Atlantic Hurricane Season of 1979

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ABSTRACT

A general summary of the 1979 hurricane season is presented. Included are highlights of the season, comparisons of activity in recent years with long-term averages, and comment on large-scale atmospheric features which prevailed during the season and their impact on storm tracks. Finally, there are accounts of individual storms, which give meteorological details and the influence of synoptic features on their tracks and intensity.

1. General summary

The outstanding events of the 1979 hurricane season were: 1) Hurricane David, which devastated the island of Dominica, killing 56 and leaving 60 000 of the 80 000 residents homeless, then killing over 2000 in the Dominican Republic while causing damage estimated by that country's Government in excess of 1 billion U.S. dollars and leaving 200 000 homeless; 2) Hurricane Frederic, which caused an estimated $2.3 billion damage in the United States, making it the costliest United States hurricane in history; 3) 42 inches of rain in 24 h near Alvin, Texas, during Tropical Storm Claudette, which is a United States 24 h rainfall record; 4) the greatest 1-year damage total in the United States from tropical cyclones—over $3 billion.

As can be seen in Fig. 2, the 1979 hurricane season was characterized by many developments close to land areas and tracks which affected large geographical areas. This resulted in extensive areas of the western North Atlantic land masses being under gale or hurricane warnings. Five of the first six storms required the issuance of gale warnings in the first storm advisory. Fig. 1a shows the areas under either a tropical cyclone gale or hurricane warning in 1979, and Fig. 1b shows the hurricane warning areas only. In addition, several areas of Cuba experienced gale force winds. In the United States, only 13% of the 3200 n mi of coastline along the Gulf and Atlantic coasts escaped tropical cyclone warnings.

There were more storms in the deep tropics, United States landfalls and intense hurricanes than in recent years. Fig. 2 and Table 1 give the tracks and statistics of the 1979 named tropical cyclones and a late October subtropical storm. The total of eight named storms of which five became hurricanes is below the most recent 30-year averages of ten and six, respectively, even if the subtropical storm of late October is included. The 1979 season continued the generally below-normal activity of the past decade. Nineteen seventy-nine is the tenth consecutive year that the number of hurricanes has been average or below. However, there were five landfalls of storms/hurricanes in the United States. Three were hurricanes and one was a major[1] hurricane. The average number of storm/hurricane landfalls per year is three, of which two are hurricanes. Major hurricanes average two landfalls every three years. Nevertheless, the decade of the seventies had the lowest number of landfalling United States hurricanes and major hurricanes in this century—12 and 4, respectively (Hebert and Taylor, 1979). The previous lows for any decade in this century were 14 and 5.

After 13 consecutive years without a hurricane, the Lesser Antilles, Puerto Rico, the Virgin Islands and the Florida east coast were seriously affected by hurricanes. The Mobile, Alabama–Pascagoula, Mississippi area had its most intense hurricane of this century. Frederic was the first hurricane to strike Mobile directly since 1932. David was the first hurricane to strike the Cape Canaveral area directly since 1926. Mobile, Pensacola in 1926, and Cape Canaveral had gone the longest time without a hurricane for locations south of Cape Hatteras, North Carolina. David was the most intense hurricane of the season, and probably of this century, in the eastern Caribbean Sea area. It was the strongest hurricane at Dominica since 1834 and at Santo Domingo, Dominican Republic since 1930.

Lawrence (1978, 1979) addressed the question of

[1] A major hurricane has winds > 110 mi h^{-1} and/or storm surge of 9 ft of more. See Hebert and Taylor (1979) for additional criteria.

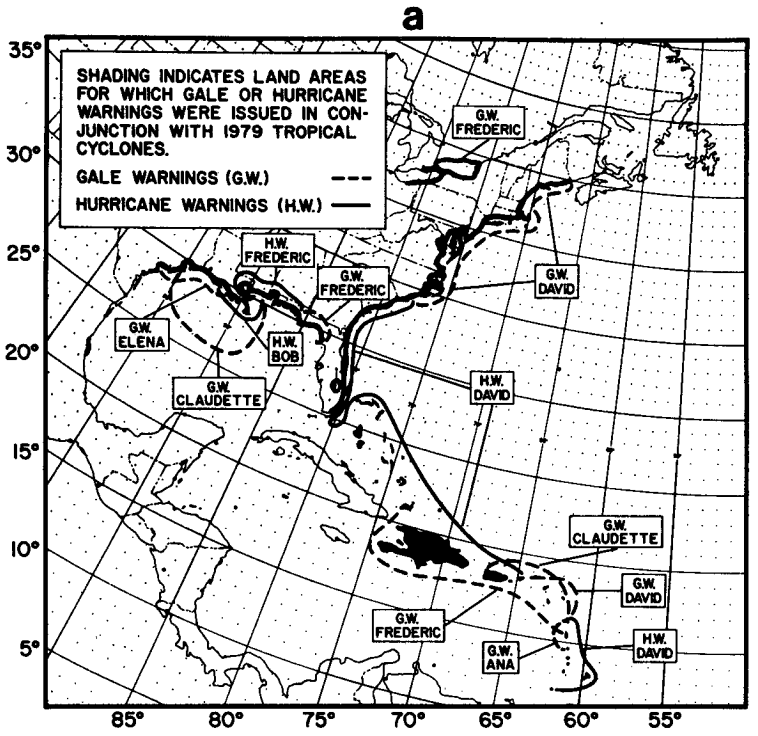

FIG. 1a. Land areas for which gale or hurricane warnings were issued in conjunction with 1979 tropical cyclones.

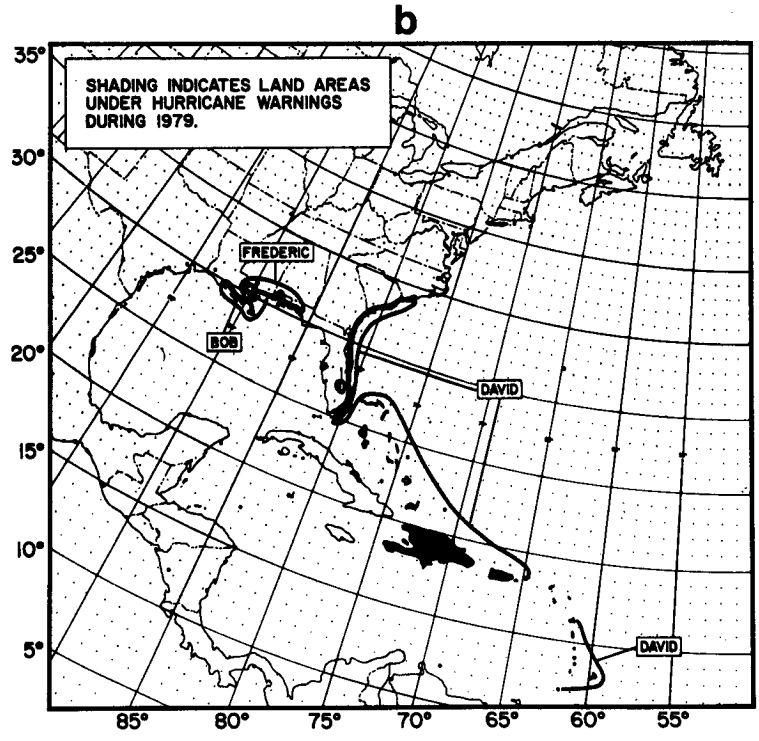

FIG. 1b. Land areas under hurricane warnings during 1979.

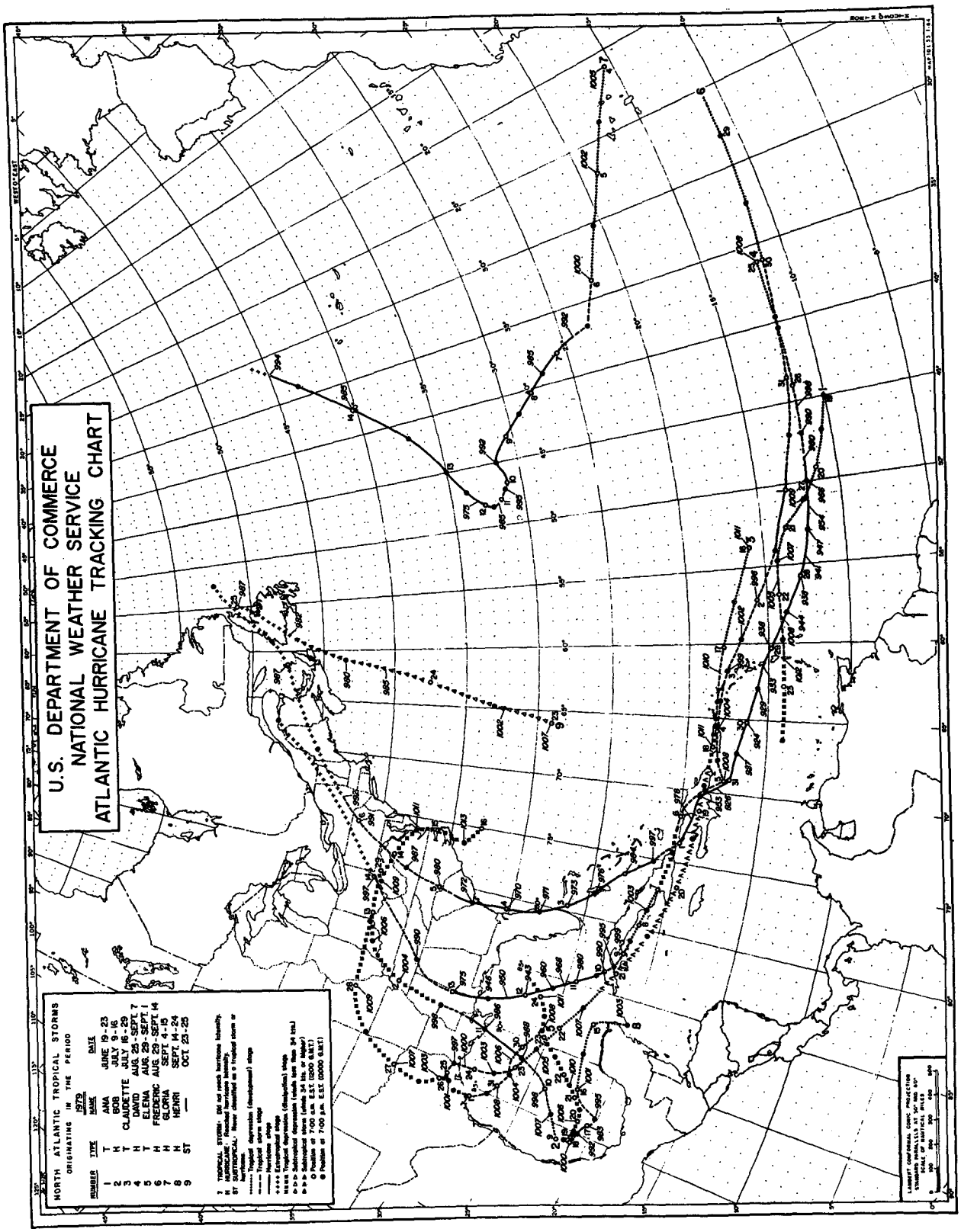

FIG. 2. Tracks of 1979 North Atlantic tropical and subtropical cyclones.

TABLE 1. Summary of North Atlantic tropical and subtropical cyclone statistics, 1979.

No.	Name	Class	Dates	Maximum sustained winds (kt)	Lowest pressure (mb)	U.S. damage ($ million)[1]	Deaths
1.	Ana	T	19–23 June	50	1005		
2.	Bob	H	9–16 July	65	986	20	U.S., 1
3.	Claudette	T	16–29 July	45	997	400	U.S., 2 (includes 1 Puerto Rico)
4.	David	H	25 Aug–7 Sept	150	924	320	U.S., 12 (includes 7 Puerto Rico) 56 Dominica >2000 Dominican Republic
5.	Elena	T	29 Aug–1 Sept	35	1004	<10	U.S., 2
6.	Frederic	H	29 Aug–14 Sept	115	943	2300	U.S., 5 7 St. Maarten
7.	Gloria	H	4–15 Sept	85	975		
8.	Henri	H	14–24 Sept	75	983		
9.	—	ST	23–25 Oct	65	980		

T—tropical storm (winds 34–63 kt).
H—hurricane (winds 64 kt or higher).
ST—subtropical storm (winds 34 kt or higher).
[1] Includes Puerto Rico and U.S. Virgin Islands.

declining accuracy in both official and objective forecasts in relationship to ongoing changes in the National Meteorological Center (NMC) analyses, data sources and storm locations. The great persistence of the formation and movement of 1979 tropical cyclones through data-rich areas resulted in the second lowest 24 h official forecast errors[2] of record for the hurricane season. Objective forecasts also improved markedly over recent years. These occurrences were undoubtedly a result of persistent large-scale circulation features over the Atlantic and eastern United States from June to September as evidenced in the discussion of individual months by Taubensee (1979a,b), Wagner (1979) and Dickinson (1979).

2. Individually named storms

a. Tropical Storm Ana, 19–23 June

Ana was the first June storm to form east of the Lesser Antilles since 1933 and only the second during the past 100 years of record. Ana occurred earlier in June, but the 1933 storm and Ana both reached storm strength at approximately the same longitude.

The disturbance which was to become Ana left the African west coast late on 14 June. Satellite pictures indicated that a depression was forming near 10°N, 45°W on 19 June. The depression moved toward the west-northwest at ~12 kt until late on the 20th when it slowed and turned toward the northwest in response to a weak trough approaching in the higher latitude westerlies. Slight strengthening occurred at this time. Air Force reconnaissance reports indicated that the depression was nearing tropical storm strength late on 21 June, and this was confirmed on the morning of 22 June by another reconnaissance flight which reported winds of 50 kt.

Ana was named at 1600 GMT 22 June and gale warnings were issued for the islands from Martinique to Guadeloupe since the storm center was less than 200 mi away. However, strong westerlies at high levels began shearing the convection from the circulation center, and Ana reached the islands as a minimal tropical storm late that day. Continued weakening took place as the storm turned more to the west, and Ana was downgraded to a tropical depression on the morning of 23 June, and to a tropical wave in the central Caribbean Sea early on 24 June.

The maximum sustained winds in Ana were estimated to be 50 kt on the morning of 22 June and the minimum central pressure of 1005 mb also occurred during that time. There was no heavy rainfall in the islands, and no reports of gale force winds. No deaths nor significant damage have been reported.

b. Hurricane Bob, 9–16 July

The disturbance from which Bob evolved showed little signs of development until it passed across the Yucatan Peninsula of Mexico on 7 July. A depression formed in the southwest Gulf of Mexico on 9 July, and began moving northeastward in advance of a low-pressure trough approaching from the west. An Air Force reconnaissance plane reported a developing tropical storm centered ~400 n mi south of the Louisiana coast on the morning of 10 July with winds of 50 kt and lowest pressure of 998 mb. The pressure had dropped 14 mb since a reconnais-

[2] To be published in the 1979 annual data and verification tabulation of Atlantic tropical cyclones.

TABLE 2. Meteorological data of Hurricane Bob, 9–16 July 1979. Data in Tables 2–5 are based on information available and may not represent extreme values which occurred.

Location	Date	Pressure (inches)		Wind (mph)				Tide (ft)		Rainfall (inches)	
		Low	Time[a]	Fastest mile	Time[a]	Peak gust	Time[a]	Highest MSL	Time[a]	Storm total	Dates
Louisiana											
Buoy 26.0°N 90.0°W	10	29.65	1900	S 37	1700						
Buoy 26.0°N 93.5°W	10	29.69	1700	NNE 30	1400	38					
Mobil Oil Rig 28.2°N 91.8°W	11	29.37	0300	N 45	0200						
Mobil Oil Rig 28.3°N 93.0°W	11	29.45	0300	N 23	0200						
Mobil Oil Rig 28.5°N 90.1°W	11	29.33	0300	S 63	0300						
Mobil Oil Rig 28.7°N 92.3°W	11			NW 30	0300						
Grand Isle CG	11	29.32		SE 58	0600	SE 63	0600	3.8[b]			
Morgan City										3.88	10–11
Boothville WSMO	11	29.52				SE 53	0430				
Lafayette FSS	11	29.66		18						0.12	10–11
New Orleans WSMO	11	29.28		SE 44	0837	SE 60	0811			2.76	10–11
New Orleans FSS	11			35		S 58	0251				
Belle Chase NAS	11	29.37		31		51				2.21	10–11
Slidell WSFO	11	29.44								3.30	10–11
Lake Pontchartrain											
West end	11							2.9			
Mandeville	11							5.1			
Industrial Canal	11							2.6			
Rigolets	11							3.8			
St. Charles Parish CD	11					60					
Norco	11	29.22									
Baton Rouge WSO	11	29.57	1430	21	1451	38	1447			2.74	10–11
Mississippi											
Bay St. Louis	11	29.58	1000			SSE 64	1000	5.0[b]			
Gulfport	11	29.22		SE 55		S 60		6.3		3.75	
Harrison County CD	11	29.23	1420			63	1400	6.3		5.85	
Biloxi Backbay	11							5.2			
Pascagoula Churn	11			S 25		S 53	1225				
West Pascagoula River								3.4			
East Pascagoula River								4.2			
Columbia	11					55					
Jackson WSFO	11	29.42	1455	26	1440	38	1427			2.27	11
Alabama											
Dauphin Island Churn	11	29.78	0700			S 52	1027				
Dauphin Island Sea Lab	11	29.75	0900	31	1144	50	1144			1.50**	
Mobile WSO	11	29.75	1253	32	1355	41	1109			1.97	
Mouth of Mobile River	11							4.2	1110		
Indiana											
Spencer										5.21	13
Princeton										3.63	13

[a] Central Standard Time.
[b] Above normal.
[c] Estimated.

sance flight on the previous day. Gale warnings were issued at 1600 GMT extending from Vermilion Bay, Louisiana, to Biloxi, Mississippi. Bob was upgraded to a hurricane at 2200 GMT that day as an afternoon reconnaissance flight reported hurricane force winds and a pressure of 988 mb. Gale warnings were changed to hurricane warnings at that time. Bob had become the first July hurricane in the Gulf of Mexico since 1959.

Bob turned more to the north and accelerated to a forward speed of 15 kt as it crossed the Louisiana coast near Grand Isle, Louisiana, about daybreak on 11 July. This motion was associated with the effects of the deepening low-pressure trough approaching from the west. The upper atmospheric acceleration of the wind field over Bob produced by this trough is believed to have contributed significantly to the hurricane's rather rapid intensification. The maximum sustained wind of 65 kt and minimum central pressure of 986 mb occurred near landfall. After moving inland, the center passed just west of New Orleans later that morning. Bob weakened rapidly after crossing Lake Pontchartrain.

Along the coast, the statistics associated with Bob

were typical of a minimal hurricane. Tides were generally 3–5 ft above normal and rainfall totals were between 3 and 6 inches. Highest winds were 45–55 kt and a few locations reported 65 kt gusts. Eight tornadoes were reported, but only the one in Biloxi, Mississippi produced significant damage. The remnants of Bob gave 3–5 inches of rain in southern Indiana, causing significant flooding. Table 2 gives detailed meteorological data for Bob. There was one death in Louisiana. Coastal damage was less that $5 million, but exceeded $15 million in the Indiana floods.

c. Tropical Storm Claudette, 16–29 July

Claudette was a tropical storm for two brief periods separated by a 5-day interval during which it weakened to a disorganized tropical wave. Claudette left the African coast as the strongest wave of the year at midtropospheric levels. The rawinsonde report from Dakar, Senegal at 1200 GMT 12 July showed winds of 85 kt at 550 mb.

A surface circulation was first evident on 16 July about 450 n mi east of the Leeward Islands. Based on Air Force reconnaissance reports of 45 kt winds the next morning, the depression was upgraded to tropical storm Claudette at 1600 GMT 17 July, even though the minimum central pressure was 1011 mb. Once again, gale warnings were required in the first tropical storm advisory because of the proximity of the storm center to the islands. This time the areas warned were the Leeward Islands, the Virgin Islands and Puerto Rico. It was the third consecutive storm in which gale warnings were issued in the first storm advisory. As had been the case with Ana, strong upper level westerly winds caused Claudette to weaken to a depression over Puerto Rico and to a tropical wave over Hispaniola. No sustained gale force winds were reported on any of the islands. The highest gust of 45 kt was reported on Antigua. Rainfall amounts of 7–8 inches fell on Guadeloupe, causing some flooding. Amounts exceeding 9 inches fell in southern Puerto Rico. There was one death by drowning in Puerto Rico and damage was estimated at $750,000 because of river floods.

Phase two of tropical storm Claudette began as the tropical wave remnants moved into the southeastern Gulf of Mexico on the morning of 21 July. A depression formed later that day, and reached tropical storm strength during the morning of 23 July. Gale warning were issued with the first tropical storm advisory at 1300 GMT from Biloxi, Mississippi to Freeport, Texas.

At this time, the center of Claudette was poorly defined and elongated in a north-south direction. Satellite center locations fell systematically to the north of reconnaissance center locations. There is some evidence that the satellite images were depicting a middle-level vorticity center which parallelled the track of the surface center as determined from aerial reconnaissance. During the evening of 23 July reconnaissance reports indicated that the surface center to the south had weakened to a depression, so gale warnings were discontinued early on 24 July. A dominant center, however, formed in the northern part of the elongated area and began drifting northward shortly before daybreak. Offshore oil rigs began reporting gale force winds, necessitating gale warnings once again at 1430 GMT. This time they extended from Grand Isle, Louisiana to Galveston, Texas. Because of poor center definition, the best track for Claudette (shown in Fig. 2) is considerably smoothed in the Gulf of Mexico, in order to reconcile satellite and reconnaissance locations that were frequently at variance with each other.

The center crossed the coast near the Texas-Louisiana border about 1800 GMT. It was expected to continue northward and spread heavy rains through the lower Mississippi Valley. Accordingly, gale warnings were discontinued along the coast at 2200 GMT. However, the development of a small high-pressure system aloft to the north of the center blocked the northward movement of Claudette, and caused it to turn slowly to the west, describing a tight loop over extreme southeast Texas during the next 24 h before finally moving off to the north. Because the center remained close to the coast, Claudette did not weaken and offshore oil rigs continued to report winds of gale force for 30 h after the center moved inland. Claudette's lowest pressure of 997 mb occurred near Beaumont, Texas after the center had moved inland. Maximum sustained winds in Claudette were 45 kt both east of the Virgin Islands and in the northwest Gulf of Mexico before landfall.

Claudette will be long remembered along coastal southeast Texas for the torrential rains which occurred while the center was making a loop in that area. A report of 42 inches in 24 h by an observer near Alvin, Texas is a United States 24 h rainfall record. This may also be a record for the world's greatest 24 h rainfall occurring over flat terrain. There were several reports of storm rainfall exceeding 30 inches from Alvin, Freeport and Sargent, Texas, making Claudette one of the wettest tropical cyclones ever to affect the United States. Fig. 3 is an isohyetal map prepared by the National Weather Service's Southern Region Headquarters office in Fort Worth, Texas, based on a bucket survey taken shortly after the storm.

The highest winds on the coast were estimated to be 45–55 kt in gusts at Cameron, Louisiana, around the time of landfall. Tides of 2–4 ft above normal caused minor damage along the Louisiana coast. Table 3 gives the meteorological data for Claudette.

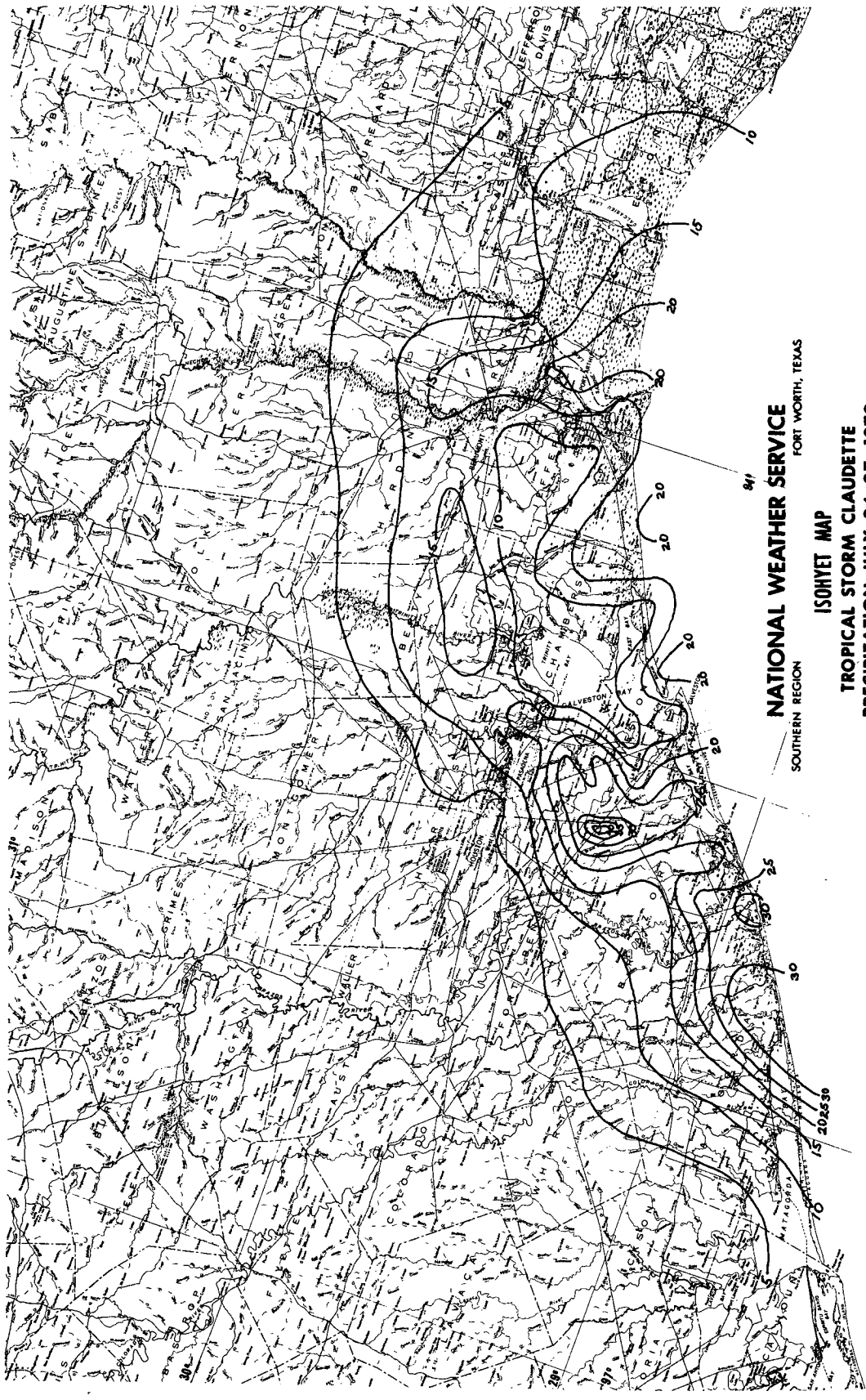

FIG. 3. Map of tropical storm Claudette rainfall (inches) 24–27 July 1979. (Courtesy NWS Southern Region Headquarters, Fort Worth, TX.)

TABLE 3. Meteorological data of Tropical Storm Claudette, 16–29 July 1979.

Location	Date	Pressure (inches) Low	Pressure (inches) Time[a]	Wind (mph) Fastest mile	Wind (mph) Time[a]	Wind (mph) Peak gust	Wind (mph) Time[a]	Tide (ft) Highest MSL	Tide (ft) Time[a]	Rainfall (inches) Storm total	Rainfall (inches) Dates	Remarks
Lesser Antilles												
Martinique	17									2.72		
Guadeloupe	17			SSE 35	1550					7–8		
Antigua	17					52				2.30		
Barbuda	17					46						
Puerto Rico												
Ponce										8.06	17–18	
United States												
Texas												
Beaumont-Port Arthur WSO	24	29.46	1705	53	25/0518	60	25/0521	2–4[b,c]		12.75	23–26	
Port Arthur										16.84	24–27	
Sabine CG	25							4–5[b]				
Galveston WSMO	24	29.66	1813	NE 20	23/1859	NE 33	23/1251	3.8	23/0630	16.95	25–26	
Baytown										14.24	25–26	
Texas City	23							3.5		12.58	25–26	
Houston Int'l Airport										2.83	25–26	
Alvin WSO										30.70	24–27	
Sargent										34.50	24–27	
Freeport	26			SSW 48	0600			3.1		30.20	24–27	
42 S Freeport	25					45–60[b]	0750					
Louisiana												
Cameron	24	29.56	1615			50–60[b]	1415	3.9[b]	1040			
Lake Charles	24	29.61	1700	S 28	25/0226	39	25/1058	4.0		9.18	23–26	
Mobil Oil Rig 28.3°N 93.0°W	24			S 46	1000							
Mobil Oil Rig 28.7°N 92.3°W	24			SE 52	0600							
Mobil Oil Rig 28.2°N 91.8°W	24			SSE 40	0600[d]							
Conoco Oil Rig 29.3°N 93.0°W	25			S 50	2325							

[a] Central Standard Time.
[b] Estimated.
[c] Above normal.
[d] First of several occurrences.

There was one death in Texas by drowning. The damage from the flooding produced by Claudette's heavy rains is estimated at $400 million. Claudette was the tenth costliest tropical cyclone in United States history, and the only one not of hurricane intensity to rank in the top 25 (Hebert and Taylor, 1979).

d. Hurricane David, 25 August–7 September

1) GENERAL

David was a typical Cape Verde hurricane. Characteristics of this type of hurricane are 1) attaining hurricane intensity well east of the Lesser Antilles; 2) following a parabolic track around the periphery of the Azores-Bermuda high and frequently affecting the Lesser Antilles, the Greater Antilles and the United States; 3) maintaining major hurricane intensity for the duration of the hurricane, unless weakened by landfall; and 4) expanding in size with movement to higher latitudes to become both large and intense before reaching the United States. A large number of people both on land and at sea felt the impact of David. Hurricane warnings were posted in advance of David for most of the Lesser Antilles, Puerto Rico, Hispaniola, the Bahamas, and from the middle Florida Keys northward to southern North Carolina. Gale warnings preceded the inland storm from North Carolina northward to Eastport, Maine. Historically, there have been few storms whose effects were so widespread.

2) METEOROLOGICAL HISTORY

The Atlantic subtropical ridge extended westward to the vicinity of the United States east coast during most of David's history, causing David to move steadily across the Atlantic and into the eastern Caribbean Sea. Intensification also proceeded at a steady pace from the depression development ~1500 mi east of the Lesser Antilles on 25 August to a severe hurricane with a minimum pressure of 924 mb south of Puerto Rico, as upper level wind flow fields maintained favorable outflow patterns.

David took the first of two significant jogs in track while centered just south of the eastern tip of the Dominican Republic. A sudden turn to the north-northwest brought the center inland just west of Santo Domingo on 31 August causing the full effects of the hurricane to lash that city. The hurricane turned toward the west and weakened briefly to tropical storm strength while crossing Hispaniola, and emerged over water near the northwest tip of Haiti. Two hypotheses are presented for the abrupt change in course. The first is the passage of a short-

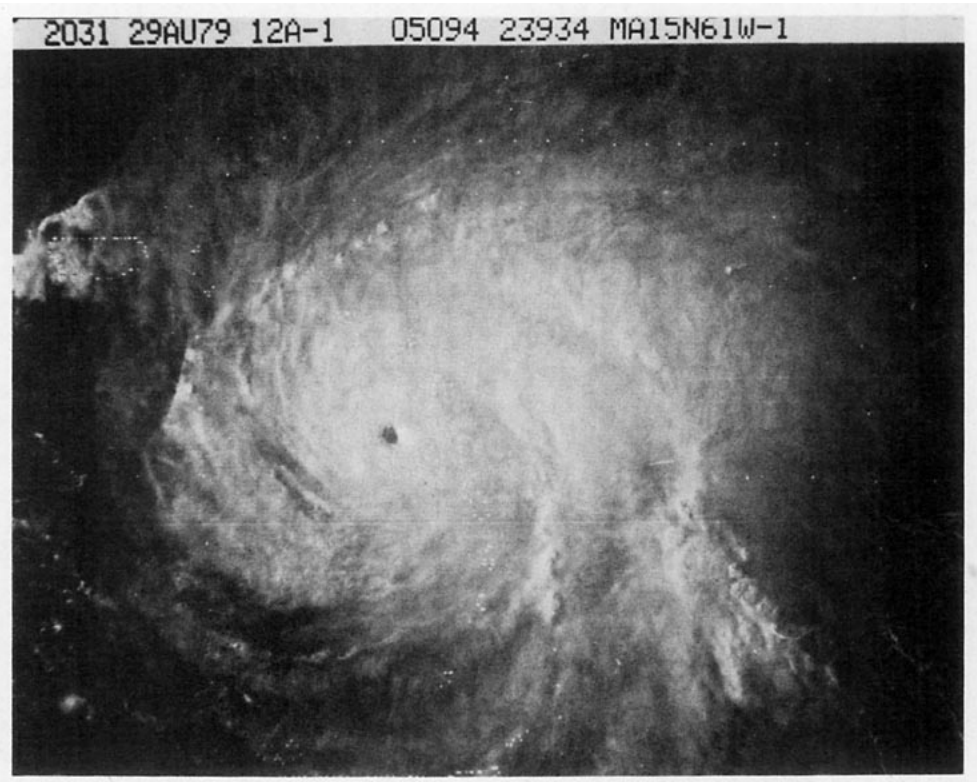

FIG. 4. SMS 2 visible satellite picture of Hurricane David at 2031 GMT 29 August 1979, shortly after devastating Dominica.

wave trough in the westerlies which was located north of the hurricane along longitude 70°W on 31 August, and could subtly have weakened the subtropical ridge. The second is the interaction of the hurricane circulation with the mountainous terrain of Hispaniola which has peaks exceeding 10 000 ft, although the theoretical aspects of such an interaction are poorly understood.

The second significant jog occurred as the restrengthening David approached the southeast Florida coast on a northwesterly course. As the center crossed Andros Island in the western Bahamas, it appeared to be heading toward the Miami area, but a turn to the north-northwest brought a landfall just north of Palm Beach. Intensification practically ceased during this period, and David did not make a United States landfall as a major hurricane of the Cape Verde type. The jog in track while approaching the Florida southeast coast appeared to be typical of the trochoidal motion frequently associated with hurricanes. The lack of intensification under apparently favorable environmental conditions cannot be explained. The impact of such small-scale changes can be quite large, both on lives and property, and the causes for these changes remains an important subject for hurricane research.

After moving back over the water north of Cape Canaveral, David moved inland again near Savannah, Georgia, with little change in intensity from its earlier landfall. Even though the center of David stayed inland after moving into Georgia, it remained close enough to the coast to produce gale force winds well out to sea along the Atlantic seaboard. The storm weakened only slowly before losing tropical characteristics over New York State and the extratropical low continued to bring strong winds all the way to the Canadian maritime provinces.

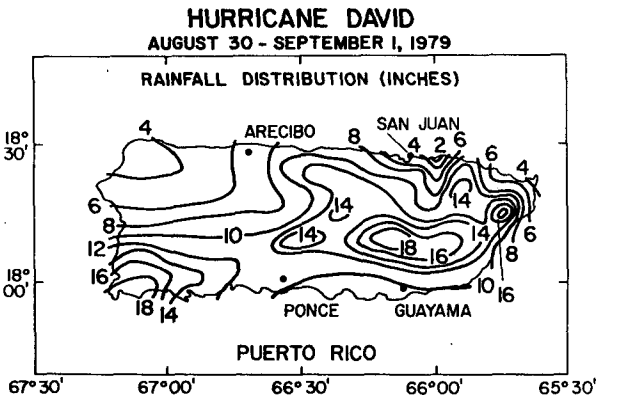

FIG. 5. Map of Hurricane David rainfall (inches) in Puerto Rico 30–31 August–1 September 1979. (Courtesy NWS San Juan Forecast Office.)

TABLE 4. Meteorological data of Hurricane David, 25 August–7 September 1979.

Location	Date	Pressure (inches) Low	Pressure (inches) Time[a]	Wind (mph) Fastest mile	Wind (mph) Time[a]	Wind (mph) Peak gust	Wind (mph) Time[a]	Tide (ft) Highest MSL	Tide (ft) Time[a]	Rainfall (inches) Storm total	Rainfall (inches) Dates	Remarks
Lesser Antilles												
Barbados (Seawell)	28	29.58	2300	S 29	29/1000	S 40	29/1600					
Martinique (Fort-De-France)	29	29.38	1000	W 52	1000	SW 62	0900					
Dominica (Roseau)	29					94[b]	1045			8.50[b]		Calm 1430–1500
Guadeloupe (Le Raizet)	29			NE 52	1200	NE 64	1200					
Antigua	29					58				2–3		
Montserrat	29					70–80[b]						
St. Maarten	29	29.76	2000			60	1805			1.82	29–31	
Puerto Rico and U.S. Virgin Islands												
St. Croix										11.55	8/30–9/1	
St. Thomas										6.03	8/30–9/1	
Puerto Rico												
San Juan	30			ENE 34	0800	ENE 43	0800			2.19	8/30–9/1	
Magueyes Island (S.W. Coast)	30					70–80[b]				19.90	8/30–9/1	
Dominican Republic												
Santo Domingo	31			100–125[b]								
Bahamas												
Georgetown, Exuma	2	29.46	0700	E 52	0700							
Kemps Bay, Andros	2	29.47	1300	NNE 69	1300							
West End, Grand Bahama	3	29.30	0655	ESE 46	0655							
Nassau, New Providence Is.	2	29.47	1045	E 48	1345	ENE 64	1245					
United States												
Florida												
Key West WSO	3	29.58	0500	N 26	0357	NE 39	2/1156	0.8[d]	0634	0.03		
Key West CG	3			N 25		N 36		1.0[e]				
Marathon CG	3			25		35						
Islamorada	3			30		40		2.0[e]				
Miami WSMO	3	29.33	0652	WSW 30	3/1050	44						
Miami CG	3	29.50				NE 58						
Miami Beach	3			NE 58	0300	69						
West Palm Beach WSO	3	28.87	1020	N 58	3/0925	N 75	3/0942	1.5		2.17	2–4	
Sikorsky ACFT	3					83				5.00	2–4	
Port Mayaca	3					80						
Canal Point	3					70						
Clewiston	3					57						
Jupiter	3	28.73				85				3.55	2–4	In eye
Highway A1A	3					92						
Jupiter Inlet CG	3			ENE 60[b]		80[b]						
Stuart	3	28.80	1300			N 69	1100					In eye 1145–1300
Jensen Beach	3	28.70	1300							3.38	3	
Sebring	3									7.91	3–4	
White City	3	28.69	1417									
Fort Pierce CG	3	28.73		NE 70		95		4.0[e]		8.92		In eye
Vero Beach	3	28.36	1400							8.10	3–4	
Fort Drum										7.30	3–4	
Kenansville												In eye
Melbourne FSS	3	28.68		ENE 31	1550	70	1448					
South Melbourne Beach	3			E 61		86	1600					
Port Canaveral CG	3			NE 60[b]		80[b]		4.0[e]				
Patrick AFB	3			NE 39		NE 68				6.28	3–4	
Kennedy Space Center	3	28.74	2219	E 46	2148	E 77	2113	5.0[e]		4.67	3–4	
Orlando WSO	3	29.19	2355	NNE 35	1458	N 54	1535					
Herndon Airport	3	29.20	2330	N 28	1553	N 52	1553			3.71	3–4	
Orlando	4					60				3.49	3–4	
Daytona Beach WSO	4	28.98	0208	NE 34	3/1755	NE 55	3/1728	5.3	1710	3.82	3–4	
Beachfront	3					66	3/2000†					
Halifax River	3							3.0[e]				
Ponce de Leon Inlet CG	3			ENE 40		60		3.0[e]				
Marineland	4	29.12	0315			67	3/2200			2.60	3–4	
Palm Coast	4	28.97	0354			68	3/1939					
St. Augustine	4	29.10	0300			ENE 48	3/2350			2.43	3–4	
Jacksonville WSO	4	29.20	0640	W 30	1155	NE 46	3/2359			2.91	3–4	
Jacksonville Beach						NE 55	3/2235			1.50	3–4	
Mayport CG		29.66		ENE 30		45		3.4[e]	3/2200			
Bar Pilot						52						
Fernandina Beach	4	29.13	1000			NW 47	0530					
Georgia												
Brunswick												
St. Simon Island	4			NE 40		45						
Savannah WSO	4	28.65	1755	E 58	1718	E 68	1707			6.86	4–5	In eye
River	4							12.0[d]				
Tybee Island	4							12.0[d]				

TABLE 4. (*Continued*)

Location	Date	Pressure (inches) Low	Pressure (inches) Time[a]	Wind (mph) Fastest mile	Wind (mph) Time[a]	Wind (mph) Peak gust	Wind (mph) Time[a]	Tide (ft) Highest MSL	Tide (ft) Time[a]	Rainfall (inches) Storm total	Rainfall (inches) Dates	Remarks
South Carolina												
Charleston WSO	4	29.36	1910	S 43	2346	SE 56	1830	8.8[d]		6.76	4–5	
Hilton Head	4					70[b]						
Columbia WSFO	5	29.26	0330	NE 28	4/1656	NE 43	4/1520			5.26	4–5	
Conway										7.43	4–5	
Eutawville										9.21	4–5	
Dillon										7.65	4–5	
North Carolina												
Brunswick County								3–5[e]				
Wilmington WSO	5	29.72	0451	S 40	1657	SE 46	0332			7.38		
Wrightsville Beach	5			SE 44	0325	SE 60	0325					
Lake Waccamaw										8.75	4–5	
Elizabeth Town										7.15	3–4	
Pender County								4.0[e]				
Jacksonville												
New River	5				0347	SSE 54	0347					
Atlantic Beach	5				1015	SSE 53	1015					
Havelock—Cherry Point	5				1432	S 41	1432					
Pamlico River								2–7[e]				
Cape Hatteras WSO	6	29.84	0200	SSW 35	0155	S 43	5/1507			10.73	4–6	
Hatteras										6.65	4–6	
Raleigh WSFO	5	29.12	1353	SSE 23	0953	E 36	0743			2.67	5–6	
Elizabeth City FSS										8.52	5–6	
Virginia												
Norfolk WSO	5					41	2250			4.31	5–6	
Richmond WSO	5	29.40		S 30	1900	SE 45	1602			2.71		
Montebello										6.60		
Maryland												
Baltimore (BWI ARPT)	6	29.32	0400	35	1923	52	1918			4.41	5–6	
Fort McHenry	6							4.0[e]	0100			
Silver Spring										6.89	5–6	
Forestville										7.50	5–6	
Delaware												
Wilmington WSO	6	29.49	0553	37	0128	53	0203	4.0[d]	5/2000	1.96		
New Jersey												
Atlantic City WSO	6	29.53	0535	SSE 35	0454	SE 51	0508			1.46	5–6	
City Office				SE 32	0400	SE 58	0505			1.85	5–6	
Trenton WSO	6	29.45	0330	SE 30	0500	SE 54	0446					
New York												
Binghampton WSO	6	29.39	0904	24	0445	35	0435			1.87		
Connecticut												
Bridgeport	6					S 69	0913					
Rhode Island												
Quonset Point	6					S 77	1145					
New Hampshire												
Mt. Washington	6					174	1500					

[a] Eastern Standard Time.
[b] Estimated.
[c] First of several occurrences.
[d] Above mean low water.
[e] Above normal.

3) METEOROLOGICAL DATA, DEATHS, DAMAGES

(i) Leeward Islands, Virgin Islands, Puerto Rico, Dominican Republic, Haiti, Bahamas. David reached maximum strength of 150 kt and minimum pressure of 924 mb south of Puerto Rico on 30 August, but there was little difference in strength when David struck Dominica and Santo Domingo. As usual, all wind equipment was destroyed during passage of the hurricane eye, but winds at both Dominica and Santo Domingo probably exceeded 125 kt. The strong winds levelled Dominica leaving 60 000 of the 80 000 residents homeless. Fig. 4 shows David near maximum strength shortly after devastating Dominica. Sustained hurricane force winds probably occurred on portions of Martinique, Guadeloupe, and the adjacent smaller islands. Crop damages on the islands of Dominica, Martinique and Guadeloupe were in the hundreds of millions of dollars. There were 56 deaths on Dominica, but none were reported on any of the other islands. Hurricane force winds may have occurred along the extreme southwest coast of Puerto Rico, but no storm surge of any consequence occurred in this area.

Instead, floods from torrential rains produced most of the deaths and damage, except those caused directly by winds at Dominica. In Puerto Rico, rainfall totals approached 20 inches in the southwest and east-central areas causing severe flooding

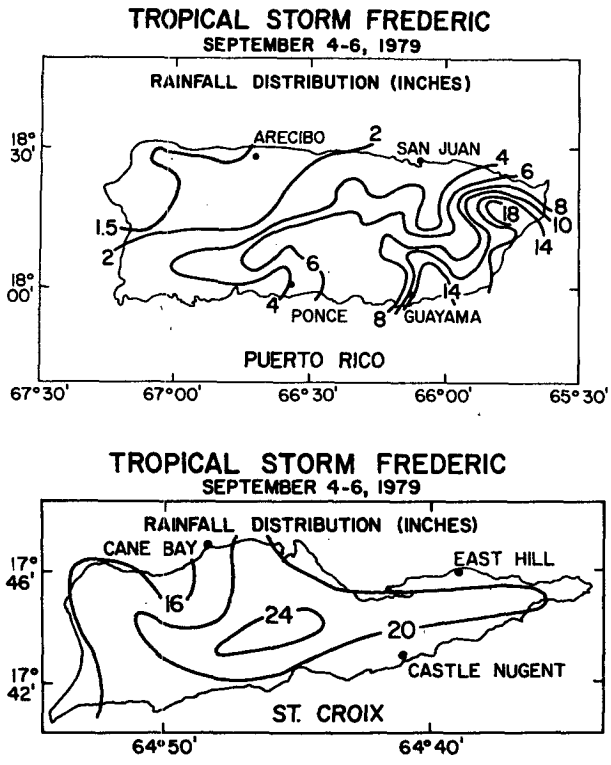

FIG. 6. Map of tropical storm Frederic rainfall (inches) in Puerto Rico and St. Croix 4–6 September 1979. (Courtesy NWS San Juan Forecast Office.)

over many sections on 31 August. Fig. 5 is a map of the David rainfall in Puerto Rico. Seven persons died there and damages were about $70 million. In the Dominican Republic, river floods accounted for most of the 2000 deaths and damage in excess of 1 billion U.S. dollars attributed to David by that country's government. More than 200 000 were left homeless in the Dominican Republic. David had little apparent effect on Haiti because of the rapid weakening of the storm after moving inland over the Dominican Republic. In the Bahamas, David was much weaker, but hurricane force winds likely occurred over Andros Island and Bimini. Table 4 gives meteorological data for David in the Caribbean area, the Bahamas and the United States.

(ii) United States. David was not a major hurricane when it struck the United States. The landfall central pressure of 972 mb and estimated maximum winds of 85 kt just north of Palm Beach, Florida, around midday on 3 September changed little before the second landfall near Savannah Beach, Georgia, approximately 24 h later. Savannah reported a minimum pressure of 970 mb. No sustained hurricane force winds were measured along the coast, but gusts of hurricane force were reported from Palm Beach northward to the Cape Canaveral area. Because of the acute angle at which the hurricane approached the Florida coast and its lack of strengthening, tides were only 2–4 ft above normal in most areas. Gale force winds occurred along most of the coastline from southeast Florida to Maine. Gusts exceeded hurricane force at Quonset Point, Rhode Island. On Mount Washington, New Hampshire, winds gusted to 152 kt. Damaging tornadoes associated with David occurred in Melbourne Beach, Florida, the District of Columbia and adjacent portions of Virginia and Maryland, and Delaware. Other tornadoes occurred in South Carolina, Pennsylvania, and New Jersey. Rainfall amounts ranged from 6 to 9 inches along the Florida east coast near the center passage, and from Georgia to Maryland along and east of the track of David. Wind and rain were responsible for widespread power outages all along the eastern seaboard. In the New York metropolitan area, 2.5 million people were without electricity at one time or another.

In the United States, there were five deaths directly attributed to David and there were about 10 more indirect deaths. Damage in the United States was not great at any one location, but the cumulative total caused by winds, tides, floods and tornadoes is estimated in excess of $320 million. Based on figures obtained from preparedness officials, approximately 400 000 persons evacuated vulnerable areas in advance of David.

e. Tropical Storm Elena, 29 August–1 September

Elena was named a tropical storm at the same time as Frederic. Ship, buoy and satellite data indicated a depression was forming from a weak tropical wave in the central Gulf of Mexico on the morning of 29 August. This was confirmed later in the day by an Air Force reconnaissance plane. Minimal tropical storm strength of 35 kt winds was reached the following afternoon, as the system moved west-northwest at ~10 kt. Because the forecast was for the storm to reach the Texas coast in 24 h, gale warnings were issued at 2200 GMT on the 30th from Port O'Connor, Texas to Morgan City, Louisiana. No further strengthening took place before landfall, however, as Elena remained under anticyclonically curved northerly flow at 200 mb throughout its existence. While this weather pattern sometimes allows initial development of a tropical storm, convection is usually stifled, and significant strengthening occurs only if this flow pattern changes.

Elena dissipated rather rapidly after moving inland near Matagorda, Texas, on the morning of 1 September, and could no longer be identified even as a tropical depression 24 h later.

The maximum sustained winds associated with Elena were 35 kt, and the minimum pressure of 1004 mb occurred during the evening of 30 August. The highest wind on land was a 40 kt gust at Galveston, Texas, on the evening of 1 September.

Highest tides were about 3 ft above mean sea level at Galveston and Baytown, Texas. The only heavy rain of consequence fell on downtown Houston, Texas, which recorded 4.6 inches, and Beaumont, Texas, which had 3 inches. Two persons drowned in Houston from flooding caused by the heavy rains. In a related incident, three crewmen were killed on a ship in Houston when it was struck by lightning and caught fire while thunderstorms associated with Elena were in the vicinity. Except for the ship, damage along the coast was minimal.

f. Hurricane Frederic, 29 August–14 September

1) METEOROLOGICAL HISTORY

The tropical wave from which Frederic developed left the west African coast late on 27 August with little to distinguish it from most other waves. By midday on 28 August, however, satellite pictures showed a rather large, circular area of convection south of the Cape Verde Islands. Peripheral ship and satellite data indicated that a tropical depression had formed by 0600 GMT 29 August. The depression gradually strengthened while moving westward at 18 kt for the next 24 h and reached tropical storm strength while centered near 11.5°N, 36.0°W about 1200 GMT on the 30th. Frederic continued at a remarkably steady 18 kt forward movement for the next 48 h while gradually turning toward the west-northwest. Conditions appeared ideal for Frederic to become a very intense hurricane as David had done in the same area. An eye became visible on infrared satellite pictures about 0600 GMT 1 September, and Frederic was upgraded to a hurricane near 13°N, 49°W in National Hurricane Center advisories.

About this time, the outflow from David, which had become a very intense hurricane and was lashing Hispaniola, began to spread over Frederic, stifling the latter's outflow, and the newborn hurricane weakened to a tropical storm again by 0000 GMT 2 September. Frederic gradually turned more toward the west and decelerated. The weakening trend continued until winds finally dropped below storm strength while Frederic was centered just north of Haiti about 1800 GMT 6 September.

Frederic passed over Puerto Rico and the Dominican Republic, which helped disrupt the low-level wind circulation. The storm actually moved toward the southwest at less than 10 kt while centered southeast of the Dominican Republic, and then suddenly changed course toward the northwest during the afternoon of 5 September, in a manner remarkably similar to David, passing just west of Santo Domingo about 0000 GMT on the 6th.

As David weakened over the northeastern United States, Frederic continued slowly westward over or just south of the Cuban coast for the next three days. Escaping the unfavorable influence of David, and now centered over open water, Frederic proceeded to strengthen beginning about midday on the 7th, and regained tropical storm strength ~100 mi east of the Isle of Pines, Cuba, about 0000 GMT on 9 September. Frederic turned toward the northwest during the next 48 h, moving at an average forward speed of 4 kt, and regained hurricane intensity over the western end of Cuba about 1200 GMT 10 September. Factors which probably contributed to the strengthening while the center was so close to land were the very warm sea surface temperatures of 29–30°C, the large cyclonic envelope of the storm, and the establishment of a large anticyclone at 200 mb over the storm.

Except for the trochoidal motion frequently observed with tropical cyclones, Frederic moved steadily northwest and turned to the north-northwest with a slow increase in forward speed for the next 60 h, the eye passing across Dauphin Island, Alabama, about 0300 GMT 13 September and the coastline near the Mississippi-Alabama border about 1 h later.

Frederic turned north and northeast and increased its forward speed to 20 kt during the next 24 h, losing hurricane intensity near Meridian, Mississippi, about 1200 GMT on the 13th, and becoming part of a frontal low-pressure area near the southwest corner of Pennsylvania about 1200 GMT on the 14th. The extratropical remnants of Frederic moved very rapidly northeastward through Pennsylvania, New York and western New England during the day, and exited from northern Maine that evening.

2) METEOROLOGICAL STATISTICS, DEATHS AND DAMAGES

(i) Leeward Islands, Virgin Islands, and Puerto Rico. Frederic weakened approaching the Leeward Islands and post-analysis indicates sustained winds had dropped below hurricane force well before the center reached the Leeward Islands. Maximum sustained winds were 25–35 kt with gusts of 45–60 kt. Rainfall amounts reported were 10 inches in 12 h in eastern Puerto Rico . . . 12 inches in 24 h in St. Thomas . . . and 24 inches in 30 h at St. Croix. Fig. 6 shows rainfall in Puerto Rico and St. Croix during Frederic's passage. A few tornadoes were reported in the Virgin Islands and Puerto Rico. Seven deaths were reported at St. Maarten when a fishing boat sunk.

(ii) Dominican Republic, Haiti, and Cuba. Frederic continued to weaken to a tropical depression while centered over eastern Cuba, but regained hurricane status before leaving western Cuba. Heavy rains exceeding 24 inches occurred over portions of the Dominican Republic, lasting for several days after the center passed, and augmenting the damage caused by David. Rains diminished as Frederic moved over eastern Cuba, but heavy rains and gale

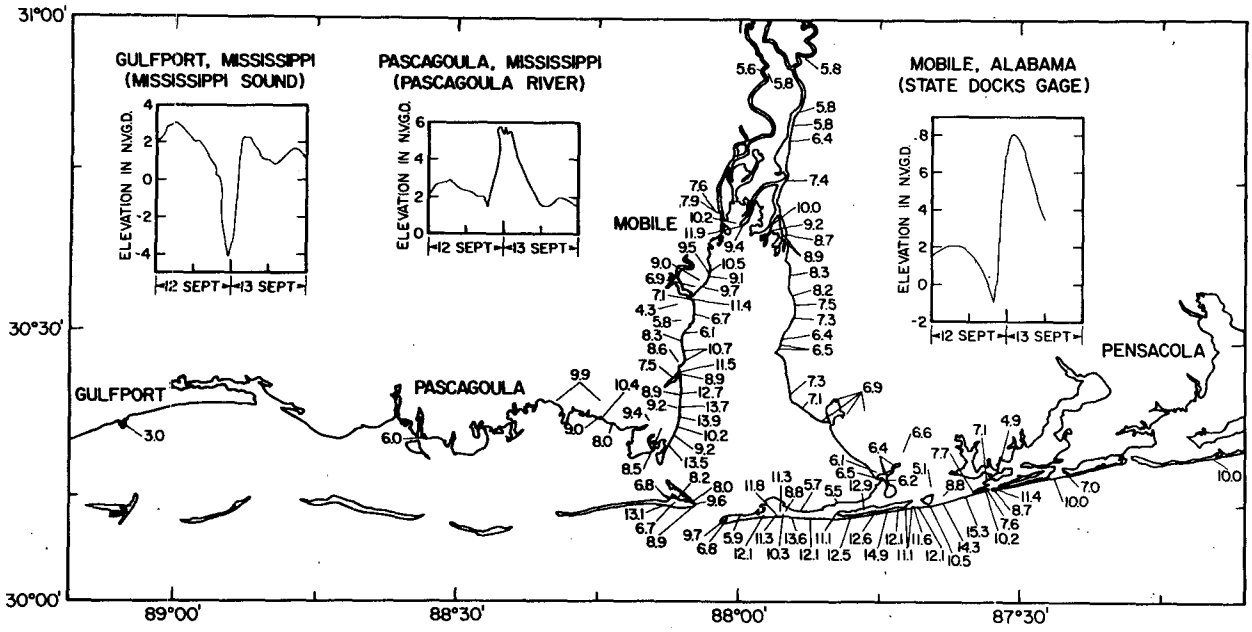

FIG. 7. High water marks associated with hurricane Frederic 12 September 1979. N.V.G.D. in insets is National Vertical Geodetic Datum of 1929, essentially mean sea level. (Courtesy U.S. Army Corps of Engineers, Mobile District.)

force winds were reported over western Cuba as the depression regained hurricane strength. No reports of deaths or damage have been received from these areas.

(iii) United States. As Frederic strengthened over the southeastern Gulf of Mexico, winds of 45–50 kt were reported at Dry Tortugas during the evening of the 10th and morning of the 11th.

The highest winds reported on land in squalls and gusts are as follows: Dauphin Island bridge 126 kt; Dauphin Island Sea Laboratory 119 kt before equipment destroyed; Pascagoula Ingalls shipyard 110 kt; Pascagoula Civil Defense 100 kt before equipment broke. Except for a brief period of 50 kt winds, sustained hurricane force winds were recorded on the Dauphin Island bridge anemometer (elevation 65 ft above water) for over 6 h from approximately 2300 GMT 12 September until 0500 GMT 13 September.

The maximum sustained winds in Frederic during its lifetime were estimated at 115 kt, based on aircraft reconnaissance and pressure-wind relationships. The NOAA research aircraft reported a 1500 flight level wind of 138 kt a short time prior to landfall—very close to the peak gust observed at Dauphin Island. The lowest central pressure of 943 mb was reported by an Air Force reconnaissance aircraft about 1200 GMT on the 12th, when the center was about 200 mi southeast of Mobile. However, the central pressure reported by reconnaissance aircraft during the last 6 h up to landfall was 946 mb. Unofficial pressure reports along the coast in the eye were Dauphin Island Sea Laboratory 943 mb, Grand Bay, Alabama 931 mb (appears unrealistic), Pascagoula Civil Defense 946 mb. The pressure reading of 943 mb at the Dauphin Island Sea Laboratory appears to be low, since it was not in the eye of the hurricane. Meridian, Mississippi had a minimum sea level pressure of 977 mb—the lowest in their records. Light winds were observed at Pascagoula CD for ~1 h and over the western end of Dauphin Island. Calm winds were *not* observed in Mobile.

Gale force winds in gusts occurred near the track of Frederic throughout eastern Mississippi, western Alabama, and many sections of Tennessee, Kentucky, southern Ohio, western portions of Pennsylvania and New York, and through western New England. Along the coasts, gale force winds or higher occurred from the eastern part of New Orleans southward to the Mississippi River delta, and eastward to the Panama City area, as well as along portions of the New England coast and Lakes Ontario and Erie.

Tides of 8–12 ft or more above normal were reported in the hurricane warning area from Pascagoula, Mississippi, to western Santa Rosa Island. Fig. 7 shows some of the high water marks associated with Frederic, as determined by the U.S. Army Corps of Engineers. Heights up to 15 ft above mean sea level were found in Gulf State Park, Alabama, to the east of Gulf Shores. Heights ranged from 7 ft on the east side of Mobile Bay to 12 or 13 feet along the middle west shore and at the causeway at the head of the Bay. The insets of Fig. 7 show some of the rapid changes in water levels as Frederic made landfall.

Rainfall amounts of 8 to 12 inches fell from Pascagoula to Mobile. Four to 7 inches were recorded through other parts of eastern Mississippi, western Alabama, and northwestern Florida northward

through Tennessee and Kentucky to southern Ohio and western New York. The heavy rains in Ohio and New York resulted from the interaction of the dying Frederic and a cold front, producing record floods which caused major damage.

The meteorological data for Frederic are presented in Table 5. Fig. 8 shows the rainfall distribution in Mississippi and Alabama. Of interest is the maximum just left of the track near the landfall point, and relative minimum just east of the landfall extending east-northeastward across Mobile Bay. This distribution of rainfall at the coast has been observed fairly often, and has been attributed in part to loss of precipitation in gages located in the path of the hurricane's extreme winds (usually just right of the track), or loss of gages themselves. However, radar displays during Frederic's landfall indicated a rather large echo-free area moving over the rainfall minimum in Fig. 8. Fig. 9 shows the Pensacola National Weather Service radar at 0204 GMT 13 September illustrating this.

Over a dozen tornadoes were reported, mostly along the Gulf coastal sections, but they caused no deaths or injuries and only minor property damage. Five deaths have been directly attributed to Frederic in the United States, only one of which occurred along the coast when a person was swept off a boat near Pensacola. The damage estimate of $2.3 billion makes Frederic the costliest hurricane ever to hit the United States, exceeding the $2.1 billion attributed to Agnes' floods in 1972. Insurance industry estimates of insured losses are $750 million. Based on information from preparedness officials, approximately 250 000 persons were evacuated in advance of Frederic.

g. Hurricane Gloria, 4–15 September

Gloria was the first storm of the 1979 season not to affect any land areas. It began as a well-organized African disturbance, and became a tropical depression soon after moving off the African coast on 4 September. It passed just north of the Cape Verde Islands, following a northwesterly course instead of the usual westerly course for early September. This northwesterly course is attributed to the influence of a pronounced trough in the westerlies over the east central North Atlantic.

Satellite picture classifications of wind speed indicated that Gloria reached tropical storm strength on 6 September, and hurricane strength early the following day, while located ~1000 mi southwest of the Azores. The hurricane moved steadily northwest about 10 kt for the next two days before turning to the southwest and weakening briefly to a tropical storm late on the 10th. The weakening and blocking of the hurricane was associated with a higher latitude frontal system and its following high-pressure area. After the high passed to the north, Gloria turned toward the northeast and accelerated in advance of the next frontal system, losing tropical characteristics ~300 mi northwest of the Azores late on the 14th, after merging with a large low-pressure system.

Satellite classifications of strength indicate Gloria reached its maximum intensity of 85 kt on 13 September with an estimated minimum central pressure of 975 mb. Gloria was a threat only to marine interests, and there have been no reports of damage sustained by shipping.

h. Hurricane Henri, 14–24 September

While Henri existed as a tropical cyclone for almost 10 days, only three of these were as a tropical storm or hurricane. At one time or another during its life, Henri headed in each direction of the compass without ever making a loop. In addition, Henri became only the second hurricane of this century to form in the Gulf of Mexico and not make landfall as a storm.

Henri formed from an African wave which moved into the extreme northwest Caribbean Sea on 14 September. Reports from a NOAA reconnaissance aircraft indicated that a depression had formed near Cozumel, Mexico late on the 14th. On the morning of the 15th an Air Force reconnaissance plane located the center north of the northeast tip of the Yucatan Peninsula. It was moving westward, as a large high-pressure system to the north blocked any northward motion. It is not certain whether the original center moved across the northeast Yucatan Peninsula during the previous night, or whether a new center formed in the broad envelope of low pressure as the original center dissipated.

Winds reached tropical storm strength on the morning of the 16th as the center turned southwest under the continued blocking influence of the large high-pressure system to the north. Henri became a hurricane during the early morning hours of 17 September as the center turned to the northwest when the ridge of high pressure over the northwest Gulf of Mexico weakened. A broad area of low pressure then developed over the western Gulf of Mexico, causing the movement of Henri to become slow and erratic. After reaching maximum strength of 75 kt and a minimum sea level pressure of 983 mb in the Bay of Campeche on 17 September, Henri weakened steadily for the next 48 h, and became a tropical depression on the afternoon of the 19th. One factor which may have contributed to the weakening of Henri was that some of the low-level inflow came from the land mass of Mexico, restricting the storm's moisture supply. Another was the development of a non-tropical low-pressure system near the central Texas coast which developed gale force winds and rains exceeding 10 inches, channeling the available moisture northwestward rather than into Henri's circulation. Air Force reconnaissance, satellite pictures and coastal radar information all indicated lack of tropical storm characteristics in this low-pressure

TABLE 5. Meteorological data of Hurricane Frederic, 29 August–14 September 1979.

Location	Date	Pressure (inches) Low	Pressure (inches) Time[a]	Wind (mph) Fastest mile	Wind (mph) Time[a]	Wind (mph) Peak gust	Wind (mph) Time[a]	Tide (ft) Highest MSL	Tide (ft) Time[a]	Rainfall (inches) Storm total	Rainfall (inches) Dates	Remarks
Lesser Antilles												
Antigua	3					62				12–14	3–5	
St. Barthelmy	3					80						
St. Maarten	3	29.48	1345			70	1400			12.00	3–5	
St. Kitts	3	29.54	1005			45–50	0945			11.59	3–5	
Saba	3			35	1346	52	1346					
St. Eustatius	3					75	1000			6.92	3–5	
Puerto Rico and U.S. Virgin Islands												
St. Croix										15–24	4–6	
St. Thomas	4			E 29	0800	E 52	0800			10–14	4–6	
St. John										10–14	4–6	
San Juan	4					ENE 38	0200					
Cape San Juan	4			ENE 58	0300							
Gurabo (N.E.)										18.07	4–6	
Cuba												
Guantanamo										>6.88	7–8	
Santa Cruz Del Sur	7			SSW 46	2000							
Bahia Honda	10	29.29	1100	NE 52	0100							
Paso Real De San Diego	10	29.28	0500	S 40	1100							
Pinar Del Rio	10	29.30	0800									
United States												
Florida												
Dry Tortugas	10			E 58	2000[d]							
Key West	11	29.67	0200	SE 29	10/2300	SE 43	10/1900					
Cape San Blas	12	29.56	1600	ESE 21	1800	ESE 40	1800	4.0[e]	1800			
Apalachicola WSO	12	29.66	1856	SE 25	1235	SE 35	1235	4.2[e]	1900			
Panama City CG	12							3.0[e]	2100			
Eglin AFB	12	29.51	1800	ESE 41	2119	ESE 56	2119			0.95	12	
Hurlburt AFB	12	29.38	1721	ESE 38[d]	1955	ESE 58	2029			1.38	12	
Destin CG	12	29.47	1745	ESE 55	1915	ESE 63	1900	3.0[e]	1915			
Pensacola FSS	12	29.18	1845	E 54	1944	E 78	2338			3.28		
Pensacola NAS	12	29.13	1830			E 96	1845					
Santa Rosa CG	12					98[b]	1800					
Santa Rosa Island	12							10.0				
Perdido Key	12							10.0				
Alabama												
Bay Minette	12									5.59		
Fairhope	12							9.0		4.62		
Gulf Shores	12							12.0				
Gulf State Park	12							15.0				
Fort Morgan	12							11.0				
Bayou La Batre	12							9.0				
Dauphin Island Sea Lab	12	27.84				137[e]				8.45	12–13	
Dauphin Island Churn	12					ENE 145	1939	10.0				
Dauphin Island West End	12							7.5				
Mobile WSO	12	28.38	2242	E 63	2257	E 97	2207			8.55[b]	12–13	
Mobile CD	12					101	2244					
Mobile State Docks	12							8.1				
Mobile 13 N Berry Steam Plant	12							5.5				
Montgomery WSO	13	29.54	0555	E 26	1712	SW 37	1348			0.87	13	
Birmingham FSS	13	29.42	1016	ESE 28	1005	ESE 48	1005			1.49	13	
Birmingham WSFO	13					53	0800[d]			1.42	13	
Tuscaloosa FSS	13	29.27	0853									
Anniston FSS	13	29.50	1452									
Hamilton	13									5.74	13	
Huntsville WSO	13	29.32	1355	ESE 38	1935	52	1935			2.00	13	
Mississippi												
Pascagoula CD	12	27.94	2250			115	2130[e]					
Pascagoula Churn	12	28.60	2100			127	2100					In eye 2138–2250
Pascagoula Coop	12									11.00[d]	12–13	
Pascagoula	12							6.0				
Ocean Springs	12					115[b]	2300					
Merrill	12									9.00	12–13	
Biloxi CD	12	28.82	2230			NW 98	2359					
Keesler AFB	12	28.62	2230	NNW 61	2129[e]	NW 98	13/0020[e]			7.40	12–13	
Gulfport	12					98	2300	3.0				
Bay St. Louis	12	29.10	2230			74						
Pearlington								3.3				
Meridian WSO	13	28.85	0615	N 45	0255[d]	N 69	0225[d]			4.46	13	

TABLE 5. (*Continued*)

Location	Date	Pressure (inches) Low	Pressure (inches) Time[a]	Wind (mph) Fastest mile	Wind (mph) Time[a]	Wind (mph) Peak gust	Wind (mph) Time[a]	Tide (ft) Highest MSL	Tide (ft) Time[a]	Rainfall (inches) Storm total	Rainfall (inches) Dates	Remarks
Meridian NAS	13	28.90	0700	NE 29	0400	NE 50	0400					
Laurel	13					83						
Jackson WSFO	13	29.40	0517	21	0254[d]	39	0514			1.53		
Columbia	13	29.27				51	0030					
Hattiesburg	13	29.01		70–80[b]		90[b]						
Poplarville	13					100[e]						
Louisiana												
New Orleans WSMO	12	29.47		NW 22	1750	NW 36	2052					
New Orleans FSS	12	29.42		NW 46	2300[d]	NW 58	2300[d]					
Slidell WSO	12	29.35										
Grand Isle CG	12	29.49		WNW 17	2100	WNW 32	2100	2.0[c]				
Boothville	12	29.29		48	1338	58	1419	4.5				
Lake Pontchartrain												
South Shore	12							3.7				
Midlake	12							3.7				
North Shore	12							3.4				
Miss. River Gulf Outlet	12							4.2				
Bogalusa	12									1.38	12	
Tennessee												
Nashville	13									6.19	13	
Kentucky												
Aberdeen										7.60	13–14	
Louisville										4.35	13–14	
Ohio												
30 E Akron										8.67	13–14	
Wooster										6.55	13–14	
New York												
Buffalo										4.94	14	

[a] Central Standard Time.
[b] Estimated.
[c] Above normal.
[d] First of several occurrences.
[e] Before equipment destroyed.

system, and it was handled in warning advisories accordingly.

The depression moved slowly eastward and northeastward during the next five days, never regaining significant convection. It remained just south of a cold front which had moved into the northern Gulf of Mexico, and finally became part of the frontal low pressure trough in the northern Gulf of Mexico on the 24th.

Henri threatened the southwest coastline of Mexico in the Bay of Campeche for a time, but there have been no reports of casualties or monetary losses caused by Henri.

3. Subtropical storms

Storm of 23–25 October

A frontal wave formed ~200 mi south-southwest of Bermuda on 23 October in response to a shortwave trough in the westerlies moving eastward from the southeastern United States. A rather classical development of a subtropical storm began during the afternoon of the 23rd as the low moved toward the north-northeast and gradually accelerated. Bermuda reported a minimum pressure of 1002 mb at 2100 GMT on the 23rd, and the first visible satellite picture classification of wind speed on the morning of the 24th indicated winds had reached 40 kt. Strengthening of the low was associated with the approach of a major trough in the westerlies, and the presence of a strong ridge to the north which eroded very slowly.

The storm accelerated to a forward speed of 25 kt during the afternoon of the 24th while continuing toward the north-northeast, passing through the North Atlantic shipping lanes south of Nova Scotia. An unidentified ship east of the center at 1800 GMT 24 October reported winds from the south-southeast at 65 kt with seas of 20 ft. Several other ships within 125 mi of the center reported winds of 45–50 kt. At 0000 GMT 25 October, Sable Island reported a pressure of 984.1 mb.

The storm began to lose its tropical characteristics after crossing the Gulf Stream, becoming extratropical as it approached Newfoundland, and merging with a larger extratropical low moving eastward over eastern Canada.

The lowest pressure was estimated to be 980 mb near Sable Island and the maximum sustained wind 65 kt. No effects on maritime interests have been reported.

4. Other significant systems

A tropical depression which formed in the northwestern Caribbean Sea west of Jamaica on 11 June

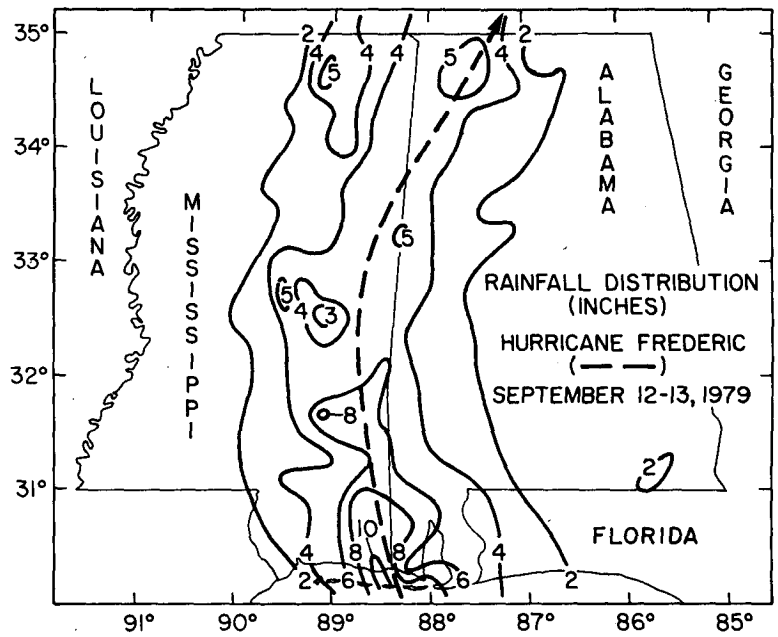

FIG. 8. Map of rainfall (inches) associated with Frederic in Mississippi and Alabama 12–13 September 1979.

produced torrential rains and record floods in the western parishes during the next two days. While maximum winds in the depression were 30 kt in squalls, the slow northeast drift of the depression during the next 36 h placed a convergence zone over the western part of the island. The depression center itself was 75 mi northwest of Negril on the 12th for the closest approach. The Kingston radar measured cloud tops to 67 000 ft on the evening of 12 June during the most intense period of rainfall. Friendship in the extreme northwest part of the island recorded over 32 inches of rainfall and much of extreme western Jamaica received in excess of 15 inches.

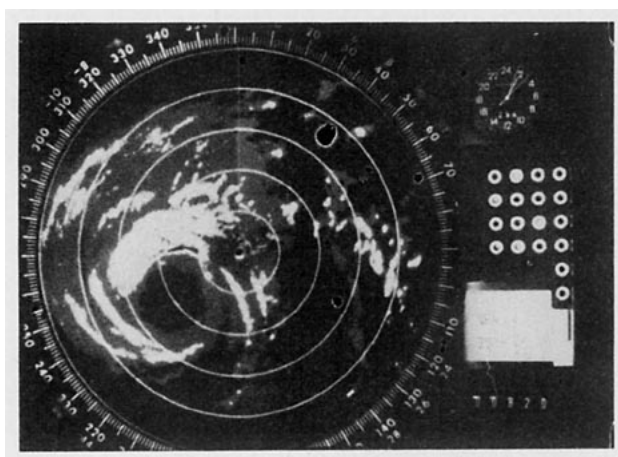

FIG. 9. Photograph of Pensacola, Florida NWS radar scope at 0204 GMT 13 September illustrating lack of heavy precipitation in area of rainfall minimum near Alabama coast in Fig. 8.

Because of saturated ground from previous heavy rains in the area, the flooding which followed led to one of Jamaica's worst meteorological disasters during the decade of the seventies, according to that country's Meteorological Service. Total damages are in excess of 100 million Jamaican dollars, including that to the over 1000 houses totally destroyed or badly damaged. There were 33 deaths according to the Jamaican government.

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