity for the depression, slightly above the original HURDAT.

October 10:

1. Maps and old HURDAT:
   - HWM analyzes an area of low pressure of 1008 mb at most near 18N 85W at 12Z.
   - Microfilm does not analyze any low pressure centers, though denotes a possible circulation center near 19N 85W at 12Z.
   - HURDAT lists a 25 kt tropical depression at 18.0N 85.0W at 12Z.
2. Ship highlights:
   - 35 kt W and 1006 mb at 16.8N 85.4W at 23Z (COADS).
3. Aircraft highlights:
   - Penetration center fix with estimated winds of 30 kt and a central pressure of 1009 mb (corrected to 1007.5 mb) at 18.3N 85.3W at 1645Z (SW).
   - Penetration center fix with estimated winds of 25 kt and a central pressure of 1008 mb at 18.7N 85.2W at 2000Z (SW).
4. Discussion:
   a. Reanalysis: On October 10, the depression turned north-northwest and its forward motion slowed. Reconnaissance reports on this day indicate it remained weak, reporting a center fix at 1645Z with a corrected pressure of 1008 mb.

October 11:

1. Maps and old HURDAT:
   - HWM analyzes an area of low pressure of 1008 mb at most near 19N 80.5W at 12Z.
   - Microfilm analyzes a broad low pressure area of 1011 mb at most with a general center near 19.5N 83.5W at 12Z.
   - HURDAT lists a 25 kt tropical depression at 19.4N 85.7W at 12Z.
2. Aircraft highlights:
   - Penetration center fix with a central pressure of 1009 mb at 19.5N 85.8W at 1453Z (SW).
   - Penetration center fix at 19.5N 85.5W at 1833Z (SW).
3. Discussion:
   a. Reanalysis: The depression slowed to a crawl on October 11, eventually turning south as it executed a tight loop. At 23Z on October 10th, a ship observed 35 kt W winds south of the system. Although relatively distant from the circulation center, aircraft and ship observations indicate the system to be somewhat monsoonal—having a broad, weak center with the strongest winds farther than normal—and this value appears reasonable. A brief tropical storm period, 12 hours, is added to HURDAT at 00 and 06Z on October 11 based on this observation. This initial strengthening to tropical storm status is 48 hours earlier than originally depicted in HURDAT. (Given how far the 35-kt winds were from the center position at 00Z, there is some uncertainty about how representative they are.) Remaining nearly stationary, the system weakened back to a depression by 12Z, with reconnaissance reporting a central pressure of 1009 mb at 1453Z. A ship well to the north reported 40 kt NNE winds at 12Z; however, a stationary front was present over the southern Gulf of Mexico and is likely the primary factor in that observation rather than the depression.

October 12:

1. Maps and old HURDAT:
   - HWM analyzes an area of low pressure of 1008 mb at most near 19N 81W at 12Z.
   - Microfilm analyzes an area of low pressure of 1009 mb at most near 20N 85.5W at 12Z.
   - HURDAT lists a 30 kt tropical depression at 19.2N 85.8W at 12Z.
2. Aircraft highlights:
   - 15 kt NNE and 1007 mb at 19.2N 86.3W at 00Z (COADS).
3. Aircraft highlights:
   - Penetration center fix with flight level winds of 30 kt at 19.2N 85.8W at 1630Z (SW).
4. Discussion:
   a. Reanalysis: On October 12, the depression regained tropical storm status, as it gradually turned northeast. A ship observed 15 kt NNE and 1007 mb near the center at 00Z, yielding an estimated central pressure of 1005 mb. A pressure of 1005 mb suggests maximum winds of 37 kt from the south of 25N from the Brown et al. pressure-wind relationship. Because the storm was barely moving and had a slightly below-average ROCI, the intensity is assessed at 30 kt, up slightly from 25 kt originally. Based upon subsequent ship observations early on the 13th, tropical storm intensity was likely reached at 12Z and rapid intensification ensued from that point through the next two days.

October 13:

1. Maps and old HURDAT:
   - HWM analyzes a tropical storm of 1000 mb at most near 21N 84.5W at 12Z.
   - Microfilm analyzes an area of low pressure of 1002 mb at most near 21N 84.5W at 12Z.
   - HURDAT lists a 60 kt tropical storm at 21.0N 84.6W at 12Z.
2. Ship highlights:
   - 40 kt SE and 1004 mb at 20.6N 84.3W at 00Z (COADS).
   - 25 kt SW and 999 mb at 20.0N 84.7W at 02Z (COADS).
   - 45 kt E and 1000 mb at 21.5N 84.5W at 12Z (COADS).
   - 130 kt WSW and 983 mb at 21.2N 84.7W at 15Z (COADS, could be doubled from actual 65 kt).
   - 65 kt S and 998 mb at 21.3N 84.3W at 18Z (MWL).
   - 65 kt W and 1002 mb at 21.1N 84.7W at 18Z (COADS).
   - 60 kt NNE and 997 mb at 21.7N 85.0W at 18Z (COADS).
3. Station highlights:
   - 35 kt N and 999 mb in Cabo San Antonio, Cuba at 19Z (SW).
   - 979 mb (exact time unknown) in Guane, Cuba and maximum winds of 75 kt at 2230Z (MWR).
   - 15 kt ESE and 1005 mb in San Cristobal, Cuba at 23Z (SW).
4. Aircraft highlights:
   - Radar center fix at 21.1N 84.6W at 1306Z (SW).
   - Radar center fix with flight level winds of 50 kt and a 25 nmi eye at 21.7N 84.6W at 1825Z (SW).
5. Discussion:
   a. MWR: "Isbell reached hurricane intensity as it neared the extreme western portion of Cuba on October 13. The area around Guane was most affected, resulting in heavy damage and three fatalities. The hurricane then moved on a generally northeastward course across southern Florida to near 31N before recurving northward and moving inland over coastal North Carolina and weakening. In Cuba wind gusts of 70 mph occurred as far east as Boyeros Airport near Havana with a pressure of 979 mb (28.91 in.) reported in the hurricane area farther west."

   b. Reanalysis: On October 13, two ships sailed near the center of Isbell; one reported 40 kt SE with 1004 mb (00Z) and the other 25 kt SW with 999 mb (02Z). Extrapolating from the latter, an estimated central pressure of 996 mb was obtained for this period. A central pressure of 996 mb suggests maximum winds of 54 kt from the south of 25N Brown et al. pressure-wind relationship. Accounting for later observations, an intensity of 55 kt is chosen for this time, a major increase from 40 kt originally in HURDAT. Rapid intensification ensued throughout October 13 as Isbell approached western Cuba. At 15Z, a ship reported 130 WSW winds—considered erroneous—and a pressure of 983 mb. A peripheral pressure of 983 mb suggests maximum winds of at least 74 kt from the south of 25N Brown et al. pressure-wind relationship. At 18Z, two ships observed hurricane-force winds near the center. Based on these three reports, Isbell is now considered to have reached hurricane-status at 12Z, six hours earlier than originally in HURDAT. Around 19Z, Isbell is analyzed to have made landfall over extreme western Cuba. Several hours later, it passed over Guane where a pressure of 979 mb was observed in the eye; 75 kt was observed at 2230Z. A central pressure of 979 mb suggests maximum winds of 79 kt

from the south of 25N Brown et al. pressure-wind relationship. By this time, the hurricane had spent several hours over land and likely weakened somewhat. Accordingly, landfall intensity is assessed at 85 kt, a Category 2 hurricane, and slightly above the original HURDAT landfall intensity of 80 kt at 18Z, just before landfall.

October 14:

1. Maps and old HURDAT:
   - HWM analyzes a hurricane of 1004 mb at most near 24.5N 83W at 12Z.
   - Microfilm analyzes an area of low pressure of 1002 mb at most near 24N 83.3W at 12Z.
   - HURDAT lists a 110 kt hurricane with a pressure of 964 mb at 25.1N 82.0W at 12Z.
2. Ship highlights:
   - 35 kt W and 1005 mb at 21.6N 84.6W at 00Z (COADS).
   - 25 kt WNW and 1003 mb at 21.0N 84.7W at 00Z (COADS).
   - 45 kt ENE and 999 mb at 24.5N 83.4W at 12Z (COADS).
   - 45 kt SW and 1007 mb at 24.5N 81.1W at 20Z (SW).
   - 50 kt E and 999 mb at 27.0N 80.9W at 23Z (SW).
3. Station highlights:
   - 50 kt E and 971 mb (likely too low) around 15Z at Dry Tortugas, Florida (MWR).
   - 63 kt S and 999 mb in Key West, Florida at 1645Z (MWR).
   - 973 mb in Everglades, Florida at 2130Z with maximum winds of 80 kt at an unknown time (MWR).
4. Aircraft highlights:
   - Radar center fix with a 22 nmi eye at 22.6N 84.1W at 0100Z (SW).
   - Radar center fix at 23.3N 83.4W at 0650Z (SW). Penetration center fix with estimated surface winds of 135 kt, an extrapolated central pressure of 964 mb (965 mb based on height), and a 20 nmi eye at 24.2N 82.7W at 1300Z (SW).
   - Penetration center fix with estimated surface winds of 116 kt, 86 kt flight level winds, a central pressure of 968 mb, and a 25 nmi eye at 25.1N 82.0W at 1755Z (SW). Estimated surface winds of 108 kt with a central pressure of 970 mb and an eye diameter of 26 nmi around 19Z (NOAA Research).
   - Penetration center fix with estimated surface winds of 110 kt, flight level winds of 65 kt, and an extrapolated pressure of 970 mb at 25.8N 81.4W at 2108Z (SW).
5. Discussion:
   a. MWR: "The center of Hurricane Isbell entered Florida near Everglades City around 1600 EST [21Z] October 14 where a calm was experienced from 1615 to 1640 EST [2115 to 2140Z]. It crossed the peninsula and existed in the Jupiter-Juno Beach area around 2130 EST. This represented a northeastward movement of around 20 mph. The center passed some 47 mi to the northwest of Miami where peak gusts were 63 mph and the lowest pressure was 1000 mb (29.53 in.). Highest winds around the eye were 90 mph along both Florida coasts. Radar indicated marked asymmetry in the precipitation pattern around Isbell as it approached the southwestern Florida coast. This proved to be the case; no rain of consequence occurred at Everglades City after the center passed. Winds were considerably less in the rear portion than in the

forward portion of the storm which in turn accounted for the small storm surge."

b. Reanalysis: Isbell weakened briefly due to its interaction with Cuba; based on the pressure observation in Guane, the hurricane is assessed with 75 kt winds at 00Z on October 14. This is a major decrease from 95 kt originally in HURDAT. Around this time, the aforementioned stationary front over the Gulf had retrograded to the northwest and begun consolidating into a defined low. This system served to produce shear over Isbell and bring cooler, drier air into the western portion of its circulation. Despite this, Isbell continued to intensify over the warm waters of the Gulf. At 13Z, reconnaissance reported a central pressure of 964 mb, estimated surface winds of 135 kt, and an eye diameter of 20 nmi. A central pressure of 964 mb suggests maximum winds of 97 kt from the south of 25N and 91 kt from the north of 25N from the Brown et al. pressure-wind relationships. Given an average RMW of 18 nmi, 15 kt forward speed, a slightly below-average OCI of 1008 mb, and lending some credit to the 135 kt surface estimate, an intensity of 100 kt is chosen for 12Z. This constitutes the peak intensity of Isbell and is a slight decrease from the 110 kt originally in HURDAT. At 1455Z a pressure of 971 mb was reported at Dry Tortugas in the Florida Keys; however, the station was not within the eyewall of Isbell and this reading appears to be erroneously low. Slight weakening took place thereafter with reconnaissance reporting a central pressure of 968 mb at 1755Z. Based on acceleration of the hurricane and all other factors remaining steady, an intensity of 95 kt is maintained for 18Z, a major decrease from 110 kt originally in HURDAT. Isbell made landfall along the southwest Florida coastline around 21Z, close to or over Everglades City. A recon fix at 2108Z located the center over the city and reported a pressure of 970 mb and estimated surface winds of 110 kt. The city itself observed a pressure of 973 mb at 2130Z and maximum winds of 80 kt at an unknown time. A central pressure of 970 mb suggests maximum winds of 90 kt from the south of 25N and 84 kt from the north of 25N from the Brown et al. pressure-wind relationships. Based on these data, an intensity of 90 kt is chosen for landfall, making Isbell a Category 2 impact for southwest Florida.

October 15:

1. Maps and old HURDAT:
   - HWM analyzes a hurricane of 996 mb at most near 29.5N 77.5W at 12Z.
   - Microfilm analyzes a hurricane with winds of 80 kt and a pressure of 980 mb near 29.4N 77.4W at 12Z.
   - HURDAT lists an 80 kt hurricane with a pressure of 980 mb at 29.6N 77.3W at 12Z.
2. Ship highlights:
   - 50 kt SSE and 1002 mb at 25.2N 79.2W at 00Z (COADS).
   - 45 kt SSW and 1004 mb at 25.3N 79.6W at 00Z (COADS).
   - 50 kt E and 1002 mb at 32.0N 78.4W at 18Z (COADS).
   - 40 kt SW and 1004 mb at 28.5N 75.6W at 18Z (Micro).
3. Station highlights:
   - 58 kt (direction unknown) and 981 mb at Everglades Experiment Station (26.7N 80.6W) at 0130Z (MWR).

- 978 mb in eye at Juno Beach, Florida at 0218z. 80 kt (direction unknown) at Indiantown, Florida likely around 02Z (MWR).

4. Aircraft highlights:
   - Radar center fix at 26.4N 80.5W at 0007Z (SW).
   - Penetration center fix with flight level winds of 90 kt, a central pressure of 985 mb, and a 30 nmi poorly defined eye at 28.7N 78.6W at 0830Z (SW).
   - Penetration center fix with estimated surface winds of 90 kt, a central pressure of 972 mb, and a 20 nmi poorly defined eye at 29.1N 78.2W at 1000Z (SW).
   - Penetration center fix with estimated surface winds of 130 kt, flight level winds of 90 kt, a central pressure of 980 mb, and a 30 nmi poorly defined eye at 29.7N 77.6W at 1300Z (SW).
   - Penetration center fix with 70 kt flight level winds, a central pressure of 986 mb, and a 10-15 nmi elliptical eye at 30.5N 76.6W at 1800Z (SW).
5. Discussion:
   a. Reanalysis: Accelerating across the southern Florida Peninsula, Isbell only weakened slightly before emerging over the Atlantic around 0230Z. The Kaplan and DeMaria inland decay model was run for one period starting at 21Z on October 14 with 90 kt, yielding 68 kt for 00Z on October 15. However, Indiantown reported 80 kt sustained winds at 02Z, and Juno Beach reported a pressure of 978 mb during the eye passage. A central pressure of 978 mb suggests maximum winds of 75 kt from the north of 25N Brown et al. pressure-wind relationship. Based on these data, the 00Z intensity is assessed at 80 kt, a major decrease from the erroneous 110 kt shown in HURDAT. A central pressure of 985 mb from aircraft was reported at 0830Z after Isbell emerged over water, but this appears to be erroneous. Isbell slowly filled the remainder of 15th. A central pressure of 980 mb from a 13Z reconnaissance fix suggests maximum winds of 73 kt from the north of 25N Brown et al. pressure-wind relationship. Weighting the estimated surface winds slightly, an intensity of 80 kt is analyzed at 12Z, same as 80 kt originally. A central pressure of 986 mb from an 18Z reconnaissance fix suggests maximum winds of 65 kt from the north of 25N Brown et al. pressure-wind relationship. An intensity of 75 kt is analyzed at 18Z, slightly above HURDAT due to some weighting of the surface wind estimates and a subsequent 75 kt report at 06Z on the 16th.

October 16:

1. Maps and old HURDAT:
   - HWM analyzes a tropical storm of 1000 mb at most near 35N 76W at 12Z.
   - Microfilm analyzes an area of low pressure of 996 mb at most near 35N 76W at 12Z.
   - HURDAT lists a 40 kt extratropical storm with a pressure of 1000 mb at 34.9N 76.4W at 12Z.
2. Ship highlights:
   - 75 kt N and 994 mb at 33.7N 75.9W at 06Z (COADS/MWL).
   - 30 kt E and 998 mb at 32.2N 78.6W at 06Z (COADS).
   - 45 kt S and 1020 mb at 27.0N 71.6W at 06Z (COADS).
   - 20 kt SW and 995 mb at 33.9N 76.3W at 12Z (COADS).
   - 35 kt SW at 33.5N 75.7W at 12Z (COADS).
   - 30 kt WSW and 998 mb at 34.0N 76.4W at 18Z (COADS).
   - 40 kt E and 1000 mb at 37.1N 74.8W at 18Z (COADS).
3. Aircraft highlights:

- Penetration center fix with a central pressure of 990 mb and a 25 nmi eye at 32.1N 76.1W at 0100Z (SW).
- Penetration center fix with estimated surface winds of 60 kt at 33.8N 76.4W at 0635Z (SW).
- Radar Center fix with estimated surface winds and a central pressure of 1000 mb at 34.3N 77.3W at 1000Z (SW).

4. Station highlights:
   - 10 kt N and 994 mb in Cherry Point, North Carolina at 14Z (SWO).
   - 40 kt S, with gusts to 65 kt, at 15Z and 997 mb at 19Z in Elizabeth City, North Carolina (MWR).
5. Discussion:
   a. MWR: "Isbell, no longer of hurricane intensity when it reached the North Carolina coast near Morehead City, rapidly became extratropical as it continued northward toward Norfolk. Highest winds reported in this area was a gust of 75 mph at Elizabeth City, N.C., while the peak gust in the Norfolk [Virginia] area was 72 mph."

   b. Reanalysis: Fujiwhara interaction with the aforementioned low over the Gulf pulled Isbell to the north and later northwest on October 16. Although the hurricane's central pressure steadily rose, its circulation shrunk and winds remained strong in a small area near the center. A ship at 06Z encountered 75 kt N with 994 mb. A time series of the ship's observations shows no obvious signs of a high bias and the winds are considered reliable; thus winds are assessed at 75 kt at that time. Turning northwest, Isbell rapidly weakened as it neared the North Carolina coastline. Transition into an extratropical cyclone was also underway by this time, though the overall temperature gradient may be exaggerated by the much larger extratropical system to Isbell's southwest. Coastal observations indicate Isbell made landfall around 13Z, just west of Morehead City, as a tropical storm. Cherry Point and Morehead City observed a noticeable spike in temperatures as Isbell passed through, indicating the system retained a small warm-core and was still a tropical cyclone upon moving ashore. Central pressure at landfall is assessed at 992 mb, based on an observation of 15 kt N and 994 mb at Cherry Point. 992 mb central pressure suggests 56 kt from the north of 25N and 60 kt from the north of 35N pressure-wind relationships. As Isbell was in the process of merging with the oncoming extratropical cyclone, an intensity of 55 kt is chosen for landfall and at 12Z. This is a substantial boost in the intensity from the 40 kt shown originally. The tropical storm landfall in North Carolina is a new addition to HURDAT, which previously showed Isbell crossing the coast as an extratropical cyclone. Transition into an extratropical cyclone was complete by 16Z, with a defined warm front present. The circulation rapidly dissipated after 18Z as it was absorbed into an approaching storm. Dissipation is now indicated 6 hours earlier than originally in HURDAT.

Date	Original HURDAT Central Pressure	Evidence	Changes

Oct 9 12Z	1008 mb	Could not verify source, removed due to uncertainty	Removed
Oct 10 18Z	1008 mb	Penetration center fix: 1008 mb around 1645Z	Retained
Oct 11 12Z		Penetration center fix: 1009 mb around 1453Z	1009 mb
Oct 12 00Z		COADS: 15 kt NNE 1007 mb at 00Z	1005 mb
Oct 12 18Z	1005 mb	Pressure was steadily deepening throughout the day and the HURDAT value conflicts with other observations.	Removed
Oct 13 00Z		COADS: 25 kt NW 999 mb at 02Z	996 mb
Oct 13 18Z	979 mb	Moved to October 14 00Z	Removed
Oct 14 00Z		Guane, Cuba: 979 mb during eye passage, time uncertain but likely around 23Z	979 mb
Oct 14 12Z	964 mb	Penetration center fix: 964 mb around 1300Z	Retained
Oct 14 18Z	968 mb	Penetration center fix: 968 mb around 1755Z	
Oct 15 12Z	980 mb	Penetration center fix: 980 mb around 1755Z	
Oct 15 18Z	986 mb	Penetration center fix: 986 mb around 1800Z	
Oct 16 00Z	990 mb	Penetration center fix: 990 mb around 0100Z	
Oct 16 06Z	994 mb	Based on a ship observation of 75 kt and 994 mb at 06Z, a central pressure of 994 mb appears too high; however, a replacement central pressure could not be derived. The value is removed altogether accordingly.	Removed
Oct 16 12Z	1000 mb	Cherry Point, NC: 15 kt N 994 mb at 14Z	992 mb

Tropical Storm Twelve [November 5–10, 1964] – AL121964

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43840 11/05/1964 M= 6 12 SNBR= 944 NOT NAMED   XING=0 SSS=0                  L
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43845 11/05*113 801  25    0*118 805  25    0*122 808  25    0*126 810  25    0*
43845 11/05*116 801  25    0*119 805  25    0*122 808  25    0*126 810  30 1006*
            ***             ***                                      **  ****

43850 11/06*130 811  25    0*135 813  30    0*139 814  35    0*141 818  35    0*
43850 11/06*130 811  30 1003*134 812  35    0*138 812  40    0*140 815  40 1001*
                    ** **** *** ***  **      *** ***  **      *** ***  **  ****

43855 11/07*142 824  35    0*142 828  35    0*142 833  35    0*145 840  35  997*
43855 11/07*142 821  50    0*144 829  60    0*147 836  50    0*150 841  45  997*
                ***  **      *** ***  **      *** ***  **      *** ***  **

43860 11/08*150 847  35    0*155 850  30    0*160 854  25    0*164 858  25    0*
43860 11/08*155 846  35    0*158 850  30    0*161 854  30 1006*164 858  30    0*
            *** ***         ***             ***       ** ****         **

43865 11/09*168 861  25    0*173 867  25    0*178 876  25    0*182 883  25    0*
43865 11/09*168 863  30    0*173 869  30    0*178 876  25 1008*181 881  25    0*
                ***  **          ***  **                  **** *** ***

43870 11/10*185 889  25    0*  0   0   0    0*  0   0   0    0*  0   0   0    0*
43870 11/10*183 885  25 1009*  0   0   0    0*  0   0   0    0*  0   0   0    0*
            *** ***     ****
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43875 TS

Tropical Storm Landfall

11/07 1000Z 14.6N 83.3W 60 kt Nicaragua

Significant Revisions

1. Several central pressures were added based upon aircraft and station observations.
2. Intensity boosted on the 7th based upon impacts described at landfall in Nicaragua.

Daily Summary:

November 1-3:

1. Maps and old HURDAT:

- Microfilm analyzes an area of low pressure of 1008 mb at most near 11.5N 79.5W at 12z on November 3.

2. Discussion:

- MWR: "There was evidence of a perturbation on the [ITCZ] in northern Colombia and Venezuela as early as November 1, and heavy rains continued intermittently in the Caribbean north of Panama for the next four to five days as the disturbance drifted west-northwestward."
- Reanalysis: The origins of this unnamed tropical storm appear to be from a weak disturbance associated with the ITCZ over the southwestern Caribbean Sea, north of Panama, in early November. Pressures in the region slowly decreased over the following days as the system drifted west-northwest.

November 4:

1. Maps and old HURDAT:

- Microfilm analyzes an area of low pressure of 1008 mb at most near 13N 79.5W at 12z.

2. Discussion/MWR: "A weak cyclonic circulation was evident on the 4th east of San Andres Island, with pressure about 2 mb below normal."

November 5:

1. Maps and old HURDAT:

- HWM analyzes a weak area of low pressure near 12.5N 80W at 12z.
- Microfilm analyzes an area of low pressure of 1010 mb at most near 12.5N 79.5W at 12z.
- HURDAT lists a tropical depression at 12.2N 80.8W with winds of 25 kt at 12z.

2. Station highlights:

- 10 kt N and 1007 mb on San Andres at 18Z (micro).

3. Discussion/Reanalysis: Synoptic data depicts the formation of a weak, closed circulation by 00Z and initiation of the system as a tropical depression is made at this time, in agreement with the original HURDAT. Slow intensification ensued as the depression drifted to the northwest. A 1006 mb central pressure is added to HURDAT at 18Z based on an observation of 10 kt N and 1007 mb on San Andres Island. A pressure of 1006 mb suggests maximum winds of 35 kt from the south of 25N Brown et al. pressure-wind relationship. Based on low environmental pressures and the cyclone's slow forward motion, the winds at 18Z are assessed slightly below this at 30 kt.

November 6:

1. Maps and old HURDAT:

- HWM analyzes an area of low pressure of 1004 mb at most near 13.5N 81.5W at 12z.
- Microfilm analyzes a tropical cyclone of 1008 mb at most near 14N 81.5W at 12z.
- HURDAT lists a tropical storm at 13.9N 81.4W with winds of 35 kt at 12z.

2. Ship highlights:

- 40 kt N at 15.2N 81.2W at 12Z (COADS).
- 20 kt SW and 1003 mb at 13.5N 81.0W at 18Z (COADS).

3. Aircraft highlights:

- Center fix with 1001 mb and peak winds of 30 kt at 13.9N 81.4W ~18Z (MWR/micro).

4. Station highlights:

- 10 kt NW and 1004 mb on San Andres at 00Z (micro).

5. Discussion:

- MWR: "By 1900 EST November 5 [(0000 UTC November 6)] the depression had moved to a position northeast of San Andres where the pressure was now 1004 mb…A plane was sent to investigate the area on the 6th and found a minimum pressure of 1001 mb but maximum winds of only 35 mph. It is believed that there must have been scattered stronger squalls. That night several ships reported winds in the 40 to 45 mph range. The tropical storm moved inland over extreme north-eastern Nicaragua and extreme northern Honduras during the night of the 6th."
- Reanalysis: The depression made its closest approach to San Andres around 00Z, passing roughly 40 nmi to the northeast. A pressure of 1004 mb was reported on the island at that time along with 10 kt NW winds, which serves as the basis for the addition of a 1003 mb central pressure. A pressure of 1003 mb suggests maximum winds of 41 kt from the south of 25N Brown et al. pressure-wind relationship. An intensity of 30 kt is chosen for 00Z based on continued slow speed, low environmental pressures, and the weak winds reported on San Andres in close proximity to the center. Intensification into a tropical storm is estimated to have taken place around 06Z, six hours

earlier than originally in HURDAT. This estimate is extrapolated from a 40 kt ship observation at 12Z. A westward turn and slight increase in forward speed took place soon after. A 1001 mb central pressure is added at 18Z based on recon fix of 1001 mb around the same time as well as a ship observation of 20 kt SW and 1003 mb. A pressure of 1001 mb suggests maximum winds of 45 kt from the south of 25N Brown et al. pressure-wind relationship. The intensity for 18Z is assessed slightly below this value for the same reasons as previous estimates.

November 7:

1. Maps and old HURDAT:

- HWM analyzes a tropical storm of 1004 mb at most near 14.5N 84W at 12z.
- Microfilm analyzes an area of low pressure of 1004 mb at most near 14.2N 84W at 12z.
- HURDAT lists a tropical storm at 14.2N 83.3W with winds of 35 kt at 12z.

2. Ship highlights:

- 35 kt E and 1010 mb at 17.9N 83.0W at 06Z (COADS).

3. Aircraft highlights:

- 997 mb central pressure at 1730Z (MWR, SW).

4. Station highlights:

- 25 kt N and 1002 mb at Puerto Cabezas, Nicaragua at 00Z (micro).
- 20 kt W and 1005 mb on San Andres at 00Z (COADS).
- 20 kt S and 1002 mb at Puerto Cabezas, Nicaragua at 12Z (COADS).

5. Discussion:

- MWR: "A reconnaissance plane found a central pressure of 997 mb over land the next day. The storm decreased somewhat in intensity over land, and, while it moved out to sea briefly over the Gulf of Honduras, it was not over water long enough to re-intensify significantly…The meteorological service of Honduras reported on the storm as follows: According to reports from the people of Caukira [likely now "Cauquira"], water flooded the entire town and five small houses were destroyed. Tides were as high as 18 feet. In the town of Rus-Rus a bridge was destroyed. The entire zone around Caratasca Lagoon was evacuated in order to avoid casualties. According to several seamen from Brus Laguna, the winds were up to 90 mph in their area. In Puerto Castilla the rainfall was so great that the river flooded and destroyed the bridge. In the Bay Islands and neighboring cays there was also considerable damage due to strong winds and heavy rainfall. Press reports indicate heavy damage from wind, rain, and subsequent flooding in northeastern Nicaragua. Crops, particularly bananas, were destroyed…It is not believed that sustained winds of hurricane force occurred in this storm. Maximum speeds were probably around 60 mph in squalls. At 200 mb, there was excellent outflow from the storm area; and, it was, no doubt, beginning to intensify fairly rapidly in the few hours before landfall on the Nicaraguan coast."
- Dirección General de Aeronáutica Civil in Honduras (SW): "We do not have any special met. information…"
- Reanalysis: Favorable environmental conditions allowed for rapid intensification to ensue as it approached the northeastern coast of Nicaragua. Although no direct observations from the center are available, Nicaraguan media reported that winds of 70 kt occurred in the country. Additionally, the meteorological agency of Honduras stated that winds of 80 kt were estimated in Brus Laguna along the northeastern coast. The track was adjusted northward late on the 7th and early on the 8th to bring the center closer to Brus Laguana (which would have occurred late on the 7th). Based on these reports along with the presence of wind damage, a peak intensity of 60 kt is chosen for this system at 06Z. This is a major increase from the 35 kt

originally in HURDAT. Landfall in Nicaragua, north of Puerto Cabezas, took place around 10Z at peak intensity. Microfilm plots indicate that no observation was in the city at 06Z; however, observations at 00Z and 12Z concur with the passage of the cyclone. It is possible that the storm further strengthened into a Category 1 hurricane before it made landfall; however, a lack of concrete evidence inhibits confidence in upgrading the system. A good analog for the development and rapid intensification of this system is Hurricane Ida in 2009, which quickly organized into to a 70 kt hurricane 30 hours after genesis before striking Nicaragua. (The Honduran letter references Caukira, where the tides were allegedly "18 feet". It is likely that "Caukira" is now referred to as "Cauquira", which is located at 15.3N 83.6W. SPLASH (a simplified storm surge model) output indicates 18 feet for storm surge for that area would be due to a hurricane near the boundary between a Category 4 or Category 5. It does not seem plausible that the system reached major hurricane status, much less Category 4 or 5. On the other hand, it is possible that this inundation was referring to rainfall-produced flooding along Rio Patuca in the general region of Cauquira. Such an interpretation would be consistent with evacuations AFTER the system came through of nearby Caratasca Lagoon.)
After moving onshore a center fix with 997 mb was made by recon around 18Z, which verifies the central pressure already in HURDAT. (Note that since the measurement was taken over land, more uncertainty is present than usual.) A pressure of 997 mb suggests maximum winds of 53 kt from the south of 25N Brown et al. pressure-wind relationship. Accounting for the reduction in the sustained wind due to increased land friction, an intensity of 45 kt is chosen for 18Z.

November 8:

1. Maps and old HURDAT:

- HWM analyzes a tropical storm of 1008 mb at most near 16N 86W at 12z.
- Microfilm analyzes an area of low pressure of 1008 mb at most near 15.5N 86W at 18z.
- HURDAT lists a tropical depression at 16.0N 85.4W with winds of 25 kt at 12z.

2. Station highlights:

- 20 kt NNE and 1008 mb on Guanaja Island, Honduras at 12Z (micro).

3. Discussion/Reanalysis: Continued weakening took place as the system acquired a more northerly component to its track. Degradation to a tropical depression occurred by 06Z, as originally shown in HURDAT. The depression emerged over the Gulf of Honduras around 12Z and passed through the Bay Islands. A central pressure of 1006 mb is added at 12Z based on an observation of 20 kt NNE and 1008 mb on Guanaja Island, Honduras. A pressure of 1006 mb suggests maximum winds of 35 kt from the south of 25N Brown et al. pressure-wind relationship. Based on previous weakening from being overland as well as the system's slow movement, an intensity of 30 kt is chosen for 12Z, slightly above the original HURDAT.

November 9:

1. Maps and old HURDAT:

- HWM analyzes a weak area of low pressure near 18.5N 87.5W at 12z.
- Microfilm analyzes a weak area of low pressure near 18N 86.5W at 12z.
- HURDAT lists a tropical depression at 17.8N 87.6W with winds of 25 kt at 12z.

2. Aircraft highlights:

- Center fix with a central pressure of 1008 mb at 1215z at 17.8N 87.6W (Micro).

3. Discussion/Reanalysis: Little change took place on this date as the depression turned more westerly. A central pressure of 1008 mb is added at 12Z on November 9 based on a recon fix of 1008 mb at 1215Z. A pressure of 1008 mb suggests maximum winds of 30 kt from the south of 25N Brown et al. pressure-wind relationship. Winds at 12Z are assessed slightly lower than the suggested value at 25 kt based on the system's slow movement. The depression later passed over Ambergris Caye, Belize, around 16Z before making landfall in extreme northern Belize around 20Z.

November 10:

1. Maps and old HURDAT:

- Microfilm analyses an open area of low pressure near 18N 88.5W at 12z.
- HURDAT lists a tropical depression at 18.5N 88.9W with winds of 25kt at 00z.

2. Discussion/Reanalysis: A central pressure of 1009 mb is added at 00Z on November 10 based on an observation of 10 kt N and 1011 mb in Chetumal, Mexico. Dissipation as a tropical cyclone took place before 06Z, unchanged from the original HURDAT, as the system opened up into a trough over the Yucatan Peninsula.

Sources: the NHC microfilm maps (Micro.), the Historical Weather Maps series (HWM), the COADS ship database, Monthly Weather Review (MWR), Mariners Weather Log (MWL), and the NHC Storm Wallets (SW).

New Tropical Storm [July 24 – 27, 1964] – AL131964

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00000 07/23/1964 M= 5  2 SNBR=XXXX UNNAMED        XING=0
00000 07/23*338 810  20    0*343 800  20    0*348 788  20    0*355 776  20    0*
00000 07/24*360 765  25    0*362 755  25    0*365 750  30    0*365 748  35    0*
00000 07/25*365 743  35 1008*366 733  35 1007*368 720  40    0*371 705  45 1003*
00000 07/26*376 690  45    0*385 676  50    0E402 663  50    0E420 650  50    0*
00000 07/27E433 637  45    0E443 622  45    0E455 605  40    0E470 590  35    0*
00000 TS
```

Daily Metadata:

July 23:

1. Maps:
   - HWM analyzes a 1015 mb low near 35N 78.5W at 12Z.
   - Microfilm depicts nothing of interest at 12Z.
2. Discussion:
   a. Reanalysis: A weak low pressure developed around 00Z, centered over South Carolina. The non-baroclinic system was co-located with a mid to upper-level trough from the 23rd through the 25th and - because of this - the system exhibited some subtropical cyclone characteristics. (Formal subtropical cyclone status is not an option until routine satellite imagery became available.)

July 24:

1. Maps:

- HWM analyzes a 1013 mb low near 35.5N 74W at 12Z.
- Microfilm analyzes a low of at most 1014 mb near 35.5N 75.5W at 12Z.
- MWL analyzes a low center at 36N 74W at 12Z.

2. Ship highlights:
   - 35 kt NE and 1012 mb at 37.1N 75.1W at 18Z (COADS).
   - 5 kt E and 1011 mb at 36.7N 74.7W at 18Z (COADS).
   - 15 kt NE and 1011 mb at 37.0N 74.4W at 18Z (COADS).
   - 40 kt ENE and 1012 mb at 37.6N 74.5W at 21Z (COADS).
3. Discussion:
   a. Reanalysis: The system initially moved east-northeast, reaching the Atlantic Ocean by 06Z on the 24th. A ship, callsign -96, just to the northwest of the center reported 25 kt NE winds at 12Z, serving as a basis for the 30 kt intensity. At 18Z, the same ship reported winds of 35 kt while another ship to the east-northeast reported 30 kt ENE. Based on this, the system likely intensified into a tropical storm by 18Z.

July 25:

1. Maps:
   - HWM analyzes a low at the tail end of a stationary front a near 36.5N 71.5W at 12Z.
   - Microfilm analyzes a low, placed along a frontal system, near 37.0N 73.0W at 12Z.
   - MWL analyzes a low center at 36.5N 72W at 12Z.
2. Ship highlights:
   - 35 kt ENE 1013 mb at 38.5N 73.7W at 00Z (COADS).
   - 10 kt E and 1009 mb at 36.6N 74.8W at 00Z (COADS).
   - 20 kt N and 1009 mb at 36.5N 74.6W at 06Z (COADS).
   - 35 kt NE and 1005 mb at 37.8N 72.1W at 12Z (COADS).
   - 35 kt NE and 1014 mb at 37.0N 75.2W at 12Z (lightship; COADS).
   - 20 kt SW and 1005 mb at 35.6N 70.6W at 18Z (COADS).
   - 35 kt NNW and 1009 mb at 35.4N 72.2W at 18Z (COADS).
   - 20 kt SW and 1005 mb at 37.1N 71.2W (70.2W?) at 18Z (COADS).
3. Discussion:
   a. MWL: "One depression developed 30 to 40 kt winds in squalls from the 25th through the 27th as it moved northeastward of the coast from Cape Hatteras area to Nova Scotia."

   b. Reanalysis: The cyclone drifted eastward at first before gradually accelerating on July 25 as it interacted with a frontal boundary just to the north. Slight intensification occurred on this day with ships reporting steadily decreasing pressures. At 12Z, a ship reported 35 kt NE and 1005 mb. Six hours later, an estimated central pressure of 1003 mb is obtained from two ships reporting 20 kt winds and 1005 mb. A pressure of 1003 mb indicates maximum sustained winds of 44 kt from the north of 35N subset of the Landsea et al. pressure-wind relationship. A peak intensity of 45 kt is chosen at 18Z based on these data.

July 26:

1. Maps:
   - HWM analyzes a low of at most 1000 mb near 41N 65W at 12Z.
   - Microfilm analyzes a low, with a frontal system extending northeast, of at most 1002 mb near 39.5N 67W at 12Z.
   - MWL analyzes a low center at 40.5N 70.5W at 12Z.
2. Ship highlights:
   - 35 kt NE and 1002 mb at 38.3N 69.6W at 00Z (COADS).
   - 45 kt NW and 1009 mb at 38.0N 68.6W at 06Z (COADS).
   - 45 kt NNW and 1001 mb at 38.3N 68.4W at 06Z (COADS).
   - 45 kt SW and 1005 mb at 39.0N 64.5W at 12Z (COADS).
   - 25 kt S and 998 mb at 40.6N 65.6W at 12Z (COADS).
   - 40 kt SW and 1000 mb at 40.5N 63.8W at 18Z (COADS).
   - Multiple other gales observed
3. Discussion:
   a. Reanalysis: Transition into an extratropical cyclone is assessed by 12Z on July 26, with a well-defined warm front extending northeast from the center. A notable temperature gradient is also present across the circulation by this time. Some baroclinic intensification occurred on this day while undergoing extratropical transition, with peak winds estimated at 50 kt, based on multiple observations of 45 kt winds from ships. The storm maintained these winds through the remainder of the day as it tracked northeast.

July 27:

1. Maps:
   - HWM analyzes a 1004 mb low near 46N 59W at 12Z.
   - Microfilm analyzes a low of at most 1014 mb near 11.0N 40.0W at 12Z.
   - MWL analyzes a low center at 46N 59.5W at 12Z.
2. Ship highlights:
   - 40 kt SW and 1010 mb at 41.0N 61.8W at 00Z (COADS).
   - 40 kt SW and 1010 mb at 41.0N 61.1W at 06Z (Micro).
   - 35 kt S and 1018 mb at 43.9N 53.2W at 12Z (COADS).
3. Discussion:
   a. Reanalysis: On July 27, the system began weakening as it approached Nova Scotia. Ships continued to report gale-force winds in the southeast quadrant of the storm through 12Z, though a few ships continued to report 30 kt winds at 18Z. Dissipation is noted after 18Z just along the southern coast of Newfoundland as the system is absorbed into a developing extratropical cyclone to the west.

1964 – Additional notes

1) Historical Weather Maps depict an area of low pressure over the central Atlantic starting on January 25. Trapped by a 1036 mb high near the Azores, the system meandered in the same general region between 25-30N and 40-50W for the next

week. A well-defined closed low is present by January 26 and the system may have become a tropical or subtropical depression on this date. Ships in the vicinity of the system generally reported winds of 25-30 kt; only one 35 kt observation was received nearby the cyclone. Initially, the strongest winds were a few degrees from the center, but by January 27 they contracted inward. This indicates that the system was likely close to being a true tropical cyclone; however, whether or not it acquired prolonged gale-force winds is questionable. The storm reached its peak on this day with a central pressure of 1004 mb; this value was estimated from a 1006 mb peripheral observation with 20 kt winds. A central pressure of 1004 mb suggests maximum sustained winds of 36 kt from the north of 25N Brown et al. pressure-wind relationship. The system soon weakened and became a broad low or trough on January 28. It continued to meander in the same general region for a few more days before being absorbed by a cold front on February 1. This system is on David Roth's list of suspects.

Date	Latitude	Longitude	Status
January 25	27N	45W	Low
January 26	29N	45W	Tropical/Subtropical depression?
January 27	30N	47W	Tropical/Subtropical storm?
January 28	27N	47W	Tropical/Subtropical depression?
January 29	28N	46W	Broad low
January 30	26N	50W	Broad low
January 31	27N	48W	Broad low
February 1			Absorbed

2) Historical Weather Maps depict an extratropical cyclone developing from a frontal boundary over Southern Louisiana on May 1-2. The system steadily deepened as it moved eastward, emerging over the Atlantic on May 3. A strong ridge to its north forced the system southward, placing it over the Gulf Stream. Numerous ships off the Southeastern United States reported gale to storm force winds in association with the system. It appears that the low occluded on May 4 and acquired some hybrid characteristics. However, it remained an exceptionally large storm with the strongest winds well over 200 nmi from the center. After reaching its southernmost point on May 5, the cyclone turned northeast toward Bermuda, regaining frontal features in the process. After meandering near Bermuda on May 6-7, the system trekked east and was ultimately absorbed into a frontal boundary over the central Atlantic.

It does not appear that this storm came close to being tropical or subtropical at any point and thus is not added to HURDAT. This system is on Jack Beven's list of suspects.

Date	Latitude	Longitude	Status
May 2	31N	88W	Extratropical
May 3	32N	78W	Extratropical
May 4	31N	76W	Occluded low
May 5	27N	73W	Occluded low
May 6	32N	66W	Extratropical
May 7	34N	66W	Extratropical
May 8	33N	61W	Extratropical
May 9			Absorbed

3) TIROS satellite imagery indicates a possible tropical cyclone on July 15 near 21N 41W. HWM depicts nothing of interest in the region around this time and no useful ship observations were obtained via COADS. As a result, no analysis of this possible cyclone can be made. This system is on Jack Beven's list of suspects.

4) TIROS satellite imagery indicates a possible tropical cyclone on September 19 near 16N 27W. HWM depicts nothing of interest in the region around this time and ship observations do not provide enough conclusive data. As a result, no analysis of this possible cyclone can be made. This system is on Jack Beven's list of suspects.

5) Data from COADS, alongside microfilm and historical weather maps, indicate a low pressure system, possibly a tropical depression, south of the Cape Verde Islands at 06z on October 4. Historical Weather Maps plot a 30 kt S ship observation in the same area at 12Z. After clearing the Cape Verde Islands, no data on this system exists for three days as it tracked generally west-northwest across the Atlantic. On October 8, a trough was identified over the Central Atlantic and is assumed to be a continuation of the same system as previously mentioned. The following day, a small low consolidated along the northern end of this trough. Aircraft reconnaissance investigated the low twice on October 10, with both flights reporting peak winds of no more than 30 kt; however, the strongest winds were apparently well displaced from the center. It is likely that this low became a tropical or subtropical depression on this day as it moved slowly north. On October 11, it accelerated ahead of an approaching cold front and was absorbed into the system later that day.

Since there is no indication this system acquired gale-force winds, it is not added into HURDAT. This system is on Jack Beven's list of suspects.

Date	Latitude	Longitude	Status
October 4	11N	24W	Tropical depression?
October 5			Unknown
October 6			Unknown
October 7			Unknown
October 8	16N	44W	Trough
October 9	27N	49W	Tropical depression?
October 10	30N	57W	Tropical/subtropical depression?
October 11			Absorbed

6) Historical Weather Maps depict a large frontal boundary draped across the Gulf of Mexico by October 13. A powerful 500 mb low over the Mississippi River Valley energized this front and a surface low appears to have developed that day. According to the 1964 Monthly Weather Review entry on Hurricane Isbell this system funneled cool, dry air into the hurricane, suggesting that it was not tropical in nature. Observations from COADS, coupled with microfilm analyses, show the system to have become a defined low by either October 14 or 15. The best case for this system being a tropical or subtropical cyclone is early on October 15. On this day, its pressure fell to 1002 mb and winds up to 50 kt were observed within 100 nmi of the center. Due to its proximity to Isbell, its not entirely certain if the system had a closed center at this time and may have instead been an intense, sharp trough. Later on October 15, the system transitioned into an extratropical cyclone and intensified as it accelerated northeast across Florida and into The Carolinas. The system absorbed Isbell while over North Carolina and slowed, bringing heavy rains and strong winds to the Mid-Atlantic States. Thereafter it

accelerated northeast again and was ultimately absorbed by another extratropical cyclone over Atlantic Canada by October 20.

Due to the considerable uncertainty in the storm's structure (i.e., the amount of baroclinicity and whether the system had a well-defined center on the 15th), this system was not added into HURDAT.

Date	Latitude	Longitude	Status
October 13	24N	88W	Extratropical
October 14	26N	88W	Extratropical
October 15	28N	84W	Tropical storm?/extratropical
October 16	33N	80W	Extratropical
October 17	37N	76W	Extratropical
October 18	39N	72W	Extratropical
October 19	48N	64W	Extratropical
October 20			Absorbed

7) Historical Weather Maps depict a low pressure system developing from the tail end of a frontal boundary over the northwestern Caribbean Sea on October 28. The system remained fairly weak as it moved slowly northward. Ship observations indicate the low to have obtained a central pressure of 1007 mb. With no measurements of winds in excess of 25 kt, it is assumed this system peaked as a weak tropical depression. After moving across central Cuba during the overnight of October 29-30, the system transitioned into an extratropical cyclone as it accelerated northeast. It later became entangled with a frontal system before dissipating by November 1.

Due to the lack of evidence that this system was a tropical storm, it is not added to HURDAT. This system is on Jack Beven's list of suspects.

Date	Latitude	Longitude	Status
October 28	19N	82W	Tropical depression?
October 29	20N	82W	Tropical depression?
October 30	29N	69W	Extratropical
October 31	34N	59W	Extratropical
November 1			Absorbed

8) Historical Weather Maps depict a frontal low developing west of the Iberian Peninsula on October 31. The system quickly became a well-defined feature of its own the following day while taking an unusual westerly course. HWM analysis indicates the system to have a pressure of 1012 mb at most. Very high environmental pressures, courtesy of a 1036 mb high to the northwest, allowed for gale-force winds to develop. Ships in the region reported temperatures in the upper 50s, well below what would be associated with a tropical or subtropical cyclone. Thereafter, the system accelerated and weakened before being absorbed by a large storm complex well to the southeast of Newfoundland. This system is on Jack Beven's list of suspects.

Date	Latitude	Longitude	Status
October 31	48N	13W	Extratropical
November 1	47N	14W	Occluded low
November 2	48N	27W	Occluded low
November 3			Absorbed

9) Historical Weather Maps and microfilm depict the formation of an extratropical cyclone off the coast of Florida on November 1. Although gale-force winds were present relatively close to the center, the system displayed well-defined frontal features throughout its existence and never appeared to acquire tropical or subtropical characteristics. On November 3, the cyclone accelerated eastward and merged with a large frontal boundary over the central Atlantic on November 5. This system is on Jack Beven's list of suspects.

Date	Latitude	Longitude	Status
November 1	27N	79W	Extratropical
November 2	31N	80W	Extratropical
November 3	29N	74W	Extratropical
November 4	27N	56W	Extratropical
November 5			Merged with frontal boundary

10) Historical Weather Maps and microfilm depict the presence of a broad low pressure system over the eastern Atlantic on November 22. Moving generally northwest, the large system changed very little over the next few days. Ships in the vicinity reported gale-force winds starting late on November 23; however, these were well-removed from the center of circulation and at least partially related to a strong 1036 mb ridge to the northwest. The cyclone either merged with a frontal boundary or became a very elongated trough on November 25. Remaining nearly stationary for three days, it eventually regained a defined circulation on November 27. By this point, cool, dry air began wrapping around the western periphery of the cyclone. The system appears to have peaked early on November 28 around 1000 mb. Thereafter, the storm slowly weakened as it drifted northward. It was later absorbed into a frontal system on December 1.

Due to the very broad nature of the storm, never having gales close to its center, this system was not added into HURDAT. This system is on Jack Beven's list and suspects a single event and David Roth's list of suspects as two separate storms: a tropical storm from November 22-25 and a subtropical depression from November 26-30.

Date	Latitude	Longitude	Status
November 22	22N	33W	Broad low
November 23	24N	36W	Broad low
November 24	30N	38W	Broad low
November 25	32N	38W	Extratropical/front
November 26	31N	40W	Extratropical/front
November 27	33N	40W	Occluded low
November 28	34N	39W	Occluded low
November 29	33N	43W	Occluded low
November 30	39N	43W	Extratropical
December 1			Absorbed

11) Historical Weather Maps indicate the formation of a broad, weak low over the central Atlantic on November 29. It appears to have been at least partially related to a weak front extending from the previous suspect. After tracking eastward for a few days, the system turned north-northeast on December 1 and intensified. Ships near the center reported pressures as low as 1000 mb; however, winds remained relatively weak. The first gales were not reported until December 3, by which time the circulation became increasingly elongated. The following day,

it merged with an approaching cold front and turned eastward. The system later dissipated north of the Azores Islands on December 6.

Due to the very broad nature of the storm, never having gales close to its center, this system was not added into HURDAT. This system is on Jack Beven's and David Roth's list of suspects.

Date	Latitude	Longitude	Status
November 29	24N	56W	Broad low
November 30	22N	51W	Broad low
December 1	29N	43W	Broad low
December 2	31N	39W	Broad low
December 3	34N	38W	Broad low
December 4	39N	39W	Extratropical
December 5	38N	36W	Extratropical
December 6			Dissipated

12) Historical Weather Maps depict the formation of an extratropical cyclone to the southwest of Newfoundland on December 10. With a strong 1032-1036 mb ridge to its west, the system dropped south over the Central Atlantic, ultimately reaching a point around 25N 50W where it stalled on December 13. During this time, it slowly shed its frontal features and became a broad low by December 14 nearly identical to the previous two suspects. Gale force winds were reported well away from the storm's center, indicating it never completely lost its non-tropical nature. By December 15, the system turned north ahead of an approaching cold front. It reached its peak on this day as a sub-1000 mb system. The cyclone subsequently merged with the front on December 16 and lost its identity the following day.

Due to the very broad nature of the storm, never having gales close to its center, this system was not added into HURDAT. This system is on Jack Beven's and David Roth's list of suspects.

Date	Latitude	Longitude	Status
December 10	41N	49W	Extratropical
December 11	36N	46W	Extratropical
December 12	27N	43W	Extratropical
December 13	24N	49W	Extratropical
December 14	27N	51W	Occluded low
December 15	30N	51W	Extratropical
December 16	32N	39W	Extratropical
December 17			Absorbed

13) Historical Weather Maps and microfilm depict a large frontal boundary over the Central Atlantic on December 18. By December 21, a defined low developed along this front. Moving slowly to the east, the system deepened and gradually shed its extratropical characteristics and became a broad, occluded low by December 23. Situated south of a large 1040 mb ridge, ships along the northern periphery of the cyclone reported gale to storm-force winds throughout the storm's duration. The storm remained exceptionally large as it stalled southwest of the Azores Islands on December 25. After turning back to the west on December 27, it began to interact with a smaller low (also a suspect listed below) to its southwest. Energy from this large system seemingly transferred to the smaller one and the initial storm was absorbed into it on December 28.

This storm remained far too broad to be considered a tropical or subtropical cyclone and was not added into HURDAT. This system is on Jack Beven's and David Roth's list of suspects.

Date	Latitude	Longitude	Status
December 21	27N	42W	Extratropical
December 22	32N	40W	Extratropical
December 23	33N	38W	Occluded low
December 24	34N	36W	Occluded low
December 25	33N	35W	Occluded low
December 26	34N	34W	Occluded low
December 27	35N	37W	Occluded low
December 28	37N	44W	Extratropical
December 29			Absorbed

14) Historical Weather Maps and microfilm indicate the formation of a frontal low near Berumuda on December 22. Over the following several days, this system tracked southeast around the periphery of the much larger cyclone near the Azores. During this time, it steadily shed its extratropical features and appeared to be transitioning into a tropical or subtropical cyclone. On December 26, the cyclone dipped below 25N and acquired a mostly isothermal structure. It may have become a tropical or subtropical depression on this day, but data is ambiguous as to the overall nature of the cyclone. Turning northeast, the cyclone deepened to 999 mb by 18Z on December 27 (based on ship observations near the center). Three observations of gale-force winds were received within 200 nmi of the center during the time it was closest to being tropical or subtropical. However, aside from late on the 27th, wind observations near the center remained generally weak. On December 28, it began absorbing the large non-tropical cyclone to its northeast and regained extratropical characteristics. The extratropical system persisted for several more days, coming close to Newfoundland on January 1, 1965, before being absorbed by a much larger extratropical cyclone.

This suspect is the closet to being considered a tropical or subtropical cyclone, but due to uncertainty in how close it was to actually completely shedding its non-tropical nature, it was not added to HURDAT.

Date	Latitude	Longitude	Status
December 22			Frontal low
December 23	32N	61W	Extratropical
December 24	31N	58W	Extratropical
December 25	27N	57W	Extratropical
December 26	24N	52W	Tropical/subtropical depression?
December 27	27N	47W	Tropical/subtropical storm?
December 28	31N	45W	Tropical/subtropical storm?
December 29	37N	42W	Extratropical
December 30	40N	45W	Extratropical
December 31	42N	49W	Extratropical
January 1	47N	53W	Extratropical
January 2			Merged with another extratropical low

1965 Atlantic Hurricane Database Reanalysis – Sandy Delgado and Chris Landsea – Revised 2019

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

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

Unnamed Tropical Storm [June 13-20, 1965] – AL011965

```
43880 06/11/1965 M= 8  1 SNBR= 945 NOT NAMED   XING=1 SSS=0
43880 06/13/1965 M= 8  1 SNBR= 945 NOT NAMED   XING=1 SSS=0
         **

43885 06/11*  0   0   0    0*125 913  25    0*136 913  25    0*146 913  25    0*
43885 06/11*  0   0   0    0*  0   0   0    0*  0   0   0    0*  0   0   0    0*

43890 06/12*157 913  25    0*168 911  25    0*179 910  25    0*189 910  25    0*
43890 06/12*  0   0   0    0*  0   0   0    0*  0   0   0    0*  0   0   0    0*

43895 06/13*199 910  25    0*209 910  25    0*220 910  25    0*231 910  30    0*
43895 06/13*  0   0   0    0*  0   0   0    0*  0   0   0    0   0*231 910  30    0*

43900 06/14*241 911  35    0*251 909  35    0*261 905  35    0*269 900  40    0*
43900 06/14*242 911  35    0*253 909  40    0*263 906  40    0*271 902  45    0*
            ***              ***       **      ***  ***  **      ***  ***  **

43905 06/15*278 891  45    0*290 877  45    0*304 860  45    0*319 842  40    0*
43905 06/15*280 895  45 1005*293 882  50 1006*307 865  50 1007*323 842  40    0*
            *** ***     **** ***  ***  ** **** ***  ***  ** **** ***

43910 06/16E335 821  35    0E350 791  30    0E362 762  25    0E370 740  25    0*
43910 06/16E337 821  35    0E350 791  35    0E360 762  40    0E366 730  40    0*
            ***                       **      ***       **      ***  ***  **

43915 06/17E377 717  25    0E384 694  25    0E390 670  25    0E395 645  25    0*
43915 06/17E373 710  45    0E380 700  50    0E385 685  50    0E389 665  45    0*
            *** ***  **      ***  ***  **      ***  ***  **      ***  ***  **

43920 06/18E400 618  25    0E404 591  25    0*  0   0   0    0*  0   0   0    0*
43920 06/18E390 650  40    0E394 635  35    0E399 620  35    0E405 600  35    0*
            *** ***  **      ***  ***  **      **** ***  **      **** ***  **
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June 19th and 20th are new to HURDAT

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43921 06/19E415 575  35    0E430 535  35    0E442 500  35    0E450 470  35    0*
43923 06/20E452 445  35    0E453 420  35    0E460 380  30    0E470 330  30    0*
43925 TS
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U.S. Tropical Storm Landfall

06/15 11Z 30.4N 86.9W 50 kt FL

Significant Revisions:

1. Genesis delayed by 2 ½ days based upon ship and station observations;
2. A few central pressures added based upon aircraft and ship observations;
3. Intensity substantially increased on the 16th to the 18th (as an extratropical cyclone) based on ship observations;
4. Position substantially shifted to the west-southwest on the 17th and 18th based on ship observations;
5. Dissipation delayed by 2 ½ days based on ship observations.

Daily Metadata:

June 10:

1. Maps and old HURDAT:

- HWM analyzes a closed low pressure of at most 1008 mb at 15.0N, 93.0W at 12Z.
- HURDAT does not list an organized system on this date.
- Microfilm shows a closed low pressure of at most 1008 mb near 14.0N, 96.0W and a tropical wave stretching from the central Gulf of Mexico to south of Guatemala at 12Z.

2. Land highlights:

- 10 kt N and 1005 mb at Salina Cruz, Mexico at 00Z (micro).

3. Discussion:

- MWR: "During the period June 9-10, a cut-off upper Low developed over the northwestern Gulf of Mexico from a shearing trough in the westerlies. The effects of this Low reached well into the Tropics and were probably responsible for the northward movement of a vortex off the intertropical convergence zone."
- Reanalysis: A disturbance developed along the monsoon trough in the Eastern Pacific around June 10th as a tropical wave approached the area. The nephanalysis on the microfilm at 12Z on the 10th indicate that a large area of convection had developed south of the Gulf of Tehuantepec. The ship "4973", located near 11N 90W at 12Z on the 10th, on a generally westward course, shows pressures of 1005 mb and lower on the 10th, but nearby ships indicate that the ship's reported pressures are about 6 mb too low, thus they are discounted. The HWM at 500 mb on the 10th depict a cut-off low over the northern Gulf of Mexico and a deepening trough over the Southwest United States. This allowed the disturbance to move slowly northward over the next couple of days.

June 11:

1. Maps and old HURDAT:

- HWM analyzes a spot low near 20.0N, 93.0W in the Bay of Campeche and another spot low near 13.5N, 92.0W near the coast of Guatemala in the eastern Pacific at 12Z.
- HURDAT lists a 25 kt tropical depression at 13.6N, 91.3W at 12Z.
- Microfilm shows an area of disturbed weather in the Gulf of Tehuantepec but does not show a closed low pressure at 12Z.

2. Discussion:

- MWR: "On June 11 a TIROS picture indicated a disturbed area along and south of the Guatemalan coast."
- Reanalysis: Genesis is shown originally in HURDAT at 06Z on June 11th as a 25 kt tropical depression, but synoptic observations in the eastern Pacific, eastern Mexico and western Central America indicate that the disturbance did

not have a well-defined center, nor did one form until the system was over the eastern Bay of Campeche a couple days later.

June 12:

1. Maps and old HURDAT:

- HWM analyzes a spot low at 17.6N, 91.5W at 12Z.
- HURDAT lists a 25 kt tropical depression at 17.9N, 91.0W at 12Z.
- Microfilm shows an area of disturbed weather over Yucatan, southern Mexico, Guatemala and western Central America but does not show a closed low pressure at 12Z.

2. Discussion:

- MWR: "During the next 48 hr. the disturbance moved into the Gulf of Mexico, passing just west of Merida, Yucatan."

June 13:

1. Maps and old HURDAT:

- HWM analyzes a spot low at 22.0N, 91.7W at 12Z.
- HURDAT lists a 25 kt tropical depression at 22.0N, 91.0W at 12Z.
- Microfilm shows a closed low pressure of at most 1011 mb at 23.0N, 86.0W at 12Z.

2. Aircraft highlights:

- Penetration center fix estimated surface winds of 35 kt at 23.1N, 90.9W around 21Z (micro/MWR).

3. Discussion:

- MWR: "On the afternoon of June 13, a reconnaissance aircraft found evidence of a Low at the 700-mb level and surface winds estimated at 40 mph some distance to the east of the Low."
- Reanalysis: Late on June 13th, surface observations from ships and data from a reconnaissance aircraft indicate that the disturbance became better organized and a 30 kt tropical depression is analyzed to have developed on this day at 18Z, 60 hours later than originally shown in HURDAT. (It is noted, though, that a low pressure area that presumably was the precursor disturbance appeared at least intermittently on the microfilm maps prior to the genesis time, and thus the original track makes at least some sense.)

June 14:

1. Maps and old HURDAT:

- HWM analyzes a tropical storm of at most 1008 mb at 26.0N, 91.0W at 12Z.
- HURDAT lists a 35 kt tropical storm at 26.1N, 90.5W at 12Z.
- Microfilm shows a closed low pressure of at most 1007 mb at 25.5N, 90.5W at 12Z.

2. Ship highlights:

- 40 kt SSE and 1007 mb at 25.0N, 90.0W at 06Z (NOMAD buoy)(MWR/micro).
- 35 kt S and 1012 mb at 29.0N, 87.0W at 15Z (WALLET).
- 35 kt SSW and 1013 mb at 28.3N, 86.4W at 18Z (COADS).
- 35 kt SSE and 1010 mb at 30.1N, 87.5W at 21Z (COADS).

3. Discussion:

- MWR: "The 0600 GMT June 14 report from NOMAD, the automatic weather buoy at 25N, 90W, indicated winds near 45 mph and a sea level pressure of 1006 mb. (29.71 in.). This suggested that some intensification was occurring. A Navy reconnaissance aircraft found no well-defined circulation but did report a large, flat low pressure system with lowest pressure of 1005 mb. (29.68 in.), showery weather, and strongest winds well to the east of the Low as on the previous day. It was not a cold core system. The approach of an active

trough in the westerlies turned the storm toward the northeast and increased its forward speed to 25 mph."

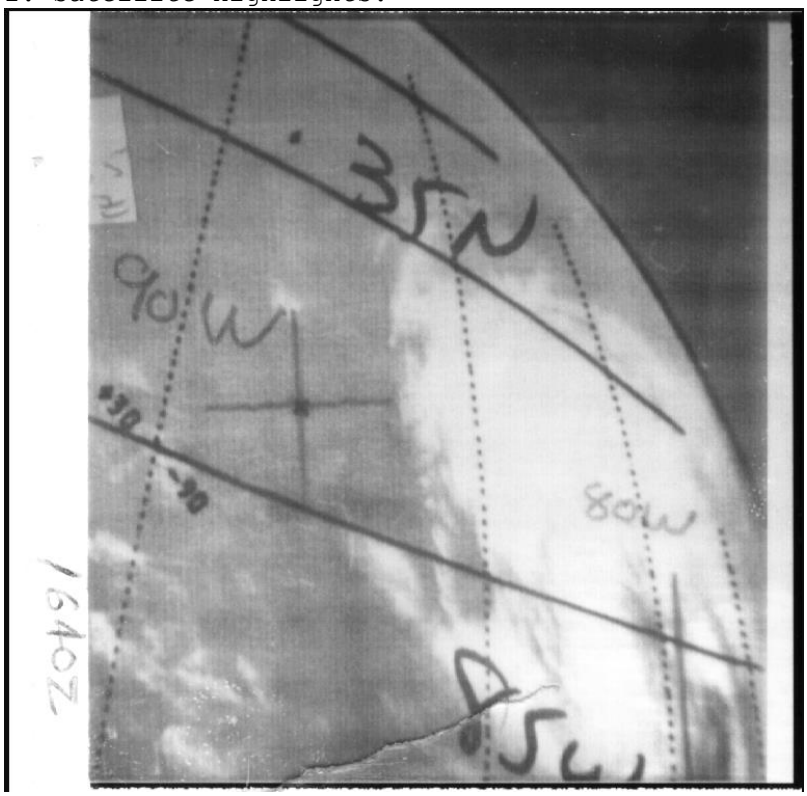
- Discussion: Intensification to a tropical storm is analyzed six hours later, at 00Z on June 14th, same as originally shown in HURDAT. The tropical storm was never well-organized, as the circulation remained elongated north-south for most of its lifetime as a tropical cyclone, and the strongest winds were located about 120 nm to the east of the center of the circulation during this time. Based on these characteristics, it is possible that the system was a subtropical cyclone but without daily satellite images, it cannot be verified. Moreover, on June 14th and 15th, the HWM at 500 mb depicts a trough of low pressure over the central United States, extending to the northern Gulf of Mexico over the system, which is also consistent with a subtropical cyclone designation. The NOMAD buoy, near 25N 90W, shows surface winds of 40 kt at 06Z on the 14th which is the intensity indicated at that time. A couple of ships also reported gale-force winds on the 14th.

June 15:

1. Maps and old HURDAT:

- HWM analyzes a closed low pressure of at most 1008 mb at 30.0N, 86.0W with a stationary front to the north at 12Z.
- HURDAT lists a 45 kt tropical storm at 30.4N, 86.0W at 12Z.
- Microfilm shows a closed low pressure of at most 1008 mb at 30.0N, 87.0W at 12Z.

2. Satellite highlights:



3. Ship highlights:

- 15 kt SW and 1008 mb at 29.1N, 87.4W at 06Z (COADS).
- 10 kt NW and 1008 mb at 30.0N, 87.2W at 12Z (COADS).

4. Land highlights:

- 45-50 kt SSW (gusts to 65 kt) at Alligator Point, FL at 12Z (WALLET).
- 50 kt SSW at Dog Island, FL at 12Z (WALLET).

- 35-40 kt and 1006 mb at Panacea, FL at 1230Z (WALLET).

5. Aircraft highlights:

- Penetration center fix measured a central pressure of 1006 mb, estimated surface winds of 32 kt and an eye diameter of 35 nm at 27.4N, 89.6W at 0043Z (WALLET).

6. Discussion:

- MWR: "The Low moved into the Florida Panhandle between Valparaiso and Panama City on the morning of June 15. Highest sustained winds reported on the Florida Panhandle were 50 to 60 mph, with gusts to 75 mph, at Alligator Point, while Dog Island reported winds of 60 mph. Damage was confined to the immediate coast in the vicinity of Apalachicola and was mainly the result of high tides of 2 to as much as 6 ft. above normal. General rains in excess of 5 in. were reported in the Tallahassee-Apalachicola area. However, there was no flooding of consequence."
- Discussion: On June 15th, the tropical storm turned to the northeast and gained in forward speed. A reconnaissance aircraft investigated the tropical cyclone late on the 14th and early on the 15th encountering a large, broad circulation and estimated surface winds just below gale-force intensity. The reconnaissance measured a minimum pressure of 1006 mb and 10 kt, thus a central pressure of 1005 mb is added to HURDAT at 00Z on the 15th. A central pressure of 1005 mb suggests maximum sustained winds of 34 kt from the north of 25N Brown et al. pressure-wind relationship. (Despite the original claim in the seasonal write-up that the system was not cold core, the 500-mb chart on the Historical Weather Maps suggests an upper-level trough with a temperature gradient was located over the surface center. This suggests that the cyclone had at least some subtropical characteristics, and thus the wind-pressure relationships may not be fully applicable.) Based on coastal observations a few hours later in the Florida panhandle, the intensity is retained at 45 kt as originally shown in HURDAT at 00Z on the 15th. At 06Z on the 15th, a ship reported 15 kt SW and 1008 mb, thus a central pressure of 1006 mb is added to HURDAT. The elongated center of the tropical cyclone made landfall in the Florida panhandle around 11Z as a 50 kt tropical storm. The landfall occurred at 30.4N, 86.9W, on Santa Rosa Island, located between Pensacola and Fort Walton Beach. Alligator Point, FL, reported 45-50 kt sustained winds at 12Z on the 15th. At the same time, Dog Island, FL reported 50 kt sustained winds. These locations are about 120 nm east of the landfall location and are the justification for slightly boosting the intensity at landfall from 45 to 50 kt. It is interesting to note that the strongest winds in nearby Apalachicola, FL were only 25 kt. A ship reported 10 kt and 1008 mb at 12Z on the 15th, thus a central pressure of 1007 mb is added to HURDAT just after landfall.

June 16:

1. Maps and old HURDAT:

- HWM analyzes an extratropical cyclone of at most 1012 mb at 35.0N, 76.5W at 12Z.
- HURDAT lists a 25 kt extratropical depression at 36.2N, 76.2W at 12Z.
- Microfilm shows an extratropical cyclone of at most 1012 mb at 36.0N, 76.0W at 12Z.

2. Ship highlights:

- 40 kt E and 1018 mb at 38.3N, 71.7W at 12Z (COADS).
- 35 kt NE and 1023 mb at 39.6N, 69.2W at 18Z (COADS).

3. Discussion/Reanalysis: After landfall, the tropical cyclone began to interact with a stationary frontal boundary over the southeastern United States. Synoptic observations indicate that it became an extratropical

cyclone at 00Z, same as originally shown in HURDAT. The circulation of the extratropical cyclone became less organized and may have weakened into a trough early on the 16th while crossing the southeastern United States. Late on the 16th, the system approached the Atlantic, entering the ocean through North Carolina and once again intensified as an extratropical cyclone. Gale-force winds were reported by a couple of ships at 12Z and 18Z on the 16th. On the other hand, HURDAT maintained the extratropical cyclone below gale-force intensity for the rest of its lifetime. The system is analyzed to have been a minimal gale at 00Z and 06Z, up from 30 kt originally. An intensity of 40 kt is analyzed at 12Z and 18Z on the 16th, up from 25 kt originally in HURDAT, a major intensity change.

June 17:

1. Maps and old HURDAT:
- HWM analyzes an extratropical cyclone of at most 1008 mb at 38.2N, 68.2W at 12Z.
- HURDAT lists a 25 kt extratropical depression at 39.0N, 67.0W at 12Z.
- Microfilm shows an extratropical cyclone of at most 1012 mb at 37.0N, 68.0W at 12Z.

2. Ship highlights:
- 40 kt ENE and 1013 mb at 38.0N, 72.1W at 00Z (COADS).
- 50 kt NE and 999 mb at 38.5N, 70.1W at 06Z (micro).
- 35 kt SE and 1012 mb at 39.6N, 68.6W at 12Z (COADS).
- 35 kt ENE and 1020 mb at 40.8N, 66.7W at 18Z (COADS).

3. Discussion:
- MWR: “An ill-defined Low, the remnants of the storm, moved through the Carolinas and eventually developed into an active wave on a frontal system off the middle Atlantic coast on June 17-18.”
- Reanalysis: On June 17th, the cyclone continued to intensify off the East Coast of the United States reaching an intensity of 50 kt at 06Z, also the peak intensity as a post-tropical cyclone. 50 kt is analyzed at 06Z and 12Z on the 17th, up from 25 kt originally in HURDAT, major intensity changes. Major intensity changes are also analyzed at 00Z and 18Z on the 17th as HURDAT originally analyzed an intensity of 25 kt at both time slots and the analyzed intensity is 45 kt for both time slots.

June 18:

1. Maps and old HURDAT:
- HWM analyzes an extratropical cyclone of at most 1004 mb at 40.0N, 63.0W at 12Z.
- HURDAT lists a 25 kt extratropical depression at 40.4N, 59.1W at 06Z (last position).
- Microfilm shows an extratropical cyclone of at most 1012 mb at 37.0N, 68.0W at 12Z.

2. Ship highlights:
- 35 kt SW and 1006 mb at 37.0N, 63.3W at 00Z (micro).
- 35 kt S and 1018 mb at 37.0N, 57.5W at 06Z (COADS).
- 35 kt W and 1010 mb at 37.8N, 62.7W at 18Z (micro).

3. Discussion/Reanalysis: The extratropical cyclone continued on a northeastward course on June 18th and gradually weakened. The last position in HURDAT is at 06Z on the 18th but synoptic data indicate that the extratropical cyclone did not dissipate at this time but instead two days later.

June 19:

1. Maps and old HURDAT:
   - HWM analyzes an extratropical cyclone of at most 1008 mb at 44.0N, 52.0W at 12Z.
   - Microfilm shows an extratropical cyclone of at most 1008 mb at 45.0N, 50.0W at 12Z.
2. Ship highlights:
   - 20 kt NE and 1005 mb at 42.0N, 59.6W at 00Z (COADS).
3. Discussion/Reanalysis: On June 19th, the post-tropical cyclone turned more to the east with little change in intensity.

June 20:

1. Maps and old HURDAT:
   - HWM analyzes an extratropical cyclone of at most 1008 mb at 46.0N, 36.0W at 12Z.
   - Microfilm shows an extratropical cyclone of at most 1008 mb near 44.0N, 38.0W at 12Z.
2. Ship highlights:
   - 35 kt SW and 1020 mb at 38.1N, 40.6W at 06Z (COADS).
   - 20 kt S and 1003 mb at 47.1N, 30.6W at 18Z (COADS).
3. Discussion/Reanalysis: Ship reports early on June 21st indicate that the circulation had dissipated, thus the last position is analyzed at 18Z on June 20th, 60 hours later than originally shown in HURDAT.

Additional Discussion: The reason for this tropical storm not to have been named is unknown. Reconnaissance aircrafts flew a couple of missions during the time the system was over the Gulf of Mexico and a couple of ships reported gale-force winds, including the NOMAD buoy. The system was also identified as being tropical in the MWR. The decision to upgrade the system apparently took place soon after its occurrence as the MWL September 1965 edition shows, the section of the May-July 1965 Rough Logs (below) already mentions the system as an unnamed tropical storm. The track of the system in the "Track of Centers of Tropical Cyclones at Sea Level, North America," June, 1965, is labeled "Unnamed TS." This was published in the November 1965 issue of the MWL:

The unnamed tropical storm was first discovered on June 11 by a TIROS picture which indicated a disturbed area off the south Guatemalan coast. During the next 48 hr. the disturbance moved northward at about 10 kt., passing into the Gulf of Mexico west of Merida. On June 14 reports from the weather buoy NOMAD of winds near 40 kt. qualified the circulation as a tropical storm, as it turned northeastward. With a forward speed of about 20 kt., it moved into the Florida Panhandle, between Valparaiso and Panama City on the morning of the 15th, as an ill-defined LOW. The Alligator Point CHURN station reported sustained winds of 43 to 52 kt., with gusts to 65 kt. The LOW became extratropical over land and moved into the Atlantic north of Cape Hatteras on the morning of the 16th as an active wave on a frontal system. The Navy destroyer HARTLEY and the 6,192-ton Norwegian freighter BLUE MASTER collided off Virginia Beach, Virginia in the heavy rain and seas associated with this system. The HARTLEY suffered a 15-ft. high, 10-ft. wide gash in its starboard side which flooded the engine room. Heavy winds and seas drove the vessel to within 500 yd. of the beach, where it anchored. A helicopter dropped a towline and the vessel was pulled to safety by Navy tugs. The BLUE MASTER sustained slight damage but continued on her voyage.

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

Hurricane Anna [August 21-26, 1965] – AL021965

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43935 08/21*  0   0   0    0*324 518  35    0*330 520  35    0*337 521  35    0*
43935 08/21*  0   0   0    0*324 523  35    0*330 523  35    0*336 521  35    0*
                           ***              ***             ***

43940 08/22*342 521  35    0*346 521  35    0*351 522  35    0*356 522  35    0*
43940 08/22*341 521  35    0*346 521  35    0*351 522  35    0*356 522  35    0*
           ***

43945 08/23*360 521  35    0*364 520  40    0*369 519  50    0*375 516  65    0*
43945 08/23*360 521  45    0*364 520  55    0*369 520  65    0*375 520  75    0*
                     **                **          ***  **          ***  **

43950 08/24*383 513  65    0*390 509  70    0*398 503  75    0*411 488  80    0*
43950 08/24*383 518  85    0*390 513  90    0*398 503  90    0*411 483  90    0*
              ***  **          ***  **                **          ***  **

43955 08/25*430 460  75    0*451 424  75    0*471 381  75    0*491 334  70    0*
43955 08/25*430 453  85    0*451 422  80    0*471 381  75    0*491 334  65    0*
              ***  **          ***  **                                  **

43960 08/26E510 279  70    0E526 210  70    0E541 126  65    0*  0   0   0    0*
43960 08/26E510 279  55    0E530 200  50    0E550 145  45    0*  0   0   0    0*
                     **          ***  **      ***  ***  **

43965 HR
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Significant Revisions:

1. Substantially stronger on the 23rd based upon satellite and radar imagery;
2. Substantially stronger on the 24th based upon ship observations;
3. Substantially weaker (as an extratropical cyclone) on the 26th based upon ship observations;
4. Position shifted substantially east-northeastward at 06Z on the 26th and west-northwestward at 12Z on the 26th.

Daily Summary:

August 19:

1. Maps and old HURDAT:
   - HWM analyzes a closed low pressure of at most 1016 mb at 25.0N, 45.0W at 12Z.
   - HURDAT does not list an organized system on this date.
   - Microfilm shows a tropical wave or trough extended between 17N-30N, along 46W at 12Z.
2. Disucussion:
   - MWR: "On August 16 the TIROS satellite photographed a weak circulation just northwest of the Cape Verde Islands."

- ATSR: "A weak circulation north of the Cape Verde Islands photographed by a TIROS satellite on 16 August was probably the first indication of Hurricane ANNA. The system was kept under close scrutinization as it moved slowly across the North Atlantic, but there was no intensification."
- Reanalysis: Hurricane Anna developed from a tropical wave that left the African coast on August 15th. The tropical wave entered the Atlantic Ocean at a high latitude, passing north of the Cape Verde Islands on August 16th according to the MWR. This likely kept the disturbance from developing further as it moved over cooler waters. The tropical wave maintained a west-northwest heading and on August 19th, it was located in the central Atlantic.

August 20:

1. Maps and old HURDAT:

- HWM analyzes a closed low pressure of at most 1016 mb at 24.0N, 47.0W at 12Z.
- HURDAT does not list an organized system on this date.
- Microfilm shows a tropical wave or trough extended between 18N-29N, 41W-64W at 12Z.

2. Discussion/Reanalysis: Surface observations indicate that the system remained disorganized on August 19th and 20th as it began to slow down as a frontal boundary approached from the west.

August 21:

1. Maps and old HURDAT:

- HWM analyzes a closed low pressure of at most 1016 mb at 33.5N, 52.5W with a cold front to the west at 12Z.
- HURDAT lists a 35 kt tropical storm at 33.0N, 52.0W at 12Z.
- Microfilm shows a closed low pressure of at most 1016 mb at 34.0N, 53.5W with a cold front to the west at 12Z.

2. Ship highlights:

- 35 kt SW at 32.6N, 51.8W at 12Z (micro).

3. Discussion:

- MWR: "Data during the next few days were sparse but this was probably the first indication of Anna, and on August 21 the system was of tropical storm intensity some 800 mi. east of Bermuda."
- ATSR: "On 21 August FLEWEACEN SUITLAND issued a minimal wind warning on the cyclone as it was considered extratropical at this time. Twelve hours later the warning was canceled as there was no evidence of winds greater than 33 knots."
- Reanalysis: Early on August 21st, synoptic data show that the low-level circulation became better organized. A 35 kt tropical storm is analyzed at 06Z on the 21st, same as originally analyzed in HURDAT. A ship reported 35 kt SW at 12Z on the 21st, the first report of gale-force winds.

August 22:

1. Maps and old HURDAT:

- HWM analyzes a hurricane of at most 1016 mb at 35.8N, 52.8W with a cold front to the northwest at 12Z.
- HURDAT lists a 35 kt tropical storm at 35.1N, 52.2W at 12Z.
- Microfilm shows a closed low pressure of at most 1018 mb at 36.0N, 53.0W with a cold front to the northwest at 12Z.

2. Discussion/Reanalysis: Anna slowly moved northward on August 22nd while embedded in high environmental pressures. Ship observations near the center were sparse on this day and no intensification is analyzed.

August 23:

1. Maps and old HURDAT:

- HWM analyzes a tropical storm of at most 1012 mb at 37.5N, 52.0W with a cold front just to the west at 12Z.
- HURDAT lists a 50 kt tropical storm at 36.9N, 51.9W at 12Z.
- Microfilm shows a closed low pressure of at most 1016 mb at 38.0N, 53.0W with a cold front going through the center at 12Z.

2. Satellite highlights:

3. Ship highlights:

- USS Randolph: Radar center fix at 37.8N, 51.9W at 21Z (WALLET).

4. Discussion:

- MWR: "During the morning of the 23d, a TIROS picture indicated an area 180 mi. in diameter with an eye visible near 36' N., 51' W. By afternoon the aircraft carrier Randolph reported a well-defined eye displayed by radar at 37' 45' N., 51' 53' W. At this time, Anna, probably of hurricane intensity, was moving on a northerly course."
- ATSR: "However, at 2100Z on 23 August the USS RANDOLPH reported a well-defined radar eye at 37-45N 51-53W and ANNA became a tropical storm. It is interesting to note that ANNA achieved hurricane intensity at a higher latitude than any other storm observed in the Atlantic Ocean."
- Reanalysis: On August 23rd, Anna quickly intensified based on imagery from TIROS and the ship USS Randolph by radar. Around 12Z on the 23rd, MWR indicates that the TIROS image showed an eye (though the image itself is not available) and nine hours later, the USS Randolph reported a well-defined

eye. Thus, intensification to a hurricane is analyzed at 12Z on the 23rd, six hours earlier than originally shown in HURDAT, a minor intensity change consistent with the Dvorak technique for initial visible presence of an eye.

August 24:

1. Maps and old HURDAT:

- HWM analyzes a hurricane of at most 1004 mb at 40.5N, 49.8W with a cold front to the northwest at 12Z.
- HURDAT lists a 75 kt hurricane at 39.8N, 50.3W at 12Z.
- Microfilm shows a tropical storm of at most 1008 mb at 40.3N, 50.4W with a cold front to the northwest at 12Z.

2. Ship highlights:

- 35 kt S and 1017 mb at 36.0N, 50.3W at 00Z (COADS).
- 35 kt SSE and 1012 mb at 37.0N, 49.0W at 04Z (COADS).
- 60 kt SE and 992 mb at 34.3N, 51.2W at 06Z (micro).
- 85 kt ENE at 39.0N, 51.0W at 09Z (MWL).
- ~976 mb at 39.0N, 51.0W at 0930Z (MWL).
- 80 kt NW and 985 mb at 39.0N, 51.0W at 10Z (COADS/MWL).
- 60 kt NW and 992 mb at 39.0N, 51.0W at 11Z (COADS/micro).
- 45 kt at 41.7N, 48.6W at 14Z (WALLET).
- 50 kt SE and 1007 mb at 42.3N, 47.3W at 18Z (COADS).
- 60-70 kt ENE at 42.2N, 46.8W at 1930Z (WALLET).
- 65 kt WSW at 42.5N, 45.7W at 2250Z (WALLET).

3. Discussion:

- MWR: "On the 24th several ships reported winds of 60 to 70 mph."
- Reanalysis: On August 24th, Anna continued to intensify as it turned to the northeast and accelerated. Early on the 24th, the ship SS Excelsior encountered the hurricane, measuring a minimum pressure near 976 mb around 0930Z and maximum sustained winds of 85 kt. The article in the MWL indicates that the ship did not cross the center of the hurricane, thus the 976 mb is not a central pressure. A peripheral pressure of 976 mb suggests maximum surface winds greater than 77 kt from the north of 25N Brown et al. pressure-wind relationship. Due to the synoptically small size of the hurricane, high environmental pressures, and observed 85 kt, an intensity of 90 kt is analyzed at 12Z on the 24th, up from 75 kt originally in HURDAT, a major intensity change. 90 kt is also the peak intensity of this tropical cyclone, up from 80 kt originally in HURDAT, a minor intensity change. Another ship, the SS Kenuta, reported hurricane-force winds late on the 24th.

August 25:

1. Maps and old HURDAT:

- HWM analyzes a hurricane of at most 1004 mb at 47.5N, 38.8W with a cold front just to the west at 12Z.
- HURDAT lists a 75 kt hurricane at 47.1N, 38.1W at 12Z.
- Microfilm shows that the hurricane has moved north of the map at 12Z.

2. Ship highlights:

- 60 kt NW at 42.6N, 45.3W at 00Z (COADS).
- 35 kt S and 1014 mb at 44.0N, 41.0W at 03Z (COADS).
- 45 kt S and 1010 mb at 44.0N, 41.0W at 06Z (COADS).
- 75 kt S and 990 mb at 46.1N, 38.7W at 0830Z (micro/WALLET).
- 60 kt W at 46.1N, 38.7W at 11Z (micro/WALLET).

3. Aircraft highlights:

- Radar center fix estimated an eye diameter of 20-25 nm at 44.5N, 37.8W at 0355Z (WALLET).
- TWA estimated a center fix near 46N, 36W around 16Z (WALLET).

4. Discussion:

- MWR: "On the 25th the SS Quisgueya reported winds of 85 mph and 15- to 30-ft. seas. Anna was about 600 mi northwest of the western Azores and moving on a rapidly accelerating northeastward course."
- Reanalysis: On August 25th, Anna was rapidly moving to the east-northeast over the North Atlantic and gradually losing strength. At 0355Z on the 25th, a reconnaissance aircraft made a radar center fix and estimated an eye diameter of 20-25 nm.

August 26:

1. Maps and old HURDAT:

- HWM analyzes an extratropical cyclone at 54.0N, 17.0W at 12Z.
- HURDAT lists a 65 kt extratropical cyclone at 54.1N, 12.6W at 12Z (last position).

2. Ship highlights:

- 35 kt SW and 1009 mb at 50.3N, 25.5W at 00Z (COADS).
- 45 kt SW and 1015 mb at 50.5N, 23.5W at 06Z (COADS).

3. Discussion:

- MWR: "The hurricane became extratropical west of Ireland on the 26th. Anna was most unusual, since the development into a hurricane occurred at a higher latitude in the Atlantic than ever observed before. There was no known damage or loss of life attributed to Anna."
- Reanalysis: Late on the 25th, surface observations indicate that Anna was becoming extratropical and the process was completed around 00Z on August 26th, same as originally shown in HURDAT. Also at 00Z on the 26th, the system weakened below hurricane intensity. The original HURDAT maintained Anna with hurricane-force winds until its last position at 12Z on the 26th but the synoptic data shows that the extratropical cyclone was on a weakening trend. The circulation became elongated east-west and less defined on the 26th and the last position is analyzed at 12Z on this day, about 300 miles west of Ireland, same as originally shown in HURDAT.

August 27:

1. Maps and old HURDAT:

- HWM analyzes two extratropical cyclones over the northeast Atlantic and it appears that Anna has merged or been absorbed at 12Z.
- HURDAT does not list an organized storm on this date.

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 Betsy [August 27 - September 13, 1965] – AL031965

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43970 08/27/1965 M=18  3 SNBR= 947 BETSY       XING=1 SSS=3

43975 08/27*109 505  25    0*111 521  30    0*114 535  30    0*116 545  30 1007*
43975 08/27*110 505  25    0*112 518  30    0*114 531  30    0*117 545  30 1007*
           ***              *** ***              ***          ***

43980 08/28*120 558  30    0*130 578  30    0*140 598  30 1010*153 614  30    0*
43980 08/28*121 561  30    0*128 579  30    0*140 598  30 1010*151 611  30    0*
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43985 08/29*162  621   30 1010*174  626   30    0*192  634   35 1007*205  643   40   997*
43985 08/29*162  620   30 1010*176  627   35    0*192  635   40 1007*205  643   55   999*
                 ***          ***  ***   **          ***   **                 **    ***

43990 08/30*212  647   65    0*218  651   65    0*224  655   65    0*226  656   65  1002*
43990 08/30*212  648   55  997*218  651   55    0*224  655   55    0*226  657   60   994*
                 ***   **  ***            **                 **          ***   **    ***

43995 08/31*227  657   65  994*227  658   65  990*225  661   70    0*225  660   70   984*
43995 08/31*227  658   60  996*228  658   60  990*225  660   55  998*225  660   55   996*
                 ***   **  *** ***       **          ***   **  ***            **    ***

44000 09/01*225  661   75    0*223  666   75  980*222  675   80  988*223  680   70   987*
44000 09/01*225  660   65    0*223  666   70  984*222  674   70  988*223  680   70   987*
                 ***   **                     ***      ***   **

44005 09/02*225  685   80  970*226  693   90    0*228  702  105  942*234  709  105   945*
44005 09/02*225  685   85  970*226  693  105    0*228  702  120  942*234  709  115   945*
                       **                ***                 ***                 ***

44010 09/03*241  713  110    0*247  721  110    0*253  729  110  955*263  737  115   950*
44010 09/03*241  715  105    0*247  722  100  959*254  729  100  955*263  737  105   950*
                 ***  ***          ***  ***  ***  ***      ***                 ***

44015 09/04*269  743  120  951*273  747  120  946*281  753  120  951*286  756  115   946*
44015 09/04*269  743  105  951*274  748  105  946*281  753  105  951*287  756  105   946*
                      ***       ***  ***  ***                ***       ***       ***

44020 09/05*288  754  110  943*290  753  110  954*290  753  105  952*286  754  100   968*
44020 09/05*289  755  105  943*290  753  100  948*289  753   95  952*287  754   85   968*
            ***  ***  ***                     ***  ***       **       ***       **

44025 09/06*280  754   95  973*275  758  100  968*269  763  100  966*262  765  100     0*
44025 09/06*281  755   80  973*275  759   90  963*269  763   90  966*262  767  100   959*
            ***  ***   **                **  ***            **           ***       ***

44030 09/07*258  767  100  956*256  769  105  956*253  772  110  957*253  779  110   952*
44030 09/07*258  767  105  956*256  770  105  954*253  772  105  957*253  779  105   952*
                      ***           ***       ***          ***                 ***

44035 09/08*252  785  110  961*251  795  110  954*251  807  110  952*253  822  105   948*
44035 09/08*252  786   95  961*251  795   95  958*250  806  100  952*252  820  100     0*
                 ***   **                **  *** ***  *** ***       ***  ***  ***

44040 09/09*255  836  110    0*259  853  115    0*264  869  120  951*273  881  125   953*
44040 09/09*255  836  100  954*259  853  100  950*265  869  100  951*274  881  100   953*
                      ***  ***          ***  *** ***      ***       ***       ***

44045 09/10*283  892  135  941*296  907   90  948*308  918   65  965*323  920   55     0*
44045 09/10*284  892  115  946*296  906   95  948*307  917   65  965*320  922   50     0*
            ***       ***  ***      ***   **       ***  ***            ***  ***   **

44050 09/11*330  920   35    0*340  915   30    0*346  910   30    0*355  902   25     0*
44050 09/11*331  920   35    0*340  915   30  997*347  909   30    0*355  900   25     0*
            ***                           ***  ***  ***                      ***

44055 09/12*363  884   20    0*370  875   20    0E380  865   20    0E390  850   20     0*
44055 09/12E363  890   20    0E372  878   20    0E380  865   20    0E387  848   20     0*
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               ***          *** ***                          *** ***

44060 09/13E390 830  20    0*  0   0   0    0*  0   0   0    0*  0   0   0    0*

44065 HRCFL3 LA3
44065 HRBFL3 CFL3 LA4
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Tropical Storm Landfall

August 29th 08Z 17.9N 62.9W 35 kt St. Barthélemy
August 29th 09Z 18.2N 63.0W 35 kt Anguilla

Hurricane Landfall

September 7th 20Z 25.3N 78.1W 105 kt Bahamas

U.S. Hurricane Landfall

September 08th – 11Z – 25.0N 80.5W – 100 kt – Category 3 – 952 mb – 1009 mb OCI – 375 nm ROCI – 30 nm RMW
September 10th – 04Z – 29.2N 90.1W – 115 kt – Category 4 – 946 mb – 1010 mb OCI – 275 nm ROCI – 30 nm RMW

Significant Revisions:

1. Several central pressures were added and revised based primarily upon aircraft reconnaissance data;
2. Intensity boosted upward substantially on the 29th and the 2nd based upon aircraft reconnaissance data;
3. Intensity revised substantially downward on the 31st, 4th–6th, and 8th–10th based upon aircraft reconnaissance data.

Daily Summary:

August 21:

1. Maps and old HURDAT:

- HWM and HURDAT do not show an organized system on this date.
- Microfilm shows a spot low near 10N, 33W at 12Z.

August 22:

1. Maps and old HURDAT:

- HWM and HURDAT do not show an organized system on this date.
- Microfilm shows a spot low near 12N, 29W at 12Z.

August 23:

1. Maps and old HURDAT:

- HWM and HURDAT do not show an organized system on this date.
- Microfilm shows a closed low pressure of at most 1010 along the ITCZ near 7N, 30.5W at 12Z.

2. Satellite highlights:

- TIROS: Satellite center fix at 7.5N, 29.0W at 1245Z (WALLET).

3. Discussion:

- MWR: "The TIROS weather satellite photographed a disturbed area on August 23 in the eastern Atlantic near 7.5N, 29.5W."
- Reanalysis: Hurricane Betsy developed from a tropical wave that left the African coast around August 19th. The first indication of the disturbance was a TIROS image showing the disturbed weather along the ITCZ southwest of the Cape Verde

Islands on August 23rd. Ship data between the Lesser Antilles and the CVI is sparse, and no intensification was noted until the disturbance was a couple of hundred miles from the Windward Islands.

August 24:

1. Maps and old HURDAT:

- HWM and HURDAT do not show an organized system on this date.
- Microfilm shows a closed low pressure of at most 1010 along the ITCZ near 9N, 33W at 12Z.

August 25:

1. Maps and old HURDAT:

- HWM and HURDAT do not show an organized system on this date.
- Microfilm shows a closed low pressure of at most 1010 along the ITCZ near 7.5N, 38W at 12Z.

August 26:

1. Maps and old HURDAT:

- HWM and HURDAT do not show an organized system on this date.
- Microfilm shows a closed low pressure of at most 1012 along the ITCZ near 4N, 46W at 12Z.

August 27:

1. Maps and old HURDAT:

- HWM indicates a spot low near 11.5N, 53.5W at 12Z.
- HURDAT lists this as a Tropical Depression with 30 kt winds at 11.4N, 53.5W at 12Z.
- The MWR North Atlantic Tropical Cyclones chart showed a center at 11.5N, 53.5W (am) and at 12N, 55.8W (pm).
- Microfilm shows a closed low pressure of at most 1010 mb at 11N, 52.5W at 12Z.

2. Ship highlights:

- 35 kt ESE and 1014 mb at 15.5N, 52.5W at 1800Z (COADS).

3. Satellite highlights:

- TIROS: Satellite center fix at 13N, 52W, estimated winds of 50 kt at 1308Z (WALLET).

4. Aircraft highlights:

- Penetration center fix measured a central pressure of 1007 mb and estimated surface winds of 30-35 kt near 11.5N, 54.0W at 1604Z (WALLET).

5. Discussion:

- MWR - "Reasonable extrapolation shows that this was probably the same system that was discovered by aircraft reconnaissance as a weak tropical depression on August 27, some 350 mi east-southeast of Barbados. By midday the central pressure was 1007 mb and by evening the depression was named Betsy."
- ATSR - "Early on 27 August a TIROS satellite photograph disclosed a weak circulation near 13N 52W. A Navy reconnaissance aircraft was diverted to this area and a tropical depression was found near 11.5N 54.5W at 1900Z."
- Reanalysis - Development into a tropical depression is analyzed at 00Z on August 27th, same as originally shown in HURDAT. However, the time of genesis is uncertain due to the sparse data in the area. A reconnaissance aircraft made a center penetration around 1604Z on the 27th estimating surface winds of 30-35 kt and a central pressure of 1007 mb. A ship reported 35 kt SE and 1014 mb at about 250 nm to the north at 18Z on the 27th. As the ship is well removed from the center of the system, its representativeness is suspect and the system is maintained as a tropical depression. A TIROS satellite image was taken on the 27th showing an area of cloudiness but does not show enough detail to describe the organization of the system. (Central pressures values for almost every 6 hour period were present in the original HURDAT between August 27th at 18Z and September 10th at 12Z. Some of these were obviously analyses that were added in, not based upon actual observations. Thus, based on proceeding and subsequent actual observations, some were retained, others removed and new central pressure values added. Detailed information on these changes can be found in the table at the end.)

August 28:

1. Maps and old HURDAT:

- HWM indicates a tropical storm with a pressure of at most 1008 mb near 14.5N, 59.9W at 12Z.
- HURDAT lists this as a Tropical Depression with 30 kt winds at 14N, 59.8W at 12Z.

- The MWR North Atlantic Tropical Cyclones chart showed a center at 14N, 59.9W (am) and at 16.5N, 62.2W (pm) with a pressure of 1010 mb.
- Microfilm shows a closed low pressure of at most 1012 mb at 14.2N, 60.3W at 12Z.

2. Ship highlights:

- 35 kt ESE and 1016 mb at 14.6N, 53.6W at 00Z (COADS).
- 35 kt SE with a pressure of 1014 mb at 13.7N, 54.7W at 06Z (COADS).
- 35 kt E and 1011 mb at 18.3N, 60.8W at 18Z (micro).

3. Discussion:

- North Atlantic TC - "On the 28th it passed through the Lesser Antilles, accompanied by winds of 35 to 50 knots well east of the center over the open Atlantic. Maximum winds in the Islands were briefly 35 kt in gusts".
- MWR - "No intensification occurred until two days later after Betsy had passed through the Lesser Antilles. No significant damage was reported from the islands".
- Reanalysis - On August 28th, Betsy continued moving northwestward toward the Lesser Antilles as a tropical depression. The tropical depression briefly entered the northeastern Caribbean Sea around 18Z on the 28th. The lowest reported pressure in the Lesser Antilles was only 1010 mb at 18Z on the 28th, consistent with the system being a tropical depression.

August 29:

1. Maps and old HURDAT:

- HWM indicates a tropical storm with a pressure of at most 1012 mb near 19.8N, 63.8W at 12Z.
- HURDAT lists this as a Tropical Storm with 35 kt winds at 19.2N, 63.4W at 12Z.
- The MWR North Atlantic Tropical Cyclones chart showed a center at 19N, 64.3W (am) and at 21N, 64.8W (pm).
- Microfilm shows a tropical wave across the Leeward Islands extending from the eastern Caribbean Sea to the central Atlantic at 12Z.

2. Ship highlights:

- 40 kt SE at 19.8N, 61.7W at 15Z (micro).

3. Aircraft highlights:

- Penetration center fix measured a central pressure of 1007 mb and estimated surface winds of 55 kt at 19.4N, 63.5W at 13Z (WALLET).
- Penetration center fix measured a central pressure of 999 mb and estimated surface winds of 70 kt at 20.6N, 64.4W at 1836Z (WALLET).
- Penetration center fix estimated surface winds of 70 kt and a central pressure of 997 mb at 20.9N, 64.4W at 2105Z (WALLET).

4. Discussion:

- MWR - "By afternoon of the 29th, Betsy had intensified, with hurricane force winds reported from reconnaissance aircraft and it remained a mature hurricane through September 10… By the 29th, the day on which rapid intensification occurred, Betsy had moved to the northwest of the Leeward Islands and was located only a short distance south of the upper trough".
- North Atlantic TC - "On the 29th, reports from aircraft, ships, and island stations indicated Betsy had intensified to hurricane force while located some 200 miles north-northeast of San Juan, Puerto Rico."
- Reanalysis - A reconnaissance aircraft investigated the tropical cyclone on August 29th measuring a central pressure of 1007 mb but estimated surface winds of 55 kt at 13Z. A central pressure of 1002 mb suggests maximum surface winds of 32 kt from the south of 25N Brown et al. pressure-wind relationship. Based on a forward speed of about 20 kt and weighing the visual estimate some, an intensity of 40 kt is analyzed at 12Z on the 29th, up from 35 kt originally in HURDAT. Intensification to a tropical storm is analyzed at 06Z on the 29th, six hours earlier than originally shown. Also early on the 29th, Betsy made landfall in St. Barthélemy

and Anguila. The next reconnaissance aircraft measured a central pressure of 999 mb and estimated surface winds of 70 kt at 1836Z on the 29th. A central pressure of 999 mb suggests maximum surface winds of 49 kt from the south of 25N pressure-wind relationship. Due to a forward speed of about 15 kt and weighing the visual estimate some, an intensity of 55 kt is analyzed at 18Z on the 29th, up from 40 kt originally in HURDAT.

August 30:

1. Maps and old HURDAT:

- HWM indicates a tropical storm with a pressure of at most 1012 mb near 22.8N, 65.8W with a stationary front to the northwest at 12Z.
- HURDAT lists this as a Category 1 hurricane with 65 kt winds at 22.4N, 65.5W at 12Z.
- The MWR North Atlantic Tropical Cyclones chart showed a center at 22.5N, 65.5W (am) with a pressure of 994 mb and at 22.9N, 65.9W (pm).
- Microfilm shows a closed low pressure of at most 1012 mb at 22.5N, 66.3W with a cold front to the north at 12Z.

2. Ship highlights:

- 35 kt E and 1018 mb at 21.7N, 63.3W at 00Z (micro).
- 40 kt W and 1009 mb at 20.2N, 63.5W at 06Z (COADS).
- 35 kt SW and 1013 mb at 22.8N, 64.1W at 18Z (micro).

3. Aircraft highlights:

- Penetration center fix measured a central pressure of 1002 mb and estimated surface winds of 65 kt at 22.5N, 65.6W at 1335Z (WALLET).
- Penetration center fix measured a central pressure of 994 mb and estimated surface winds of 75 kt at 22.6N, 65.8W at 1915Z (WALLET).
- Penetration center fix measured a central pressure of 996 mb and estimated surface winds of 70 kt at 22.8N, 65.8W at 2250Z (WALLET).

4. Discussion:

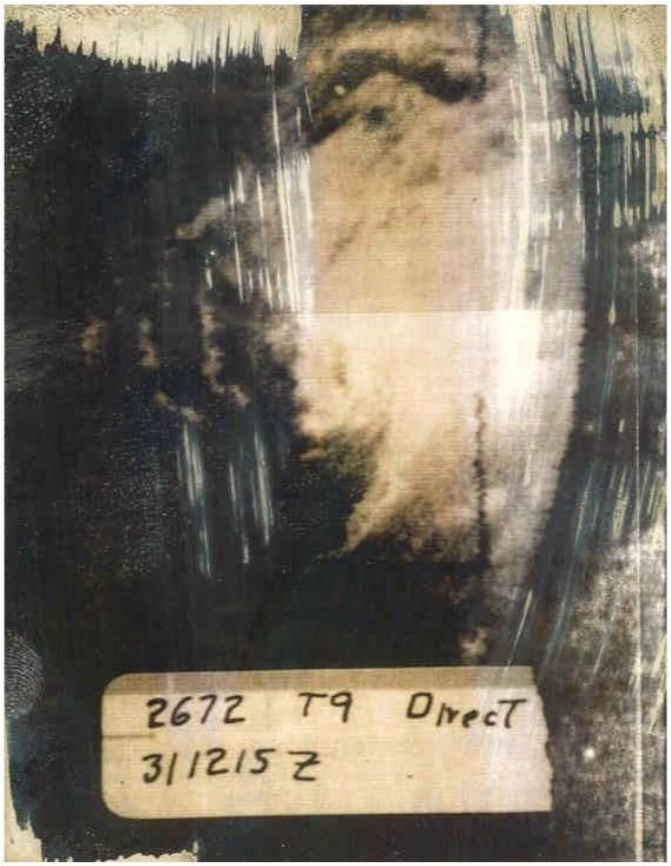
- North Atlantic TC - “During the next 2 days Betsy slowed down, moved rather erratically, and lost some intensity. Maximum winds decreased to about 55 kt and the central pressure rose some 10 mb.”
- Reanalysis - Late on the 29th, Betsy was once again over Atlantic waters moving northwestward but slowing its forward speed. At 2105Z on the 29th, a penetration center fix measured a central pressure of 997 mb and maximum surface winds of 70 kt were estimated. A central pressure of 997 mb suggests maximum surface winds of 53 kt from the south of 25N pressure-wind relationship. Based on a forward speed of about 10 kt, an intensity of 55 kt is analyzed at 00Z on August 30th, down from 65 kt originally in HURDAT, a minor intensity change. It is important to point out that originally HURDAT had a sharp increase in intensity from 40 kt at 18Z on the 29th to 65 kt at 00Z on the 30th and such rapid change in intensity seems unlikely based on the data available from ships and reconnaissance aircrafts. Late on this day, the forward speed of the tropical storm came to a halt about 300 nm north of Puerto Rico. Another reconnaissance aircraft investigated Betsy on the 30th measuring a central pressure of 994 mb and estimating surface winds of 75 kt at 1915Z. A central pressure of 994 mb suggests maximum surface winds of 58 kt from the south of 25N pressure-wind relationship. Since Betsy was almost stationary at this time but weighing the visual wind estimate some, an intensity of 60 kt is analyzed at 18Z on the 30th, down from 65 kt originally in HURDAT, a minor intensity change. A TIROS satellite image on the 30th show a well-organized tropical cyclone with most of the cloudiness over the northern and eastern quadrants. It is possible that Betsy was being affected by some southwest shear and dry air since the image shows almost no convection over the western and southern quadrants.

August 31:

1. Maps and old HURDAT:

- HWM indicates a tropical storm with a pressure of at most 1012 mb near 23.1N, 66.2W with a frontal boundary to the north at 12Z.
- HURDAT lists this as a Category 1 hurricane with 70 kt winds at 22.5N, 66.1W at 12Z.
- The MWR North Atlantic Tropical Cyclones chart showed a center at 22.5N, 66.1W (am) and at 22.2N, 66.9W (pm).
- Microfilm shows a closed low pressure of at most 1012 mb at 23.1N, 66.1W at 12Z.

2. Satellite highlights:



3. Aircraft highlights:

- Radar center fix at 22.7N, 65.7W at 01Z (WALLET).
- Penetration center fix measured a central pressure of 990 mb at 22.9N, 65.5W at 0507Z (WALLET).
- Penetration center fix measured a central pressure of 998 mb and estimated an RMW of about 15 nm at 22.5N, 66.0W at 1305Z (WALLET).
- Penetration center fix measured a central pressure of 996 mb, estimated surface winds of 58 kt and an eye diameter of 14 nm at 1930Z (WALLET).

4. Discussion:

- Reanalysis - On August 31st, the central pressure of Betsy as reported by the reconnaissance aircrafts fluctuated from 990 mb to 998 mb. A penetration center fix at 0507Z measured a central pressure of 990 mb. A central pressure of 990 mb suggests maximum surface winds of 64 kt from the south of 25N pressure-wind relationship. Since the storm was almost stationary at this time and subsequent lowered surface wind estimates, an intensity of 60 kt is analyzed at 06Z on the 31st, down from 65 kt originally in HURDAT, a minor intensity change. Ship observations reported no gales or low pressures associated with Betsy on this day.

A reconnaissance aircraft at 1930Z on the 31st reported a central pressure of 996 mb, estimated surface winds of 58 kt and an eye diameter of 14 nm. An eye diameter of 14 nm suggest an RMW of about 10 nm and the climatological value is 18 nm.

September 1:

1. Maps and old HURDAT:

- HWM indicates a hurricane with a pressure of at most 1000 mb near 23.4N, 67W at 12Z.
- HURDAT lists this as a Category 1 hurricane with 80kt winds at 22.2N, 67.5W at 12Z.
- The MWR North Atlantic Tropical Cyclones chart showed a center at 22.1N, 67.5W (am) and at 22.3N, 68.8W (pm).
- Microfilm shows a closed low pressure of at most 1012 mb at 23.2N, 67.5W at 12Z.

2. Satellite highlights:

3. Ship highlights:

- 35 kt NNE and 1014 mb at 23.2N, 68.4W at 00Z (micro).
- 35 kt NE and 1014 mb at 24.2N, 68.7W at 06Z (micro).
- 35 kt N with a pressure of 1009 mb at 22.4N, 68.4W at 12Z (COADS).

4. Aircraft highlights:

- Radar center fix at 22.5N, 66.0W at 0147Z (WALLET).
- Penetration center fix measured a central pressure of 984 mb and estimated surface winds of 70 kt at 22.4N, 66.9W at 0834Z (WALLET). (Note that there is an inconsistency with this fix: the fix log in the storm wallet says the 984 mb fix was at 0834 UTC, while the vortex message suggests it was at 0610 UTC.)
- Penetration center fix measured a central pressure of 988 mb and estimated an eye diameter of 10 nm at 22.1N, 67.5W at 1237Z (WALLET).
- Penetration center fix measured a central pressure of 987 mb at 22.3N, 68.0W at 18Z (WALLET).

- Penetration center fix measured a central pressure of 975 mb, estimated surface winds of 100 kt and an eye diameter of 15 nm at 21Z (WALLET).
- Penetration center fix measured a central pressure of 970 mb and estimated an eye diameter of 30 nm at 2350Z (WALLET).

5. Discussion:

- MWR - "There was a second marked intensification during September 1 and 2 when the central pressure fell approximately 40mb to 942mb, the lowest recorded during the hurricane's life history. This deepening cannot be readily explained because of lack of data".
- Reanalysis - Early on September 1st, the tropical cyclone began to move to the west and observations from the reconnaissance aircrafts indicate that it intensified. A penetration center fix measured a central pressure of 984 mb and estimated surface winds of 70 kt at 0834Z on the 1st. A central pressure of 984 mb suggests maximum surface winds of 72 kt from the south of 25N pressure-wind relationship. Based on a forward speed of about 6 kt but a RMW smaller than average, an intensity of 70 kt is analyzed at 06Z on the 1st, lower than 75 kt originally shown in HURDAT. Intensification to a hurricane is analyzed at 00Z on the 1st, 48 hours later than originally shown in HURDAT. The next reconnaissance aircraft measured a central pressure of 988 mb and estimated an eye diameter of 10 nm at 1237Z on the 1st. A central pressure of 988 mb suggests maximum surface winds of 67 kt from the south of 25N pressure-wind relationship. An eye diameter of 10 nm suggests an RMW of about 8 nm and the climatological value is 18 nm. Based on a forward speed of about 6 kt and small RMW, an intensity of 70 kt is analyzed at 12Z on the 1st, down from 80 kt originally in HURDAT, a minor intensity change.

September 2:

1. Maps and old HURDAT:

- HWM indicates a hurricane with a pressure of at most 1008 mb near 23.2N, 70.5W at 12Z.
- HURDAT lists this as a Category 3 hurricane with 105 kt winds at 22.8N, 70.2W at 12Z.
- The MWR North Atlantic Tropical Cyclones chart showed a center at 22.8N, 70.1W (am) and at 24N, 71.5W (pm).
- Microfilm shows a closed low pressure of at most 1008 mb at 23.5N, 70.5W at 12Z.

2. Ship highlights:

- 40 kt E and 1008mb at 23.8N, 68.9W at 12Z (COADS).
- 40 kt SE and 1009 mb at 24.1N, 69.7W at 18Z (COADS).

3. Aircraft highlights:

- Penetration center fix measured a central pressure of 942 mb, estimated surface winds of 85 kt and an eye diameter of 15 nm at 22.8N, 70.2W at 1150Z (WALLET).
- Penetration center fix measured a central pressure of 945 mb and estimated surface winds of 100 kt at 23.5N, 71.0W at 1813Z (WALLET).

4. Radar highlights:

- Turks and Caicos center fix at 22.5N, 68.6W at 0015Z (WALLET).
- Turks and Caicos center fix at 22.6N, 69.6W at 0615Z (WALLET).
- Turks and Caicos center fix at 22.9N, 70.2W at 1215Z (WALLET).
- Turks and Caicos center fix at 23.5N, 71.0W at 1815Z (WALLET).

5. Discussion:

- North Atlantic TC - "On September 1, however, the hurricane began moving westward and by the night of the 2nd, winds had increased to 110 to 130 kt near the center and the central pressure was 945 mb".
- Reanalysis: From late on the 1st to midday on September 2nd, Betsy underwent through a period of rapid intensification where the central pressure decreased

from 987 mb at 18Z on the 1st to 942 mb at 1150Z on the 2nd, 45 mb in about 18 hours. A reconnaissance aircraft measured a central pressure of 970 mb and estimated an eye diameter of 30 nm at 2350Z on the 1st. A central pressure of 970 mb suggests maximum surface winds of 91 kt from the south of 25N pressure-wind relationship intensifying subset. An eye diameter of 30 nm suggests an RMW of about 23 nm and the climatological value is 17 nm. Based on a forward speed of about 6 kt and an RMW slightly above the climatological value, an intensity of 85 kt is analyzed at 00Z on the 2nd, up from 80 kt originally in HURDAT, a minor intensity change. Intensification to a major hurricane is analyzed at 06Z on the 2nd, six hours earlier than originally shown in HURDAT. Another reconnaissance aircraft measured a central pressure of 942 mb, estimated surface winds of 85 kt and an eye diameter of 15 nm at 1150Z on the 2nd. A central pressure of 942 mb suggests maximum surface winds of 119 kt from the south of 25N pressure-wind relationship intensifying subset. An eye diameter of 15 nm suggests an RMW of about 10 nm and the climatological value is 14 nm. Based on a forward speed of about 7 kt and RMW slightly below the climatological value, an intensity of 120 kt is analyzed at 12Z on the 2nd, up from 105 kt originally shown in HURDAT, a minor intensity change. 120 kt is also the peak intensity of Betsy, down from 135 kt originally shown in HURDAT at 00Z on September 10th. The rapid intensification was followed by a period of weakening based on reports from reconnaissance aircrafts. A penetration center fix at 1813Z on the 2nd reported a central pressure of 945 mb and estimated surface winds of 100 kt. A central pressure of 945 mb suggests maximum surface winds of 116 kt from the south of 25N pressure-wind relationship. Based on a forward speed of 9 kt, an intensity of 115 kt is analyzed at 18Z on the 2nd, up from 105 kt originally shown in HURDAT, a minor intensity change. Ships remained in the periphery of Betsy on the 2nd, only reporting gale-force winds.

September 3:

1. Maps and old HURDAT:
   - HWM indicates a hurricane with a pressure of at most 1000 mb near 25.7N, 73.2W with a stationary front to the northwest at 12Z.
   - HURDAT lists this as a Category 3 hurricane with 110 kt winds at 25.3N, 72.9W at 12Z.
   - The MWR North Atlantic Tropical Cyclones chart showed a center at 25.5N, 72.8W (am) and at 26.9N, 74.1W (pm).
   - Microfilm shows a closed low pressure of at most 1008 mb at 23.5N, 70.5W with a stationary front to the north at 12Z.
2. Satellite highlights:

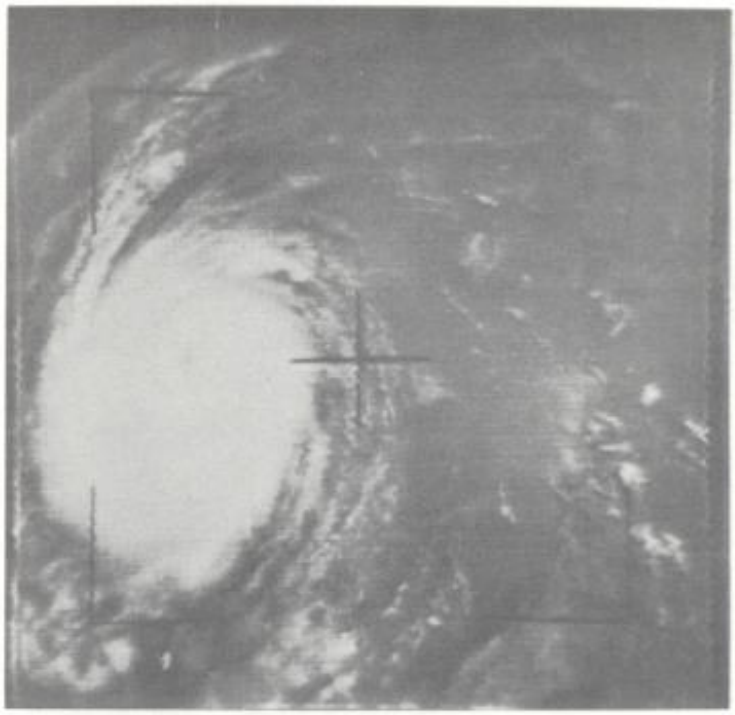


FIGURE 3.—Betsy at 1043 EST September 3, 1965, photographed by TIROS X.

3. Ship highlights:
- 40 kt E and 1008 mb at 25.5N, 71.0W at 00Z (micro).
- 35 kt E and 1009 mb at 26.4N, 70.8W at 06Z (COADS).
- 40 kt NE and 1008 mb at 27.9N, 73.8W at 12Z (HWM).

4. Aircraft highlights:
- Penetration center fix measured a central pressure of 959 mb and estimated an eye diameter of 20 nm at 24.3N, 71.5W at 0311Z (WALLET).
- Penetration center fix measured a central pressure of 955 mb, estimated surface winds of 75 kt and an eye diameter of 20 nm at 25.4N, 72.9W at 1150Z (WALLET).
- Penetration center fix measured a central pressure of 950 mb, estimated surface winds of 100 kt and an eye diameter of 25 nm at 26.4N, 73.8W at 1858Z (WALLET). (Note that the 1706Z fix indicated double eyewalls at 20 nm and 50 nm diameters.)
- Penetration center fix measured a central pressure of 951 mb, estimated surface winds of 95 kt and an eye diameter of 50 nm at 26.9N, 74.3W at 2329Z (WALLET).

5. Discussion:
- North Atlantic TC - "On the 3rd, hurricane Betsy skirted the Bahamas moving northwestward".
- Reanalysis - The first reconnaissance aircraft to investigate the hurricane on September 3rd measured a central pressure of 959 mb and estimated an eye diameter of 20 nm at 0311Z. A central pressure of 959 mb suggests maximum surface winds of 99 kt from the south of 25N and 96 kt from north of 25N pressure-wind relationships. An eye diameter of 20 nm suggests an RMW of about 15 nm and the climatological value is 18 nm. Based on a forward speed of about 8 kt and an RMW near average, an intensity of 100 kt is analyzed at 06Z on the 3rd, down from 110 kt originally shown in HURDAT, a minor intensity change. Another reconnaissance aircraft measured a central pressure of 955 mb, estimated surface winds of 75 kt and an eye diameter of 20 nm at 1150Z on the 3rd. A central pressure of 955 mb suggests maximum surface winds of 100 kt from the north of 25N and 106 kt from the south of 25N pressure-wind relationships. An eye diameter of 20 nm suggests an RMW

of about 15 nm and the climatological value is 17 nm. Based on a forward speed of about 8 kt and an RMW close to the climatological value, an intensity of 100 kt is analyzed at 12Z on the 3rd, down from 110 kt originally shown in HURDAT, a minor intensity change. The next reconnaissance aircraft measured a central pressure of 950 mb, estimated surface winds of 100 kt and an eye diameter of 25 nm at 1858Z on the 3rd. A central pressure of 950 mb suggests maximum surface winds of 105 kt from the north of 25N and 111 kt from the south of 25N pressure-wind relationships. An eye diameter of 25 nm suggests an RMW of about 20 nm and the climatological value is 16 nm. Based on a forward speed of about 13 kt and an RMW slightly larger than average, an intensity of 105 kt is analyzed at 18Z on the 3rd, down from 115 kt originally shown in HURDAT, a minor intensity change. TIROS captured an image of Betsy on the 3rd showing a well-organized hurricane with banding features, a central dense overcast and an eye.

September 4:

1. Maps and old HURDAT:

- HWM indicates a hurricane with a pressure of at most 1000 mb near 28.5N, 75.7W with a stationary front to the north at 12Z.
- HURDAT lists this as a Category 4 hurricane with 120 kt winds at 28.1N, 75.3W at 12Z.
- The MWR North Atlantic Tropical Cyclones chart showed a center at 28N, 75.1W (am) and at 28.9N, 75.5W (pm).
- Microfilm shows a closed low pressure of at most 1012 mb at 28.4N, 75.4W with a stationary front to the north at 12Z.

2. Ship highlights:

- 40 kt SE and 1006 mb at 26.0N, 73.0W at 00Z (COADS).
- 40 kt E and 1011 mb at 29.1N, 73.2W at 06Z (COADS).
- 45 kt SSW and 1004 mb at 26.9N, 75.1W at 12Z (COADS).
- 40 kt W and 1005 mb at 27.2N, 76.2W at 18Z (COADS).

3. Aircraft highlights:

- Penetration center fix measured a central pressure of 946 mb, estimated surface winds of 100 kt and an eye diameter of 35 nm at 27.3N, 74.8W at 0615Z (WALLET).
- Penetration center fix measured a central pressure of 946 mb, estimated surface winds of 100 kt and an eye diameter of 35 nm at 27.3N, 74.8W at 0615Z (WALLET).
- Penetration center fix measured a central pressure of 951 mb, estimated surface winds of 100 kt and an eye diameter of 35 nm at 28.2N, 75.3W at 1150Z (WALLET).
- Penetration center fix measured a central pressure of 945 mb, estimated surface winds of 110 kt and an eye diameter of 25 nm at 28.2N, 75.5W at 1506Z (WALLET).
- Penetration center fix measured a central pressure of 945 mb and estimated surface winds of 110 kt at 28.9N, 75.6W at 2040Z (WALLET).
- Penetration center fix measured a central pressure of 943 mb and estimated an eye diameter of 30 nm at 28.8N, 75.4W at 2350Z (WALLET).

4. Discussion:

- North Atlantic TC - “During the 4th, it again slowed down, and gradually moved on a small clockwise loops as a large high pressure area over the eastern United States effectively blocked an further northward movement”.
- Reanalysis - On September 4th, the intensity of Betsy remained generally steady, though the reconnaissance reports strongly suggest that an eyewall replacement was completed around 00Z on the 4th due to the expansion of the eye diameter. A reconnaissance aircraft investigated the hurricane at 0615Z on the 4th measuring a central pressure of 946 mb and estimated surface winds of 100 kt and an eye diameter of 35 nm. A central pressure of 946 mb suggests maximum surface winds of 114 kt from the north of 25N pressure-wind relationship intensifying subset. An eye diameter of 35 nm suggests an RMW of about 25 nm and the climatological value

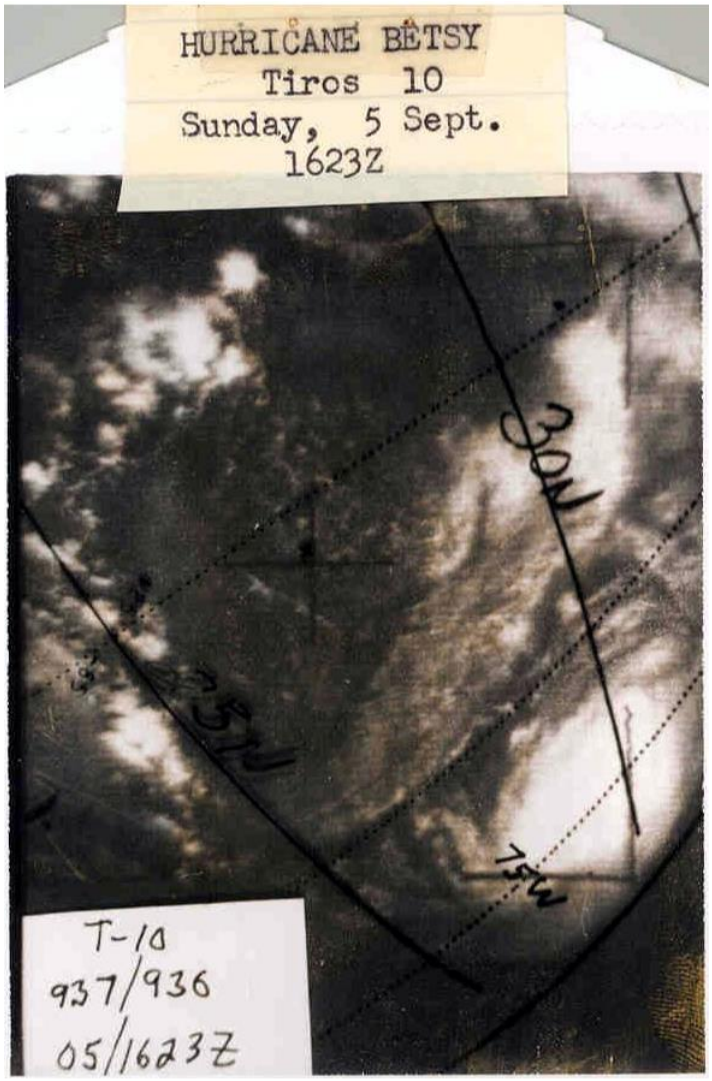
is 17 nm. Due to a forward speed of about 7 kt and an RMW larger than average, the intensity is analyzed at 105 kt at 06Z on the 4th, down from 120 kt originally in HURDAT, a major intensity change. Late on the 4th, the forward speed of Betsy again decreased to almost stationary while north of the northwestern Bahamas. An image captured by TIROS on the 4th shows a well-organized hurricane, well-defined eye, central dense overcast and banding features.

September 5:

1. Maps and old HURDAT:

- HWM indicates a storm with a pressure of at most 1000 mb near 29.5N, 76W with a stationary front to the northeast at 12Z.
- HURDAT lists this as a Category 3 hurricane with 105 kt winds at 29N, 75.3W at 12Z.
- The MWR North Atlantic Tropical Cyclones chart showed a center at 29N, 75.2W (am) and at 28N, 75.5W (pm).
- Microfilm shows a closed low pressure of at most 1012 mb at 28.0N, 75.0W with a stationary front to the northeast at 12Z.

2. Satellite highlights:



3. Ship highlights:

- 40 kt NE and 1017 mb at 31.8N, 78.5W at 18Z (micro).

4. Aircraft highlights:

- Penetration center fix measured a central pressure of 948 mb at 29.0N, 75.3W at 0550Z (WALLET).
- Penetration center fix measured a central pressure of 952 mb, estimated surface winds of 110 kt and an eye diameter of 25 nm at 28.9N, 75.3W at 1230Z (WALLET).
- Penetration center fix measured a central pressure of 968 mb, estimated surface winds of 80 kt and an eye diameter of 20 nm at 28.7N, 75.4W at 1645Z (WALLET).
- Penetration center fix estimated an eye diameter of 20 nm at 28.5N, 75.5W at 2054Z (WALLET).

5. Discussion:

- Reanalysis - A reconnaissance aircraft measured a central pressure of 943 mb and estimated an eye diameter of 30 nm at 2350Z on the 4th. A central pressure of 943 mb suggests maximum surface winds of 112 kt from the north of 25N pressure-wind relationship. An eye diameter of 30 nm suggests an RMW of about 23 nm and the climatological value is 18 nm. Based on a forward speed of almost stationary and RMW larger than average, an intensity of 105 kt is selected at 00Z on September 5th, down from 110 kt in HURDAT, a minor intensity change. Betsy weakened on the 5th based on reconnaissance central pressure reports. The next penetration center fix measured a central pressure of 948 mb at 0550Z on the 5th. A central pressure of 948 mb suggests maximum surface winds of 107 kt from the north of 25N and 102 kt from the north of 25N weakening subset, pressure-wind relationships. Based on a forward speed of almost stationary, an intensity of 100 kt is analyzed at 06Z on the 5th, down from 110 kt originally in HURDAT, a minor intensity change. Another penetration center fix measured a central pressure of 952 mb, estimated surface winds of 110 kt and an eye diameter of 25 nm at 1230Z on the 5th. A central pressure of 952 mb suggests maximum surface winds of 103 kt from the north of 25N pressure-wind relationship. An eye diameter of 25 nm suggests an RMW of about 20 nm and the climatological value is 18 nm. Based on a forward speed of almost stationary, an intensity of 95 kt is analyzed at 12Z on the 5th, down from 105 kt originally in HURDAT, a minor intensity change. The next penetration center fix measured a central pressure of 968 mb, estimated surface winds of 80 kt and an eye diameter of 20 nm at 1645Z on the 5th. A central pressure of 968 mb suggests maximum surface winds of 87 kt from the north of 25N and 83 kt from the north of 25N weakening subset, pressure-wind relationships. Based on a forward speed of almost stationary, an intensity of 85 kt is analyzed at 18Z on the 5th, down from 100 kt originally in HURDAT, a minor intensity change.

September 6:

1. Maps and old HURDAT:

- HWM indicates a hurricane with a pressure of at most 992 mb near 27.5N, 77.2W with a stationary front to the northeast at 12Z.
- HURDAT lists this as a Category 3 hurricane with 100 kt winds at 26.9N, 76.3W at 12Z.
- The MWR North Atlantic Tropical Cyclones chart showed a center at 27N, 76W (am) and at 25.9N, 76.7W (pm).
- Microfilm shows a closed low pressure of at most 1000 mb at 26.8N, 76.3W at 12Z.

2. Ship highlights:

- 40 kt ENE and 1017 mb at 32.9N, 77.0W at 00Z (COADS).
- 50 kt NW and 1003 mb at 26.8N, 76.0W at 06Z (micro).
- 50 kt S and 996 mb at 26.4N, 75.4W at 12Z (COADS).
- 120 kt N and 990 mb at 26.3N, 76.9W at 18Z (micro).

3. Land highlights:

- 155 kt NW and 969 mb at Hope Town, Bahamas at 18Z (MWR).
- 127 kt at Marsh Harbour, Bahamas at 19Z (Bahamas).

- 962 mb at Dunmore Town, Bahamas (no time given, but likely late on the 6th or early on the 7th)(MWR).

4. Aircraft highlights:

- Penetration center fix measured a central pressure of 973 mb, estimated surface winds of 110 kt and an eye diameter of 20 nm at 28.0N, 75.4W at 00Z (WALLET).
- Penetration center fix measured a central pressure of 963 mb and estimated an eye diameter of 15 nm at 27.5N, 75.9W at 0640Z (WALLET).
- Penetration center fix measured a central pressure of 958 mb and estimated an eye diameter of 12 nm at 27.3N, 76.0W at 0840Z (WALLET).
- Penetration center fix measured a central pressure of 966 mb, estimated surface winds of 105 kt and an eye diameter of 35 nm at 26.8N, 76.4W at 1312Z (WALLET).
- Penetration center fix measured a central pressure of 959 mb, estimated surface winds of 100 kt and an eye diameter of 40 nm at 26.1N, 76.6W at 21Z (WALLET).

5. Radar highlights:

- Miami center fix estimated an eye diameter of 53 nm at 26.2N, 76.7W at 1812Z (WALLET).

6. Discussion:

- MWR – "Late on September 5, Betsy began a rather unusual southwestward movement, and on the 6th the hurricane was just off Great Abaco Island. Betsy continued through the northern Bahamas with the eye passing just north of Nassau. Total losses in the islands were 5 million pounds ($14 million); much of it was crop losses. It is estimated that between 150,000 and 200,000 pounds ($500,000) will be expended by governmental and charitable organizations to repair the damages".
- North Atlantic TC – "On Labor Day, the 6th, the hurricane moved slowly parallel to Great Abaco Island, where hurricane force winds were reported for 20 hours, reaching a maximum of 128 kt during the late afternoon".
- Reanalysis - Another satellite image captured by TIROS showed Betsy as a well-organized tropical cyclone on the 6th, including an eye in the center of a central dense overcast. By early on September 6th, Betsy had completed a small clockwise loop north of the northwestern Bahamas and began to move to the southwest toward the islands. A reconnaissance penetration center fix measured a central pressure of 973 mb, estimated surface winds of 110 kt and an eye diameter of 20 nm at 00Z on the 6th. A central pressure of 973 mb suggests maximum surface winds of 81 kt from the north of 25N pressure-wind relationship. An eye diameter of 20 nm suggests an RMW of about 15 nm and the climatological value is 21 nm. Based on a forward speed of about 6 kt and RMW smaller than average, an intensity of 80 kt is analyzed at 00Z on the 6th, down from 95 kt originally in HURDAT, a major intensity change. At 0640Z on the 6th, a reconnaissance aircraft measured a central pressure of 963 mb and estimated an eye diameter of 15 nm. A central pressure of 963 mb suggests maximum surface winds of 92 kt from the north of 25N pressure-wind relationship. An eye diameter of 15 nm suggests an RMW of about 10 nm and the climatological value is 20 nm. Based on a forward speed of about 7 kt and an RMW smaller than normal, an intensity of 90 kt is analyzed at 06Z on the 6th, down from 100 kt originally in HURDAT, a minor intensity change. At 18Z on the 6th, Betsy was near the northwest Bahamas and Hope Town reported sustained winds of 155 kt. Observations from ships and reconnaissance aircrafts do not support winds of that intensity. A reconnaissance aircraft measured a central pressure of 959 mb, estimated surface winds of 100 kt and an eye diameter of 40 nm at 21Z on the 6th. This information, just three hours after the report from Hope Town, would suggest an intensity of about 95 kt. See discussion on September 7th for intensity reanalysis for 18Z on the 6th through 18Z on the 7th.

September 7:

1. Maps and old HURDAT:

- HWM indicates a hurricane with a pressure of at most 984 mb near 25.5N, 77.5W at 12Z.

- HURDAT lists this as a Category 3 hurricane with 110kt winds at 25.3N, 77.2W at 12Z.
- The MWR North Atlantic Tropical Cyclones chart showed a center at 25.2N, 77.5W (am) and at 25.1N, 78.5W (pm).
- Microfilm shows a closed low pressure of at most 996 mb at 25.5N, 76.2W at 12Z.

2. Ship highlights:

- 40 kt and 1001 mb at 26.2N, 74.2W at 00Z (micro).
- 50 kt S and 982 mb at 25.3N, 76.1W at 06Z (micro).
- 50 kt SW and 1000 mb at 23.9N, 76.6W at 12Z (COADS).
- 45 kt SW and 1001 mb at 23.7N, 76.9W at 18Z (COADS).

3. Land highlights:

- 65 kt SW and 978 mb at Eleuthera Island, Bahamas at 00Z (micro).
- 131 kt ENE at Green Turtle Cay, Bahamas at 06Z (MWR).
- 60 kt SSW and 991 mb at South Andros, Bahamas at 12Z (micro).
- 966 mb at Nassau, Bahamas at 15Z (MWR).
- 40 kt SSE and 994 mb at Eleuthera Island, Bahamas at 18Z (micro).

4. Aircraft highlights:

- Penetration center fix measured a central pressure of 956 mb at 25.9N, 76.7W at 01Z (WALLET).
- Penetration center fix measured a central pressure of 960 mb and estimated an eye diameter of 39 nm at 25.7N, 76.7W at 03Z (WALLET).
- Penetration center fix measured a central pressure of 954 mb, estimated surface winds of 80 kt and an eye diameter of 45 nm at 26.0N, 76.9W at 0550Z (WALLET).
- Penetration center fix measured a central pressure of 957 mb and estimated an eye diameter of 45 nm at 25.3N, 77.0W at 1146Z (WALLET).
- Penetration center fix measured a central pressure of 959 mb and estimated surface winds of 115 kt at 25.9N, 77.9W at 15Z (WALLET).
- Radar center fix at 25.3N, 77.8W at 18Z (WALLET).
- Penetration center fix measured a central pressure of 952 mb, estimated surface winds of 125 kt and an eye diameter of 50 nm at 25.1N, 78.1W at 21Z (WALLET).

5. Radar highlights:

- Miami center fix at 25.8N, 76.6W at 0033Z (WALLET).
- Miami center fix at 25.6N, 77.1W at 0610Z (WALLET).
- Miami center fix estimated an eye diameter of 45 nm at 25.2N, 77.4W at 1210Z (WALLET).
- Miami center fix estimated an eye diameter of 46 nm at 25.5N, 78.1W at 1811Z (WALLET).

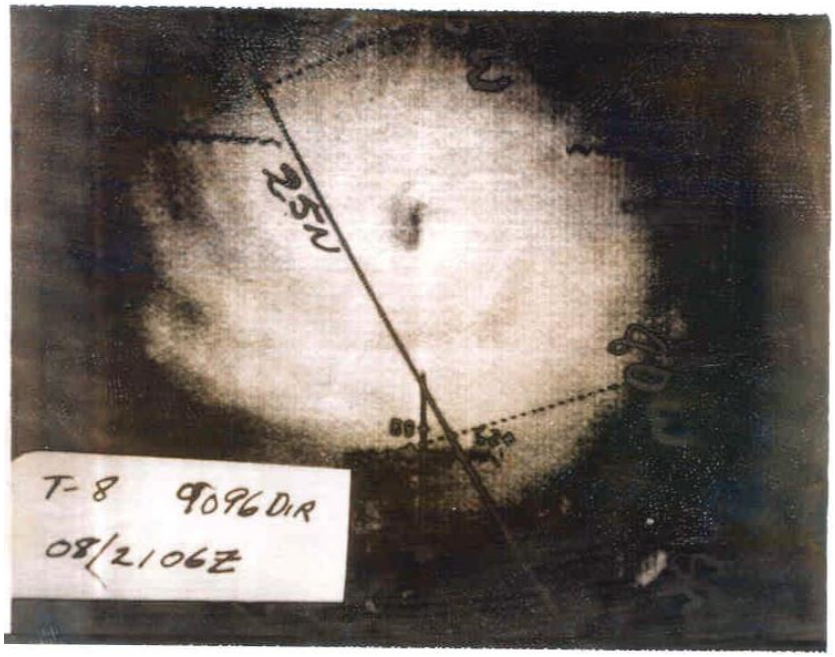
6. Discussion:

- MWR - “After leaving the Bahamas, Betsy moved a westerly course and passed over the Florida Keys”.
- North Atlantic TC - “On the morning of the 7th the hurricane center, about 40 miles in diameter, swept westward just north of the Bahamian capital at Nassau. Lowest pressure at this time was 957 mb. Violent winds and high tides caused moderate to heavy damage throughout the northern and central Bahamas”.
- Reanalysis - On September 7th, Betsy turned to the west and late on the day clipped northern North Andros Island. A reconnaissance aircraft measured a central pressure of 956 mb at 01Z on the 7th. A central pressure of 956 mb suggests maximum surface winds of 99 kt from the north of 25N and 105 kt from the south of 25N pressure-wind relationships. 131 kt at Green Turtle Cay and 155 kt at Hope Town were reported in MWR at 18Z on the 6th and 06Z on the 7th, respectively. This value for Hope Town may have come from the Hope Town Lighthouse (26.5N 77.0W). The location for Green Turtle Cay measurement cannot be precisely located (26.8N 77.3W). These values are supposedly fastest mile readings. 155 kt fastest mile

converts to about 145 kt 1 min sustained wind. Such a value appears to be extremely high compared with what the aircraft reconnaissance suggests from the central pressure and eye diameter (only 95 kt). We contacted the Bahamian Weather Service about these records for Betsy. They had no records for the Hope Town measurements, but did confirm that the Green Turtle Cay were unofficial observations. "On September 6th the winds recorded at Green Turtle Cay was 125 mph at 8pm and by 5am the next morning the winds were measured between 135-150 mph the peak winds of the storm there were measured at 150 mph at 5am Tuesday." They also provided additional official observations: "147 mph winds were official winds measured in Abaco and were taken from the Department of Meteorology Hurricane Betsy's official report to the Bahamas Cabinet. It was also reported in the Abaco's Commissioner's report and yes it was sustained winds and it was measured at 2pm [on the 6th] at Marsh Harbour." This value was measured at Marsh Harbour Airport (26.5N 77.1W). The 147 mph report is consistent with what Mr. Wayne Neely's published in his book "The Major Hurricanes to Affect the Bahamas", he states that the "highest winds were measured in Abaco of 147 miles per hour". 147 mph is 127 kt fastest mile, which converts to about 121 kt 1 min sustained, which is still inconsistent with what was being reported by the aircraft. The intensity of Betsy remained steady on the 7th as the central pressures reported by the reconnaissance aircrafts fluctuated some between 950 mb and 958 mb. Taking a blend of what is suggested by aircraft reconnaissance (around 95 to 100 kt) with these measurements, an intensity of 100 kt is analyzed at 18Z on the 6th and 105 kt is analyzed from 00Z through 18Z on the 7th. This is very close to what was in HURDAT originally.

September 8:

1. Maps and old HURDAT:
   - HWM indicates a storm with a pressure of at most 984mb near 25.3N, 81W at 12Z.
   - HURDAT lists this as a Category 3 hurricane with 110 kt winds at 25.1N, 80.7W at 12Z.
   - The MWR North Atlantic Tropical Cyclones chart showed a center at 25.1N, 80.8W (am) and at 25.6N, 83.4W (pm).
   - Microfilm shows a closed low pressure of at most 1000 mb at 25.0N, 80.7W at 12Z.
2. Satellite highlights:



3. Ship highlights:

- 60 kt NNE and 996 mb at 26.1N, 79.9W at 00Z (micro).
- 50 kt NE and 988 mb at 26.0N, 80.1W at 06Z (COADS).
- 80 kt E and 987 mb at 26N, 80.1W at 12Z (COADS).
- 80 kt N and 999 mb at 24.1N, 84.0W at 18Z (micro).

4. Land highlights:

- 55 kt SW and 992 mb at Mangrove, Bahamas at 00Z (MWR/micro).
- 87 kt ENE at Plantation Key, FL at 0830Z (MWR).
- 952 mb at Tavernier, FL at 1210Z (MWR).
- 70 kt SW at Key West, FL at 1520Z (TC Data).
- 40 kt SW and 984 mb at Key West, FL at 18Z (micro).

5. Aircraft highlights:

- Radar center fix measured a central pressure of 961 mb and estimated an eye diameter of 40 nm at 25.2N, 78.6W at 00Z (WALLET).
- Radar center fix measured a central pressure of 958 mb and estimated an eye diameter of 40 nm at 25.1N, 79.5W at 06Z (WALLET).
- Penetration center fix measured a central pressure of 954 mb, estimated surface winds of 100 kt and an eye diameter of 37 nm at 25.1N, 80.0W at 0850Z (WALLET).
- Penetration center fix measured a central pressure of 954 mb, estimated surface winds of 85 kt and an eye diameter of 38 nm at 25.1N, 80.6W at 1148Z (WALLET).
- Penetration center fix measured a central pressure of 953 mb and estimated an eye diameter of 25 nm at 25.1N, 81.3W at 1453Z (WALLET).
- Penetration center fix measured a central pressure of 948 mb, estimated surface winds of 95 kt and an eye diameter of 34 nm at 25.2N, 82.0W at 18Z (WALLET). (Note that this value of central pressure looks suspect. First, this pressures is 6 mb lower than the pressures measured before and after it. Second, the recorded 700 mb height is 40-50 m higher than those other fixes. Because of these concerns, this central pressure is not used.)
- Penetration center fix measured a central pressure of 954 mb and estimated surface winds of 100 kt at 25.3N, 82.8W at 2148Z (WALLET).

6. Radar highlights:

- Miami center fix estimated an eye diameter of 40 nm at 25.2N, 78.6W at 0010Z (WALLET).
- Miami center fix estimated an eye diameter of 42 nm at 25.1N, 79.7W at 0709Z (WALLET).
- Key West center fix estimated an eye diameter of 31 nm at 25.0N, 81.0W at 1243Z (WALLET).
- Miami center fix estimated an eye diameter of 30 nm at 25.3N, 82.3W at 1840Z (WALLET).

7. Discussion:

- Ho et al. - "28.11 inches" (951.9 mb) at Tavernier, FL – RMW 22 nmi – 11 kt forward speed – landfall pt 25.0N, 80.5W".
- Jarrell et al - "Sep – SE FL3" (Jarrell et al. (1992).
- Schwerdt et al. - "948 mb at 25.2N, 82.1W – 1013 mb PenV – RMW 17 nmi – speed 15 kt – 91 kt est max sustained 10m, 10-min wind.
- North Atlantic TC - "Betsy moved westward during the afternoon and evening of the 7th and was the second major hurricane of record to approach Florida after moving southwestward. Betsy reached the coast in the upper Keys and extreme lower peninsula area during the early morning hours of the 8th. The southern edge of the hurricane eye passed over Marathon and the northern edge over Flamingo Ranger Station – indicating the eye was at least 35 miles in diameter as it moved across Florida Bay…Lowest pressure reported in Florida was 952 mb at Tavernier on the southern end of Key Largo. Winds there reached 140 mph estimated at 3:10 am EST on the 8th. Wind speeds reached 100 mph or higher in gusts from about Ft. Lauderdale

to Everglades City; sustained winds of 100mph or higher were recorded between Big Pine Key and Homestead. Gales lasted about 38 hours at Miami".

- Reanalysis - On September 8th, Betsy reached the Gulf Stream and made landfall in the Florida Keys as it gained in forward speed. A penetration center fix measured a central pressure of 958 mb and an eye diameter of 40 nm at 06Z on the 8th. A central pressure of 958 mb suggests maximum surface winds of 97 kt from the north of 25N and 103 kt from the south of 25N pressure-wind relationships. An eye diameter of 40 nm suggests an RMW of about 30 nm and the climatological value is 17 nm. Based on a forward speed of about 9 kt and an RMW larger than average, an intensity of 95 kt is analyzed at 06Z on the 8th, down from 110 kt originally in HURDAT, a minor intensity change. Landfall in the Florida Keys is analyzed to have occurred around 11Z on the 8th with maximum sustained winds of 100 kt, making Betsy a major hurricane at landfall. The eye of Betsy crossed Tavernier Key, where a central pressure of 952 mb was measured, and is analyzed as a central pressure. A central pressure of 952 mb suggests maximum sustained winds of 111 kt from the south of 25N and 108 kt from the north of 25N, both from the intensifying subset of the pressure-wind relationship. Due to a forward speed of about 10 kt and RMW larger than average, an intensity of 100 kt is analyzed at 12Z on the 8th, down from 110 kt originally in HURDAT, a minor intensity change. Ships registered winds up to hurricane-force, including 80 kt at 12Z and 18Z on the 8th. Over land, Plantation Key registered sustained winds of 87 kt and Key West experienced 70 kt during the hurricane passage. After crossing the keys, Betsy entered the eastern Gulf of Mexico.

September 9:

1. Maps and old HURDAT:

- HWM indicates a storm with a pressure of at most 992 mb near 26.6N, 87.1W at 12Z.
- HURDAT lists this as a Category 4 hurricane with 120kt winds at 26.4N, 86.9W at 12Z.
- The MWR North Atlantic Tropical Cyclones chart showed a center at 26.4N, 86.9W (am) and at 28N, 89 (pm).
- Microfilm shows a closed low pressure of at most 1000 mb at 26.7N, 86.7W at 12Z.

2. Ship highlights:

- 40 kt NNE and 1007 mb at 27.5N, 87.0W at 00Z (micro).
- 60 kt S and 1002 mb at 24N, 84.5W at 06Z (COADS).
- 35 kt WSW and 998 mb at 24.8N, 87.1W at 12Z (COADS).
- 45 kt SE and 1009 mb at 28.7N, 84.5W at 18Z (COADS).

3. Land highlights:

- 41 kt E at Pensacola, FL at 2022Z (SWO).

4. Aircraft highlights:

- Radar center fix at 25.5N, 83.5W at 0015Z (WALLET).
- Penetration center fix measured a central pressure of 954 mb and estimated an eye diameter of 35 nm at 25.8N, 84.3W at 0315Z (WALLET).
- Penetration center fix measured a central pressure of 950 mb and estimated an eye diameter of 35 nm at 25.9N, 85.3W at 06Z (WALLET).
- Penetration center fix measured a central pressure of 951 mb, estimated surface winds of 120 kt and an eye diameter of 60 nm at 26.3N, 87.1W at 1340Z (WALLET).
- Penetration center fix measured a central pressure of 953 mb at 27.3N, 88.1W at 18Z (WALLET).
- Penetration center fix measured a central pressure of 946 mb and estimated surface winds of 140 kt at 27.8N, 88.6W at 2106Z (WALLET).

5. Radar highlights:

- Key West center fix estimated an eye diameter of 31 nm at 25.4N, 83.7W at 0045Z (WALLET).

- Tampa center fix estimated an eye diameter of 30 nm at 25.9N, 85.0W at 0536Z (WALLET).
- New Orleans center fix estimated an eye diameter of 48 nm at 27.2N, 88.0W at 1809Z (WALLET).

6. Discussion:

- MWR - "Betsy turned toward the northwest on entering the Gulf of Mexico; the hurricane's forward speed increased to 22 mph, well above the average speed for Gulf storms".
- Reanalysis - On September 9th, Betsy turned to the northwest and began approaching the Louisiana coastline. The intensity remained steady around 100 kt based on central pressure reports from the reconnaissance aircrafts between 950 mb and 954 mb.

September 10:

1. Maps and old HURDAT:

- HWM indicates a hurricane with a pressure of at most 988 mb near 31.5N, 92.5W with a cold front to the north at 12Z.
- HURDAT lists this as a Category 1 hurricane with 65 kt winds at 30.8N, 91.8W at 12Z.
- The MWR North Atlantic Tropical Cyclones chart showed a center at 31N, 92W (am) and at 33N, 92W (pm).
- Microfilm shows a closed low pressure of at most 1000 mb at 30.9N, 91.9W with a cold front to the north at 12Z.

2. Ship highlights:

- 45 kt SW and 1003 mb at 26.3N, 87.5W at 00Z (COADS).
- 40 kt SW and 1007 mb at 29.2N, 88.9W at 12Z (COADS).

3. Land highlights:

- 969 mb at Quarantine, LA at 03Z (TC Data).
- 948 mb at Grand Isle, LA at 0351Z (TC Data).
- 948 mb at Houma, LA at 0630Z (TC Data);
- 118 kt SSE and of 977 mb at Port Sulphur, LA at 04Z (TC Data).
- 962 mb at Burtville, LA at 0945Z (TC Data).
- 970 mb at Melville, LA at 1330Z (TC Data).
- 53 kt NNE at Monroe, LA at 1404Z (MWR).
- 986 mb at Monroe, LA at 2035Z (CLIMO).

4. Aircraft highlights:

- Penetration center fix measured a central pressure of 946 mb, estimated surface winds of 145 kt and an eye diameter of 80 nm at 28.4N, 89.2W at 00Z (WALLET).
- Radar center fix estimated a central pressure of 956 mb and an eye diameter of 45 nm at 29.5N, 90.5W at 06Z (WALLET).
- A pressure of 941mb at 27.9N, 88.8W at 2230Z (HO).

5. Radar highlights:

- New Orleans center fix estimated an eye diameter of 35 nm at 28.3N, 89.2W at 0006Z (WALLET).
- Lake Charles center fix at 29.7N, 90.7W at 0614Z (WALLET).
- Lake Charles center fix estimated an eye diameter of 12 nm at 31.0N, 91.9W at 1240Z (WALLET).

6. Discussion:

- Ho et al. - "27.79 inches" (941.1 mb) from RECON at 27.9N, 88.8W– RMW 32 nmi – 17 kt forward speed – landfall pt 29.1N, 90.1W".
- Schwerdt et al. - "941 mb at 28.2N, 89.2W – 1011 mb PenV – RMW 32 nmi – speed 17 kt – 93 kt est max sustained 10m, 10-min wind;
- Jarrell et al. - "LA3 – Cat 3 – 948 mb".

- North Atlantic TC - "The tropical storm passed west of Monroe about 2:30pm on the 10th, then veered northeastward into eastern Arkansas…"About midnight the center passed 35 miles southwest of New Orleans where the extreme wind was estimated at 125 mph and 4 hours later moved just to the west of Baton Rouge, where wind gusts reached 92 mph. Betsy then turned northward and winds decreased to below hurricane force by the time the center into north-central Louisiana".
- MWR - "The eye arrived at Grand Isle, LA, shortly after 2100CST, September 9. The sea level pressure of 28.00 in reported in the eye at Grand Isle and at Houma a few hours later was the lowest recorded at any land station during the hurricane's life history. The eye was 40 mi in diameter on the Louisiana coast – just the same as when it passed over the Keys early in the morning of the 8th".
- Reanalysis - At 2106Z on the 9th, a reconnaissance aircraft reported a central pressure of 946 mb and estimated surface winds of 140 kt. At 2135Z, New Orleans radar estimated an eye diameter of 37 nm. A central pressure of 946 mb suggests maximum surface winds of 114 kt from the north of 25N pressure-wind relationship intensifying subset. An eye diameter of 37 nm suggests an RMW of about 28 nm and the climatological value is 17 nm. Port Sulphur reported 118 kt fastest mile (30 sec) at 04Z on the 10th, suggesting 1-min sustained winds of 112 kt. The height of the anemometer is unknown. Based on a fast forward speed of about 15 kt, RMW larger than climatology, environmental pressures lower than normal (OCI 1009 mb) and the Port Sulphur observation, an intensity of 115 kt is analyzed at 00Z on September 10th, down from 135 kt originally shown in HURDAT, a major intensity change. Landfall in southeastern Louisiana is analyzed at 04Z on the 10th with maximum sustained winds of 115 kt. At 0351Z on the 10th, Grand Isle reported a minimum pressure of 948 mb and observations from the New Orleans radar and reconnaissance aircrafts show that the center of Betsy made landfall about 6 nm west of the city, thus it is not a central pressure, but is very close. Ho's Louisiana landfall pressure of 941 mb is the same as that currently in HURDAT for 0000 UTC 10 September. This seems to have come from the vortex message for the fix at 0000 UTC 10 September, which reports a 941 mb pressure that was not put into the fix log. The dropsonde for this fix was 946 mb, while the extrapolation using current formulas is 945 mb. Thus Ho's value appears to not be supported by the available observations. After landfall, Betsy rapidly weakened. The Kaplan and DeMaria model was run for 06Z, 12Z and 18Z on the 10th, and 00Z on the 11th yielding 90 kt, 63 kt, 45 kt and 32 kt, respectively. An intensity of 95 kt is selected for 06Z on the 10th, 65 kt at 12Z, 50 kt at 18Z and 35 kt at 00Z on the 11th (up from from 90 kt, same, down from 55 kt and same, respectively, originally in HURDAT), minor intensity changes. Houma, LA measured a central pressure of 948 mb at 06Z on the 10th. Over water, a central pressure of 948 mb suggests maximum sustained winds of 107 kt from the north of 25N pressure-wind relationship. Taking into account that the system was overland, a reduction of 15% is applied suggesting an intensity of 91 kt. A minimum pressure of 970 mb was reported at Melville, LA, at 1330Z and 53 kt were registered at Monroe, LA at 1404Z on the 10th. Monroe, LA also reported a minimum pressure of 986 mb at 2035Z on the 10th. Weakening below major hurricane intensity and hurricane intensity is analyzed at 06Z and 18Z on the 10th, respectively, same as originally shown in HURDAT.

September 11:

1. Maps and old HURDAT:

- HWM indicates a closed low pressure of at most 1004 mb near 35N, 92.5W with a stationary front just to the northwest at 12Z.
- HURDAT lists this as a tropical depression with 30 kt winds at 34.6N, 91W at 12Z.
- The MWR North Atlantic Tropical Cyclones chart showed a center at 35N, 90W (am) and at 37N, 87W (pm).
- Microfilm shows a closed low pressure of at most 1004 mb at 35.0N, 91.0W with a stationary front just to the northwest at 12Z.

2. Land highlights:

- 15 kt NNE and 1002 mb at Little Rock, AR at 06Z (micro).

3. Discussion:

- North Atlantic TC - "It passed through eastern Arkansas on the 10th and 11th, then through northern Kentucky on the 12th as it continued to weaken and acquire Extratropical characteristics. Peak winds in Arkansas were near 45 mph, in gusts, and only 20 to 30 mph, or lower in other areas of the middle Mississippi and lower Ohio Valleys".
- Reanalysis - Weakening to a tropical depression is analyzed at 06Z on the 11th, same as originally shown in HURDAT.

September 12:

1. Maps and old HURDAT:

- HWM indicates an extratropical low pressure of at most 1016 mb near 37.5N, 87W at 12Z.
- HURDAT lists this as an extratropical depression with 20 kt winds at 38N, 86.5W at 12Z.
- The MWR North Atlantic Tropical Cyclones chart showed a center at 39N, 86W (am) and at 40N, 82W (pm).
- Microfilm shows an extratropical cyclone of at most 1016 mb at 37.5N, 86W at 12Z.

2. Discussion:

- Reanalysis - On September 11th, Betsy turned to the northeast ahead of a frontal boundary and transition to an extratropical cyclone is analyzed to have occurred around 00Z on the 12th, 12 hours earlier than originally shown in HURDAT.

September 13:

1. Maps and old HURDAT:

- HWM and Microfilm indicate a stationary front over the central and eastern United States at 12Z.
- HURDAT lists this as an extratropical depression with 20 kt winds at 39N, 83W at 00Z (last position).

2. Discussion:

- MWR - "Betsy was the most destructive hurricane of record. The damage in Florida was not as great as the amount attributed to Donna (1960) or to Dora (1964), but in Louisiana, damage from Betsy alone exceeds that from any other hurricane by millions. Even if the damage figure were adjusted for the increased property evaluation over the years, the devastation caused by Betsy probably would equal or exceed that attributed to any of the other major natural disaster of all time".
- Reanalysis - The system continued to weaken and dissipation is analyzed to have occurred after 00Z on the 13th over the Ohio River Valley.

Date	Original HURDAT Central Pressure	Evidence	Changes
Aug 27 18Z	1007 mb	Penetration center fix: 1007 mb around 1604Z on Aug 27th	Retained
Aug 28 12Z	1010 mb	No central pressures reported around this time but synoptic data indicates that it is reasonable	
Aug 29 00Z	1010 mb		

Aug 29 12Z	1007 mb	Penetration center fix: 1002 mb at 13Z on Aug 29th	1002 mb
Aug 29 18Z	997 mb	Penetration center fix: 999 mb at 1836Z on Aug 29th	999 mb
Aug 30 00Z		Penetration center fix: 997 mb at 2105Z on Aug 30th	997 mb
Aug 30 18Z	1002 mb	Penetration center fix: 994 mb at 1915Z on Aug 30th	994 mb
Aug 31 00Z	994 mb	Penetration center fix: 996 mb at 2250Z on Aug 30th	996 mb
Aug 31 06Z	990 mb	Penetration center fix: 990 mb at 0507Z on Aug 31th	Retained
Aug 31 12Z		Penetration center fix: 998 mb at 1305Z on Aug 31th	998 mb
Aug 31 18Z	984 mb	Penetration center fix: 996 mb at 1930Z on Aug 31th	996 mb
Sep 01 06Z	980 mb	Penetration center fix: 984 mb at 0834Z on Sep 01st	984 mb
Sep 01 12Z	988 mb	Penetration center fix: 988 mb at 1237Z on Sep 01st	
Sep 01 18Z	987 mb	Penetration center fix: 981 mb at 18Z on Sep 01st	
Sep 02 00Z	970 mb	Penetration center fix: 970 mb at 2350Z on Sep 01st	Retained
Sep 02 12Z	942 mb	Penetration center fix: 942 mb at 1150Z on Sep 02nd	
Sep 02 18Z	945 mb	Penetration center fix: 945 mb at 1813Z on Sep 02nd	
Sep 03 06Z		Penetration center fix: 959 mb at 0311Z on Sep 03rd	959 mb
Sep 03 12Z	955 mb	Penetration center fix: 955 mb at 1150Z on Sep 03rd	
Sep 03 18Z	950 mb	Penetration center fix: 950 mb at 1858Z on Sep 03rd	
Sep 04 00Z	951 mb	Penetration center fix: 951 mb at 2329Z on Sep 03rd	Retained
Sep 04 06Z	946 mb	Penetration center fix: 946 mb at 0615Z on Sep 04th	

Sep 04 12Z	951 mb	Penetration center fix: 951 mb at 1150Z on Sep 04th	
Sep 04 18Z	946 mb	Penetration center fix: 946 mb at 18Z on Sep 04th	
Sep 05 00Z	943 mb	Penetration center fix: 943 mb at 2350Z on Sep 04th	
Sep 05 06Z	954 mb	Penetration center fix: 948 mb at 0550Z on Sep 05th	948 mb
Sep 05 12Z	952 mb	Penetration center fix: 952 mb at 1230Z on Sep 05th	
Sep 05 18Z	968 mb	Penetration center fix: 968 mb at 1645Z on Sep 05th	Retained
Sep 06 00Z	973 mb	Penetration center fix: 973 mb at 0002Z on Sep 06th	
Sep 06 06Z	968 mb	Penetration center fix: 963 mb at 0640Z on Sep 06th	963 mb
Sep 06 12Z	966 mb	Penetration center fix: 966 mb at 1312Z on Sep 06th	Retained
Sep 06 18Z	959 mb	Penetration center fix: 959 mb at 21Z on Sep 06th	
Sep 07 00Z	956 mb	Penetration center fix: 956 mb at 01Z on Sep 07th	Retained
Sep 07 06Z	956 mb	Penetration center fix: 954 mb at 0550Z on Sep 07th	954 mb
Sep 07 12Z	957 mb	Penetration center fix: 957 mb at 1146Z on Sep 07th	
Sep 07 18Z	952 mb	Penetration center fix: 952 mb at 21Z on Sep 07th	Retained
Sep 08 00Z	961 mb	Penetration center fix: 961 mb at 00Z on Sep 08th	
Sep 08 06Z	954 mb	Penetration center fix: 958 mb at 06Z on Sep 08th	958 mb
Sep 08 12Z	952 mb	Penetration center fix: 953 mb at 1453Z on Sep 08th	Retained
Sep 08 18Z	948 mb	Penetration center fix: 948 mb at 18Z on Sep 08th (This value looks suspect. First, this pressures is 6 mb lower than the pressures measured before and after it. Second, the recorded 700 mb height is 40-50 m higher than those other fixes.)	Removed

Sep 09 00Z		Penetration center fix: 954 mb at 2148Z on Sep 08th	954 mb
Sep 09 06Z		Penetration center fix: 950 mb at 06Z on Sep 09th	950 mb
Sep 09 12Z	951 mb	Land: 952 mb Tavernier, FL, at 1210Z on Sep 09th	952 mb
Sep 09 18Z	953 mb	Penetration center fix: 953 mb at 18Z on Sep 09th	Retained
Sep 10 00Z	941 mb	Penetration center fix: 946 mb at 00Z on Sep 10th	946 mb
Sep 10 06Z	948 mb	Land: 948 mb at Houma, LA, at 06Z on Sep 10th	Retained
Sep 10 12Z	965 mb	No central pressure reported around 12Z on Sep 10th but based on a minimum pressure of 970 mb at 13Z at Melville, LA, it appears reasonable	
Sep 11 06Z		Land: 25 kt NE and 1002 mb at Little Rock, AR at 06Z on Sep 11th	997 mb

Sources: the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, Monthly Weather Review, Navy reconnaissance book, Mariners Weather Log, National Hurricane Research Project (NHRP), North Atlantic Tropical Cyclones, Local Climatological Data, Surface Weather Observations, Schwerdt et al. (1979), Ho et al. (1987), Jarrell et al. (1992), Neely (2006) "The Major Hurricanes to Affect the Bahamas", and NHC Storm Wallets.

Hurricane Carol [September 15 – October 3, 1965] – AL041965

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44070 09/16/1965 M=16  4 SNBR= 948 CAROL       XING=0 SSS=0
44075 09/16*  0   0   0    0*133 201  25    0*130 220  25    0*127 238  25    0*
44080 09/17*125 256  25    0*123 274  25    0*123 292  30    0*124 307  35    0*
44080 09/17*125 256  25    0*123 274  25    0*123 292  30    0*124 304  35    0*
                                                            ***

44085 09/18*126 319  40    0*129 331  40    0*132 343  40    0*135 356  40    0*
44085 09/18*126 315  40    0*129 326  40    0*132 336  40    0*135 346  40    0*
                           ***             ***             ***

44090 09/19*140 368  40    0*148 379  40    0*155 387  40    0*163 392  40    0*
44090 09/19*141 358  40    0*148 370  40    0*155 382  40    0*163 390  40    0*
           *** ***             ***             ***             ***

44095 09/20*170 396  45    0*179 400  50    0*189 403  55    0*197 406  65    0*
44095 09/20*171 396  45    0*179 400  50    0*189 403  55    0*197 406  65    0*
           ***

44100 09/21*204 408  65    0*215 409  65  974*230 410  65  974*249 411  70    0*
44100 09/21*205 408  75  976*215 409  80    0*229 410  80  974*248 411  80    0*
           ***      **  ***          **    * ***      **      ***      **
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44105 09/22*268 412  75    0*288 414  75    0*308 418  75  980*324 422  75    0*
44105 09/22*268 412  80    0*288 414  80    0*308 418  80  980*324 422  75    0*
                     **               **               **

44110 09/23*333 426  70  992*339 429  65    0*344 430  65  988*348 430  65    0*
44110 09/23*333 426  70    0*339 428  65    0*344 432  65  988*348 433  60    0*
                           *     ***              ***            ***  **

44115 09/24*351 429  65    0*352 426  65    0*352 423  65    0*351 420  65  991*
44115 09/24*351 431  55  992*352 428  55    0*351 424  55  992*349 420  55  991*
                ***  **  ***     ***  **      *** ***  **  *** ***      **

44120 09/25*349 417  65    0*344 414  65    0*340 411  65  986*338 410  65  986*
44120 09/25*347 417  55    0*344 414  60    0*340 412  65  986*336 411  65  986*
           ***       **               **          ***          *** ***

44125 09/26*335 410  65  986*333 410  65    0*330 410  65  998*327 412  65    0*
44125 09/26*334 410  65  986*332 410  65    0*330 410  60  992*327 412  60    0*
           ***            ***                          **  ***          **

44130 09/27*326 415  65    0*328 418  65    0*331 419  70    0*334 419  70    0*
44130 09/27*326 415  60    0*328 418  60    0*331 419  60    0*334 419  60    0*
                     **               **               **               **

44135 09/28*337 418  70  992*340 418  70    0*346 417  70    0*356 409  70  988*
44135 09/28*337 418  55  992*340 417  55    0*346 415  60    0*356 409  60  988*
                     **          ***  **          ***  **               **

44140 09/29*366 393  75    0*376 376  80    0*387 354  85    0*401 329  80  984*
44140 09/29*368 394  70    0*381 376  80    0*394 350  80    0*404 320  75  984*
           *** ***  **      ***              *** ***  **      *** ***  **

44145 09/30*415 302  75    0*427 274  70    0*428 247  70    0*418 220  65    0*
44145 09/30*412 289  75    0*420 265  70    0E424 243  65    0E418 220  60    0*
           *** ***            *** ***        **** ***  **     *          **

44150 10/01*407 197  65    0*398 178  45    0E388 160  25    0E376 142  25    0*
44150 10/01E410 197  55    0E395 178  55    0E378 160  50    0E363 152  50    0*
           ****       **     ****       **     ***       **     *** ***  **
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(October 2nd and 3rd are new to HURDAT)

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44151 10/02E350 145  45    0E340 140  40    0E330 140  35    0E320 140  35    0*
44153 10/03E310 140  30    0E304 140  25    0E298 140  20    0*  0    0    0    0*

44155 HR
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Significant Revisions:

1. A few central pressures were added based primarily upon aircraft reconnaissance;
2. A large increase in intensity is introduced on the 21st based upon aircraft reconnaissance observations;
3. A large reduction in intensity is introduced on the 28th based upon aircraft reconnaissance observations;
4. Extratropical transition is indicated 24 hours earlier based upon ship observations;

5. A large increase in intensity is introduced on the 1st (as an extratropical cyclone) based on ship observations;
6. Two additional days are added to the lifecycle of the system (as an extratropical cyclone).

Daily Summary:

September 15:

1. Maps and old HURDAT:
- HWM does not show an organized system at 12Z.
- HURDAT does not list an organized system on this date.
- Microfilm shows an active ITCZ with a closed low pressure center near 11N, 29W and another near 4N, 15W at 12Z.

2. Discussion:
- MWR: "Hurricane Carol probably had its beginning in a weak low pressure area that moved off the African coast on September 15."

September 16:

1. Maps and old HURDAT:
- HWM analyzes a spot low pressure at 14.2N, 21.0W at 12Z.
- HURDAT lists a 25 kt tropical depression at 13.0N, 22.0W at 12Z.
- Microfilm shows a closed low pressure of at most 1012 mb near 12.5N, 22.0W at 12Z.

2. Discussion:
- MWR: "The disturbance moved rapidly westward as indicated by satellite photographs on the 16th and 17th."
- ATSR: "The first indication of CAROL was a disturbed area moving rapidly to the west in TIROS photographs of 16 and 17 September."
- Reanalysis: Hurricane Carol developed from a tropical wave that exited the African coast late on September 15th or early on the 16th based on coastal and ship observations. The disturbance became better organized as it moved westward and a 25 kt tropical depression is analyzed to have developed at 06Z on September 16th between the Cape Verde Islands and West Africa, same as originally shown in HURDAT.

September 17:

1. Maps and old HURDAT:
- HWM analyzes a spot low pressure at 12.9N, 29.3W at 12Z.
- HURDAT lists a 30 kt tropical depression at 12.3N, 29.2W at 12Z.
- Microfilm shows a tropical cyclone symbol at 11.2N, 28.0W at 12Z.

2. Discussion:
- Reanalysis: On September 17th and 18th, the system moved away from the Cape Verde Islands and into an area of less ship traffic, thus the data became sparse. Intensification to a tropical storm is retained at 18Z on the 17th.

September 18:

1. Maps and old HURDAT:
- HWM analyzes a spot low pressure at 13.6N, 34.2W at 12Z.
- HURDAT lists a 40 kt tropical storm at 13.2N, 34.3W at 12Z.
- Microfilm shows a tropical cyclone symbol at 11.2N, 34.9W at 12Z.

2. Ship highlights:
- 35 kt SE and 1015 mb at 14.9N, 33.3W at 18Z (micro).

3. Discussion:
- MWR: "On the 18th the ship *Sunpalemzo* reported winds of 40 mph, seas of 12 to 15 ft., and about normal surface pressures. These reports indicate that Carol was a storm at that time; and, from the height of the seas, it appears that Carol probably reached storm intensity the previous day."

- Reanalysis: A ship recorded 35 kt SE at 18Z on the 18th, the first reported gale-force winds.

September 19:

1. Maps and old HURDAT:
- HWM analyzes a spot low pressure at 16.0N, 39.0W at 12Z.
- HURDAT lists a 40 kt tropical storm at 15.5N, 38.7W at 12Z.
- Microfilm shows a closed low pressure at 14.8N, 39.8W at 12Z.
2. Ship highlights:
- 35 kt SE and 1015 mb at 13.3N, 33.5W at 00Z (micro).
3. Satellite highlights:
- TIROS: Center fix at 16.0N, 39.0W at 1524Z (WALLET).
4. Discussion:
- MWR: "The storm slowed and turned toward the north on the 19th."
- ATSR: "A tropical storm warning was issued on 19 September based on a TIROS photo and the following day a Navy reconnaissance aircraft located the storm center on radar. From 19 through 22 September CAROL moved rapidly to the north along the western edge of a 500 mb anticyclone, but for the next five days she remained within 100 miles of 30N 42W while maintaining hurricane force winds and making a complete loop. During this five day period CAROL was located in an area of extremely weak gradient just to the south of the westerlies at the 500 mb level."
- Reanalysis: On September 19th, Carol turned to the northwest and decreased its forward speed.

September 20:

1. Maps and old HURDAT:
- HWM analyzes a tropical storm of at most 1008 mb at 19.2N, 40.2W at 12Z.
- HURDAT lists a 55 kt tropical storm at 18.9N, 40.3W at 12Z.
- Microfilm shows a tropical storm of at most 1008 mb at 17.8N, 42.9W at 12Z.
2. Ship highlights:
- 35 kt E and 1011 mb at 20.8N, 41.6W at 12Z (COADS).
- 35 kt NE and 1011 mb at 21.2N, 41.0W at 15Z (COADS).
- 35 kt E and 1009 mb at 21.6N, 40.5W at 15Z (COADS).
- 35 kt NE and 1009 mb at 21.9N, 40.0W at 21Z (COADS).
3. Satellite highlights:
- TIROS: Center fix at 19.5N, 41.0W and estimated winds at 55 kt at 1353Z (WALLET).
4. Aircraft highlights:
- Radar center fix measured a peripheral pressure of 1001 mb at 19.5N, 40.2W at 1745Z (WALLET).
- Penetration center fix measured a central pressure of 976 mb and an eye diameter of 60 nm at 20.3N, 40.7W at 2315Z (WALLET).
5. Discussion:
- MWR: "A Navy reconnaissance plane located the center by radar on the 20th. The plane was about 50 mi. south of the center and reported the surface pressure at that point as 1001 mb (29.56 in). Undoubtedly Carol was of hurricane intensity at that time."
- Reanalysis: On the 20th, the tropical cyclone turned to the north-northwest as a frontal boundary approached from the northwest. The first reconnaissance aircraft to investigate the tropical cyclone arrived late on the 20th, making a penetration center fix at 2315Z. The aircraft measured a central pressure of 976 mb and estimated an eye diameter of 60 nm. A central pressure of 976 mb suggests maximum sustained winds of 83 kt from the south of 25N Brown et al. pressure-wind relationship. (Note that the aircraft was

flying at 300 mb, thus the central pressure value is substantially more uncertain than usual and that the surface eye diameter was likely smaller than 60 nm at 300 mb.) An eye diameter of 60 nm suggests an RMW of 45 nm and the climatological value is 16 nm. Due to the large RMW, an intensity of 75 kt is analyzed at 00Z on September 21st, up from 65 kt originally shown in HURDAT, a minor intensity change. The center positions reported by the reconnaissance aircrafts appear to be very uncertain compared to the synoptic data, thus they are not heavily emphasized in this analysis. The distance from land likely contributed to errors in the position estimate of the aircrafts over the Atlantic Ocean. (Central pressure values for many six hour period were present in the original HURDAT between September 21st at 00Z and September 29th at 18Z. Based on actual observations, some were retained, others removed and new central pressure values added. Detailed information on these changes can be found in the table at the end.) Intensification to a hurricane is analyzed at 18Z on the 20th, same as originally shown in HURDAT. It is possible based on the reported diameter of the eye of Carol that the hurricane intensified faster than shown and may have performed a concentric eyewall replacement cycle by the time the first reconnaissance aircraft investigated the tropical cyclone, similar to Fred in 2009 and Julia in 2010.

September 21:

1. Maps and old HURDAT:

- HWM analyzes a hurricane of at most 1000 mb at 23.5N, 41.5W with a weakening cold front to the northwest at 12Z.
- HURDAT lists a 65 kt hurricane at 23.0N, 41.0W at 12Z.
- Microfilm shows a closed low pressure of at most 1008 mb at 23.0N, 41.0W with a weakening cold front to the northwest at 12Z.

2. Ship highlights:

- 45 kt NE and 1008 mb at 22.2N, 39.7W at 00Z (COADS).
- 40 kt NE and 1010 mb at 22.5N, 39.5W at 03Z (COADS).
- 35 kt SE and 1012 mb at 21.7N, 38.3W at 06Z (micro).
- 40 kt ESE and 1009 mb at 22.9N, 38.8W at 09Z (COADS).
- 40 kt SE and 1011 mb at 23.0N, 38.4W at 12Z (COADS).
- 40 kt SE and 1011 mb at 23.9N, 38.0W at 15Z (COADS).
- 35 kt SSE and 1015 mb at 23.1N, 37.5W at 18Z (COADS).

3. Satellite highlights:

- TIROS: Center fix at 24N, 40.5W at 1324Z (WALLET).

4. Aircraft highlights:

- Penetration center fix measured a central pressure of 974 mb and an eye diameter of 45 nm at 22.2N, 41.2W at 1130Z (WALLET).

5. Discussion:

- MWR: “The following day, Air Force reconnaissance penetrated the center and recorded a central pressure of 974 mb (28.76 in).”
- Reanalysis: The next reconnaissance aircraft investigated Carol at 1130Z on September 21st measuring a central pressure of 974 mb and an eye diameter of 45 nm. (Note that the aircraft was flying at 300 mb but measured the 974 mb from a dropsonnde. The surface eye diameter was likely smaller than 45 nm at 300 mb.) A central pressure of 974 mb suggests maximum sustained winds of 85 kt from the south of 25N pressure-wind relationship. An eye diameter of 45 nm suggests an RMW of about 35 nm and the climatological value is 17 nm. Due to the large RMW and forward speed of about 15 kt, an intensity of 80 kt is analyzed at 12Z on September 21st, up from 65 kt originally shown in HURDAT, a minor intensity change. 80 kt is also the peak intensity for this tropical cyclone, down from 85 kt originally shown in HURDAT at 12Z on September 29th. The best track position at 12Z September 21st is compatible

with the recon position and ship observations, but substantially south of the satellite fix. Given the uncertainties in correctly geo-locating the satellite pictures way out over the open ocean, such an inconsistency with the recon and the ships is not surprising.

September 22:

1. Maps and old HURDAT:

- HWM analyzes a hurricane of at most 1012 mb at 31.5N, 41.5W with a weakening cold front to the northwest at 12Z.
- HURDAT lists a 75 kt hurricane at 30.4N, 41.8W at 12Z.
- Microfilm shows a hurricane of at most 1012 mb at 30.9N, 41.7W with a developing low pressure system along a frontal boundary about 600 nm to the west at 12Z.

2. Ship highlights:

- 35 kt SE and 1015 mb at 27.2N, 37.5W at 00Z (COADS).
- 35 kt SE and 1019 mb at 26.1N, 36.9W at 06Z (COADS).
- 35 kt ENE and 1021 mb at 27.0N, 48.8W at 12Z (COADS).
- 40 kt NE and 1009 mb at 33.7N, 43.0W at 18Z (COADS).
- 65 kt NE and 994 mb at 34.1N, 42.7W at 21Z (COADS).

3. Aircraft highlights:

- Penetration center fix measured a pressure of 989 mb, estimated surface winds of 75 kt and an eye diameter of 40 nm at 27.3N, 41.5W at 0035Z (WALLET). (This central pressure is not consistent with values on the 21st or later on the 22nd and is thus not considered to be reliable.)
- Penetration center fix measured a central pressure of 980 mb, estimated surface winds of 75 kt and an eye diameter of 35 nm at 31.0N, 41.7W at 1230Z (WALLET).

4. Discussion:

- MWR: "The hurricane continued northward at a rapid rate until late on the 22d. For the next five days through the morning of the 28th, Carol, maintaining hurricane force, drifted but stayed within 100 mi. of 34" N., 42" W."
- Reanalysis: Late on the 21st and into September 22nd, Carol increased in forward speed to the north reaching over 20 kt. Ships remained in the periphery of the hurricane on the 21st and 22nd, reporting winds generally below storm intensity. The exception was a ship at 21Z on the 22nd that passed near the center of Carol reporting 65 kt NE and 994 mb. A reconnaissance aircraft measured a central pressure of 980 mb, estimated surface winds of 75 kt and an eye diameter of 35 nm at 1230Z on the 22nd. A central pressure of 980 mb suggests maximum sustained winds of 73 kt from the north of 25N pressure-wind relationship. An eye diameter of 35 nm suggests an RMW of about 25 nm and the climatological value is 24 nm. Due to the fast forward speed of about 17 kt and near average size, an intensity of 80 kt is analyzed at 12Z on the 22nd, up from 75 kt originally shown in HURDAT, a minor intensity change.

September 23:

1. Maps and old HURDAT:

- HWM analyzes a hurricane of at most 1012 mb at 35.5N, 43.5W with a stationary cold front to the north at 12Z.
- HURDAT lists a 65 kt hurricane at 34.4N, 43.0W at 12Z.
- Microfilm shows a closed low pressure of at most 1016 mb at 35.0N, 43.6W at 12Z.

2. Ship highlights:

- 50 kt S and 1010 mb at 34.2N, 42.2W at 00Z (COADS).
- 35 kt S and 1013 mb at 34.2N, 41.9W at 06Z (COADS).

- 35 kt SSW and 1015 mb at 33.7N, 42.9W at 12Z (COADS).
- 35 kt SW and 1015 mb at 34.2N, 42.5W at 18Z (micro).

3. Satellite highlights:

- TIROS: Center fix at 35.5N, 43W at 1340Z (WALLET).

4. Aircraft highlights:

- Penetration center fix measured a central pressure of 988 mb, estimated surface winds of 60 kt and an eye diameter of 35 nm at 34.5N, 43.3W at 0945Z (WALLET).
- Penetration center fix measured a central pressure of 992 mb, estimated flight level winds of 55 kt and an eye diameter of 20 nm at 34.9N, 43.2W at 2212Z (WALLET).

5. Discussion:

- Reanalysis: On September 23rd, the frontal boundary to the north of Carol lifted northeastward leaving the hurricane in an area of weak steering currents and the forward speed of the tropical cyclone slowed down to a crawl. (It is of note that a suspect tropical system was within 600 nm to the west of Carol on the 22nd and 23rd. This may have contributed toward the near stalling of Carol by this time.) The next reconnaissance aircraft measured a central pressure of 988 mb, estimated surface winds of 60 kt and an eye diameter of 35 nm at 0945Z on the 23rd. A central pressure of 988 mb suggests maximum sustained winds of 62 kt from the north of 25N and 65 kt from the north of 35N Landsea et al. pressure-wind relationships. An eye diameter of 35 nm suggests an RMW of about 25 nm and the climatological value is 30 nm. Based on an RMW slightly below normal but a forward speed near stationary, an intensity of 65 kt is analyzed at 12Z on the 23rd, unchanged. Weakening below hurricane intensity is analyzed at 18Z on the 23rd, originally HURDAT did not show weakening below hurricane intensity until 06Z on October 1st, over 7 days later.

September 24:

1. Maps and old HURDAT:

- HWM analyzes a hurricane of at most 1012 mb at 36.0N, 42.3W with a stationary cold front to the north at 12Z.
- HURDAT lists a 65 kt hurricane at 35.2N, 42.3W at 12Z.
- Microfilm shows a hurricane of at most 1012 mb at 35.0N, 43.7W at 12Z.

2. Ship highlights:

- 35 kt S and 1016 mb at 34.6N, 41.8W at 13Z (WALLET).
- 45 kt NE and 1016 mb at 34.5N, 43.1W at 18Z (micro).

3. Satellite highlights:

- TIROS: Center fix at 34.5N, 41.5W at 1337Z (WALLET).

4. Aircraft highlights:

- Penetration center fix measured a central pressure of 992 mb, estimated flight level winds of 55 kt and an eye diameter of 40 nm at 35.0N, 42.8W at 09Z (WALLET).
- Penetration center fix measured a central pressure of 991 mb, estimated surface winds of 60 kt and an eye diameter of 40 nm at 34.9N, 41.9W at 1905Z (WALLET).

5. Discussion:

- Reanalysis: Another reconnaissance aircraft measured a central pressure of 992 mb and estimated an eye diameter of 20 nm at 2212Z on the 23rd. A central pressure of 992 mb suggests maximum sustained winds of 56 kt from the north of 25N and 60 kt from the north of 35N pressure-wind relationships. The estimated eye diameter appears to be erroneous based on earlier and later estimates. Data from the reconnaissance aircrafts indicates that Carol retained a large RMW on the 23rd and 24th, thus the eye

diameter estimate of 20 nm is analyzed as incorrect. An intensity of 55 kt is analyzed at 00Z on September 24th, down from 65 kt originally analyzed in HURDAT, a minor intensity change. On the 24th, Carol turned eastward and its intensity remained steady as observed by reconnaissance aircraft center penetrations measuring a central pressure of 992 mb at 09Z and 991 mb at 1905Z.

September 25:

1. Maps and old HURDAT:
- HWM analyzes a tropical storm of at most 1016 mb at 34.8N, 41.2W at 12Z.
- HURDAT lists a 65 kt hurricane at 34.0N, 41.1W at 12Z.
- Microfilm shows a tropical storm of at most 1020 mb at 33.3N, 40.9W at 12Z.

2. Ship highlights:
- 35 kt SSW and 1011 mb at 33.0N, 39.8W at 12Z (COADS).
- 55 kt WNW and 1002 mb at 32.9N, 40.8W at 18Z (COADS).

3. Satellite highlight:
- TIROS: Center fix at 33.5N, 39W at 1306Z (WALLET).

4. Aircraft highlights:
- Penetration center fix measured a central pressure of 986 mb, estimated surface winds of 55 kt and an eye diameter of 40 nm at 33.3N, 41.2W at 1156Z (WALLET).
- Penetration center fix measured a central pressure of 986 mb and an eye diameter of 50 nm at 33.6N, 41.0W at 19Z (WALLET).

5. Discussion:
- Reanalysis: On September 25th, the tropical storm moved slowly southeastward beginning a clockwise loop over the North Atlantic. A reconnaissance aircraft investigated Carol at 1156Z on the 25th measuring a central pressure of 986 mb, estimating surface winds of 55 kt and an eye diameter of 40 nm. A central pressure of 986 mb was also measured at 19Z on the 25th. A central pressure of 986 mb suggests maximum sustained winds of 65 kt from the north of 25N and 67 kt from the north of 35N pressure-wind relationships. Based on an RMW close to climatology and a ship report of 65 kt at 00Z on September 26th, an intensity of 65 kt is analyzed at 12Z and 18Z on the 25th and at 00Z on the 26th, same as originally shown in HURDAT. Thus a second period of hurricane intensity is indicated.

September 26:

1. Maps and old HURDAT:
- HWM analyzes a closed low pressure of at most 1012 mb at 33.5N, 40.8W at 12Z.
- HURDAT lists a 65 kt hurricane at 33.0N, 41.0W at 12Z.
- Microfilm shows a tropical storm of at most 1016 mb at 33.0N, 40.7W at 12Z.

2. Ship highlights:
- 65 kt WSW at 32.9N, 41.5W at 00Z (COADS).
- 60 kt SE (might be NW) and 998 mb at 32.5N, 42.4W at 03Z (COADS/micro).
- 45 kt NW at 32.6N, 41.7W at 06Z (COADS).
- 40 kt NW and 1006 mb at 32.0N, 42.5W at 12Z (COADS).

3. Aircraft highlights:
- Penetration center fix measured a central pressure of 998 mb, estimated surface winds of 60 kt and an eye diameter of 55 nm at 32.9N, 40.9W at 1228Z (WALLET). (Note that the fix log has an extrapolated pressure of 998 mb, followed by a note that the observed 700 mb height of 2972 m would support a 986 mb pressure. Based on that height and the observed temperature of 8.5C, today's extrapolation formulas give a pressure of 992 mb. In addition, there was a dropsonde with an apparent splash pressure of 992 mb, although

the drop has a different 700 mb height than the value in the fix log. 992 mb analyzed here for the central pressure.)

4. Discussion:

- Reanalysis: The next reconnaissance aircraft extrapolated a central pressure of 992 mb, estimated surface winds of 60 kt and an eye diameter of 55 nm at 1228Z on the 26th. 992 mb suggests an intensity of 60 kt from the north of 25N pressure-wind relationship and 56 kt from the north of 35N pressure-wind relationship. An intensity of 60 kt is analyzed at 12Z on the 26th, slightly less than originally shown in HURDAT.

September 27:

1. Maps and old HURDAT:

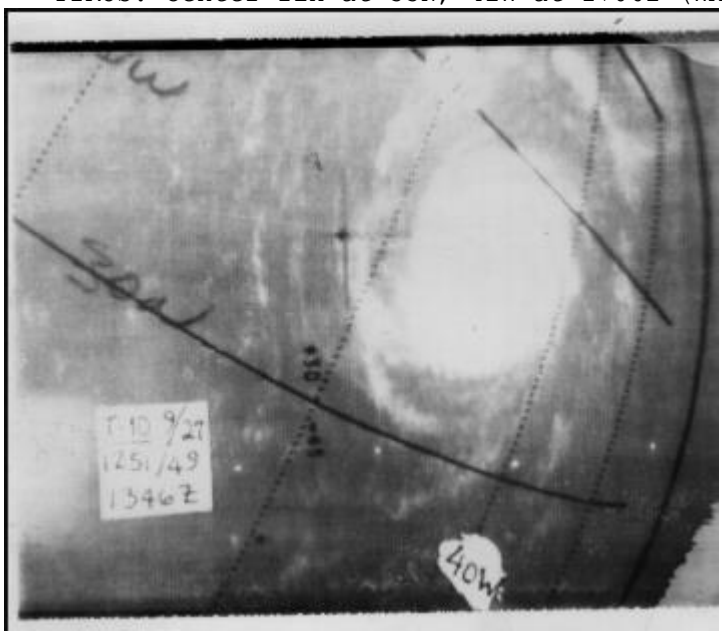
- HWM analyzes a hurricane of at most 1008 mb at 33.7N, 42.0W at 12Z.
- HURDAT lists a 70 kt hurricane at 33.1N, 41.9W at 12Z.
- Microfilm shows a tropical storm of at most 1014 mb at 32.1N, 39.9W at 12Z.

2. Ship highlights:

- 35 kt N and 1012 mb at 33.5N, 43.5W at 00Z (COADS).
- 35 kt NNE and 1019 mb at 34.2N, 43.5W at 09Z (micro).

3. Satellite highlights:

- TIROS: Center fix at 33N, 42W at 1706Z (WALLET).



4. Discussion:

- Reanalysis: On September 27th, Carol turned northward and continued to move slowly. TIROS X captured an image of Carol at 1346Z on the 27th showing a large, symmetric area of convection with some banding to the north and no signs of shear impinging into the system. No eye is apparent in the image.

September 28:

1. Maps and old HURDAT:

- HWM analyzes a hurricane of at most 1010 mb at 35.4N, 42.0W with a cold front to the west at 12Z.
- HURDAT lists a 70 kt hurricane at 34.6N, 41.7W at 12Z.
- Microfilm shows a tropical storm of at most 1012 mb at 34.0N, 41.2W with an extratropical cyclone to the northwest at 12Z.

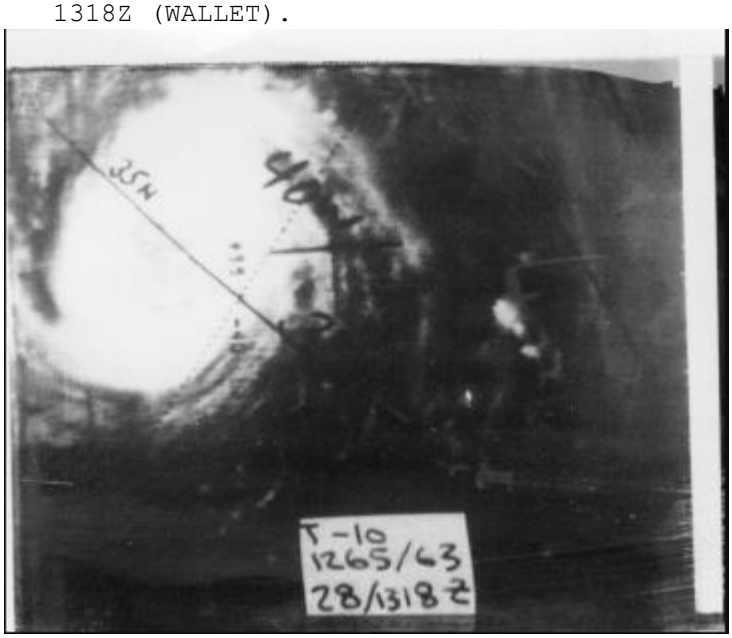
2. Ship highlights:

- 45 kt NNW and 1008 mb at 33.3N, 43.5W at 00Z (WALLET).
- 35 kt SE and 998 mb at 34.3N, 41.6W at 09Z (WALLET).

- 50 kt NW and 1001 mb at 34.2N, 42.6W at 12Z (WALLET).

3. Satellite highlights:

- TIROS: Center fix at 35N, 41W and eye diameter estimated near 100 nm at 1318Z (WALLET).



4. Aircraft highlights:

- Penetration center fix measured a central pressure of 992 mb and an eye diameter of 30 nm at 33.7N, 41.9W at 0145Z (WALLET).
- Penetration center fix measured a central pressure of 988 mb, estimated flight level winds of 65 kt and an eye diameter of 75 nm at 35.4N, 40.8W at 1747Z (WALLET).

5. Discussion:

- MWR: "The hurricane accelerated toward the east-northeast on the 28th and intensified."
- ATSR: "On 28 September CAROL was overtaken by a 500 mb trough and accelerated rapidly to the east-northeast…".
- Reanalysis: Another reconnaissance aircraft investigated Carol at 0145Z on September 28th measuring a central pressure of 992 mb and an eye diameter of 30 nm. A central pressure of 992 mb suggests maximum sustained winds of 56 kt from the north of 25N pressure-wind relationship. An eye diameter of 30 nm suggests an RMW of about 23 nm and the climatological value is 29. Due to a slow forward speed of about 3 kt and RMW slightly smaller than climatology, an intensity of 55 kt is analyzed at 00Z on the 28th, down from 70 kt originally in HURDAT, a minor intensity change. Weakening to a tropical storm is analyzed at 12Z on the 27th. TIROS X captured another image of Carol at 1318Z on the 28th indicating a slow progression northward from the day before and no significant changes to the structure of the storm. The next reconnaissance aircraft reached the tropical cyclone at 1747Z on the 28th measuring a central pressure of 988 mb and estimating an eye diameter of 75 nm. A central pressure of 988 mb suggests maximum sustained winds of 62 kt from the north of 25N and 65 kt from the north of 35N pressure-wind relationships. An eye diameter of 75 nm suggests an RMW of about 55 nm and the climatological value is 30 nm. Based on a forward speed of about 12 kt but an RMW almost twice the climatological value, an intensity of 60 kt selected at 18Z on the 28th, down from 70 kt originally in HURDAT, a minor intensity change. Late on the 28th, Carol completed the clockwise loop over the north Atlantic.

September 29:

1. Maps and old HURDAT:

- HWM analyzes a hurricane of at most 1000 mb at 39.0N, 35.0W with a cold front just to the west at 12Z.
- HURDAT lists an 85 kt hurricane at 38.7N, 35.4W at 12Z.
- Microfilm shows a tropical storm of at most 1004 mb at 37.6N, 35.3W with a frontal boundary just to the west at 12Z.

2. Ship highlights:

- 5 kt NW and 1001 mb at 36.5N, 39.1W at 06Z (micro).
- 80 kt NW and 995 mb at 39.5N, 35.3W at 12Z (micro).
- 50 kt SSW and 989 mb at 40.0N, 32.1W at 15Z (COADS).
- 60 kt N and 992 mb at 40.5N, 33.0W at 18Z (micro).
- 55 kt NNW and 1008 mb at 41.1N, 33.5W at 21Z (COADS).

3. Land highlights:

- 55 kt and gusts to 71 kt at Corvo, Azores (late on the 29th) (MWR/WALLET).

4. Satellite highlights:

- TIROS: Center fix at 39.5N, 34.5W at 1248Z (WALLET).

5. Aircraft highlights:

- Penetration center fix measured a central pressure of 984 mb, estimated surface winds of 90 kt and an eye diameter of 90 nm at 40.4N, 32.9W at 18Z (WALLET).

6. Discussion:

- MWR: "Highest winds were estimated near 100 mph on the 29th, and during the night the center passed to the north of the Azores. The highest wind reported at any land station was 64 mph with gusts to 80 mph at Corvo, the northwesternmost island in the Azores. There was no known loss of life or damage attributed to this hurricane."
- Reanalysis: On September 29th, a sweeping frontal boundary caused the tropical cyclone to accelerate northeastward. Carol also began to reintensify, becoming a hurricane again for the third time. A ship reported 80 kt NW and 995 mb at 12Z on the 29th, thus an intensity of 80 kt is analyzed at this time, down from 5 kt originally in HURDAT, a minor intensity change. This peak in intensity matches the previous peak observed eight days before. The last reconnaissance aircraft to investigate Carol made a center penetration at 18Z on the 29th measuring a central pressure of 984 mb, estimating surface winds of 90 kt and an eye diameter of 90 nm. A central pressure of 984 mb suggests maximum sustained winds of 69 kt from the north of 35N pressure-wind relationship. An eye diameter of 90 nm suggests an RMW of about 68 nm and the climatological value is 36 nm. Based on a forward speed of about 32 kt but an RMW almost twice the climatological value, an intensity of 75 kt selected at 18Z on the 29th, down from 80 kt originally in HURDAT, a minor intensity change. Carol passed to the north of the Azores late on the 29th and early on the 30th. The island of Corvo, one of the westernmost islands in the archipelago, registered sustained winds of 55 kt and gusts of hurricane intensity.

September 30:

1. Maps and old HURDAT:

- HWM analyzes a hurricane of at most 1000 mb at 42.5N, 25.0W with a cold front just to the west at 12Z.
- HURDAT lists a 70 kt hurricane at 42.8N, 24.7W at 12Z.
- Microfilm shows a low pressure system at 40.9N, 23.9W with a frontal boundary extending to the south at 12Z.

2. Ship highlights:

- 50 kt N and 1002 mb at 41.3N, 29.5W at 00Z (COADS).

- 35 kt NW and 1009 mb at 39.5N, 28.2W at 06Z (COADS).
- 50 kt W and 1005 mb at 40.7N, 22.6W at 19Z (COADS).

3. Discussion:

- MWR: "Carol lost force on the 30th."
- Reanalysis: Synoptic data late on the 29th indicated that Carol was becoming extratropical as it became embedded within the frontal boundary and a temperature gradient became more pronounced across the cyclone from west to east. Transition to an extratropical cyclone is analyzed at 12Z on September 30th, 24 hours earlier than originally shown in HURDAT. The intensity of extratropical cyclone is analyzed to have decreased below hurricane-force at 18Z on September 30th, twelve hours earlier than originally shown in HURDAT.

October 1:

1. Maps and old HURDAT:

- HWM analyzes a hurricane of at most 1004 mb at 38.8N, 16.0W with a cold front going through the center at 12Z.
- HURDAT lists a 25 kt extratropical cyclone at 38.8N, 16.0W at 12Z.
- Microfilm shows a tropical storm of at most 1004 mb at 39.2N, 16.0W with a cold front to the south at 12Z.

2. Ship highlights:

- 50 kt WNW and 1007 mb at 40.7N, 20.4W at 00Z (COADS).
- 40 kt NW and 1019 mb at 39.5N, 22.5W at 06Z (micro).
- 35 kt NW and 1005 mb at 37.4N, 18.3W at 12Z (COADS).
- 35 kt SE and 1001 mb at 36.7N, 15.0W at 18Z (COADS).

3. Discussion:

- MWR: "…and became extratropical on October 1. The system continued as a low pressure area for several days in the vicinity of the Madeira Islands."
- ATSR: "…became extratropical on 1 October."
- Reanalysis: It is interesting to note that the temperature gradient had decreased by October 1st at 12Z, when HURDAT originally indicated that it became extratropical. As the system moved southeastward, the temperatures surrounding the system increased and became more symmetric. The current analysis indicates that Carol became an occluded cyclone around 12Z on the 1st and gradually lost intensity in the following days as it lost its baroclinicity. Another possibility is that Carol did not complete its extratropical transition and retained its tropical characteristics.

October 2:

1. Maps and old HURDAT:

- HWM analyzes a closed low pressure of at most 1008 mb at 33.5N, 13.0W at 12Z.
- HURDAT does not list an organized storm on this date.
- Microfilm shows a closed low pressure of at most 1008 mb at 32.5N, 14.0W with a cold front to the south at 12Z.

2. Ship highlights:

- 40 kt WNW and 1006 mb at 34.7N, 15.6W at 00Z (COADS).
- 35 kt NW and 1009 mb at 32.8N, 14.2W at 06Z (COADS).
- 15 kt NW and 1004 mb at 32.6N, 14.1W at 12Z (COADS).
- 35 kt N and 1007 mb at 32.8N, 16.2W at 18Z (COADS).

October 3:

1. Maps and old HURDAT:

- HWM analyzes a closed low pressure of at most 1008 mb at 31.1N, 13.1W at 12Z.
- HURDAT does not list an organized storm on this date.

2. Discussion:

- Reanalysis: Carol gradually weakened on the 2nd and 3rd as it moved southward over the far northeast Atlantic. HURDAT originally indicated that Carol weakened below gale-force at 12Z on October 1st but ship observations show that the system retained gale-force winds until October 3rd at 00Z, 36 hours later than originally shown. The last position is analyzed at 12Z on the 3rd, just north of the Canary Islands, and 42 hours later than originally shown in HURDAT. The remnant low of Carol dissipated late on the 3rd.

October 4:

3. Maps and old HURDAT:

- HWM analyzes a closed low pressure of at most 1004 mb at 41.5N, 11.5W; Carol appears to have dissipated before 12Z.
- HURDAT does not list an organized storm on this date.

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.

Date	Original HURDAT Central Pressure	Evidence	Changes
Sep 21 06Z	974 mb	Penetration center fix: 974 mb at 1130Z on Sep 21st	Removed
Sep 21 12Z	974 mb		Retained
Sep 22 12Z	980 mb	Penetration center fix: 980 mb at 1230Z on Sep 22nd	
Sep 23 00Z	992 mb	No reconnaissance aircraft or ship reported a central pressure around this time, likely added on the wrong date, should be on the 24th at 00Z	Removed
Sep 23 12Z	988 mb	Penetration center fix: 988 mb at 0945Z on Sep 23rd	Retained
Sep 24 00Z		Penetration center fix: 992 mb at 2212Z on Sep 23rd	992 mb
Sep 24 12Z	992 mb	Penetration center fix: 992 mb at 09Z on Sep 24th	Retained
Sep 24 18Z	991 mb	Penetration center fix: 991 mb at 1905Z on Sep 24th	
Sep 25 12Z	986 mb	Penetration center fix: 986 mb at 1156Z on Sep 25th	
Sep 25 18Z	986 mb	Penetration center fix: 986 mb at 19Z on Sep 25th	
Sep 26 00Z	986 mb	No reconnaissance aircraft or ship report of a central pressure but based on the penetration center fixes late on the 25th and on the 26th, it looks reasonable	
Sep 26 12Z	998 mb	Penetration center fix: 986 mb at 1228Z on Sep 26th	986 mb
Sep 28 00Z	992 mb	Penetration center fix: 992 mb at 0145Z on Sep 28th	Retained
Sep 28 18Z	988 mb	Penetration center fix: 988 mb at 1747Z on Sep 28th	

Sep 29 18Z	984 mb	Penetration center fix: 986 mb at 1156Z on Sep 29th	

Tropical Storm Debbie [September 24–30, 1965] – AL051965

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44160 09/24/1965 M= 7  5 SNBR= 949 DEBBIE      XING=0 SSS=0
44165 09/24*  0   0   0    0*  0   0   0    0*175 847  25 1003*181 850  25    0*
44165 09/24*  0   0   0    0*  0   0   0    0*173 850  25    0*178 855  25 1003*
                                             *** ***       * *** ***    ****

44170 09/25*186 854  25    0*191 857  25    0*196 861  25 1005*201 865  25    0*
44170 09/25*183 859  25    0*190 863  25    0*196 867  25 1004*201 871  25    0*
            *** ***          *** ***             ***     ****     ***

44175 09/26*205 869  25    0*210 873  25    0*215 877  25    0*220 883  25 1007*
44175 09/26*205 875  25 1003*210 879  25    0*215 883  25 1005*220 888  25 1005*
                ***     ****     ***             ***     ****     ***    ****

44180 09/27*225 889  25 1006*230 895  30    0*235 901  30 1007*241 903  30 1007*
44180 09/27*225 892  25 1005*230 896  30    0*235 901  30    0*241 903  35    0*
                ***     ****     ***                        *          **    *

44185 09/28*248 904  30    0*257 900  30    0*265 897  40 1001*274 892  45 1004*
44185 09/28*248 902  40    0*255 898  50 1001*262 894  50 1001*271 892  50 1001*
                ***  **      *** ***  ** **** *** ***  **       ***       ** ****

44190 09/29*283 887  45 1004*286 886  35    0*290 885  35    0*295 887  30    0*
44190 09/29*279 893  50 1000*284 895  45 1000*288 898  35 1000*290 901  35 1002*
            *** ***  ** **** *** ***  ** **** *** ***     **** *** ***  ** ****

44195 09/30*300 889  30    0*  0   0   0    0*  0   0   0    0*  0   0   0    0*
44195 09/30*293 903  25    0*  0   0   0    0*  0   0   0    0*  0   0   0    0*
            *** ***  **
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44200 TS

U.S. Tropical Storm Landfall

09/29 20Z 29.1N 90.2W 35 kt LA

Significant Revisions:

1. Several central pressures were added based upon aircraft and station observations;
2. A large intensity change was made at 12Z on the 28th based upon aircraft observations;
3. Large west-southwestward revisions were made to the track on the 29th and 30th based upon aircraft and station observations.

Daily Summary:

September 23:

1. Maps and old HURDAT:

- HWM indicates a sharp tropical wave over the Gulf of Honduras at 12Z.
- HURDAT does not list an organized system on this date.

- Microfilm does not show an organized system at 12Z.

2. Discussion:

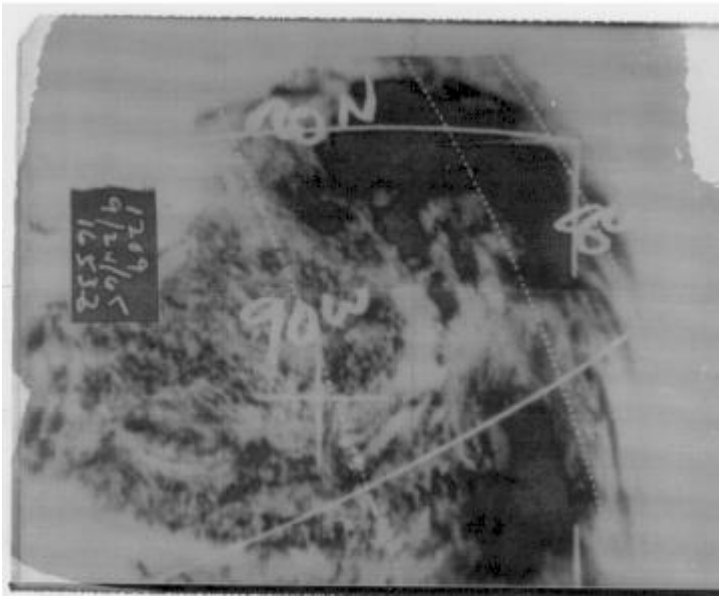
- Reanalysis: Tropical Storm Debbie originated from a tropical wave that showed little development until reaching the western Caribbean Sea around September 23rd.

September 24:

1. Maps and old HURDAT:

- HWM analyzes a closed low pressure of at most 1006 mb at 18.0N, 86.0W at 12Z.
- HURDAT lists a 25 kt tropical depression at 17.5N, 84.7W at 12Z (first position).
- Microfilm shows a closed low pressure at 18.0N, 85.6W at 12Z.

2. Satellite highlights:



3. Ship highlights:

- 5 kt SW and 1005 mb at Isla Guanaja, Honduras at 18Z (micro).

4. Aircraft highlights:

- Penetration center fix reported a central pressure of 1003 mb and estimated surface winds of 15 kt at 17.8, 85.6W around 18Z (WALLET).

5. Discussion:

- MWR: "Early on September 24, a weak tropical depression was observed off the coast of Honduras near Guanaja and Swan Island. Air reconnaissance reported a low of 1003 mb (29.62 in), but no well-defined circulations near the surface or at 700 mb. There were multiple cloud layers but no significant patterns or any significant temperature gradients. Rainfall had been moderately heavy over the western Caribbean for several days with amounts of over 5.43 in. at Swan Island in a 24-hr. period and 5.22 in. in 30-hr. at Amapala, Honduras."
- ATSR: "DEBBIE originated in the extreme western Caribbean Sea as a weak depression early on 24 September."
- Reanalysis: The slow-moving disturbance gradually became better organized over the Gulf of Honduras and a 25 kt tropical depression is analyzed to have developed on September 24th at 12Z, same as originally shown in HURDAT. The time of genesis is uncertain due to the sparse data over the western Caribbean. Nonetheless, there is some evidence that the system was organizing on the 24th not inconsistent with the existing HURDAT. Reports

from Swam Island indicate that the wind shifted from SE to S between 06Z and 12Z on the 24th and the pressure decreased three millibars. At 18Z on the 24th, Guanaja Island reported weak SW winds and 1005 mb. A reconnaissance aircraft investigated the weak tropical depression late on the 24th measuring a central pressure of 1003 mb and estimating maximum surface of not more than 15 kt. The aircraft did not find a well-defined circulation at the surface or at 700 mb. A central pressure of 1003 mb suggests maximum surface winds of 41 kt from the south of 25N Brown et al. pressure-wind relationship. Due to the slow forward speed of about 6 kt and low environment pressures (OCI 1007 mb), an intensity of 25 kt is analyzed at 18Z on the 24th, same as originally shown in HURDAT.

September 25:

1. Maps and old HURDAT:

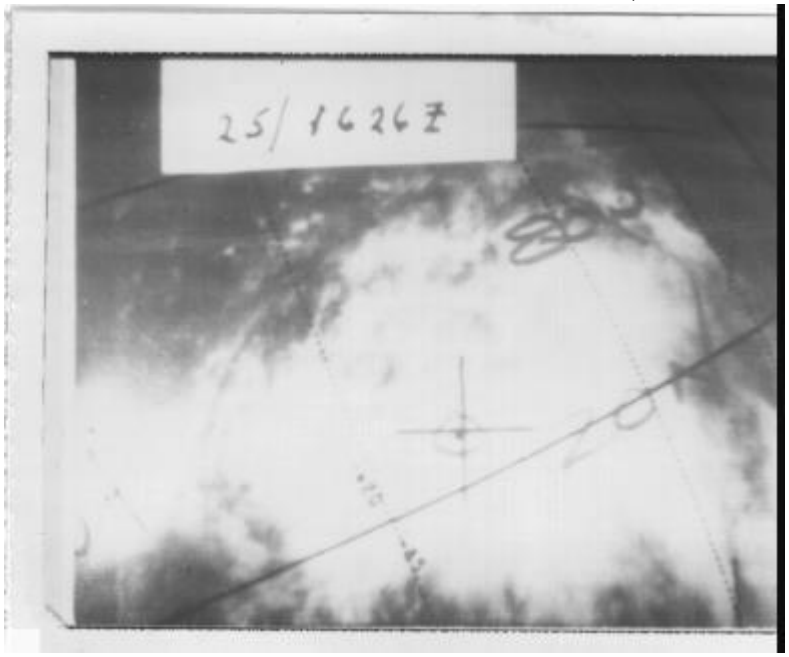
- HWM analyzes a spot low pressure at 20.1N, 86.5W with a cold front to the north over the central Gulf of Mexico at 12Z.
- HURDAT lists a 25 kt tropical depression at 19.6N, 86.1W at 12Z.
- Microfilm shows a tropical depression of at most 1006 mb at 20.2N, 86.4W with a cold front to the north at 12Z.

2. Ship highlights:

- 10 kt S and 1005 mb at 19.4N, 86.7W at 12Z (COADS).

3. Satellite highlights:

- TIROS: Satellite center fix at 20.0N, 83.0W at 1626Z (WALLET).



4. Aircraft highlights:

- Penetration center fix reported a central pressure of 1005 mb and estimated surface winds of 20 kt at 19.5, 86.2W around 1410Z (WALLET).

5. Discussion:

- ATSR: "After crossing the northeastern tip of Yucatan on the 25th, DEBBIE moved into the Gulf of Mexico and although beneath a 200 mb anticyclone there was no intensification and she remained poorly organized."
- Reanalysis: The system moved northwestward on September 25th toward the Yucatan Peninsula while remaining weak and poorly organized. A reconnaissance aircraft investigated the tropical depression at 1410Z on the 25th measuring a central pressure of 1005 mb and estimating surface winds of 20 kt. The intensity is retained at 25 kt on the 25th based on the available

data. The first official advisory was issued at 16Z on September 25th as a tropical depression, but it was identified in the advisory as "Debbie." The reason why the tropical depression was named is unknown.

September 26:

1. Maps and old HURDAT:

- HWM analyzes a spot low pressure at 21.5N, 88.0W with a stationary front to the north over the central Gulf of Mexico at 12Z.
- HURDAT lists a 25 kt tropical depression at 21.5N, 87.7W at 12Z.
- Microfilm shows a tropical depression of at most 1006 mb at 21.5N, 87.1W with a stationary front to the north at 12Z.

2. Ship highlights:

- 15 kt ENE and 1005 mb at 22.0N, 87.0W at 00Z (COADS).
- 15 kt SE and 1007 mb at 21.5N, 86.9W at 12Z (micro).
- 10 kt NNE and 1006 mb at 22.1N, 89.9W at 18Z (micro).

3. Aircraft highlights:

- Penetration center fix reported a central pressure of 1007 mb and estimated surface winds of 30 kt at 22.2, 89.5W at 1940Z (WALLET).

4. Discussion:

- MWR: "The depression crossed the extreme northeastern tip of Yucatan on the night of the 25th and emerged into the extreme southern Gulf of Mexico on the morning of the 26th even weaker than before. The sea level pressure was 1007 mb. (29.74 in) and the shower activity indicated no organization. The slow northwestward movement increased slightly on the 26th and the course became more directly northward during the 27th."
- Reanalysis: Early on September 26th, the tropical depression made landfall over the northeast portion of the Yucatan Peninsula. The system continued northwestward entering the southern Gulf of Mexico late on the 26th. A reconnaissance aircraft investigated the weak tropical depression at 1940Z on the 26th, reporting a central pressure of 1007 mb and estimated surface winds of 30 kt. Synoptic data on this day indicate that the system changed little in organization, thus the intensity is retained at 25 kt.

September 27:

1. Maps and old HURDAT:

- HWM analyzes a spot low pressure at 23.7N, 90.9W with a stationary front to the north over the northern Gulf of Mexico at 12Z.
- HURDAT lists a 30 kt tropical depression at 23.5N, 90.1W at 12Z.
- Microfilm shows a tropical storm of at most 1008 mb at 23.5N, 90.4W with a stationary front to the north at 12Z.

2. Ship highlights:

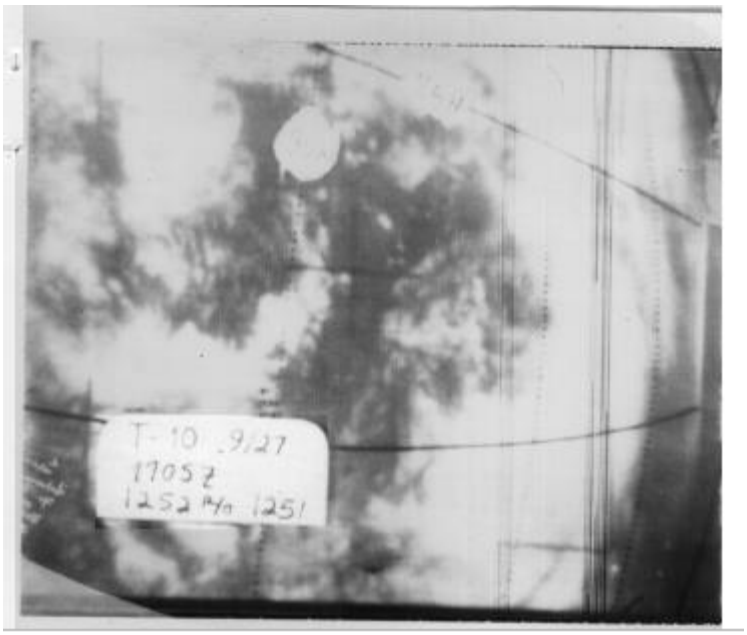
- 10 kt SW and 1006 mb at 25.0N, 90.0W at 12Z (micro).
- 35 kt N and 1010 mb at 24.0N, 95.2W at 18Z (COADS).

3. Land highlights:

- 10 kt NW and 1006 mb at Merida, Mexico at 00Z (micro).

4. Satellite highlights:

- TIROS: Satellite center fix at 22.5N, 88.0W at 1706Z (WALLET).



5. Aircraft highlights:

- Penetration center fix reported a central pressure of 1006 mb at 21.0, 89.0W at 0007Z (WALLET).
- Penetration center fix reported a central pressure of 1007 mb and estimated surface winds of 35 kt at 21.9, 90.2W at 1215Z (WALLET).
- Penetration center fix reported a central pressure of 1007 mb at 23.3, 89.8W at 19Z (WALLET).

6. Discussion:

- Reanalysis: On September 27th, Debbie slowly became better organized as it began to take a more northward course while interacting with a stationary frontal boundary over the northern Gulf of Mexico. The information provided by the reconnaissance aircrafts, ships and land stations indicate that the tropical cyclone had expanded in size, possibly acquiring some subtropical characteristics, although the 500 mb map does not show any substantial trough over the central or eastern United States. The general wind flow over the area is zonal. The large size of the system and poor state of organization made the center positions by the reconnaissance aircraft less reliable, thus more emphasis was put on the synoptic data on the 27th for the track changes. The first gales were reported at 18Z on the 27th, about 200 nm northwest of the center. Intensification to a tropical storm is analyzed at that time, eighteen hours earlier than originally shown in HURDAT, a minor intensity change.

September 28:

1. Maps and old HURDAT:

- HWM analyzes a tropical storm of at most 1004 mb at 26.7N, 89.9W with a stationary front to the north over the northern Gulf of Mexico at 12Z.
- HURDAT lists a 40 kt tropical storm at 26.5N, 89.7W at 12Z.
- Microfilm shows a closed low pressure of at most 1004 mb at 26.0N, 89.0W with a stationary front to the north at 12Z.

2. Ship highlights:

- 35 kt ENE and 1011 mb at 29.3N, 89.0W at 00Z (micro).
- 60 kt ENE and 1014 mb at 29.4N, 88.9W at 03Z (Lightship)(SWO).
- 35 kt N and 1008 mb at 25.0N, 93.9W at 06Z (COADS).
- 50 kt ENE and 1011 mb at 29.4N, 88.9W at 06Z (Lightship)(COADS/SWO).

- 35 kt S and 1007 mb at 26.0N, 87.0W at 12Z (COADS).
- 40 kt S and 1001 mb at 26.2N, 86.0W at 18Z (COADS).
- 20 kt S and 1002 mb at 27.5N, 88.8W at 18Z (micro).
- 45 kt SSE and 1004 mb at 27.7N, 87.3W at 21Z (COADS).

3. Aircraft highlights:

- Penetration center fix reported a central pressure of 1001 mb at 25.5, 89.4W at 0807Z (WALLET).
- Penetration center fix reported a central pressure of 1001 mb and estimated surface winds of 30 kt at 25.8, 88.8W at 12Z (WALLET).
- Penetration center fix reported a central pressure of 1004 mb and estimated surface winds of 45 kt at 27.6, 88.9W at 18Z (WALLET).
- Penetration center fix reported a central pressure of 1003 mb and estimated surface winds of 45 kt at 28.2, 88.5W at 2140Z (WALLET).

4. Discussion:

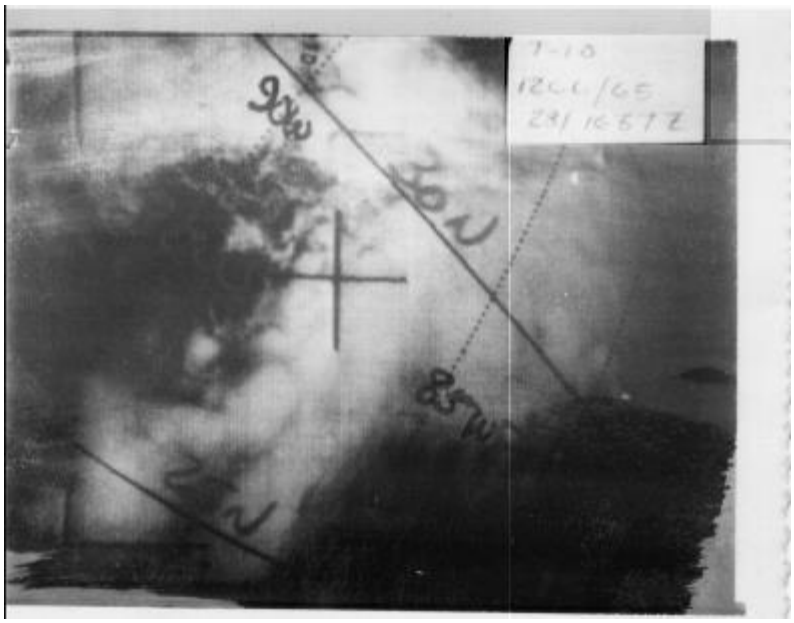
- MWR: "By morning of the 28th, some slight intensification had occurred and the depression just barely reached storm intensity. The sea level pressure was 1001 mb. (29.56 in.), and there were extensive, though poorly organized, radar echoes, mainly in the north and east quadrants. Drier and slightly cooler air was moving into the circulation by this time and no additional intensification occurred. Debbie never attained a characteristic tropical storm wind profile."
- ATSR: "There was some slight intensification on 28 September and although still very poorly organized DEBBIE reached minimal tropical storm intensity at this time. However, much to the relief of the northern Gulf coast, still reeling from BETSY's blows, cooler and drier air was introduced to the circulation during the next day and rapid dissipation occurred."
- Reanalysis: On September 28th, Debbie moved generally northward and became better organized. A reconnaissance aircraft reported a central pressure of 1001 mb at 0807Z on the 28th. A central pressure of 1001 mb suggests maximum surface winds of 45 kt south of 25N and 42 kt north of 25N from the pressure-wind relationship. Based on a blend between the values of the pressure-wind relationship and a lightship report of 50 kt at 06Z on the 28th, an intensity of 50 kt is analyzed at 06Z on the 28th, up from 30 kt originally shown in HURDAT, a major intensity change. 50 kt is also the peak intensity of this tropical cyclone, up from 45 kt originally in HURDAT. No change in intensity is analyzed from 06Z on the 28th to 00Z on the 29th as reconnaissance aircraft reports and ship data indicates that the central pressure remained around 1001 mb. A few ships reported gale-force winds on the 28th, up to 45 kt. The only ship to report storm-force winds was a lightship stationed near the mouth of the Mississippi on the 28th. It reported a peak of 60 kt at 03Z on the 28th when Debbie was still about 250 nm to the south. The height of the anemometer is unknown. Nonetheless, the ship may have had a high bias. Ship observations show that Debbie became more symmetric and synoptically smaller late on the 28th.

September 29:

1. Maps and old HURDAT:

- HWM analyzes a tropical storm of at most 1000 mb at 29.2N, 89.0W with a stationary front to the east at 12Z.
- HURDAT lists a 35 kt tropical storm at 29.0N, 88.5W at 12Z.
- Microfilm shows a tropical storm of at most 1004 mb at 29.0N, 88.3W with a warm front to the east at 12Z.

2. Satellite highlights:



3. Ship highlights:
- 45 kt ENE and 1004 mb at 29.5N, 89.1W at 00Z (Lightship)(SWO).
- 20 kt S and 1003 mb at 27.0N, 88.0W at 00Z (micro).
- 20 kt S and 1002 mb at 27.8N, 90.0W at 06Z (micro).
- 35 kt N and 1004 mb at 27.5N, 91.0W at 06Z (COADS).
- 25 kt SSW and 1003 mb at 27.4N, 88.3W at 12Z (COADS).
- 10 kt NE and 1003 mb at 28.7N, 90.9W at 18Z (micro).
- 35 kt SW and 1005 mb at 28.4N, 89.9W at 18Z (COADS).

4. Land highlights:
- 4 kt SSE and 1003 mb at NAS New Orleans, LA at 1958Z (SWO).

5. Aircraft highlights:
- Penetration center fix reported a central pressure of 1004 mb and estimated surface winds of 25 kt at 28.4, 88.6W at 00Z (WALLET).
- Penetration center fix at 29.3N, 90.6W at 18Z (WALLET).

6. Discussion:
- MWR: "By dawn on the 29th, the system was weakening and decelerating just east of the Mississippi River delta; and, by evening, the circulation had disappeared entirely."
- Reanalysis: On September 29th, Debbie turned to the northwest and slowed in forward speed as it approached the Louisiana coast. Ship and reconnaissance aircraft observations indicate that Debbie gradually weakened on the 29th, although the central pressure did not change much but the forward speed had decreased to about 3 kt late on the day. The last gale-force winds was reported at 18Z on the 29th. Landfall is analyzed over southeast Louisiana at 20Z on the 29th as a 35 kt tropical storm.

September 30:

1. Maps and old HURDAT:
- HWM and Microfilm analyze a frontal boundary over the central United States, Debbie appears to have dissipated, at 12Z.
- HURDAT lists a 30 kt tropical depression at 30.0N, 88.9W at 00Z (last position).

2. Ship highlights:
- 10 kt NNW and 1004 mb at 28.7N, 93.5W at 00Z (COADS).

3. Land highlights:

- 4 kt NW and 1004 mb at Baton Rouge, LA at 0058Z (SWO).

4. Discussion:

- MWR: "Of the several TIROS pictures of Debbie, none showed more than a mass of cloudiness with very little banding, and at no time was the center clearly defined. Reconnaissance by the Air Force, Navy, and Weather Bureau research aircraft was almost continuous during the storm's life history. No gale force winds were reported at land stations, but vessels did experience gales."
- Reanalysis: Weakening to a tropical depression is analyzed at 00Z on September 30th, six hours later than originally shown in HURDAT. Surface observations show that Debbie rapidly lost organization after landfall, dissipating after 00Z on the 30th. Thus the last position is analyzed at 00Z on the 30th, same as originally shown in HURDAT.

Date	Original HURDAT Central Pressure	Evidence	Changes
Sep 24 12Z	1003 mb	Penetration center fix: 1003 mb around 18Z on Sep 24th	Removed
Sep 24 18Z			1003 mb
Sep 25 12Z	1005 mb	Ship: 10 kt S and 1005 mb at 19.4N, 86.7W at 12Z on Sep 25th	1004 mb
Sep 26 00Z		Ship: 15 kt ENE and 1005 mb at 22.0N, 87.0W at 00Z on Sep 26th	1003 mb
Sep 26 12Z		Ship: 15 kt SE and 1007 mb at 21.5N, 86.9W at 12Z on Sep 26th	1005 mb
Sep 26 18Z	1007 mb	Ship: 10 kt NNE and 1006 mb at 22.1N, 89.9W at 18Z on Sep 26th	1005 mb
Sep 27 00Z	1006 mb	Land: 10 kt NW and 1006 mb at Merida, Mexico at 00Z on Sep 27th	1005 mb
Sep 27 12Z	1007 mb	Penetration center fix well southwest of the analyzed center, thus not a central pressure	Removed
Sep 27 18Z	1007 mb	Penetration center fix: 1007 mb at 1940Z on Sep 27th	1007 mb
Sep 28 06Z		Penetration center fix: 1001 mb at 0807Z on Sep 28th	1001 mb
Sep 28 12Z	1001 mb	Penetration center fix: 1001 mb at 12Z on Sep 28th	Retained
Sep 28 18Z	1004 mb	Ship: 20 kt S and 1002 mb at 27.5N, 88.8W at 18Z on Sep 28th	1001 mb

Sep 29 00Z	1004 mb	Ships: 20 kt S and 1003 mb at 27.0N, 88.0W at 00Z on Sep 29th 40 kt N and 1004 mb at 28.5N, 88.5W at 00Z on Sep 29th	1000 mb
Sep 29 06Z		Ship: 20 kt S and 1002 mb at 27.8N, 90.0W at 06Z on Sep 29th	1000 mb
Sep 29 12Z		Ship: 25 kt SSW and 1003 mb at 27.4N, 88.3W at 12Z on Sep 29th	1000 mb
Sep 29 18Z		Ship: 10 kt NE and 1003 mb at 28.7N, 90.9W at 18Z on Sep 29th	1002 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 Surface Analysis and NHC Storm Wallets.

Hurricane Elena [October 13–20, 1965] – AL061965

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44205 10/12/1965 M= 8  6 SNBR= 950 ELENA       XING=0 SSS=0                    L
44210 10/12*  0   0   0    0*  0   0   0    0*156 455  30    0*180 470  30    0*
44210 10/12*  0   0   0    0*  0   0   0    0*165 475  30    0*175 485  30    0*
                                             *** ***          *** ***

44215 10/13*191 486  30    0*198 504  30    0*205 520  30    0*212 531  30    0*
44215 10/13*185 495  30    0*195 505  35    0*205 516  35    0*214 527  35 1005*
            *** ***          *** ***  **          ***  **      *** ***  ** ****

44220 10/14*220 541  40    0*231 551  40    0*240 560  40 1005*245 568  40    0*
44220 10/14*223 537  40    0*231 547  40    0*239 557  40    0*247 566  45 1005*
            *** ***          *** ***               ***       * *** ***  ** ****

44225 10/15*249 574  40    0*254 580  40 1005*259 585  45 1001*263 589  50  995*
44225 10/15*251 574  45    0*255 580  45 1005*259 585  50 1001*263 589  55  995*
            ***      **       ***      **                 **                **

44230 10/16*267 592  55  995*273 597  65  991*280 603  65    0*288 602  65  992*
44230 10/16*268 594  55  995*273 599  60  991*280 603  60  992*289 602  55  992*
            *** ***               ***  **                 **  *** ***       **

44235 10/17*300 594  65  998*315 583  65  992*330 563  70  988*344 534  70  986*
44235 10/17*300 594  55    0*315 583  60  992*332 563  70  988*346 534  75  986*
                     **    *          **      ***              ***       **

44240 10/18*358 500  70    0*373 464  70    0*390 425  70  977*410 379  70    0*
44240 10/18*358 505  85    0*373 470  90    0*390 428  95  977*410 389  95    0*
                ***  **          ***  **          ***  **          ***  **

44245 10/19E435 325  70    0*  0   0   0    0*  0   0   0    0*  0   0   0    0*
44245 10/19*441 350  85    0E470 320  75    0E500 305  70    0E540 300  70    0*
            **** ***  **      **** ***  **      **** ***  **      **** ***  **
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(October 20th is new to HURDAT)

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44247 10/20E570 290   65     0E600 275   60     0E640 260   50     0*  0    0    0    0*
           **** ***   **      **** ***   **      **** ***   **
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44250 HR

Significant Revisions:

1. Corrected initial position on the 12th to provide realistic motion;
2. A few central pressures were added to HURDAT based primarily upon aircraft reconnaissance observations;
3. Intensity boosted on the 18th and 19th based upon aircraft reconnaissance;
4. Large west-northwestward adjustment of the position early on the 19th;
5. A day and a half added at the end of the system's lifecycle as an extratropical cyclone.

Daily Summary:

October 11:

1. Maps and old HURDAT:

- HWM analyzes a spot low pressure at 11.5N, 39.0W at 12Z.
- HURDAT does not list an organized system on this date.
- Microfilm does not show a surface analysis during the entire track of Elena.

2. Satellite highlights:

- TIROS: Center fix at 12N, 40W at 1322Z (WALLET).

FIGURE 7.—Very weak initial circulation of Elena at 0822 EST, October 11, 1965, from TIROS X.

3. Discussion:

- MWR: "A TIROS observation on October 11 at 1322 GMT indicated a very weak circulation near 12°N., 40°W."
- ATSR: "A weak circulation photographed by TIROS on 11 October was most probably the very early stage of ELENA."

- Reanalysis: Hurricane Elena developed from a tropical wave that moved off the western coast of Africa around October 5th. The disturbance moved westward showing little or no signs of development, although the area between the Cape Verde Islands and Lesser Antilles have sparse ship traffic, so the data coverage is poor. The first indication that the tropical wave was organizing was a TIROS image at 1322Z on October 11th showing a well-defined circulation near 12N, 40W, but lacking organized convection.

October 12:

1. Maps and old HURDAT:

- HWM analyzes a tropical wave along 51W, between 12-23N at 12Z.
- HURDAT lists a 30 kt tropical depression at 15.6N, 45.5W at 12Z (first position).

2. Discussion/Reanalysis: The disturbance turned northwestward on October 12th over the central Atlantic. The first position in HURDAT is analyzed at 12Z on the 12th, but synoptic data indicates that the disturbance may have lacked a closed circulation on this day. However, given that this is not certain, the genesis timing of the system is retained. The initial position is significantly adjusted west-northwestward to provide a realistic motion.

October 13:

1. Maps and old HURDAT:

- HWM analyzes a spot low pressure at 20.7N, 52.0W at 12Z.
- HURDAT lists a 30 kt tropical depression at 20.5N, 52.0W at 12Z.

2. Ship highlights:

- 35 kt ENE and 1010 mb at 20.8N, 53.0W at 06Z (COADS).

3. Satellite highlights:

- TIROS: Center fix at 21.5N, 52.5W at 1406Z (WALLET).

4. Discussion:

- MWR: "No additional information was received from this portion of the Atlantic until the evening of the 12th when ship reports suggested a somewhat better organized circulation at 19°N., 48.5°W. A second TIROS observation on the 13th at 1406 GMT confirmed a better organization. The overall speed of the system was 23 mph, and it does seem logical to accept the continuity and credit TIROS with finding what may be the very weakest kind of a circulation which later developed into a hurricane. Reconnaissance into the area on the 13th found no well-marked circulation but did report heights at the 850-mb. level low enough to support a sea level pressure of 1005 mb. (29.68 in.). By this time, the speed had decreased to 10 mph."
- ATSR: "Further TIROS photos on the 13th and 14th depicted a better organization of the circulation."
- Reanalysis: On the 13th, the system continued northwestward and is analyzed to have intensified into a tropical storm at 06Z on this day, 18 hours earlier than originally shown in HURDAT as a ship reported 35 kt ENE and 1010 mb at that time. A reconnaissance aircraft, likely a surveillance mission, investigated the tropical storm on the 13th, extrapolating a central pressure of 1005 mb from 850 mb. The reconnaissance mission likely occurred around 18Z on the 13th, thus the central pressure is added to this time slot. A central pressure of 1005 mb suggests maximum surface winds of 37 kt from the south of 25N Brown et al. pressure-wind relationship. Based on a forward speed of about 13 kt, an intensity of 35 kt is analyzed at 18Z on the 13th (consistent with the earlier gale report) up from 30 kt originally in HURDAT, a minor intensity change.

October 14:

1. Maps and old HURDAT:

- HWM analyzes a tropical storm of at most 1008 mb at 24.5N, 56.0W with a cold front to the northwest at 12Z.

- HURDAT lists a 40 kt tropical storm at 24.5N, 56.8W at 12Z.

2. Ship highlights:

- 35 kt SE and 1016 mb at 23.2N, 50.7W at 15Z (COADS).
- 45 kt N and 1007 mb at 24.9N, 57.1W at 18Z (COADS).

3. Aircraft highlights:

- Penetration center fix measured a central pressure of 1005 mb and estimated surface winds of 40 kt at 24.5N, 56.5W at 1630Z (WALLET).

4. Satellite highlights:

- TIROS: Center fix at 24N, 56W at 1517Z (WALLET).

5. Discussion:

- MWR: "Another TIROS observation located the center at 24°N, 57°W at 1517 GMT on the 14th. This position was in good agreement with aircraft reconnaissance made during that day."
- Reanalysis: On October 14th, Elena continued on a northwestward course and gradually intensified. Another reconnaissance aircraft reached the tropical storm late on the 14th measuring a central pressure of 1005 mb. A ship reported 45 kt N and 1007 mb at 18Z on the 14th, thus the intensity on this day kept at 40 kt at 00Z as originally shown in HURDAT and 45 kt at 18Z, up from 40 kt originally in HURDAT.

October 15:

1. Maps and old HURDAT:

- HWM analyzes a tropical storm of at most 1008 mb at 26.3N, 58.6W with a weakening stationary front to the north at 12Z.
- HURDAT lists a 45 kt tropical storm at 25.9N, 58.5W at 12Z.

2. Ship highlights:

- 45 kt ESE and 1007 mb at 25.6N, 56.3W at 00Z (COADS).
- 45 kt SE and 1011 mb at 26.7N, 55.5W at 06Z (COADS).
- 45 kt ESE and 1016 mb at 27.5N, 54.3W at 12Z (COADS).

3. Aircraft highlights:

- Radar center fix at 25.3N, 56.5W at 0130Z (WALLET).
- Penetration center fix measured a central pressure of 1005 mb and estimated surface winds of 40 kt at 25.4N, 57.7W at 0530Z (WALLET).
- Penetration center fix measured a central pressure of 1001 mb, estimated surface winds of 40 kt and an eye diameter of 20 nm at 26.0N, 58.6W at 1230Z (WALLET).
- Penetration center fix measured a central pressure of 995 mb, estimated surface winds of 55 kt and an eye diameter of 15 nm at 26.5N, 58.9W at 18Z (WALLET).

4. Satellite highlights:

- TIROS: Center fix at 27N, 57.5W at 1448Z (WALLET).

5. Discussion:

- MWR: "A detailed aircraft report on the morning of the 15th indicated a better organized storm with maximum winds of 45 mph and a sea level pressure of 1001 mb. (29.56 in.). The air mass within the storm was rather cool as had been reported earlier. The temperature in the center at 700 mb was 10° C., only 1° higher than elsewhere about the storm. This reported temperature in the center was about 1.5° higher than the mean and about the same amount lower than the mean for a weak hurricane eye. Later the 700-mb temperature rose to 15° C. Elena's winds increased to 65 mph on the 15th."
- ATSR: "…and on 15 October reconnaissance aircraft reported winds of 40 knots and a sea level pressure of 1001 mb. The storm continued to intensify as it moved to the north along the western edge of a 500 mb anticyclone. Maximum intensity was attained after recurvature into the westerlies and just before ELENA was taken by a cold front."

- Reanalysis: Little further change in intensity occurred until late on October 15th when the central pressure began to decrease. A reconnaissance aircraft reported a central pressure of 1001 mb, estimated surface winds of 40 kt and an eye diameter of 20 nm at 1230Z on the 15th. A central pressure of 1001 mb suggests maximum surface winds of 42 kt from the north of 25N pressure-wind relationship. An eye diameter of 20 nm suggests an RMW of 15 nm and the climatological value is 20 nm. Due to the small RMW and high environmental pressures (OCI 1015 mb), an intensity of 50 kt is analyzed at 12Z on the 15th, up from 45 kt in HURDAT, a minor intensity change. The next reconnaissance aircraft measured a central pressure of 995 mb, estimates surface winds of 55 kt and an eye diameter of 15 nm at 18Z on the 15th. A central pressure of 995 mb suggests maximum surface winds of 54 kt from the north of 25N intensifying subset pressure-wind relationship. An eye diameter of 15 nm suggests an RMW of about 10 nm and the climatological value is 20 nm. Due to the small RMW but slow forward speed of about 6 kt, an intensity of 55 kt is analyzed at 18Z on the 15th, up from 50 kt in HURDAT, a minor intensity change.

October 16:

1. Maps and old HURDAT:

- HWM analyzes a hurricane of at most 1000 mb at 28.5N, 60.5W with a warm front to the north at 12Z.
- HURDAT lists a 65 kt hurricane at 28.0N, 60.3W at 12Z.

2. Ship highlights:

- 35 kt SE and 1015 mb at 27.0N, 56.4W at 00Z (COADS).
- 45 kt SSW and 1014 mb at 26.1N, 57.7W at 06Z (COADS/MWL).
- 35 kt SW and 1015 mb at 25.0N, 59.2W at 12Z (COADS).

3. Aircraft highlights:

- Penetration center fix measured a central pressure of 995 mb, estimated flight level winds of 60 kt and an eye diameter of 30 nm at 26.7N, 59.2W at 0010Z (WALLET).
- Penetration center fix measured a central pressure of 991 mb, estimated surface winds of 50 kt and an eye diameter of 20 nm at 27.3N, 59.9W at 06Z (WALLET).
- Penetration center fix measured a central pressure of 992 mb, estimated surface winds of 55 kt and an eye diameter of 50 nm at 28.3N, 60.4W at 1435Z (WALLET). (It is noted that Aircraft Weather Officer reported that Elena was tilted with the 500 mb center located 20 miles northeast of the surface center.)
- Penetration center fix measured a central pressure of 992 mb, estimated surface winds of 55 kt and an eye diameter of 50 nm at 28.3N, 60.2W at 18Z (WALLET).

4. Discussion:

- MWR: "…and by early on the 16th the central pressure was down to 991 mb. (29.26 in.). This pressure would support hurricane force winds. During the 16th the hurricane recurved into the westerlies."
- Reanalysis: On October 16th, the forward speed of Elena continued to decrease as the storm turned to the north. The first reconnaissance aircraft on the 16th investigated the tropical storm at 0010Z, measuring a central pressure of 995 mb and an eye diameter of 30 nm. The intensity at 00Z on the 16th is analyzed at 55 kt, same as originally shown in HURDAT. The next reconnaissance mission measured a central pressure of 991 mb, estimated surface winds of 50 kt and an eye diameter of 20 nm at 06Z on the 16th. A central pressure of 991 mb suggests maximum surface winds of 58 kt from the north of 25N pressure-wind relationship. Thus, an intensity of 60 kt is analyzed at 06Z on the 16th, down from 65 kt originally shown in HURDAT, a

minor intensity change. The next two reconnaissance aircrafts reported a central pressure of 992 mb and an eye diameter of 50 nm at 1435Z and 18Z on the 16th. The eye diameter of 50 nm indicates that Elena was undergoing a structural reformation as the eye of the tropical cyclone had become larger. Based on the increase in the eye diameter and forward speed of about 9 kt, an intensity of 60 kt is analyzed at 12Z and 55 kt is selected at 18Z on the 16th, down from 65 kt originally in HURDAT at both time slots, minor intensity changes.

October 17:

1. Maps and old HURDAT:

- HWM analyzes a hurricane of at most 996 mb at 33.8N, 56.8W with a weakening stationary front to the northwest at 12Z.
- HURDAT lists a 70 kt hurricane at 33.0N, 56.3W at 12Z.

2. Ship highlights:

- 50 kt SSE and 1008 mb at 27.9N, 58.2W at 00Z (COADS).
- 45 kt SE at 31.8N, 56.2W at 06Z (COADS).
- 45 kt S and 1009 mb at 30.3N, 54.6W at 12Z (micro).
- 70 kt SW and 998 mb at 33.0N, 52.6W at 18Z (COADS).

3. Aircraft highlights:

- Penetration center fix measured a central pressure of 998 mb and estimated flight level winds of 50 kt at 30.3N, 59.3W at 02Z (WALLET).
- Penetration center fix measured a central pressure of 992 mb, estimated surface winds of 70 kt and an eye diameter of 20 nm at 31.3N, 58.5W at 06Z (WALLET).
- Penetration center fix measured a central pressure of 988 mb and estimated surface winds of 70 kt at 33.6N, 56.0W at 1340Z (WALLET).
- Penetration center fix measured a central pressure of 986 mb and estimated surface winds of 75 kt at 34.2N, 53.8W at 18Z (WALLET).

4. Discussion:

- MWR: "…and accelerated northeastward during the night and the forenoon of the 17th."
- Reanalysis: On October 17th, Elena turned to the northeast and increased in forward speed as a frontal boundary approached from the west. A reconnaissance aircraft measured a central pressure of 992 mb, estimated surface winds of 70 kt and an eye diameter of 20 nm at 06Z on the 17th. A central pressure of 992 mb suggests maximum surface winds of 56 kt from the north of 25N pressure-wind relationship. An eye diameter of 20 nm suggests an RMW of about 15 nm and the climatological value is 24. Based on a small RMW and forward speed of about 21 kt, an intensity of 60 kt is analyzed at 06Z on the 17th, down from 65 kt originally in HURDAT, a minor intensity change. The next aircraft measured a central pressure of 988 mb and estimated surface winds of 70 kt at 1324Z on the 17th. A central pressure of 988 mb suggests maximum surface winds of 65 kt from the north of 25N intensifying subset pressure-wind relationship. Based on a forward speed of about 28 kt, an intensity of 70 kt is analyzed at 12Z on the 17th, same as originally shown in HURDAT. Intensification to a hurricane is analyzed at 12Z on the 17th, 30 hours later than originally shown in HURDAT. The final reconnaissance aircraft on the 17th measured a central pressure of 986 mb and estimated surface winds of 75 kt at 1324Z. A central pressure of 986 mb suggests maximum surface winds of 65 kt from the north of 25N pressure-wind relationship. Due to a forward speed of about 28 kt, an intensity of 75 kt is analyzed at 18Z on the 17th, up from 70 kt originally in HURDAT. A ship at 18Z on the 17th recorded 70 kt SW and 998 mb.

October 18:

1. Maps and old HURDAT:

- HWM analyzes a hurricane of at most 1004 mb at 39.7N, 43.0W with a cold front just to the west at 12Z.
- HURDAT lists a 70 kt hurricane at 39.0N, 42.5W at 12Z.

2. Ship highlights:

- 45 kt SSW and 1008 mb at 33.2N, 48.6W at 00Z (COADS).
- 50 kt N and 1008 mb at 38.5N, 49.3W at 06Z (COADS).
- 70 kt S and 1008 mb at 37.8N, 40.1W at 12Z (COADS).
- 50 kt W and 999 mb at 38.8N, 38.5W at 18Z (COADS).

3. Aircraft highlights:

- Penetration center fix measured a central pressure of 977 mb, estimated surface winds of 120 kt and an eye diameter of 5 nm at 39.7N, 40.7W at 1425Z (WALLET).

4. Discussion:

- MWR: "The central pressure fell to 977 mb (28.85 in) on the morning of the 18th, and by late evening Elena was overtaken by a cold front. There was no known loss of life or damage attributed to this hurricane."
- Reanalysis: On October 18th, Elena maintained its small size and continued to intensify over the North Atlantic. The last reconnaissance aircraft to investigate Elena reached the hurricane at 1425Z on the 18th, measuring a central pressure of 977 mb, estimating surface winds of 120 kt and an eye diameter of 5 nm. A central pressure of 977 mb suggests maximum surface winds of 76 kt from the north of 35N Landsea et al. pressure-wind relationship. An eye diameter of 5 nm suggests an RMW of only 3-4 nm and the climatological value is 35 nm. Based on a very small RMW, forward speed of about 36 kt and weighting the visual estimate some, an intensity of 95 kt is analyzed at 12Z and 18Z on the 17th, up from 70 kt originally in HURDAT, major intensity changes. It is possible that Elena reached major hurricane intensity over the north Atlantic. A track and intensity analog is Hurricane Ellen, 1973, currently the northernmost hurricane to reach major hurricane intensity. 95 kt is also the peak intensity of this hurricane, up from 70 kt originally in HURDAT, a major intensity change. A couple of ships reported storm-force winds and a ship reported 70 kt S and 1008 mb at 12Z on the 18th.

October 19:

1. Maps and old HURDAT:

- HWM analyzes an extratropical cyclone of at most 972 mb at 52.0N, 30.5W at 12Z.
- HURDAT lists a 70 kt extratropical cyclone at 43.5N, 32.5W at 00Z (last position).

2. Ship highlights:

- 70 kt NW and 985 mb at 42.4N, 35.5W at 00Z (micro).
- 65 kt WNW and 976 mb at 45.4N, 33.5W at 03Z (MWL).
- 60 kt NNW and 970 mb at 48.2N, 32.5W at 06Z (COADS).
- 55 kt NW and 977 mb at 49.7N, 30.3W at 12Z (COADS).
- 70 kt N and 974 mb at 54.0N, 31.1W at 18Z (COADS).

3. Discussion/Reanalysis: Late on the 18th and early on the 19th, Elena passed about 300 nm northwest of the Azores. Synoptic observations late on the 18th and early on the 19th show that Elena was acquiring extratropical characteristics as the system became embedded within the frontal boundary nearby. By 06Z on the 19th, the temperature gradient across the circulation was well pronounced, thus it is analyzed at this time that Elena had become an extratropical cyclone, six hours later than originally shown in HURDAT.

October 20:

1. Maps and old HURDAT:

- HWM analyzes an extratropical cyclone of at most 988 mb at 65.0N, 27.0W at 12Z.

2. Ship highlights:

- 65 kt S and 988 mb at 57.6N, 23.0W at 00Z (COADS).
- 60 kt S and 996 mb at 58.2N, 20.7W at 06Z (COADS).
- 40 kt S and 993 mb at 59.2N, 26.0W at 12Z (COADS).

3. Discussion/Reanalysis: The last position in HURDAT is at 00Z on the 19th as a 70 kt extratropical cyclone, but the data suggests that Elena remained a strong extratropical cyclone for 36 hours more as it moved north-northeastward toward Greenland and Iceland. This is consistent with the analysis of the monthly map of tracks in the MWL. Weakening below hurricane-force intensity is analyzed at 06Z on October 20th. Late on the 20th, Elena merged with another strong extratropical cyclone to the northeast, thus the last position is analyzed at 12Z on the 20th.

Date	Original HURDAT Central Pressure	Evidence	Changes
Oct 13 18Z		MWR indicates that a reconnaissance aircraft, likely a surveillance mission, investigated the system on the 13th (likely around 18Z), reporting a central pressure extrapolated from 850 mb	1005 mb
Oct 14 12Z	1005 mb	Penetration center fix: 1005 mb at 1630Z on Oct 14th	Removed
Oct 14 18Z			1005 mb
Oct 15 06Z	1005 mb	Penetration center fix: 1005 mb at 0530Z on Oct 15th	Retained
Oct 15 12Z	1001 mb	Penetration center fix: 1001 mb at 1230Z on Oct 15th	
Oct 15 18Z	995 mb	Penetration center fix: 995 mb at 18Z on Oct 15th	
Oct 16 00Z	995 mb	Penetration center fix: 995 mb at 0010Z on Oct 16th	
Oct 16 06Z	991 mb	Penetration center fix: 991 mb at 06Z on Oct 16th	
Oct 16 12Z		Penetration center fix: 992 mb at 1435Z on Oct 16th	992 mb
Oct 16 18Z	992 mb	Penetration center fix: 992 mb at 18Z on Oct 16th	Retained
Oct 17 00Z	998 mb	Penetration center fix at 18Z on Oct 16th measured 998 mb but appears to have missed the center based on observations RECON data before and after this observation	Removed

Oct 17 06Z	992 mb	Penetration center fix: 992 mb at 06Z on Oct 17th	Retained
Oct 17 12Z	988 mb	Penetration center fix: 988 mb at 1340Z on Oct 17th	
Oct 17 18Z	986 mb	Penetration center fix: 986 mb at 18Z on Oct 17th	
Oct 18 12Z	977 mb	Penetration center fix: 977 mb at 1425Z on Oct 18th	

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.

Unnamed Tropical Storm [September 4-11, 1965] – AL071965

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44175 09/04/1965 M= 8  7 SNBR= 913 NOT NAMED   XING=0 SSS=0
44180 09/04E360 545  25    0E361 538  25    0E363 532  30    0E365 525  30    0*
44185 09/05E367 516  35    0E370 507  35    0E375 500  35    0E380 507  35    0*
44190 09/06E385 520  35    0E389 540  35    0E391 560  40    0E393 574  45    0*
44195 09/07E395 587  45    0E392 598  45    0*385 604  45    0*375 607  50    0*
44200 09/08*367 608  50  991*363 601  50    0*370 590  50    0*378 578  50    0*
44205 09/09*390 565  45    0*401 552  40    0*412 541  40    0*420 530  40    0*
44210 09/10E423 520  40    0E425 509  40    0E427 495  40    0E430 480  40    0*
44215 09/11E440 460  40    0E455 435  40    0E468 410  40    0*  0   0   0    0*
44220 TS
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Significant Revisions:

1. A new tropical storm has been added to HURDAT.

Daily Summary:

August 31:

1. Maps:

- HWM analyzes a frontal boundary over the central Atlantic at 12Z.
- Microfilm shows a closed low pressure of at most 1016 mb at 37N, 49W at 12Z.

September 1:

1. Maps:

- HWM analyzes an extratropical cyclone of at most 1012 mb at 40N, 47W at 12Z.
- Microfilm shows an extratropical cyclone of at most 1012 mb at 39N, 45W at 12Z.

2. Ship highlights:

- 35 kt N and 1012 mb at 44.3N, 44.5W at 06Z. 35 kt NE and 1012 mb at 41.6N, 49.4W at 12Z.
- 35 kt NE and 1020 mb at 42.3N, 50.5W at 18Z. All observations are from COADS.

3. Discussion:

- Reanalysis: A frontal boundary entered the northwest Atlantic Ocean on August 28th and gradually moved eastward. Ship data suggests that an extratropical cyclone developed on late on August 31st over the north Atlantic and synoptic observations indicate that gales were registered on September 1st.

September 2:

1. Maps:

- HWM analyzes a closed low pressure of at most 1012 mb at 36.5N, 49.8W with a cold front to the southeast at 12Z.
- Microfilm shows a closed low pressure of at most 1012 mb at 37N, 49W with a stationary front to the southeast at 12Z.

2. Ship highlights:

- 40 kt NE and 1019 mb at 41.3N, 53W at 00Z.
- 40 kt NNE and 1017 mb at 41.6N, 51.5W at 06Z.
- 35 kt NE and 1020 mb at 43.4N, 46.6W at 12Z. All observations are from COADS.

September 3:

1. Maps:

- HWM analyzes a spot low at 35.5N, 52W with a cold front to the northwest at 12Z.
- Microfilm shows a closed low pressure of at most 1016 mb at 35N, 51W with a cold front to the northwest at 12Z.

2. Discussion:

- Reanalysis: Over the next two days, the cyclone weakened and appears to have become a trough early on the 3rd and the winds decreased below gale-force intensity.

September 4:

1. Maps:

- HWM analyzes a closed low pressure of at most 1012 mb at 36N, 53W with a cold front to the northwest at 12Z.
- Microfilm shows a closed low pressure of at most 1012 mb at 38N, 51W with a trough to the south and cold front to the northwest at 12Z.

2. Ship highlights:

- 35 kt NE and 1024 mb at 42.8N, 56.8W at 18Z (COADS).

3. Discussion:

- MWL: "Cyclogenesis occurred on the 4th about 800 mi. south of Newfoundland."
- Reanalysis: Synoptic observations depict that another extratropical cyclone developed early on September 4th in association with an approaching frontal boundary. Therefore, genesis is analyzed at 00Z on the 4th as a 25 kt extratropical cyclone. The time of genesis agrees with the Track of Lows map of the MWL.

September 5:

1. Maps:

- HWM analyzes a closed low pressure of at most 1012 mb at 37N, 51W with a stationary front to the northwest at 12Z.
- Microfilm shows a closed low pressure of at most 1008 mb at 38N, 52.5W with a trough to the south and cold front to the southwest at 12Z.

2. Ship highlights:

- 35 kt NW and 1013 mb at 36.2N, 52.5W at 00Z.
- 35 kt S and 1008 mb at 37.9N, 49.3W at 12Z.
- 35 kt NE and 1014 mb at 41.3N, 55.4W at 18Z. All observations are from COADS.

3. Discussion:

- Reanalysis: The weak system moved northeastward and reached gale-force intensity early on September 5th. On this day the cyclone had acquired some tropical characteristics, becoming more isothermal.

September 6:

1. Maps:

- HWM analyzes an occluded low pressure of at most 1008 mb at 39N, 56.5W at 12Z.

- Microfilm shows a closed low pressure of at most 1008 mb at 38N, 56W with a cold front to the south at 12Z.

2. Ship highlights:

- 45 kt NE and 1022 mb at 43.2N, 57.4W at 00Z.
- 40 kt NE and 1014 mb at 43.3N, 54.5W at 06Z.
- 60 kt NE and 1011 mb at 41.3N, 56.6W at 12Z.
- 40 kt NE and 1013 mb at 43.3N, 54.2W at 12Z.
- 45 kt NNE and 1011 mb at 41N, 60.9W at 18Z. All observations are from COADS.

3. Discussion:

- Reanalysis: Nonetheless, by the 6th, cooler air began to move in behind the frontal boundary and the cyclone remained extratropical while turning to the northwest as a ridge of high pressure moved north of the system. A ship reported 60 kt at 06Z on September 6th but data from surrounding ships indicate that it had a high bias, thus it is not considered as a representation of the intensity of the extratropical cyclone.

September 7:

1. Maps:

- HWM analyzes a closed low pressure of at most 1004 mb at 38.5N, 61.3W at 12Z.
- Microfilm shows a closed low pressure of at most 1000 mb at 38N, 60W with a stationary front to the south at 12Z.

2. Ship highlights:

- 45 kt NE and 1007 mb at 41.1N, 59.9W at 00Z.
- 35 kt NE and 1010 mb at 41N, 64.5W at 06Z.
- 40 kt NE and 1008 mb at 40.6N, 63.1W at 12Z.
- 35 kt SW and 1007 mb at 34N, 59.8W at 18Z. All observations are from COADS.

3. Discussion:

- Reanalysis: The next day, the cyclone turned to the southwest becoming more symmetric and isothermal. Around 12Z on the 7th, ship data suggests that the system became a tropical storm, as the observed temperatures around the circulation were uniform.

September 8:

1. Maps:

- HWM analyzes a closed low pressure of at most 996 mb at 37.2N, 60.2W at 12Z.
- Microfilm shows a closed low pressure of at most 1000 mb at 38N, 58.5W at 12Z.

2. Ship highlights:

- 25 kt ESE and 994 mb at 36.9N, 60.6W at 00Z (COADS/micro).
- 35 kt NE and 995 mb at 36.9N, 60.9W at 00Z (COADS).
- 35 kt N and 1006 mb at 37.9N, 64.7W at 06Z (COADS).
- 40 kt SW and 998 mb at 36.7N, 58.1W at 12Z (COADS).
- 35 kt SSW and 1008 mb at 35.7N, 58.9W at 18Z (COADS).

3. Discussion:

- MWL: "The low circumscribed a counter-clockwise loop near 38°N, 59°W deepening to 994 mb by the 8th when it was located about 250 mi. west of where it originated. Gales were frequent in this system, especially in the western quadrants, and at times the wind approaches hurricane strength."
- Reanalysis: At 00Z on September 8th, a ship passing near the center of the tropical storm reported 25 kt SE and 994 mb, suggesting a central pressure of 991 mb, which has been added to HURDAT in this time slot. Another ship near the center (about 15 nm away) registered 35 kt NE and 995 mb, also suggesting a central pressure in the low 990s mb. A central pressure of 991 mb suggests maximum sustained winds of 61 kt from the north of 35N Landsea

et al. pressure-wind relationship. An intensity of 50 kt is analyzed at 00Z on the 8th based on a slow forward speed of about 7 kt and ship data reports of winds no higher than 40 kt. 50 kt is the peak intensity of this tropical cyclone. On this day, the tropical storm turned to the northeast, increasing in forward speed ahead of another frontal boundary. At 12Z on the 8th, a ship (about 50 nm away from the center) reported 40 kt SW and 998 mb.

September 9:

1. Maps:
   - HWM analyzes a closed low pressure of at most 1008 mb at 41N, 54W with a cold front to the northwest at 12Z.
   - Microfilm shows a closed low pressure of at most 1012 mb at 41N, 54W with a trough to the southeast at 12Z.
2. Ship highlights:
   - 40 kt NW and 1001 mb at 41.4N, 55W at 18Z.
   - 35 kt SSW and 1010 mb at 40.7N, 48.1W at 21Z. All observations are from COADS.
3. Discussion:
   - MWL: "After the 8th, the low moved northeastward."
   - Reanalysis: Observations from nearby ships early on September 9th show that the system began to reacquire extratropical characteristics as a trough developed to the south and the circulation became NE-SW elongated.

September 10:

1. Maps:
   - HWM analyzes an extratropical cyclone of at most 1004 mb at 45N, 53W at 12Z.
   - Microfilm shows an extratropical cyclone of at most 1016 mb at 38N, 58.5W at 12Z.
2. Ship highlights:
   - 40 kt S and 1008 mb at 40.6N, 48.8W at 00Z.
   - 40 kt SSW and 1008 mb at 40.8N, 49W at 06Z.
   - 35 kt NW and 1015 mb at 40.8N, 50.2W at 12Z.
   - 35 kt SW and 1011 mb at 43N, 45.3W at 18Z. All observations are from COADS.
3. Discussion:
   - Reanalysis: Transition to an extratropical cyclone is analyzed at 00Z on the 10th. During the day, the extratropical cyclone passed well southeast of Newfoundland.

September 11:

1. Maps:
   - HWM analyzes an extratropical cyclone of at most 1004 mb at 48N, 41W at 12Z.
   - Microfilm shows that the tropical cyclone has moved north of the synoptic map at 12Z.
2. Ship highlights:
   - 40 kt SW and 1010 mb at 43.5N, 46W at 00Z.
   - 35 kt S and 1021 mb at 41.8N, 37.8W at 06Z.
   - 35 kt W and 1016 mb at 44.7N, 40.8W at 15Z.
   - 35 kt W and 1020 mb at 44.5N, 41.2W at 18Z. All observations are from COADS.
3. Discussion:
   - MWL: "On the 11th it was centered about 700 mi. south of Greenland."
   - Reanalysis: On the 11th, the circulation became less organized as the system interacted with a stronger extratropical cyclone to the northwest. Data at 18Z on the 11th suggest that the circulation had opened up and the general wind flow where the system was located was associated with the stronger cyclone to the northwest. Thus, the last position is analyzed at 12Z on the 11th.

September 12:

1. Maps:

- HWM analyzes an extratropical cyclone of at most 1012 mb at 49N, 30W at 12Z.

September 13:

1. Maps:

- HWM analyzes a spot low at 48.5N, 21.5W at 12Z.

2. Discussion:

- MWL: "It veered eastward and dissipated about 500 mi. southwest of the British Isles on the 13th."

September 14:

1. Maps:

- HWM analyzes a frontal boundary over the NE Atlantic, original system appears to have dissipated, at 12Z.

Sources: the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, and Mariners Weather Log. This disturbance was in Jack Beven and David Roth's List of Suspects.

Unnamed Tropical Storm [September 29 – October 3, 1965] – AL081965

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44160 09/29/1965 M= 5  8 SNBR= 913 NOT NAMED   XING=0 SSS=0
44165 09/29E320 755  40    0E322 730  45    0E324 700  50    0E329 670  60    0*
44170 09/30E332 640  60    0E336 615  60    0E342 600  60    0E345 588  60    0*
44175 10/01E346 573  55    0E346 555  55    0E347 540  50    0E347 545  50    0*
44180 10/02E347 558  50    0*348 568  50  993*358 573  50    0*373 565  50    0*
44185 10/03*388 553  50    0*  0   0   0    0*  0   0   0    0*  0   0   0    0*
44190 TS
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Significant Revisions:

1. A new tropical storm has been added to HURDAT.

Daily Summary:

September 28:

1. Maps:

- HWM and microfilm analyze a stationary frontal boundary from the northern Gulf of Mexico to the western Atlantic, continuing as a cold front toward the north Atlantic at 12Z.

2. Ship highlights:

- 45 kt ENE and 1023 mb at 36.1N, 73.8W at 12Z.
- 45 kt NE and 1012 mb at 30.9N, 79.2W at 18Z. All observations are from COADS.

September 29:

1. Maps:

- HWM analyzes an extratropical cyclone of at most 1000 mb at 32.5N, 69.5W at 12Z.
- Microfilm shows an extratropical cyclone of at most 1004 mb at 32N, 68W at 12Z.

2. Ship highlights:

- 40 kt NE and 1014 mb at 31.8N, 78.8W at 00Z (COADS).
- 35 kt NNE and 1004 mb at 31.8N, 74.6W at 06Z (COADS).
- 45 kt SW and 1003 mb at 31.0N, 68.7W at 12Z (micro).
- 60 kt NW and 1003 mb at 30.5N, 69.5W at 18Z (COADS).
- 45 kt N and 1000 mb at 32.5N, 67.6W at 21Z (COADS).

3. Discussion/Reanalysis:

- A frontal boundary entered the western Atlantic on September 25th. The system was slow-moving and the southern portion located off the SE United States became stationary, allowing for the formation of an extratropical cyclone around 00Z on September 29th. The cyclone rapidly moved eastward and quickly intensified, reaching winds up to 60 kt late on that day according to ship reports.

September 30:

1. Maps:

- HWM analyzes an occluded cyclone of at most 988 mb at 35N, 61.5W at 12Z.
- Microfilm shows an occluded cyclone of at most 996 mb at 35.5N, 59.5W at 12Z.

2. Ship highlights:

- 45 kt N and 1002 mb at 32.8N, 66.9W at 00Z (COADS).
- 50 kt W and 993 mb at 32.7N, 62.0W at 06Z (COADS).
- 60 kt SW and 976 mb at 33N, 61W at 07Z (micro).
- 60 kt NE and 995 mb at 36.2N, 59.6W at 12Z (COADS).
- 60 kt NNE and 990 mb at 34.8N, 60.4W at 18Z (COADS).

3. Land highlights:

- 30 kt W and 992 mb at Bermuda at 00Z (micro).
- 35 kt NW and 1001 mb at Bermuda at 06Z (micro).

4. Discussion/Reanalysis:

- Early on September 30th, the system became an occluded cyclone and passed north of Bermuda producing gale-force winds on the island. At 07Z, a ship near the center reported 60 kt and 976 mb. A few other ships also registered 60 kt on this day.

October 1:

1. Maps:

- HWM analyzes an occluded cyclone of at most 996 mb at 34.5N, 54.5W at 12Z.
- Microfilm shows an occluded cyclone of at most 1004 mb at 35N, 53W at 12Z.

2. Ship highlights:

- 50 kt SW and 1002 mb at 31.5N, 55.7W at 00Z (micro).
- 45 kt NE and 1015 mb at 39.2N, 62.0W at 03Z (COADS).
- 50 kt NNE and 1017 mb at 38.9N, 61.9W at 06Z (COADS).
- 45 kt W and 1009 mb 30.3N, 55.6W at 12Z (COADS).
- 40 kt W and 1005 mb at 31.5N, 55.5W at 18Z (COADS).

3. Discussion/Reanalysis:

- On October 1st, the strong baroclinic system slowed its forward speed and began to move westward later in the day. Many ships reported gale-force winds on the 1st, with a couple registered storm-force winds. Nonetheless, data suggests that the system weakened late on the 1st. Synoptic data at that time also showed that the occluded cyclone was becoming more symmetric and the temperature gradient was decreasing across the circulation.

October 2:

1. Maps:

- HWM analyzes a closed low pressure of at most 1000 mb at 37N, 57W with a warm front to the north and an approaching cold front to the west at 12Z.
- Microfilm shows a closed low pressure of at most 1004 mb at 36.5N, 56W with a stationary front to the northeast and a trough to the south at 12Z.

2. Ship highlights:

- 45 kt NE and 1009 mb at 37.3N, 57.7W at 00Z.
- 20 kt E and 995 mb at 34.9N, 56.7W at 06Z.
- 40 kt N and 1002 mb at 36.1N, 57.4W at 06Z.

- 40 kt SE and 997 mb 36.4N, 56.4W at 12Z.
- 25 kt SSE and 998 mb at 37.2N, 56.2W at 15Z. All observations are from COADS.

3. Discussion/Reanalysis: Transition to a tropical storm is analyzed at 06Z on October 2nd. A ship near the center reported 20 kt E and 995 mb, suggesting a central pressure of 993 mb, which has been added to HURDAT at 06Z on the 2nd. A central pressure of 993 mb suggests maximum surface winds of 55 kt from the north of 25N Brown et al. pressure-wind relationship and 59 kt from the north of 35N Landsea et al. pressure-wind relationship. Based on a forward speed of about 10 kt and a few ships reporting gale-force winds, an intensity of 50 kt is analyzed at 06Z on the 2nd. 50 kt is also the peak intensity of this system as a tropical cyclone. It is important to note that although the system at this time had the strongest winds near the center (RMW of about 200 nm), was more symmetric, and was nearly isothermal, it retained some characteristics of its baroclinic origin, including a trough to the south of the center and a slight temperature gradient. The 500 mb HWM on the 2nd shows a trough over the system, thus it is possible that it may have been a subtropical cyclone.

October 3:

1. Maps:

- HWM analyzes an extratropical cyclone of at most 980 mb at 53N, 51W with a frontal boundary extending to the southwest at 12Z, the tropical cyclone appears to have been absorbed.
- Microfilm has ship data plotted but does not have a synoptic analysis at 12Z.

2. Ship highlights:

- 50 kt NE and 1007 mb at 37N, 54.6W at 00Z.
- 35 kt SSW and 1002 mb at 40.5N, 50W at 06Z.
- 45 kt S and 992 mb (likely ~10 mb too low) at 41N, 46.4W at 12Z. All observations are from COADS.

3. Discussion/Reanalysis:

- Late on the 2nd, the tropical storm turned to the northeast ahead of a frontal boundary. Surface observations indicate that it became absorbed by the frontal system after 00Z on October 3rd, thus the last position is analyzed at 00Z on the 3rd.

Unnamed Tropical Storm [October 16-19, 1965] – AL091965

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44160 10/16/1965 M= 4  9 SNBR= 913 NOT NAMED   XING=0 SSS=0
44165 10/16*  0   0   0    0*275 780  25    0*270 775  30    0*270 770  35    0*
44165 10/17*275 765  40    0*280 760  45    0*285 755  50    0*295 755  50    0*
44165 10/18*300 765  50    0*300 780  55    0*296 800  55 1004*292 818  40    0*
44165 10/19*287 825  30    0*280 833  25    0*275 840  20    0*  0   0   0    0*
44165 TS
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U.S. Tropical Storm Landfall:
18th/1500Z: 29.4N 81.1W 55 kt/1004 mb

Significant Revisions:

1. A new tropical storm has been added to HURDAT.

Daily Summary:

October 15:

1. Maps:
- HWM analyzes a trough from 28N79W to 36N73W.
- Microfilm has ship data plotted but does not have a synoptic analysis at 12Z.

2. Discussion/Reanalysis:
- Historical Weather Maps and microfilm depict a trough of low pressure along the southeastern coast of the United States on October 15th.

October 16:

1. Maps:
- HWM analyzes a closed low of at most 1014 mb near 27N77W.
- Microfilm has ship data plotted but does not have a synoptic analysis at 12Z.

2. Ship highlights:
- 35 kt NE and 1015 mb at 32.7N, 77.3W at 18Z (#2829 - COADS).

3. Discussion/Reanalysis:
- Around 12Z, the system developed a closed low and is considered a tropical depression based upon peak winds of 30 kt within the circulation of the system. System upgraded to tropical storm at 18Z based on 35 kt ship report. However, radius of this is about 350 nm from the center, in part due to high pressure well northeast of the system. Additionally, the large radius of gales suggests that the system was likely a subtropical storm, though such a designation is not available without availability of routine satellite imagery.

October 17:

1. Maps:
- HWM analyzes a closed low of at most 1014 mb near 28N72W. A dissipating cold front is analyzed from 35N78W to 35N67W.
- Microfilm has ship data plotted but does not have a synoptic analysis at 12Z.

2. Ship highlights:
- 45 kt NNE and 1015 mb at 32.9N, 77.8W at 00Z (no # - COADS). (Ships wind, pressure, and temperature data are all inconsistent with neighboring observations. Observation considered not reliable.)
- 35 kt NNE and 1013 mb at 31.7N 78.5W at 06Z (no # - COADS).
- 50 kt NE and 1016 mb at 32.6N 77.3W at 12Z (#2973 – COADS).
- 45 kt NE and 1018 mb at 33.8N 76.7W at 18Z (#2973 – COADS).

3. Discussion/Reanalysis:
- The system moved slowly northeastward on the 17th and numerous ships reported winds up to 50 kt. The radius of tropical storm force winds gradually contracted and began 150 nm from the center around 18Z.

October 18:

1. Maps:
- HWM analyzes a closed low of at most 1014 mb near 29N77W.
- Microfilm has ship data plotted but does not have a synoptic analysis at 12Z.

2. Ship highlights:
- 45 kt NE and 1013 mb at 32.5N 76.9W at 00Z (no # - COADS).
- 55 kt N and 1015 mb at 31.2N 79.2W at 06Z (#5341 – COADS).
- 45 kt E and 1018 mb at 32.6N 77.6W at 12Z (#5341 – COADS).
- 45 kt E and 1022 mb at 34.4N 75.5W at 18Z (#7145 – COADS).

3. Station highlights:
- Jacksonville Beach, NNE 30 to 35 kt gusts to 45 kt, no time (Storm Wallet).

4. Aircraft highlights:

- Center fix at 29.5N 80.5W at 1230Z with 55 kt maximum surface winds 50 nm from the center and 1004 mb central pressure and "cir eye well defined 30 miles dia" (Storm Wallet).

5. Radar highlights:

- Center fix at 29.4N 80.3W at 1145Z from Daytona Beach (Storm Wallet).

6. Discussion/Storm Wallet:

- "A low pressure area about 200 miles east of Jacksonville Florida and high pressure over the northeast part of the U.S. are combining to cause rough seas and tides of 1 to 3 feet above normal from the northeast Florida coast to New Jersey…Conditions are becoming somewhat more favorable for intensification of the low pressure area. A Navy reconnaissance plane is scheduled to check the area Monday [8th] morning." – Kraft, Weather Bureau, Miami, 0400Z.
- "Hoist Gale Warnings 7 am EST Monday from Savannah to Cape Kennedy. Gales winds will occur mostly in showers and squalls…At 7 am today the low pressure was centered some 45 miles off the upper east Florida coast and winds up to 40 miles an hour are occurring a short distance offshore in that area. Gusts to nearly 40 miles an hour have been reported at the Jacksonville Naval Air Station. Rains are occurring over most of northeast Florida and northward along the Georgia coast. The low is expected to drift very slowly westward this morning with not much change in intensity." – Hill, Weather Bureau, Miami, 1200Z
- "A low pressure centered developed off the north Florida coast late yesterday and at 930 am EST this Monday forenoono was centered a short distance north of Flagler Beach or about 30 miles north-northwest of Daytona Beach moving westward about 15 mph. A Navy reconnaissance plan this morning reported a minimum pressure of 1004 mb of 29.56 inches with winds briefly 55 to 65 mph in a few squalls northeast of the center. This storm is non-tropical in nature and should lose intensity after the center passes inland in the next hour or two. However a few squalls with winds briefly 45 to 55 mph may be expected along the northeast Florida coast during the next few hours…In combination with a strong high pressure area to the north, strong winds are being reported offshore as far north as Cape Hatteras." – Dunn, Weather Bureau, Miami, 1430Z
- "The low pressure center which was located off the north Florida coast this morning moved inland near Flagler Beach during the mid forenoon and is now located 20 to 25 miles west of Daytona Beach with decreased intensity. It appears to be moving at the moment on a moderate loop southward and will likely move back out over the Atlantic this afternoon." – Dunn, Weather Bureau, Miami, 1700Z
- "The weak low over the extreme north portion of the Florida peninsula is expected to remain nearly stationary during the night." – Sugg, Weather Bureau, Miami, 2200Z

7. Discussion/Reanalysis:

- The system moved toward the west-southwest during the day and developed an inner core of strong winds/low pressure in addition to the on-going gales well northeast of the center. The tropical storm made landfall in northeast Florida around 15Z based upon aircraft, radar, and surface observations. A central pressure of 1004 mb was observed by aircraft just before landfall. This value suggests an intensity of 38 kt from the Brown et al. north of 25N intensifying systems pressure-wind relationship. At the time of landfall, the system was quickly moving onshore – about 20 kt – and was embedded within a very large pressure gradient due to a 1034 mb high just south of New England. Based upon the ship and aircraft estimated surface winds, landfall intensity is analyzed to be 55 kt, consistent with a fast moving

system within a high pressure environment. By 18Z, the gales southeast of the Carolinas can no longer be considered to the directly due to the tropical storm. After landfall, the system quickly weakened to below tropical storm intensity by 00Z on the 19th.

October 19:

1. Maps:

- HWM analyzes weak low near 27N84W.

2. Ship highlights:

- 45 kt E and 1019 mb at 31.9N 76.5W at 00Z (#7154 – COADS).
- 40 kt E and 1018 mb at 31.0N 75.5W at 06Z (#7154 – COADS).

3. Discussion/Reanalysis:

- The system moved over the Gulf of Mexico early on the 19th as a weakening tropiocal depression. While gales continued southeast of Carolinas early on the 19th, these were not considered to be directly due to the tropical cyclone. The system dissipated after 12Z on the 19th.

Sources: the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database. This disturbance was in Jack Beven and David Roth's List of Suspects.

Unnamed Tropical Storm [November 26 – December 2, 1965] – AL101965

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44160 11/26/1965 M= 7 10 SNBR= 913 NOT NAMED   XING=0 SSS=0
44165 11/26*  0   0   0    0*  0   0   0    0*  0   0   0    0E260 580  30    0*
44170 11/27E275 560  30    0E290 545  35    0E302 535  40    0E310 540  45    0*
44175 11/28E305 543  45    0E295 545  45    0E290 540  45    0E288 530  45  997*
44180 11/29E286 520  45    0*283 512  45    0*280 510  45    0*274 512  45    0*
44185 11/30*266 516  45    0*257 514  40    0*248 510  40    0*238 506  35    0*
44190 12/01*229 508  30    0*221 515  30    0*218 530  30    0*222 545  30    0*
44195 12/02*230 558  30    0*240 570  30    0*  0   0   0    0*  0   0   0    0*
44200 TS
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Significant Revisions:

1. A new tropical storm has been added to HURDAT.

Daily Summary:

November 26:

1. Maps:

- HWM and microfilm analyze a stationary frontal boundary over the central Atlantic at 12Z.

2. Discussion/Reanalysis: A frontal boundary exited the east coast of the United States on November 22nd. The system moved eastward over the next couple of days and an extratropical cyclone is analyzed to have developed at 18Z on November 26th while located several hundred of miles northeast of the Leeward Islands.

November 27:

1. Maps:

- HWM analyzes an extratropical cyclone of at most 1004 mb at 31N, 54W at 12Z.
- Microfilm shows an extratropical cyclone of at most 1008 mb at 30.5N, 53.5W at 12Z.

2. Ship highlights:

- 35 kt N and 1015 mb at 31.9N, 56.2W at 06Z.
- 40 kt N and 1009 mb at 32.3N, 56.6W at 12Z.
- 45 kt N and 1012 mb at 32.5N, 58W at 15Z.
- 45 kt N and 1012 mb at 32.2N, 58.8W at 18Z. All observations are from COADS.

3. Discussion/Reanalysis: The system is analyzed to have reached gale-force intensity at 06Z on November 27th based on ship data showing winds of 35-40 kt.

November 28:

1. Maps:
   - HWM analyzes an occluded cyclone of at most 1004 mb at 30.5N, 54.5W at 12Z.
   - Microfilm shows an occluded cyclone of at most 1000 mb at 24.5N, 53.5W at 12Z.
2. Ship highlights:
   - 35 kt S and 1009 mb at 29.2N, 50.1W at 00Z.
   - 45 kt NNW and 1007 mb at 27.9N, 58.2W at 06Z.
   - 35 kt NNW and 1005 mb at 28.5N, 57.3W at 12Z.
   - 40 kt NW and 1003 mb at 27.2N, 56.1W at 18Z. All observations are from COADS.
3. Aircraft highlights:
   - Penetration center fix measured a central pressure of 997 mb at 28.3N, 52.5W around 15Z (micro).
4. Discussion/Reanalysis: Between the 27th and 28th, the extratropical cyclone performed a counter-clockwise loop and began to move to the southeast becoming an occluded cyclone. Late on the 28th, a reconnaissance aircraft investigated the system based on data plotted on the microfilm maps. An aircraft report around 15Z on the 28th suggests that a central pressure of 997 mb was either measured or extrapolated from flight level. Ship observations near the center at 12Z and 18Z on the 28th corroborate 997 mb as a likely central pressure, thus it has been added to the time slot of 18Z on the 28th.

November 29:

1. Maps:
   - HWM analyzes a closed low pressure of at most 1004 mb at 29N, 51W at 12Z.
   - Microfilm shows a closed low pressure of at most 1008 mb at 28N, 51W with a north-south trough extended through the center at 12Z.
2. Ship highlights:
   - 40 kt NW and 1004 mb at 27.1N, 55W at 00Z.
   - 35 kt NW and 1002 mb at 27.5N, 54W at 06Z.
   - 35 kt NW and 1001 mb at 27.7N, 50.9W at 12Z.
   - 45 kt S and 999 mb at 27N, 51W at 18Z. All observations are from COADS.
3. Discussion/Reanalysis: Late on November 28th and early on the 29th, synoptic observations indicate that the occluded cyclone was becoming more symmetric and isothermal, including an erosion of the frontal boundaries. Transition to a tropical storm is analyzed at 06Z on the 29th with an intensity of 45 kt, also the peak intensity of this tropical cyclone. A couple of ships reported gale-force winds on the 29th, including 45 kt S and 999 mb, about 30 nm away, at 18Z.

November 30:

1. Maps:
   - HWM analyzes a closed low pressure of at most 1008 mb at 35.5N, 50.5W with a frontal boundary to the northwest at 12Z.
   - Microfilm shows a closed low pressure of at most 1008 mb at 24.5N, 50.5W with a cold front to the northwest at 12Z.
2. Ship highlights:
   - 35 kt NW and 1006 mb at 26.4N, 52.5W at 00Z.
   - 35 kt NW and 1008 mb at 25.6N, 54W at 06Z.

- 35 kt NW and 1009 mb at 25.8N, 52.7W at 12Z. All observations are from COADS.

3. Discussion/Reanalysis: The tropical cyclone moved southward on the 29th and 30th, gradually weakening. Gale-force winds were reported near the center on the 30th. Another reconnaissance aircraft investigated the system on the 30th around 18Z but the microfilm maps do not show any central pressures or winds of gale-force intensity.

December 1:

1. Maps:

- HWM analyzes a spot low at 21.2N, 53.5W at 12Z.
- Microfilm shows a trough extended from 15N-25W, along longitude 58W at 12Z.

2. Discussion/Reanalysis: On December 1st, the system turned to the west and is analyzed to have weakened to a tropical depression at 00Z.

December 2:

1. Maps:

- HWM analyzes a cold front over the central Atlantic at 12Z, tropical cyclone appears to have been dissipated.
- Microfilm shows a closed low pressure of at most 1016 mb at 26N, 58W at 12Z.

2. Discussion/Reanalysis: The circulation of the cyclone became less organized late on the 1st and dissipation is analyzed to have occurred after 06Z on the 2nd, while located northeast of the Leeward Islands, about 120 nm south of where it formed a week earlier. Tropical Storm Otto in 2004 is an analog to this tropical storm.

December 3:

1. Maps:

- HWM and microfilm analyze a cold front over the central Atlantic at 12Z.

Sources: the NHC microfilm maps, the Historical Weather Maps series, the COADS ship database, and Mariners Weather Log. This disturbance was in Jack Beven and David Roth's List of Suspects.

1965 Additional Notes

1. January 8-13: Historical Weather Maps indicate that on January 9th an extratropical cyclone formed northeast of the Leeward Islands along the tail-end of a stationary frontal boundary. A synoptic-sale strong pressure-gradient generated gale-force winds about 250 nm away from the center on the 9th. The next day, the disturbance became more symmetric and lost its frontal boundaries, but a moderate temperature gradient remained present. A ship reported 35 kt NW at 06Z on the 10th about 150 nm from the center, the only gale likely not related to the strong pressure-gradient. Over the next few days, the system moved generally northward and as the pressure-gradient decreased, no more gales were reported by nearby ships. An approaching frontal boundary caused the disturbance to dissipate by January 13th. Therefore, because the data suggests that this system was likely a weakening occluded cyclone and did not acquire tropical characteristics while producing gale-force winds, it is not added to HURDAT. This disturbance was in Jack Beven's and David Roth's Lists of Suspects.

Day	Latitude	Longitude	Status
January 8	Central Atlantic		Cold front
January 9	23N	57W	Extratropical
January 10	24N	58W	Subtropical Storm?

January 11	24N	60W	Subtropical Depression?
January 12	29N	60W	Subtropical Depression?
January 13			Dissipated

2. June 10-13: Historical Weather Maps show a trough of low pressure over the central Gulf of Mexico on June 10th. The pressure-gradient between the trough and a strong ridge over the western Atlantic caused gale-force winds over the eastern Gulf of Mexico, over 300 nm away from center of the trough. A low pressure developed on June 11th and moved northward, likely becoming a tropical depression as winds caused by pressure-gradient decreased below gale-force. The poorly-organized system made landfall in the northern Gulf of Mexico on June 12th and dissipated the next day. Therefore, because the disturbance did not generate gale-force winds when it had a closed low level circulation, it is not added to HURDAT. This disturbance was in Jack Beven's Lists of Suspects.

Day	Latitude	Longitude	Status
June 10	Central Gulf of Mexico		Trough
June 11	29N	88W	Tropical Depression
June 12	31N	89W	Tropical Depression
June 13			Dissipated

3. August 6-9: Historical Weather Maps and microfilm indicate that a tropical wave was approaching the Lesser Antilles on August 6th. The disturbance became better organized on August 8th and a ship about 30 nm from the center reported 30 kt SW, suggesting a closed low level circulation and that gale-force winds might have been present on the north side of the system. COADS, HWM and microfilm show that the nearby ships only reported winds below gale-force intensity. Soon after, the disturbance entered the eastern Caribbean Sea and by August 9th, it had dissipated. Therefore, because the system did not produce gale-force winds, it is not added to HURDAT, but it may have been a short-lived tropical storm. This disturbance was in Jack Beven's Lists of Suspects.

Day	Latitude	Longitude	Status
August 6	10N-20N	53W	Tropical Wave
August 7	10N-20N	56W	Tropical Wave
August 8	16N	59W	Tropical Depression
August 9			Dissipated

4. September 20-28: Historical Weather Maps show that a frontal boundary was located over the central Atlantic Ocean on September 20th. An extratropical cyclone formed along the tail-end of the cold front on September 21st. The system initially moved northward and turned northwestward on September 23rd becoming an occluded cyclone while embedded in an area of high environmental pressures. On September 24th, the disturbance had lost its frontal boundaries and became more symmetric, possibly becoming a tropical depression as a strong cold frontal was approaching front the west. COADS indicates that the system was producing winds below gale-force intensity and winds stayed below gale-force during its lifetime. On September 25th, the disturbance turned to the northeast becoming extratropical on the 26th and was absorbed the day after. Therefore, because the system did not produce winds of gale-force, it is not added to HURDAT. This disturbance was in Jack Beven's and David Roth's Lists of Suspects.

Day	Latitude	Longitude	Status
September 20	Central Atlantic Ocean		Cold front
September 21	24N	52W	Extratropical
September 22	30N	52W	Extratropical
September 23	33N	61W	Occluded
September 24	35N	65W	Tropical Depression
September 25	42N	62W	Tropical Depression
September 26	44N	46W	Extratropical
September 27			Absorbed

5. December 23-27: Historical Weather Maps shows a stationary frontal boundary to the north of the Greater Antilles on December 23rd. Over the next few days, it weakened into a trough of low pressure that slowly moved westward until dissipating on December 27th. Gale-force winds were present on the 23rd and 24th, over 300 nm north of the disturbance, due to a strong high pressure well north of the disturbance, but as the ridge moved eastward, winds weakened below gale-force intensity. Because the system did not acquire a closed low level circulation and no gales near the center, it is not added to HURDAT. This disturbance was in David Roth's Lists of Suspects.

Day	Latitude	Longitude	Status
December 23	North of the Greater Antilles		Stationary front
December 24	North of the Greater Antilles		Stationary front
December 25	25N	69W	Trough
December 26	27N	71W	Trough
December 27			Absorbed

6. December 29 - January 4: Historical Weather Maps and microfilm depict a stationary frontal boundary located northeast of the Lesser Antilles on December 29th. An extratropical cyclone formed along the tail-end of the frontal boundary on December 30th while the disturbance was moving eastward. Ship observations indicate that gale-force winds developed early on December 31st, but likely due to the strong pressure-gradient associated with the Bermuda high to the northwest. Late on the 31st, synoptic data in the southeastern quadrant of the low also began to show gale-force winds. On January 1st, the gale-force winds extended from near the center to about 300 nm. Nonetheless, the system remained elongated NE-SW and a temperature gradient was present across the circulation. On January 2nd, the disturbance continued with gale-force winds near the center, but remained elongated with weakening warm front to the north and cold front to the south identifiable using the ship data. On January 3rd, the disturbance may briefly have been a tropical or subtropical storm as the warm and cold fronts associated with the system dissipated and gale-force winds were near the center. The system became less organized and was absorbed by a strong frontal boundary late on the 3rd or early the next day. Therefore, because the system did not definitively acquire tropical characteristics, it is not added to HURDAT. This disturbance was in Jack Beven's Lists of Suspects.

Day	Latitude	Longitude	Status
December 29	Central Atlantic Ocean		Stationary front
December 30	27N	51W	Extratropical
December 31	26N	45W	Extratropical
January 1	31N	39W	Extratropical
January 2	31N	37W	Extratropical
January 3	35N	34W	Subtropical Storm
January 4			Absorbed