Atlantic Hurricane Season of 1981

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ABSTRACT

Eleven named tropical cyclones and one subtropical cyclone were tracked during 1981 in the Atlantic-Caribbean region. There were no landfalling hurricanes.

1. Introduction

Storm tracks and statistics for the 1981 hurricane season are given in Fig. 1 and Table 1. There were eleven named tropical cyclones reaching tropical storm strength (maximum sustained surface wind speed ≥ 18 m s^{-1}), and seven of these attained hurricane force (≥ 33 m s^{-1}). Also, there was one subtropical storm. For comparison, averages for the period 1944–80 are 9.9 named tropical cyclones, including 6.0 hurricanes.

Fig. 1 shows that Arlene and Katrina, the first and last storms of the season, formed in the northwest Caribbean Sea. This is consistent with the climatology of hurricanes, with early and late season storms tending to originate over the Gulf of Mexico, western Caribbean Sea or extreme southwest North Atlantic.

Bret, Cindy, Emily and Jose have origins which are subtropical in nature; that is, they developed from weather disturbances embedded in the westerlies, north of the subtropical high pressure ridge.

The remaining five (Dennis, Floyd, Gert, Harvey and Irene) all developed from tropical disturbances which can be traced as far east as the Cape Verde Islands, if not to Africa. These systems propogated westward across the tropical Atlantic, embedded in the tradewinds.

Dennis, during August, moved to near longitude 80°W before turning northward. However, in September, four consecutive Cape Verde hurricanes recurved well to the east of North America. This pattern of storm tracks is reflected in an analysis of 100 kPa height anomalies for September 1981 (Fig. 2), where a negative value of −45 m is centered in the western North Atlantic.

There were no named storms in the Gulf of Mexico this year. A complete absence of Gulf of Mexico storms has occurred only twice before during this century (1927 and 1962).

Finally, an aspect of this season which has been observed on only two previous occasions is the occurrence of five hurricanes in one month. Emily, Floyd, Gert, Harvey and Irene all became hurricanes during September.

2. Storm summaries

a. Tropical Storm Arlene, 6–9 May

Tropical storms and hurricanes occur infrequently during the month of May. Arlene is only the 14th May storm since 1886.

Satellite pictures show that a cloud system moved northeastward from the Pacific Ocean across Central America on 4 May. By 6 May, this system had developed a low-level circulation, centered near the Cayman Islands. A surface circulation is the feature which distinguishes a tropical depression from a tropical disturbance.

Tropical storm status was attained on 7 May, when a reconnaissance flight reported a central sea-level pressure of 99.9 kPa and a surface wind speed of 21 m s^{-1}. Fig. 3 is a satellite view of Arlene at this time, showing low-level cloud banding around Arlene's center and a bright, solid cloud mass indicating deep convection east of the center.

Arlene crossed eastern Cuba and weakened to a depression on 8 May. It continued northeastward across the eastern Bahamas and, even though the surface pressure had risen to 100.4 kPa, an aircraft measured 26 m s^{-1} wind speeds within an area of convection east of the center. However, early on 9 May Arlene lost identity just east of the Bahamas as the storm's circulation merged with a large cloud mass associated with a westerly trough.

b. Tropical Storm Bret, 29 June–1 July

A low pressure system formed on 29 June, 900 km east of the North Carolina coast. This location was northwest of a frontal cloud band, which implies subtropical development.

The low moved westward and quickly strengthened. At 1800 GMT 30 June, a ship reported winds

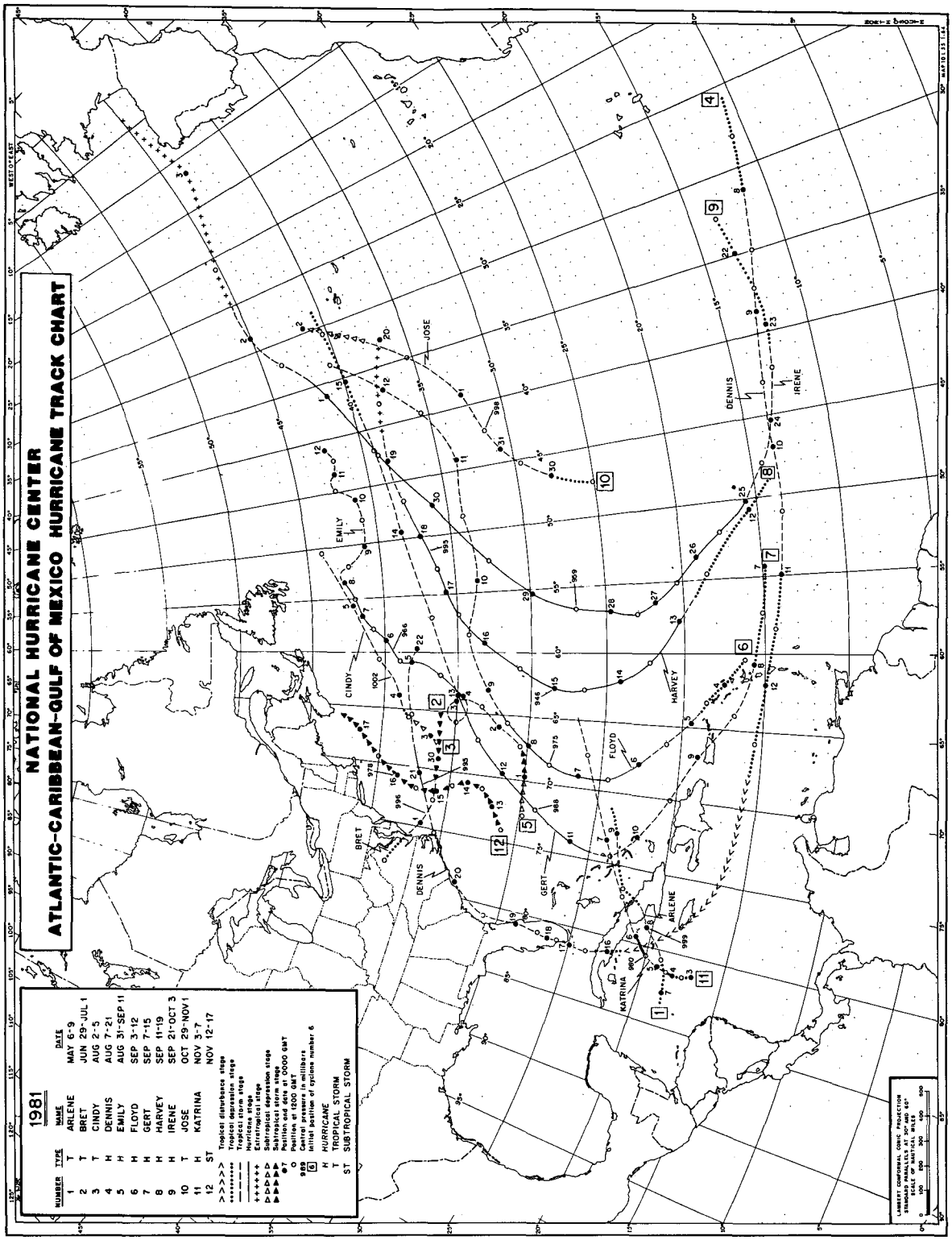

FIG. 1. Tracks of the 1981 tropical storms and hurricanes.

TABLE 1. Summary of North Atlantic tropical and subtropical cyclone statistics, 1981.

Cyclone number	Name	Class[1]	Dates[2]	Maximum[3] sustained wind ($m\ s^{-1}$)	Lowest pressure (kPa)	U.S. damage (Millions of $)	Deaths
1	Arlene	T	6-9 May	26	99.9		
2	Bret	T	29 Jun-1 Jul	31	99.6	Minor	
3	Cindy	T	2-5 Aug	26	100.2		
4	Dennis	H	7-21 Aug	36	99.5	25	
5	Emily	H	31 Aug-11 Sep	41	96.6		
6	Floyd	H	3-12 Sep	51	97.5		
7	Gert	H	7-15 Sep	46	98.8		
8	Harvey	H	11-19 Sep	59	94.6		
9	Irene	H	21 Sep-3 Oct	54	95.9		
10	Jose	T	29 Oct-1 Nov	23	99.8		
11	Katrina	H	3-7 Nov	39	98.0		Cuba 2
12		ST	12-17 Nov	31	97.8	Minor	

[1] T: tropical storm (winds 18-32 $m\ s^{-1}$).
H: hurricane (winds 33 $m\ s^{-1}$ or higher).
ST: subtropical storm (winds 18-32 $m\ s^{-1}$).
[2] The day starts at 0000 GMT.
[3] The original values were computed in knots and rounded off to the nearest 5 kt.

of 26 $m\ s^{-1}$ near the low center. Three hours later, a reconnaissance flight reported 28 $m\ s^{-1}$ winds at a flight level of 0.5 km, along with an extrapolated surface pressure of 99.7 kPa and a surface wind estimate of 33 $m\ s^{-1}$.

Tropical Storm Bret was named at 2200 GMT 30 June and gale warnings were issued for the mid-Atlantic coast from Cape Hatteras, North Carolina to Ocean City, Maryland. Fig. 4 shows Bret, midday on 30 June. Low-level cloud structure indicates a circulation center some 300 km east of the coast. Convection and high clouds are over and to the west of the apparent center.

Bret crossed the coast at approximately 0600 GMT 1 July, in the vicinity of extreme southern Maryland and southern Chesapeake Bay. The storm weakened prior to landfall. Damage was limited to local street flooding and a brief tornado touchdown in the Virginia Beach area. The storm remnant continued well inland and rainfall amounts up to 150 mm spread westward to the Ohio Valley.

Days later, two ship reports were received from vessels which encountered the storm. The first, a 14 m sloop, *Invictus*, reported an anemometer reading of 31 $m\ s^{-1}$ sustained winds, at 0300 GMT 30 June. A smaller, 11 m vessel, near the storm center at 1400 GMT reported 31 $m\ s^{-1}$ winds and 99.6 kPa surface pressure. Considering the above data, Bret has been assigned a maximum intensity estimate of 31 $m\ s^{-1}$ for the period 0600-1800 GMT 30 June.

c. *Tropical Storm Cindy, 2-5 August*

Cindy formed off the mid-Atlantic U.S. coast at the beginning of August, one month after Bret's occurrence in the same general location. Although Bret

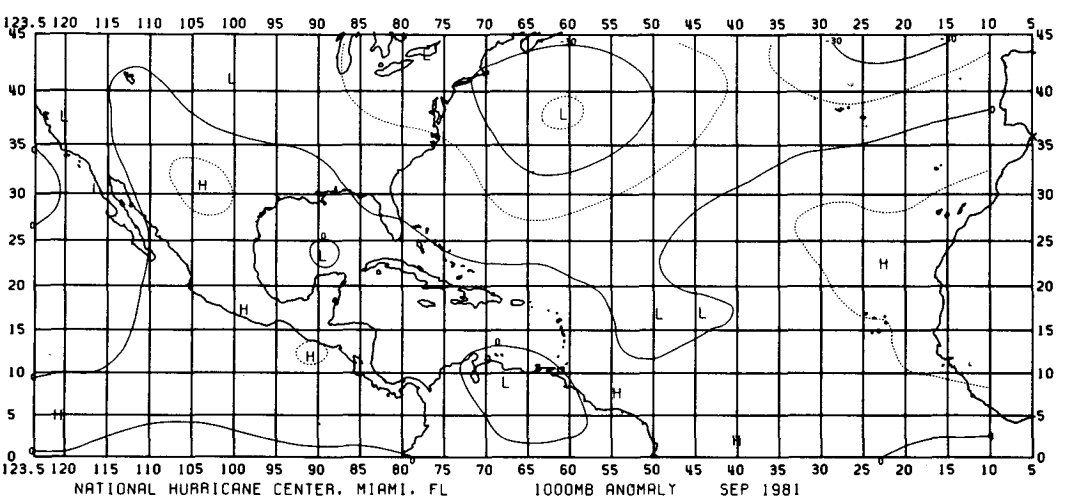

FIG. 2. Height anomalies at the 100 kPa level, September 1981.

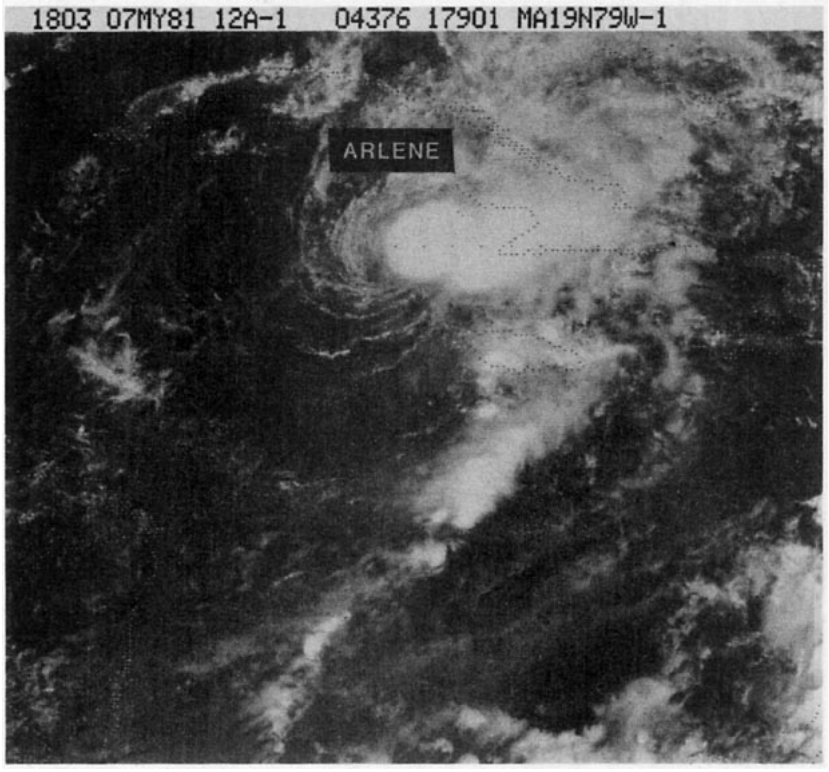

FIG. 3. Visible satellite picture of Tropical Storm Arlene approaching Cuba at 1803 GMT 7 May 1981.

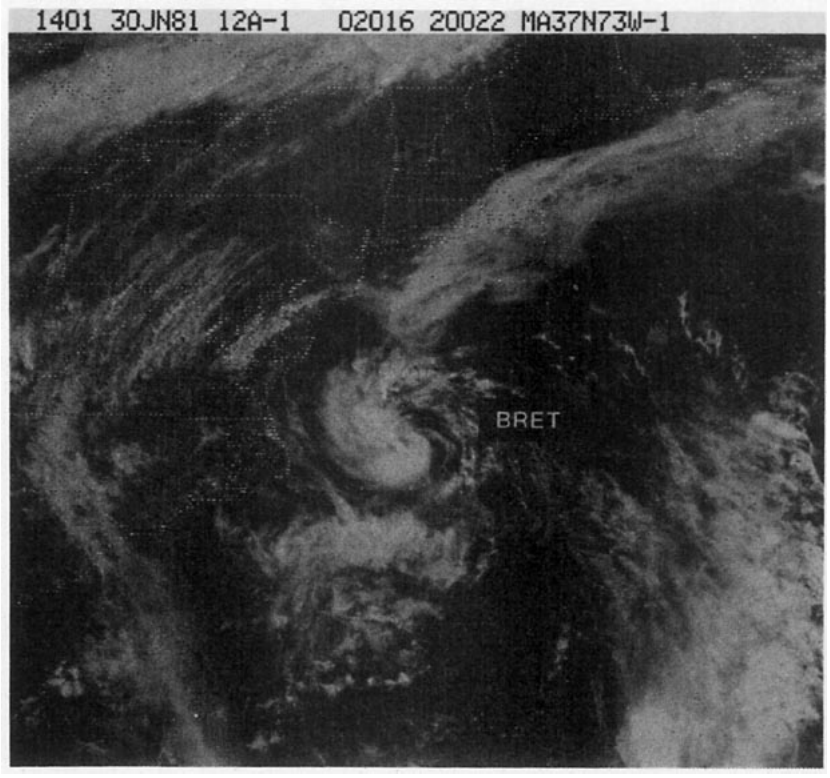

FIG. 4. Visible satellite picture of Tropical Storm Bret at 1401 GMT 30 June 1981.

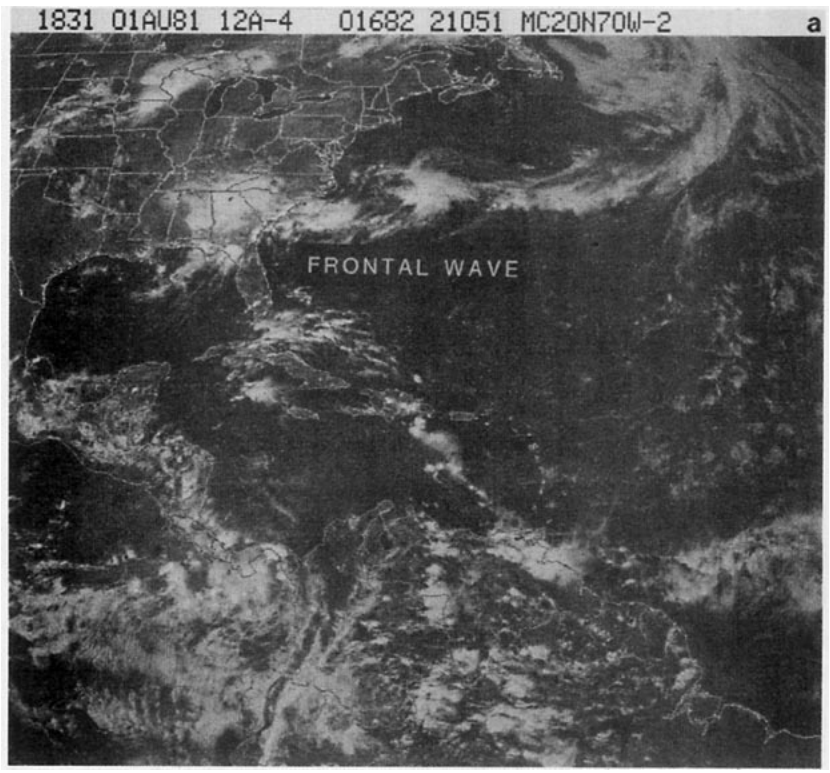

FIG. 5a. Visible satellite picture at 1831 GMT 1 August 1981 (see text).

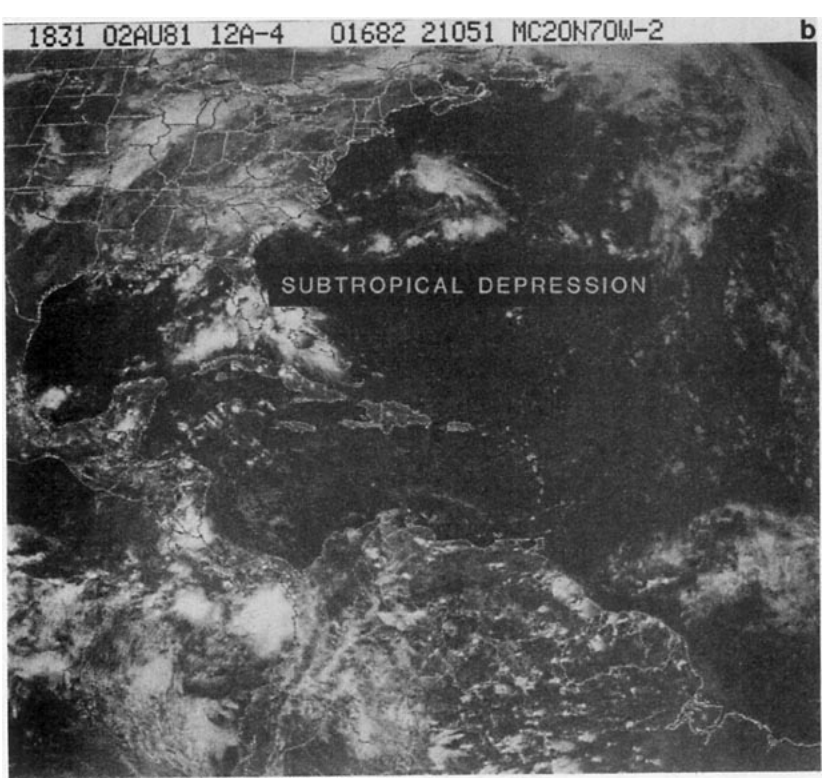

FIG. 5b. Visible satellite picture at 1831 GMT 2 August 1981.

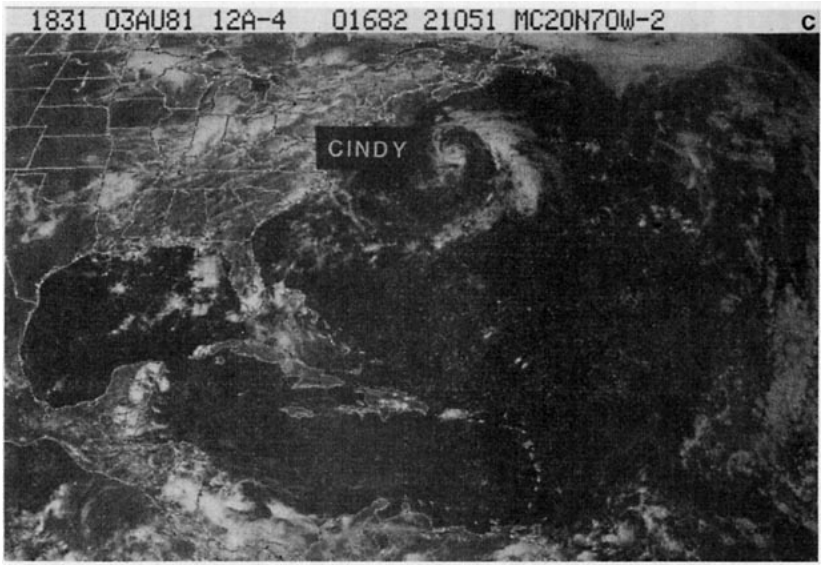

FIG. 5c. Visible satellite picture at 1831 GMT 3 August 1981.

moved toward the west, Cindy originated as a frontal wave and headed northeastward out to sea.

Fig. 5 is a series of four visible satellite pictures that show the evolution of Cindy over a 3-day period. On 1 August, an east/west zone of frontal cloudiness extended from the southern Appalachian Mountains to the north of Bermuda and beyond. A bulge toward the north is seen near longitude 70°W and this is characteristic of frontal wave development (Fig. 5a).

On 2 August, low-level cloud lines suggest the presence of a surface center, located to the north of the weakening frontal zone (Fig. 5b). This center developed from the "bulge" feature of Fig. 5a, and is identified as a subtropical depression at 1800 GMT

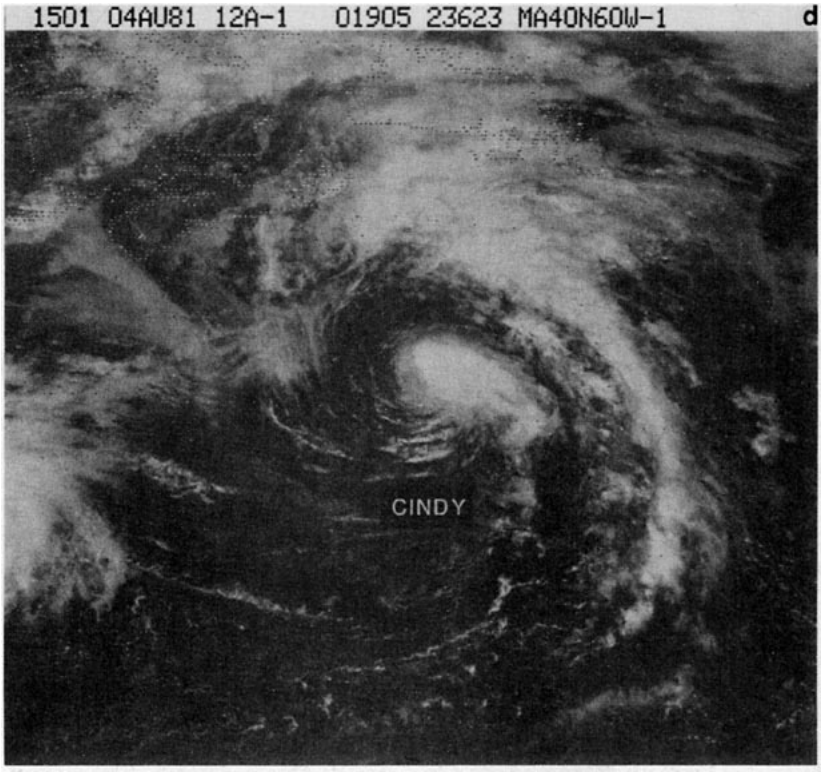

FIG. 5d. Visible satellite picture at 1501 GMT 4 August 1981.

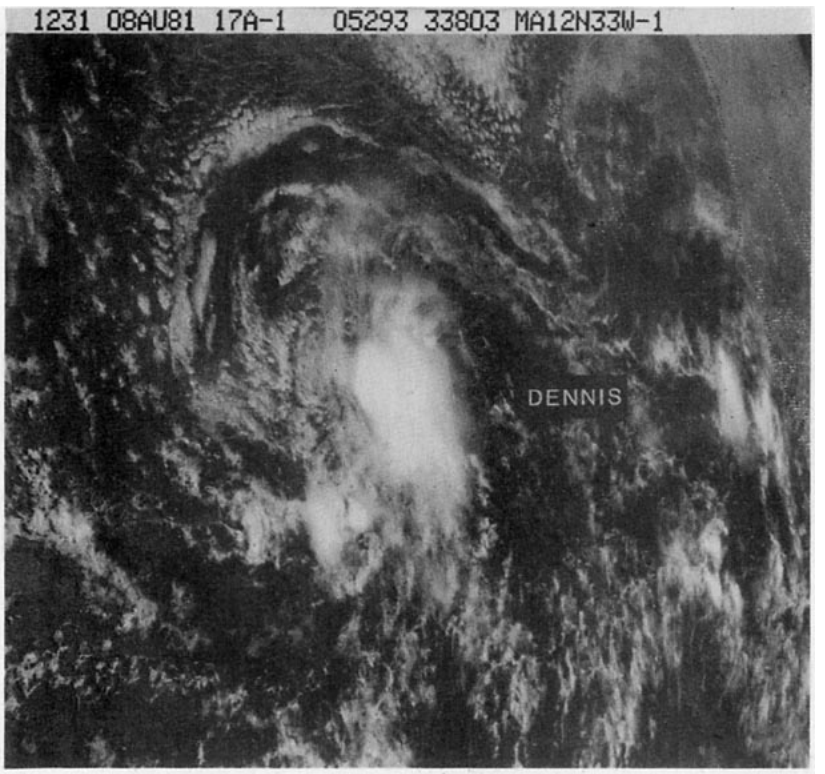

FIG. 6. Visible satellite picture of Tropical Storm Dennis at 1231 GMT 8 August 1981. The maximum surface wind speed estimate at this time is 23 m s^{-1}. The center is not well-defined in this picture, but cloud banding and cirrus overcast are prominent features.

2 August. Cyclonic banding became evident by 3 August in Fig. 5c, and Fig. 5d depicts the storm on 4 August, as it appeared within a few hours of the time of a reconnaissance flight reporting 100.2 kPa surface pressure and 26 m s^{-1} wind speed at a flight altitude of 0.5 km.

Cindy maintained a northeastward motion from the time it became a tropical storm at 1800 GMT 3 August until it evolved into an extratropical low on 5 August while passing southeast of Cape Race, Newfoundland.

d. Hurricane Dennis, 7–21 August

Dennis was the first of the 1981 storms to originate from an African disturbance. Its track extends westward across the tropical Atlantic and Caribbean, and then curves northward over Cuba and the southeastern United States. Dennis briefly reached hurricane intensity while heading away from land into the North Atlantic. Impact to land areas was confined primarily to heavy tropical rains.

Satellite pictures showed the disturbance that moved off the African coast on 5 August to be well-organized. On 8 August, Dennis was named on the basis of satellite intensity estimates of 23 m s^{-1} while the storm was centered 800 km southwest of the Cape Verde Islands. Fig. 6 is a satellite picture of Dennis as it appeared 12 h after reaching storm intensity.

Dennis moved westward at 9 m s^{-1} for a few days and then weakened. It moved through the central Lesser Antilles on 11 August as a tropical depression with a poorly defined circulation center and surface winds less than 18 m s^{-1}. It weakened further to a tropical wave on 12 August and continued across the Caribbean.

The wave nearly stalled south of Cuba on 14 and 15 August and then reintensified while turning northward. Dennis regained tropical storm status on 16 August, moving slowly northward across central Cuba and into the Florida Straits.

A hurricane watch was issued for south Florida and gale warnings were eventually extended northward along the southeast United States coast to Chesapeake Bay.

Fig. 7 is a satellite picture of the poorly-defined cloud vortex, centered over east-central Florida on 18 August. Some of the most intense convective clouds are located over extreme south Florida, where a 24 h rainfall total of 390 mm was measured in Dade County on 18 August. The storm total was 516 mm at this same location. Rainfall amounts of up to 250 mm were spread northward into the Carolinas. The highest sustained surface wind reported by any

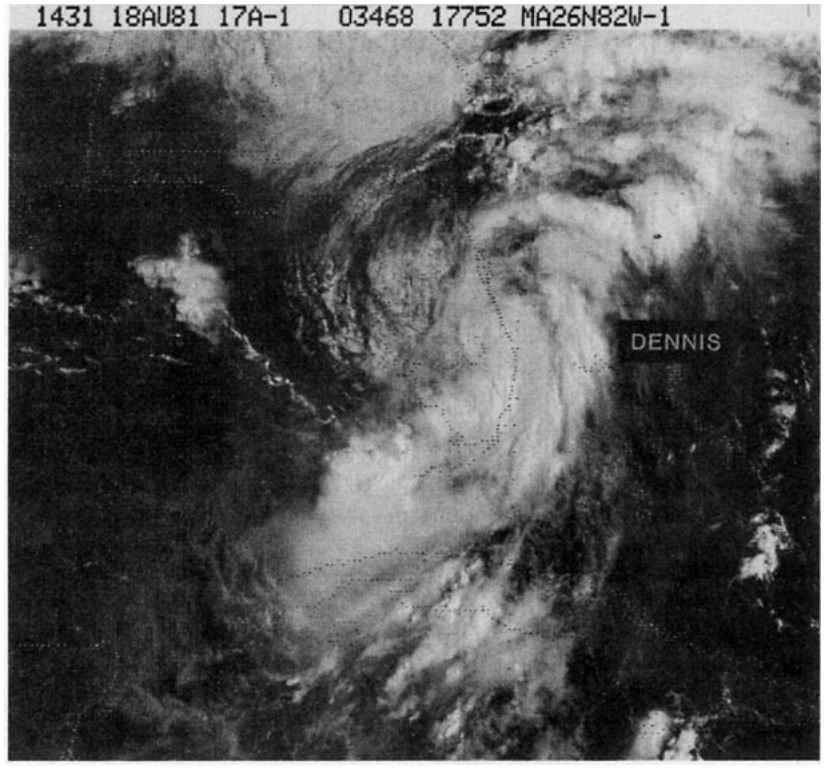

FIG. 7. Visible satellite picture of Tropical Storm Dennis at 1431 GMT 18 August 1981. The poorly-defined cloud vortex center is estimated to be near Lake Okeechobee in east-central Florida.

land station was 20 m s^{-1} at Cedar Island, North Carolina.

On 20 August 1981, Dennis was heading east-northeastward, away from the middle Atlantic states. At 1745 GMT, a reconnaissance mission reported an estimated surface wind speed of 33 m s^{-1} and a measured wind speed of 35 m s^{-1} at an altitude of 0.5 km, along with 99.5 kPa central pressure. On this basis, Dennis was upgraded to a hurricane for a 12 h period.

Fig. 8 is a satellite picture of Dennis taken within 3 h of the time of the aircraft observation noted above. This minimal hurricane does not have a well-defined center, although the general location can be estimated by inspection of the cloud structure. The system appears embedded in a larger cloud system, oriented in a general east–west direction.

The storm moved over colder water and completely lost tropical characteristics by 22 August. It is estimated that $25 million in rainfall damage, primarily to agricultural interests, was caused in the United States by Dennis.

e. Hurricane Emily, 31 August–11 September

Emily formed from a frontal wave in a manner similar to Cindy. On 31 August, a closed low-level circulation was centered 700 km east of Jacksonville, Florida, heading northeastward.

The system intensified, and the strongest surface winds were located several hundred kilometers north of the center. This is a feature common to subtropical and extratropical storms. The center passed within 75 km of Bermuda early on 2 September. Kindley Naval Air Station reported a surface pressure of 99.3 kPa. However, surface wind speeds did not reach gale force at this location.

Continuous satellite surveillance revealed that Emily's center executed a small, counterclockwise loop on 3 September, while located 300 km north of Bermuda. This was a result of the storm's forward progress being temporarily blocked by a high pressure system passing to the north.

During this looping period, Emily was heading westward toward the mid-Atlantic United States coast. Aircraft were sent to monitor the storm's motion and intensity. On 4 September, a northeastward movement was resumed, and a slow, erratic track in this general direction continued for eight more days.

Maximum surface winds reached an estimated 41 m s^{-1} at 0000 GMT 6 September and the surface pressure was 96.6 kPa. Aircraft reported that the radius of maximum winds had shrunk to 18 km by 5 September. At this time satellite pictures show a well-defined cloud vortex center and the entire cloud

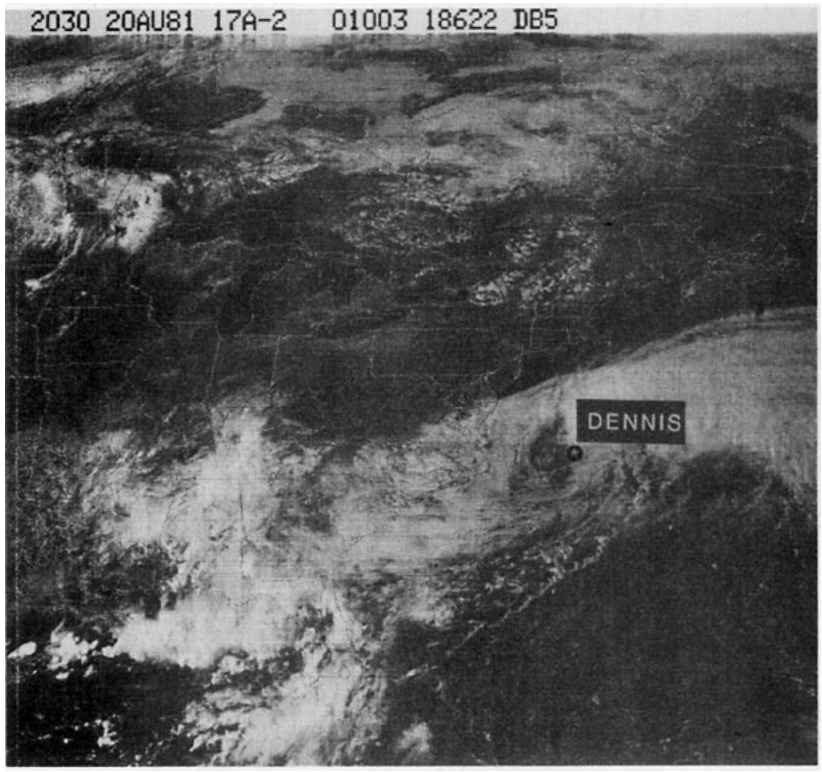

FIG. 8. Visible satellite picture of Dennis at 2030 GMT 20 August 1981. Dennis is a minimal hurricane at this time with maximum surface winds estimated at 36 m s^{-1}.

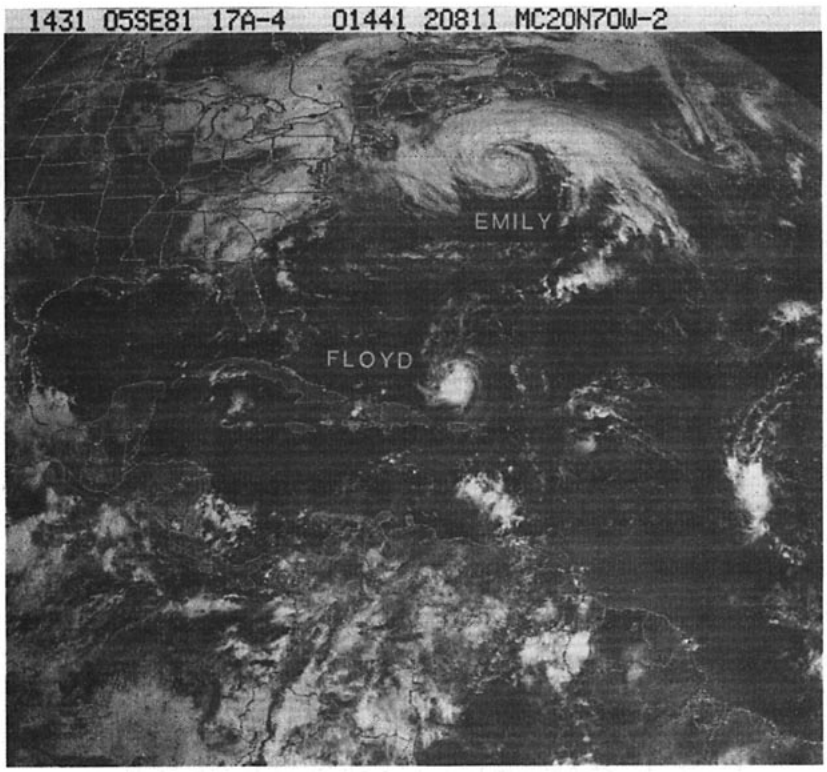

FIG. 9. Visible satellite picture of Hurricane Emily at 1431 GMT 5 September 1981. The estimated maximum surface wind speed is 39 m s^{-1} and the central sea-level pressure is 96.7 kPa at this time. Floyd, a developing tropical storm, is also seen, just north of Puerto Rico.

system associated with Emily appears isolated from other weather systems (see Fig. 9).

The hurricane weakened as it continued northeastward. Fig. 10 shows Emily centered 500 km south of Newfoundland on 8 September. Hurricane Floyd and Tropical Storm Gert are also visible in Fig. 10. By 12 September, Emily had degenerated into a broad, weak area of low pressure located in the central North Atlantic.

f. Hurricane Floyd, 3–12 September

Floyd, recognized on satellite pictures as a disturbed area east of Barbados, became a named storm on 4 September, centered 240 km northeast of San Juan, Puerto Rico. This occurred after the pre-existing depression moved across the Leeward Islands, where 145 mm of rain was measured at Antigua. The storm intensified and turned northward, toward a weakness in the subtropical ridge that remained in the wake of Emily's passage several days earlier.

While under aircraft surveillance, Floyd reached hurricane intensity on 5 September and attained its peak strength on 7 September with a wind speed of 51 m s^{-1} and 97.5 kPa surface pressure.

The hurricane briefly threatened Bermuda, but then began to weaken. The central pressure rose 2.0 kPa during the 12 h period ending at 0600 GMT 8 September and satellite pictures showed the storm's convective cloud structure advected away from the low-level circulation center. The center passed within 75 km southeast of Bermuda and maximum sustained winds at Kindley Naval Air Station remained below gale force. In Fig. 10, Floyd is seen near Bermuda. It continued east-northeastward for several days, dissipating near the Azores on 12 September.

g. Hurricane Gert, 7–15 September

On 1 September, the wave that later became Gert was observed by satellite as it moved off the African coast. The wave crossed the Atlantic and developed into a depression at 0000 GMT 7 September while approaching the Leeward Islands. Data from an aircraft monitoring the depression suggest that tropical storm intensity was reached at 0000 GMT 8 September. Gert's poorly-defined center moved across the Leewards between Dominica and Guadeloupe early on the same day. Gale force winds were not reported by any of the island observing sites.

Gert turned toward the northwest, and the storm center, better defined at this time, moved across Puerto Rico late on 8 September. The tracking of this slowly-developing storm was not sufficiently

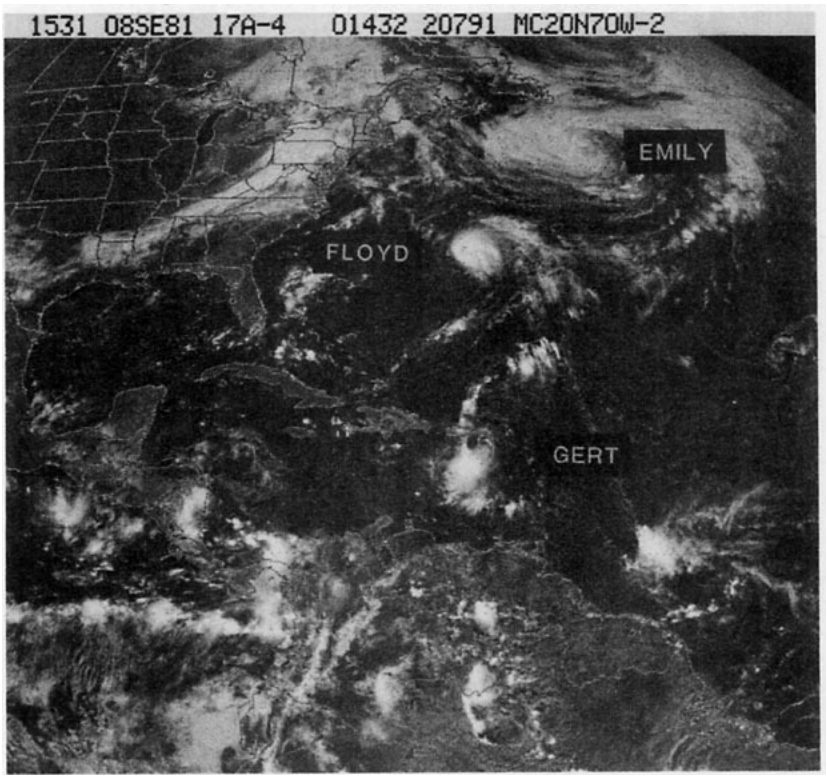

FIG. 10. Visible satellite picture at 1531 GMT 8 September 1981 of three named storms: Emily, Floyd and Gert. It is indeed coincidental that the E, F and G storms were also in existence on 8 September 1980.

precise to provide advance notice that the storm center would pass directly over Puerto Rico. It is sometimes the case with minimal tropical storms that center position estimates can be in error by as much as 100 km.

Storm intensity temporarily peaked at 26 m s^{-1} at 1200 GMT 8 September and a 24 h weakening trend began, prior to the center crossing eastern Puerto Rico. Again, there were no gale-force winds reported. The highest rainfall accumulation was 149 mm in 24 h at St. Thomas. Elsewhere in Puerto Rico, the Virgin Islands and the Lesser Antilles, rainfall totals were in the 25–100 mm range. Fig. 10 shows Gert near Puerto Rico, but with little convection near its circulation center.

The center passed within 50 km of the northeast coast of the Dominican Republic early on 9 September, and much of the storm's circulation was over the island of Hispaniola. This situation contributed to the weakening trend in progress at the time.

Gert continued northwestward. The Bahamian Government issued gale warnings for the Turks and Caicos Islands and storm warnings for the southeast and central Bahamas. Surface reports show that a well-defined circulation moved across the Turks and Caicos Islands and across Mayaguana Island in the eastern Bahamas by 10 September.

Cat Island in the central Bahamas reported northwest surface winds of up to 18 m s^{-1} as the storm center passed 75 km to the east at 1800 GMT 12 September. The highest rainfall amount from the Bahamas was 81 mm for the 6 h period ending at 1200 GMT 10 September.

A northward turn was in progress at this time, as well as a 42 h period of intensification which began at 1800 GMT 9 September. Gert became a hurricane at 1800 GMT 10 September and peaked the next day with surface winds of 46 m s^{-1} and a central pressure of 98.8 kPa. NOAA research aircraft conducted a comprehensive data-gathering at the 85.0 kPa level during the two days that Gert was a hurricane.

Gert's center passed 200 km northwest of Bermuda on 12 September. Bermuda's winds remained light, even though the surface pressure there fell to 100.0 kPa.

Proceeding east-northeastward, Gert was tracked by satellite to the vicinity of the Azores on 15 September, where its cloud remnants became indistinct.

h. Hurricane Harvey, 11–19 September

A wave moved off the African coast on 7 September. It developed a surface circulation and was assigned depression status on 11 September, while centered ~1300 km east of Dominica in the Leeward

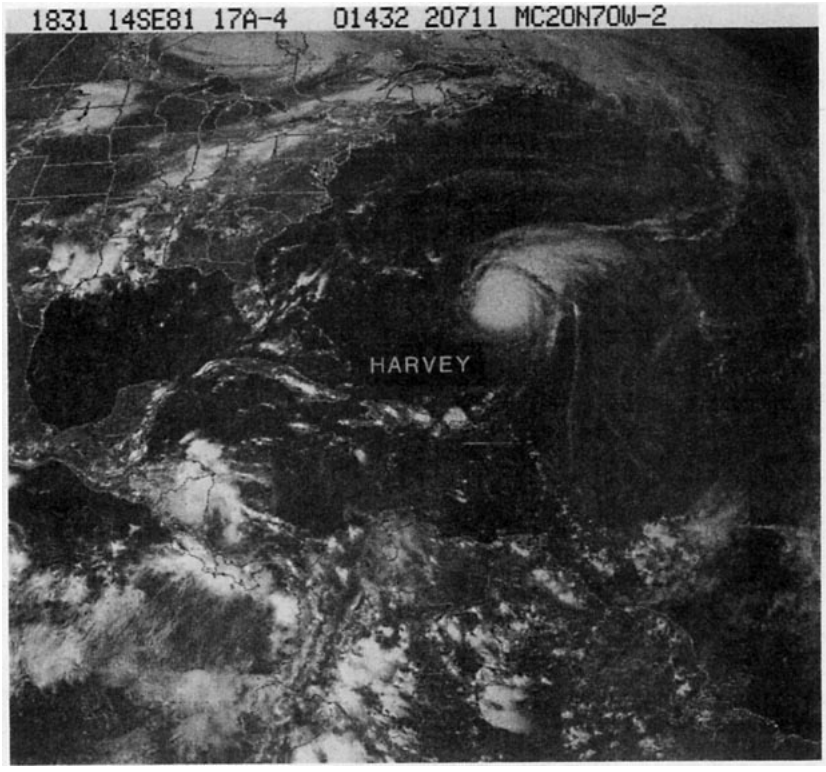

FIG. 11. Visible satellite picture of Hurricane Harvey at 1831 GMT 14 September 1981. An Air Force plane measured a sea level pressure of 95.2 kPa within minutes of the time of this picture.

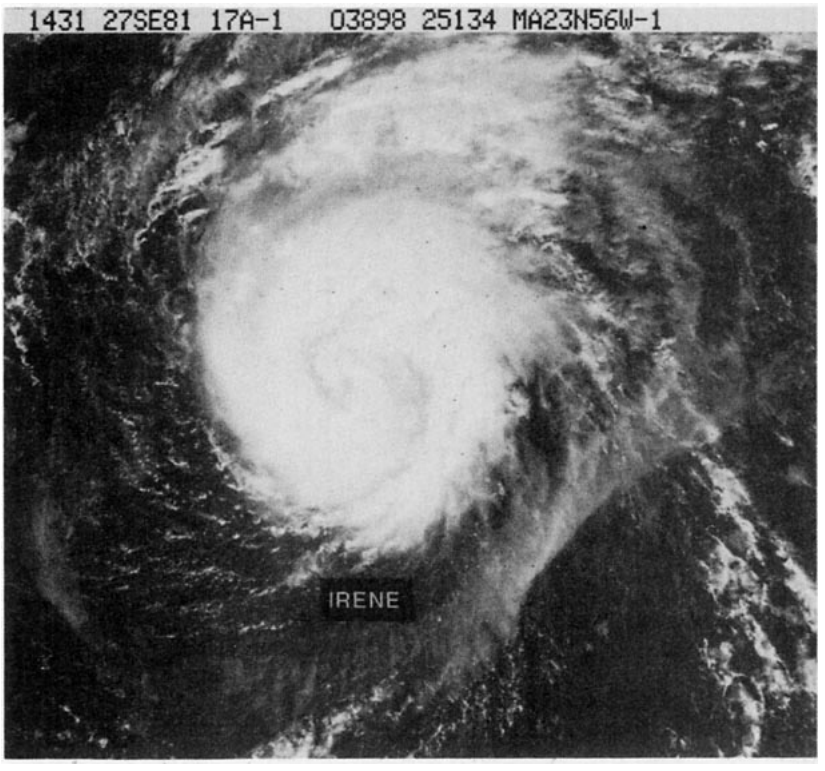

FIG. 12. Visible satellite picture of Hurricane Irene at 1431 GMT 27 September 1981. The central sea level pressure was 96.8 kPa at this time.

Islands. Turning northwestward, it became Tropical Storm Harvey at 1800 GMT 12 September and a hurricane only 6 h later. At this time, Emily and Floyd had just dissipated in the North Atlantic, and Gert was passing northwest of Bermuda.

Harvey gradually recurved toward the northeast during the period 13–16 September. Aircraft monitored the hurricane during this period and Harvey reached its maximum intensity with a 59 m s^{-1} wind speed and a minimum pressure of 94.6 kPa at 0000 GMT 15 September. This proved to be the highest sustained surface wind speed and lowest surface pressure in any of the 1981 hurricanes. Fig. 11 is a satellite picture of Harvey 6 h before its peak intensity. An eye-like feature is evident on this picture.

During 13–14 September, the hurricane was a threat to Bermuda, but early recurvature took the center over 300 km southeast of the island.

Harvey turned eastward after 16 September and weakened to a tropical storm on 18 September. During the following 24 h, deep convection near the center dissipated, but the low-level cloud circulation center was on visible satellite pictures for several more days in the far eastern North Atlantic.

i. Hurricane Irene, 21 September–3 October

Irene was the fourth in a series of Cape Verde storms. First detected on 19 September on satellite pictures as a disturbance near the African coast, the system showed evidence of a low-level circulation within 48 h. It was upgraded to a tropical storm on 23 September, and reached hurricane strength on 25 September as it turned toward the northwest.

The hurricane gradually recurved toward the northeast, finally weakening to a tropical storm on 1 October while located 400 km north of the Azores. Fig. 12 shows Irene on 27 September with deep-layer spiral banding. It continued moving eastward as it became extratropical, and eventually moved inland over France on 3 October.

Irene was tracked by aircraft during the period 25–29 September. Position and intensity estimates were based on satellite imagery at other times. The maximum surface wind speed estimate is 54 m s^{-1} and the minimum sea-level pressure is 95.9 kPa; these occurred on 28 September, when Irene was heading due northward across the central North Atlantic.

j. Tropical Storm Jose, 29 October–1 November

Jose can be traced to a midlatitude low pressure system which was located several hundred kilometers east of Newfoundland on 20 October. During the next eight days this low moved southward around the east side of the Atlantic subtropical high pressure ridge.

On 28 October, the system was centered near latitude 25°N, longitude 40°W. This is south of the

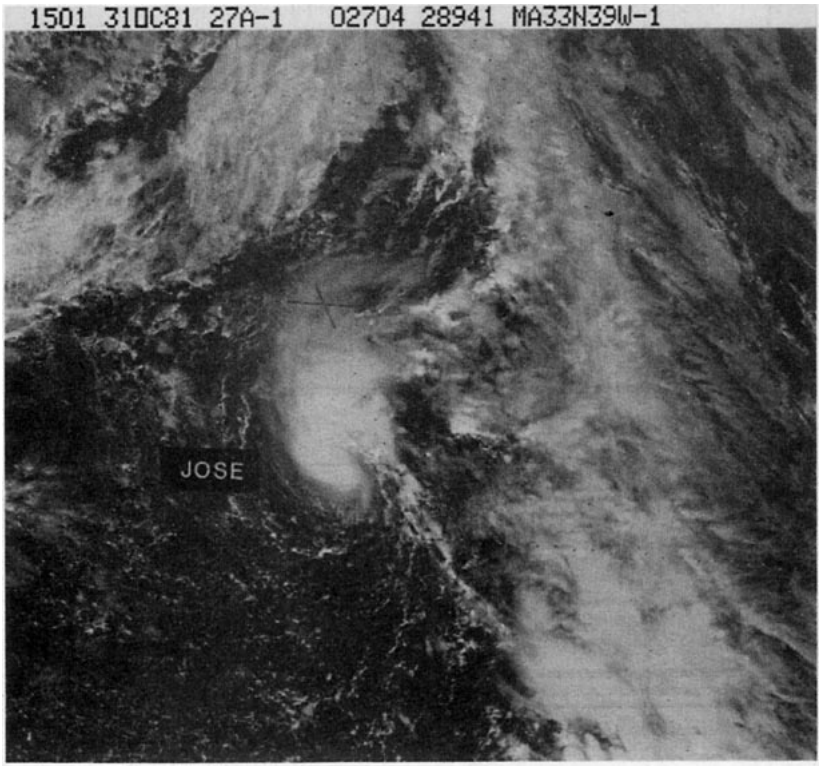

FIG. 13. Visible satellite picture of Tropical Storm Jose at 1501 GMT 31 October 1981.

Atlantic subtropical ridge. Convection increased near the circulation center and it is estimated that Jose became a tropical storm with 18 m s^{-1} wind speeds at 0000 GMT 30 October. Revising its earlier southward motion, Jose move northeastward for four days and accelerated to a forward speed of 21 m s^{-1}.

The maximum sustained surface wind speed was estimated to be 23 m s^{-1} on 31 October. There was extensive cloudiness east and north of the small tropical storm on 31 October (Fig. 13), and Jose eventually merged with this cloudiness near the Azores.

Satellite imagery was the sole source of data concerning the track and intensity of this storm.

k. Hurricane Katrina, 3–7 November

Cloudiness and showers appeared over the western Caribbean Sea on 1 November. Within 48 h a depression had developed and was centered 275 km south of the Cayman Islands. The depression strengthened while drifting northward. It became Tropical Storm Katrina early on 4 November and moved over the Cayman Islands within 24 h.

The storm accelerated toward the northeast and continued to strengthen. Aircraft reconnaissance measured a sea-level pressure of 98.0 kPa midday on 5 November, followed by a maximum surface wind estimate of 38 m s^{-1} several hours later. The result was that Cuba was threatened by an intensifying hurricane only 12 h from a potential landfall on the south coast. More than 30 000 people were evacuated from the area.

However, Katrina weakened as it approached Cuba. Maximum winds decreased to 31 m s^{-1} and the pressure rose 1.5 kPa by the time the storm center moved across eastern Cuba early on 6 November (Fig. 14). Heavy rain-induced flooding caused agricultural damage and Cuban sources reported two deaths.

The storm moved across the eastern Bahamas on the afternoon of 6 November. Maximum winds had decreased to 26 m s^{-1} even though Katrina was moving with a forward speed of 10 m s^{-1}. Aircraft were unable to locate a closed circulation later in the day and the storm remnants merged with a frontal system over the southwest North Atlantic.

l. Subtropical storm, 12–17 November

A cold front moved eastward off the U.S. east coast on 11 November and a frontal wave began to develop over the warm waters of the Gulf Stream. Ship reports indicate that a 100.4 kPa low pressure center was located 750 km east of Jacksonville, Florida on 12 November with maximum winds of 23 m s^{-1}.

The low moved generally northward for five days, paralleling the U.S. coastline, and reached Nova

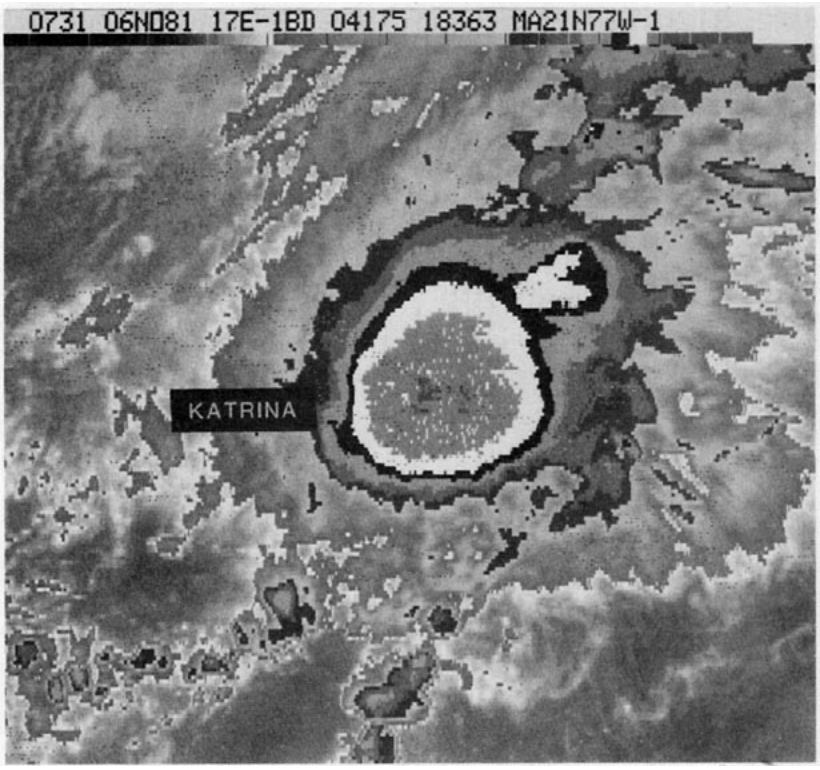

FIG. 14. Enhanced infrared image of Katrina moving across eastern Cuba at 0731 GMT 6 November 1981.

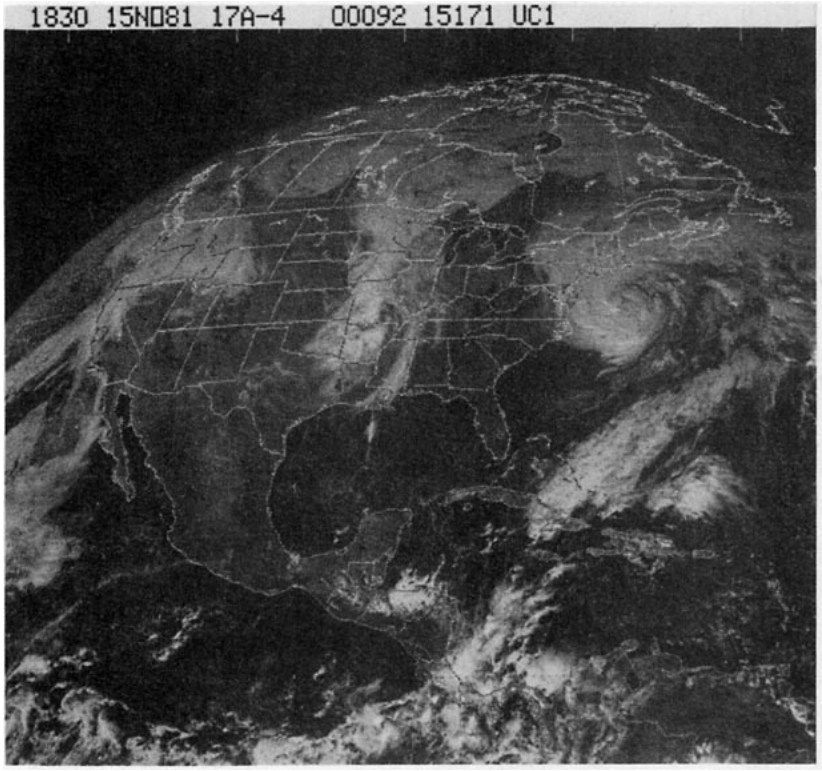

FIG. 15. Visible satellite picture of a subtropical storm near the northeast United States coast at 1830 GMT 15 November 1981. The storm's central sea level pressure was 97.8 kPa at this time.

Scotia on 17 November. Surface winds increased to 31 m s^{-1} on 14 November, while the low was moving abreast of the mid-Atlantic states. The center began to turn toward the northwest on 14 November as a blocking high pressure system moved north of the storm. At this time, a reconnaissance aircraft measured a surface pressure of 98.5 kPa, and the densely populated northeastern states appeared threatened by an intensifying storm which was acquiring the tropical characteristic of increasing convective cloudiness near its center.

The threat proved to be temporary and a north-northeast heading was resumed on 15 November, as the central pressure reached a minimum of 97.8 kPa (Fig. 15). This slow-moving storm caused coastal flooding and beach erosion along much of the Atlantic Seaboard from Florida to Maine. Gale warnings were in effect at various times from Cape Hatteras, North Carolina to Eastport, Maine, and also extended into Nova Scotia.

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