HURRICANE BETSY 1956

Report

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Hurricane seasons summaries

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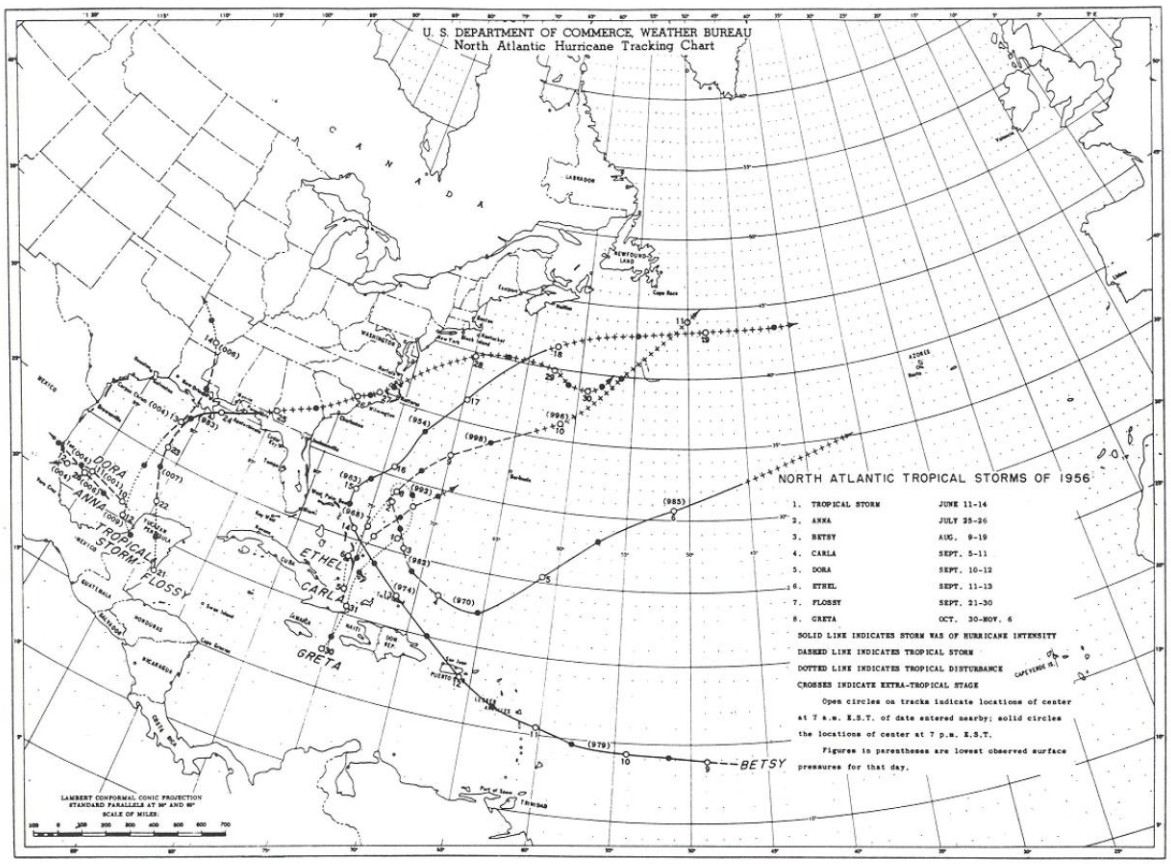

FIGURE 1.—Tracks of hurricanes and tropical storms that occurred during 1956 in the North Atlantic Ocean.

Hurricane Betsy, August 9–19.—The general circulation over the Atlantic during most of the hurricane season of 1956 and its possible relationship to the mild hurricane activity will be discussed later. A temporary break in the prevailing circulation pattern occurred early in August as the Azores-Bermuda anticyclone moved northeastward for a period of about a week and intensified while a trough extended through western Europe. Similar patterns have been noted previously [1] as antecedent to hurricane formation. Apparently the injection of cold air aloft and cyclonic vorticity into the Tropics by a meridionally-extensive trough encourages the transformation of stable waves in the easterlies, and even in the intertropical convergence zone, into unstable waves and eventually into storm circulations. Around August 9, when the development of Betsy was first suspected, the anticyclone had reached maximum intensity and immediately began to subside and to return to its previous position south of its normal location.

Lack of reports in the eastern Atlantic makes it impossible to arrive at a detailed analysis for the period preceding the first indications of this storm but there was some evidence of an easterly wave near longitude 33° W. on August 6. Extrapolation at a normal rate of movement would have brought it to the vicinity of 50° W. on the 9th. On that date the following report was received from the *M/T Marisa:* "At 1218 GMT passed through trough of tropical storm in position 14.05° N., 55.25° W. At 1200 GMT 1008 mb., winds force 10, very high wild sea, heavy squalls." It was not possible to fit this report into any logical analysis and consequently efforts were made to verify the ship's position. At 1730 GMT a corrected position of 14.05° N., 49.05° W. was obtained. This was only a short distance from the routine Gull Papa reconnaissance track but the developing storm was too small to alert the reconnaissance observer and there was no diversion from the scheduled track.

A special reconnaisance flight was made on August 10, but confirmation of storm development was received through surface ship reports before the plane reached the area. The *M/S Sagoland* at 1200 GMT reported: "Lat. 14.35° N., Long. 54.10° W., at 0400 GMT, wind 035 degrees increasing force 5, barometer 1008 mb. At 0930 GMT northeast force 11/12, barometer 1004, violent sea, heavy rain, no visibility. At 1200 GMT wind east force 6, barometer 1009, heavy seas, rain, decreasing sea." The 1200 GMT observations from the *SS Mormac Lark* and *SS Willemstadt* on the outskirts of the storm, were also helpful in the location of the storm and evaluation of its intensity.

The first advisory was issued at 1100 EST, August 10, at which time a hurricane watch was advised for the Leeward and Windward Islands from Antigua to Barbados. When reconnaissance aircraft reached the storm later in the day, it was found to be a very small hurricane but with winds of 120 m. p. h. near the center and central pressure 979 mb. The eye was defined by a very tightly closed pattern on the radar as only 10 miles in diameter.

The hurricane moved on a west-northwest course at about 17 m. p. h. during the next 24 hours and passed through the central Lesser Antilles about midday August 11. It crossed over the island of Marie Galante and between Isle des Saintes and the extreme south portion of Basse Terre, Guadeloupe. Reports indicate 18 lives lost and severe damage. On Guadeloupe, 1,000 dwellings were extensively damaged, all communications disrupted, and 50 to 60 percent of the banana, breadfruit, coconut, and papaya trees destroyed, a serious blow to the economy of the island. The banana crop loss was estimated at $3.5 million and preliminary estimates give $10 million for the total damage figure. Winds were estimated at 100 to 120 m. p. h. on Guadeloupe and the lowest pressure was 991 mb.

After moving through the Leeward Islands, the hurricane began a more northwesterly course, passing about 30 miles south of St. Croix, Virgin Islands, and reaching the southeastern tip of Puerto Rico in the early morning of August 12. Prior to reaching Puerto Rico the storm displayed a small but apparently real oscillatory motion about the mean track with an amplitude of a little less than ½ degree and a period on the order of one day. The oscillation was sufficiently definite that some forecast use could be made of it, on an extrapolation basis. Following the turn to a more northwesterly direction, this oscillation was not present or was obscured.

A hurricane watch had been ordered for Puerto Rico and the Virgin Islands on the evening of August 10. As the hurricane continued to move toward Puerto Rico, the watch was changed to hurricane warnings on the afternoon of August 11. The eye of the storm crossed Puerto Rico between 1200 and 1530 GMT, August 12, on an erratic coarse [2] between northwest and west-northwest at about 17 m. p. h., emerging on the north coast near Camuy with only slight and temporary weakening of its circulation. According to reports, all of Puerto Rico, except the southwestern portion which was protected by the mountain backbone of the island, experienced winds of 75 m. p. h. or higher in gusts. Maximum sustained winds at San Juan were 73 m. p. h., with gusts to 92 m. p. h. Rainfall totalled 3.19 inches. Ramey Air Force Base, on the northeastern tip of the island, recorded wind gusts to 115 m. p. h. Nine deaths were reported in Puerto Rico and the property damage totalled $25,500,000 or more.

Hurricane Betsy continued at a speed of about 17 m. p. h. to near Turks Island early on August 13 and, with some acceleration, reached the vicinity of San Salvador in the Bahamas about 2000 EST on that date. Winds at San Salvador reached 132 m. p. h. in gusts. Sustained winds were 100 m. p. h. or more. Approximately 5 inches of rain fell in 5 hours. Several houses were demolished and most of the churches, which are generally better constructed, lost their roofs.

Aircraft reconnaissance on August 13 had shown a slight increase in size of the storm but little change in central pressure or maximum winds. Gale winds were reported as extending 125 miles north and 60 miles south of the center. Lack of important increase in size or intensity was compatible with the fact that turbulence and rain in all quadrants were predominantly light with only intermittent bursts of heavy rain and moderate turbulence. On the 14th, central pressure was reported as 960 mb., the eye was 12 miles in diameter and well formed, and associated clouds extended 250 miles north and 200 miles to the east.

On August 14 and 15, Betsy began recurvature with sharp deceleration in forward movement. By the 16th it was moving toward the northeast and had increased its forward speed to about 20 m. p. h. Between the 13th, when the storm was near Turks Island, and the 16th, when a dropsonde was released in the eye near 30° N., 75° W., temperatures in the eye between the surface and 700 mb. fell about 2° C. The normal sea-surface temperature difference between these areas is less than 1° and, while some anomaly may have existed, it seems likely that the cooling was an indication of the beginning, even at this time, of some other factors interfering with the efficiency of the storm engine. By the 17th, a dropsonde in the eye showed that the cooling, by another 1° to 3° C., extended upward to almost the 500-mb. level. Maximum winds began to decrease on the 16th and by late August 17th had dropped to 80 m. p. h. Reconnaissance at this

time reported the eye was becoming poorly defined as the hurricane moved northeastward at about 23 m. p. h. past the latitude of Nantucket. The last advisory was issued on the morning of August 18 as the storm assumed more extratropical characteristics. It moved due east on the 19th and 20th, gradually losing its identity.

The tracking and forecasting of hurricane Betsy was aided by the availability of more information in the form of air-borne and land-based radar observations and upper air soundings than in previous years. The storm successively came within range of radar at San Juan [2], the Air Force missile range stations in the Bahamas, and the Navy Hurricane Central at Miami. The AN/CPS–9 radar at the Navy Hurricane Central, Miami, established what possibly may be a record when hurricane Betsy was off the Florida coast on the 14th. The center of Betsy was initially detected by this radar at a range of 293 nautical miles and presented a perfect scope picture for the next 26 hours until she was lost at 269 nautical miles.

Aircraft reconnaissance by the Air Force and Navy was up to its usual high standards. Despite all this, Betsy was not without forecasting problems. The most difficult problem, as it usually is, was the recurvature. From the time of inception until August 13, the movement was consistent and could be forecast with a high degree of confidence. However, on that date the center was approaching an area where recurvature appeared to be a likely possibility on the basis of climatology, and a slight possibility on the basis of the prevailing circulation. From the standpoint of public warnings, the problem was further complicated by the relatively rapid movement of 18 m. p. h. (during certain short periods on this date it appeared to move as fast as 25 m. p. h.) and the time-of-

day factor. At 1700 EST, on the 13th, it was decided that with the rate of advance and the direction and speed of movement indicated by the Riehl-Haggard [3] technique, which gave excellent results on the whole with this storm, squalliness could develop on the Florida southeast coast on the forenoon of August 14. If hurricane warnings were delayed until the next morning, and the forecast track verified, insufficient time would remain for adequate preparations. Consequently, hurricane warnings were issued for a portion of the Florida east coast. The underlying reasons for the action, and the degree of uncertainty attached to a hurricane forecast for such a period of time, were expressed in the public advisory. By the morning of August 14 stronger evidence in favor of a northward turn was appearing, and later in the day all hurricane warnings were lowered. However, there remained another 24 hours of slow movement during the recurvature process before all threat to the United States coast had definitely passed.

At 500 mb., during the early history of Betsy, a trough extended from Newfoundland to near Bermuda. The southern portion of this trough tended to fill as Betsy moved past, and heights in the area of an anticyclone along the southeastern United States coast had been rising for some time when the storm reached the area of Turks Island on August 13. This, with other factors,

created some doubt as to whether recurvature could occur east of Florida. The long-wave pattern at this time was becoming poorly defined and of small amplitude, with indications that a trough should develop in the Great Lakes region, permitting the High along the southeastern coast to persist and hamper recurvature. It was not until the 14th that developments, including the weakening of the High over the southeastern coast, began to favor the northward turn.

The accepted movement-forecast techniques were applied and were found useful to varying degrees. None were without failures at some stage, particularly during recurvature. Three 24-hour forecasts obtained by the Riehl-Haggard technique were within 17 miles, which is as close as the center can usually be located at sea. However, passage of the storm through the network of upper-air stations at Air Force missile bases and on islands to the south permitted the collection of data which may prove helpful in analyzing some of these deficiencies in our present knowledge of hurricane behavior. This is especially true of the upper troposphere, for which we have previously had severely limited data.

There were at least 27 deaths connected with Betsy, and total damage in monetary terms, including an estimate of $380,000 in the Bahamas and a few other islands, appears to be around $35,880,000.