

## ANNUAL SUMMARY

### Atlantic Hurricane Season of 1986

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#### ABSTRACT

The 1986 hurricane season for the Atlantic basin is summarized. Six named tropical cyclones were tracked; two hurricanes, Bonnie and Charley, crossed the United States coastline.

#### 1. Introduction

Two tropical storms and four hurricanes, for a total of six named tropical cyclones, were tracked in the North Atlantic–Gulf of Mexico–Caribbean oceanic region during 1986. This compares with the past 50-year average of ten tropical cyclones per year with a 1-min surface wind speed estimate of  $17 \text{ m s}^{-1}$  or higher. There have been eight times in the past 50 years when there were six or less tropical storms or hurricanes. In contrast, an all-time high of 21 occurred during the 1933 season.

The 1986 tropical cyclone tracks are shown in Fig. 1, with statistics given in Table 1. The tracks in Fig. 1 are coded so that a dotted track represents tropical depression stage, a dashed track represents tropical storm stage and a solid line represents hurricane stage. The sustained surface wind speeds for each stage, given in the footnote of Table 1, define the three stages of a tropical cyclone.

Earl was the strongest hurricane of the season with an estimated 1-min sustained surface wind of only  $46 \text{ m/s}$ . Earl was also the longest-lasting hurricane, with hurricane-force winds persisting for 7 days. The other three hurricanes had sustained winds of  $33 \text{ m s}^{-1}$  or higher for less than 24 h. However, Bonnie and Charley crossed the United States coast while winds were of hurricane intensity.

#### 2. Individual storms

##### *a. Tropical Storm Andrew, 5–8 June*

On 5 June, a subtropical depression formed near the northern Bahama Islands. Surface wind observations showed a cyclonic circulation and upper-air soundings showed that this cyclonic circulation extended upward through the height of the 200-mb surface. This upper-level cyclonic curvature is a characteristic associated with subtropical cyclones as described by Merrill (1985).

The cyclone moved northward and lost its upper-level cyclonic pattern. By 6 June, surface winds reached tropical storm strength and Andrew was named. Andrew briefly posed a threat to the mid-Atlantic coast and gale warnings were issued on 7 June from Cape Lookout, North Carolina to just south of Virginia Beach, Virginia. However, the storm recurved to the northeast, its center passing about 100 km offshore from Cape Hatteras before dissipating at sea. Sustained surface winds reached  $23 \text{ m s}^{-1}$  on the east side of the storm and there were no sustained gales over land. One drowning death in North Carolina was attributed to Andrew.

##### *b. Hurricane Bonnie, 23–28 June*

###### 1) GENERAL DESCRIPTION

Bonnie's circulation originated within a frontal cloud system drifting southward across Florida and adjacent waters for several days. By 23 June, a surface circulation formed in the east-central Gulf of Mexico and moved slowly northwestward. Surface winds increased to storm strength on the next day. On the morning of 25 June, as the storm continued moving northwestward, gale warnings and a hurricane watch were issued for the upper Texas and western Louisiana coasts. Based on reconnaissance aircraft data, Bonnie was upgraded to a hurricane at 1600 UTC 25 June and hurricane warnings were issued from Freeport, Texas to just west of Morgan City, Louisiana.

The center of the hurricane crossed the coast on the morning of 26 June just southwest of Sea Rim State Park, Texas. Figure 2 is a visible satellite picture showing the cloud structure of Bonnie 6 h after landfall. The hurricane's clouds were totally isolated from any other cloud system, a common feature of tropical cyclones.

The weakening circulation was tracked northward across east Texas and western Louisiana, then north-

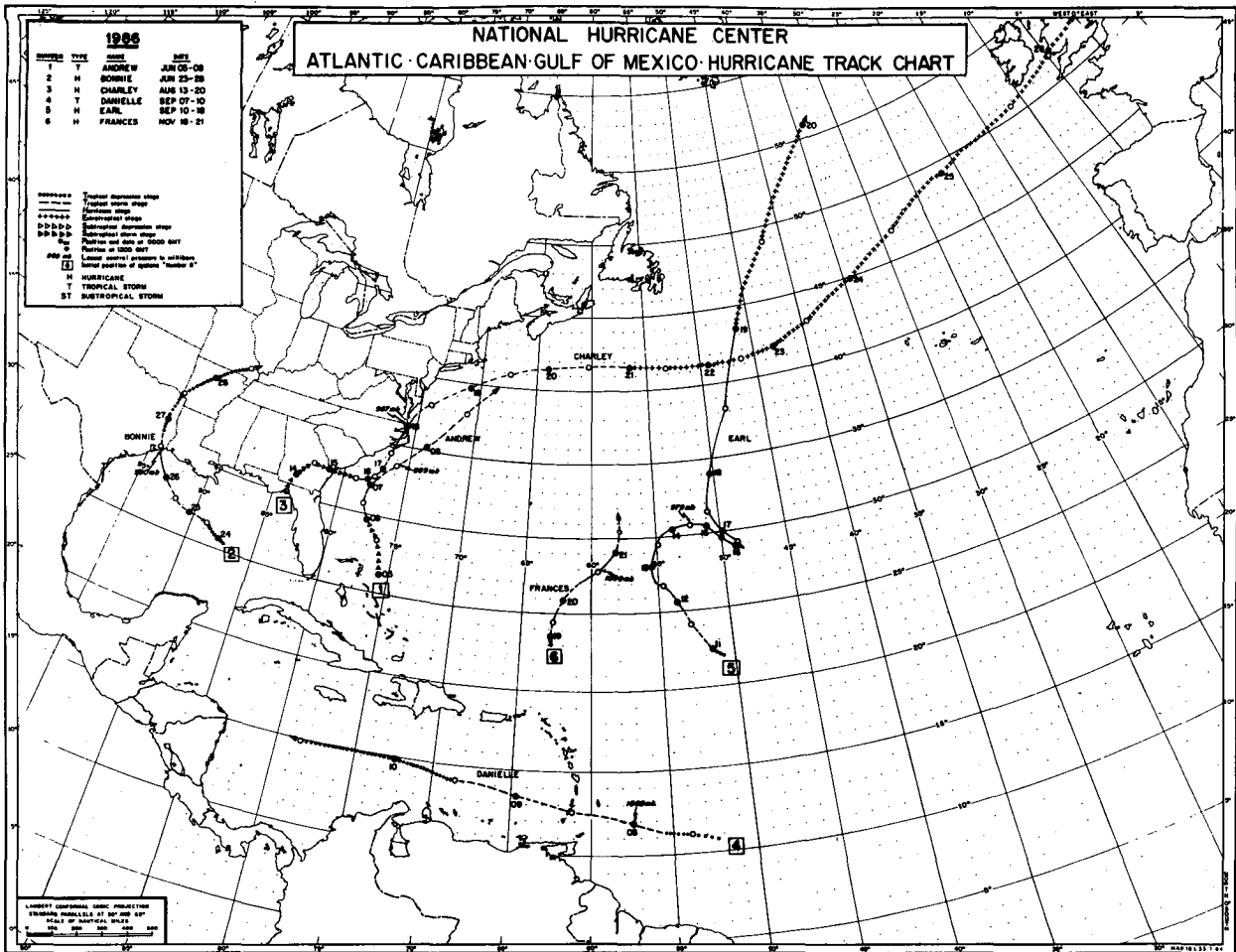


FIG. 1. Tracks of the 1986 tropical and subtropical cyclones.

eastward across Arkansas and into Missouri, before it was absorbed within another frontal cloud system on 28 June.

2) DATA

Table 2 lists selected surface observations from land stations affected by Bonnie. The lowest pressure ob-

served over land was 990.5 mb at Sea Rim State Park at 1000 UTC 26 June, the time of landfall. An hour earlier, a ship enroute from Sabine Pass to Galveston, Texas, passed through the center of the hurricane and measured a pressure of 990 mb.

The highest sustained surface wind over land was 34 m/s, also at Sea Rim State Park, 1 h after the pres-

TABLE 1. 1986 hurricane season statistics.

Number	Name	Class*	Dates†	Maximum sustained wind (m s <sup>-1</sup> )	Lowest press. (mb)	United States damage (millions of dollars)	Deaths
1	Andrew	T	5-8 Jun	23	999		1
2	Bonnie	H	23-28 Jun	39	990	2	3
3	Charley	H	13-20 Aug	36	987	15	5
4	Danielle	T	7-10 Sep	26	1000		
5	Earl	H	10-18 Sep	46	979		
6	Frances	H	18-21 Nov	39	1000		

\* T: tropical storm; wind speed 17.49-32.41 m/s (34-63 kt).

H: hurricane; wind speed 33.92 m/s (64 kt) or higher.

† Dates begin at 0000 UTC and include all tropical and subtropical cyclone stages.

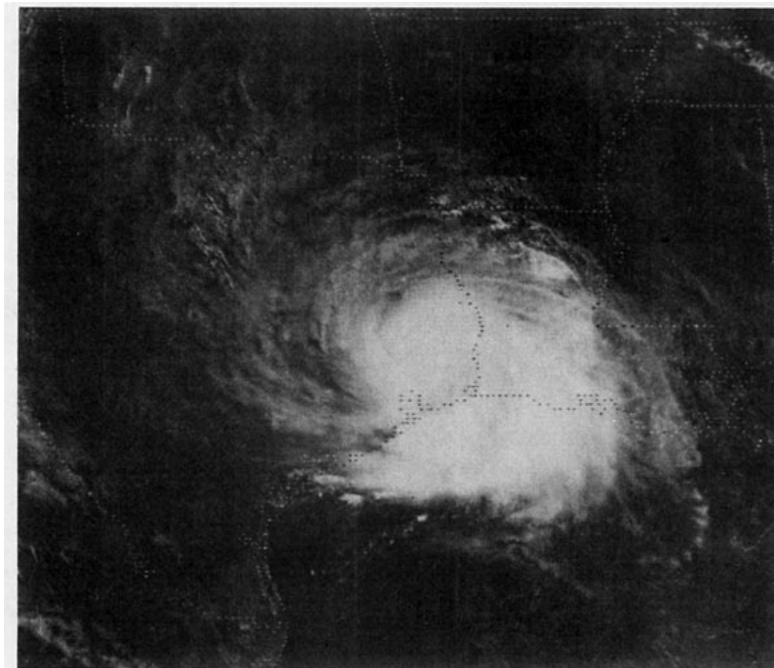


FIG. 2. Geostationary Environmental Satellite (GOES) visible picture of Bonnie at 1600 UTC 26 June 1986.

sure minimum. The highest reconnaissance aircraft wind speed measurement was  $38 \text{ m s}^{-1}$  at an altitude of 500 m and just a few hours before landfall. Oil rig WC 459A located 200 km south of Lafayette, Louisi-

ana, reported a sustained wind of  $37 \text{ m s}^{-1}$  as the hurricane went by.

The highest observed storm surge was 1.6 m above predicted astronomical tide height at Sabine Pass.

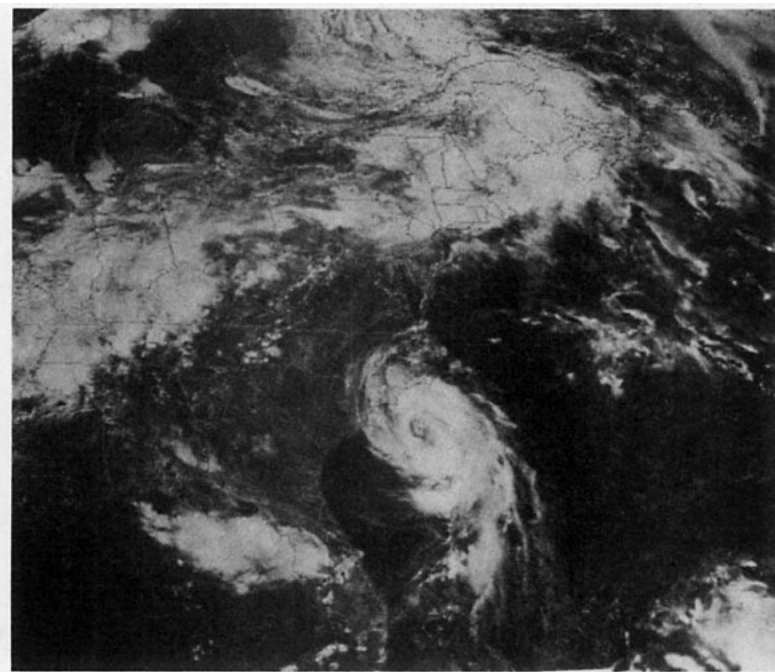


FIG. 3. Geostationary Environmental Satellite visible picture of Charley at 1630 UTC 16 August 1986.

Rainfall totals ranged up to 330 mm at Ace, Texas. Four tornadoes in east Texas and seven in Louisiana were reported. There were three deaths in the Port Arthur, Texas area attributed to Bonnie. The total damage estimate is two million dollars.

### c. Hurricane Charley, 13–30 August

#### 1) GENERAL DESCRIPTION

A broad circulation was first detected from satellite imagery on 12 August centered in the eastern Gulf of Mexico just west of Tampa, Florida. The circulation was tracked northward across the Florida Panhandle, then northeastward across Georgia and eastward back offshore on 15 August. This track was indicative of the low-level flow pattern around the western boundary of the Atlantic subtropical high pressure ridge. Then the depression strengthened into a tropical storm. Figure 3 shows Tropical Storm Charley on 16 August as it was drifting eastward to the south of North Carolina.

Charley turned northward on 17 August and strengthened to a hurricane. Its center moved across extreme eastern North Carolina and then turned northeastward and moved again over the Atlantic where its maximum winds fell below hurricane force. The tropical storm moved parallel to the northeast

United States coast and then headed out to sea. It gradually was transformed into a large extratropical storm with gale-force winds spreading out far from its center. In this form, the storm moved across the North Atlantic shipping lanes and was tracked to the British Isles and northern Europe by the end of August.

Gale warnings were initially issued for portions of North Carolina on 16 August, several hours after the time of the satellite picture in Fig. 3. For the next 2 days, 17 and 18 August, hurricane warnings were issued piecemeal from Bogue Inlet, North Carolina to Sandy Hook, New Jersey, including Pamlico and Albermarle Sounds and southern Chesapeake and Delaware bays. Gale warnings were issued as far north as Chatham, Massachusetts.

#### 2) DATA

Table 3 shows that the lowest surface pressure reported on land was 992.6 mb at Swanquarter, North Carolina at 1850 UTC 17 August. At 2100 UTC, a reconnaissance aircraft measured 987 mb while flying over Albemarle Sound.

The highest sustained surface wind speed was 43 m s<sup>-1</sup> at the Chesapeake Bay Bridge and Tunnel at 2300 UTC, on the east side of the hurricane's center. The

TABLE 2. Selected observations of Hurricane Bonnie, June 1986.

Location	Minimum sea level pressure (mb)		Maximum surface wind speed (m s <sup>-1</sup> )			Storm surge <sup>†</sup> (m)	Rain <sup>‡</sup> (mm)
	Pressure (mb)	Time (UTC) date	1-min average	Peak gust	Time (UTC)* date		
<b>Texas</b>							
Ace							330.2
Alvin			8	11	2007 26 June		15.7
Anahuac			18				
Bolivar Peninsula						1.2	
Galveston	1011.1	0910 26 June	12	15	0930 26 June	0.7	9.7
Goodrich							228.6
High Island				39			161.5
Hobby Airport	1012.4	0848 26 June	9	13	2048 26 June		1.0
Houston Airport	1012.7	0852 26 June	10	14	2252 25 June		3.8
Livingston Dam							292.1
Port Arthur	1004.5	1242 26 June	25	34	1254 26 June		123.7
Sabine Lake	1010.0	1146 26 June	18	28	1146 26 June		
Sabine Pass	1005.1	1000 26 June	28			1.6	
Sea Rim State Park	990.5	1000 26 June	34	44	1100 26 June		
Vidor							203.2
Winnie				28			
<b>Louisiana</b>							
Calcasieu Pass						0.9	
Cameron	1012.9	0900 26 June	24	28	1138 26 June		
Lake Charles	1013.6	0758 26 June	11	19	1237 26 June		12.4
New Orleans Intl. Airport	1015.0	0650 26 June	6	9	1352 25 June		
Slidell	1015.4	0654 26 June	10	14	1521 25 June		7.6

\* Time of 1-min wind, except when only a gust is given.

† Tide height above normal.

‡ Storm total.

TABLE 3. Selected observations of Hurricane Charley, August 1986.

Location	Minimum sea level pressure (mb)		Maximum surface wind speed ( $m s^{-1}$ )			Storm surge <sup>†</sup> (m)	Rain <sup>‡</sup> (mm)
	Pressure	Time (UTC) date	1-min average	Peak gust	Time (UTC)* date		
North Carolina							
Atlantic Beach			16	26	1130 17 Aug.		
Buxton	999.3	1605 17 Aug.	22	29	1630 17 Aug.	0.2	69.3
Cape Lookout			21	26	1100 17 Aug.		
Cherry Point	998.6	1355 17 Aug.	13	17	1230 17 Aug.		40.6
Duck			25	34	2000 17 Aug.		
Frisco	999.3	1645 17 Aug.	25	35	1725 17 Aug.		
Jacksonville	1000.3	1056 17 Aug.	9	13	1656 17 Aug.		21.6
New Bern	1002.7	1450 17 Aug.	8	11	1450 17 Aug.		43.4
Swanquarter	992.6	1850 17 Aug.	26	35	1930 17 Aug.		
Wilmington	1004.1	0905 17 Aug.		29			12.2
Virginia							
Cape Henry			24	37	2300 17 Aug.		
Chesapeake Bay Bridge and Tunnel			43	47	2300 17 Aug.	0.8	
Norfolk	999.0	0100 18 Aug.	18	28	0050 18 Aug.		27.4
Maryland							
Assateague Island				33	1000 18 Aug.		82.6
Baltimore	1008.8	0930 18 Aug.		13	1858 17 Aug.		7.4
Bryantown							90.7
Churchton							90.9
Hollywood							107.7
Mount Victoria							69.9
Ocean City			22	35	1030 18 Aug.	0.6	68.6
Patuxent NAS							54.1
Prince Frederick							39.6
Salisbury	1000.3	1000 18 Aug.		21	0700 18 Aug.		43.2
Delaware							
Georgetown							3.8
Lewes							11.9
Rehoboth Beach	1000.3	1000 18 Aug.	23	34	1100 18 Aug.		
Wilmington	1006.4	1000 18 Aug.	9	13	1157 18 Aug.		0.5
New Jersey							
Atlantic City	1005.9	1251 18 Aug.	18	26	1450 18 Aug.	0.5	33.0
Long Beach Island			26	34	1200 18 Aug.		
New York							
Islip							13.2
JFK	1010.2	2000 18 Aug.	8	16	2000 18 Aug.	0.6	6.6
La Guardia							20.8
New York City			8	16	2000 18 Aug.		9.1
Massachusetts							
Chatham	1005.0	0650 19 Aug.	17	21	0313 19 Aug.		68.1
Nantucket Island	1005.8	0530 19 Aug.	27		0530 19 Aug.	1.2	81.3

\* Time of 1-min wind, except when only a gust is given.  
<sup>†</sup> Tide height above normal.  
<sup>‡</sup> Storm total.

highest aircraft wind speed was  $34 m s^{-1}$  at the altitude of the 850-mb pressure. Wind speeds of tropical storm strength were reported in Virginia, Maryland, Delaware, New Jersey and Massachusetts.

The peak storm surge reported was 1.2 m above normal astronomical tide at Nantucket Island, Massachusetts. Rainfall totals ranged to a maximum of 107.7 mm in Maryland.

Five deaths were associated with Charley: three in Maryland, one in North Carolina and one in Virginia. The total damage estimate is 15 million dollars.

*d. Tropical Storm Danielle, 7–10 September*

Danielle can be traced back to a disturbance that moved westward off the African coast on 1 September. By the morning of 7 September, satellite pictures showed that a low-level circulation was approaching the Lesser Antilles of the Caribbean and, on the same afternoon, wind speeds were estimated to have reached storm strength.

The storm moved west-northwestward through the Windward Islands on 8 September, causing some crop damage at St. Vincent and the Grenadine Islands. Danielle continued into the central Caribbean, where the low-level circulation separated from the deep convection which is believed to be the primary energy source of tropical cyclones. By 10 September, the circulation had dissipated.

Aircraft reconnaissance indicated that the strongest winds at an altitude of 500 m were  $25 \text{ m s}^{-1}$ , on 8 September, when the storm was passing through the Windward Islands.

*e. Hurricane Earl, 10–18 September*

Following Danielle's origin by a few days, another tropical disturbance moved off the African coast on 4 September. However this disturbance was located several hundred kilometers farther north.

After moving across the tropical Atlantic, this system turned northward and, on 9 September, interacted with an upper-level circulation. This resulted in the formation of a low-level circulation on 10 September, centered 2000 km east of Puerto Rico.

The depression quickly intensified, and when a reconnaissance aircraft reached the area late on 11 September, flight-level winds were  $39 \text{ m s}^{-1}$ . On the next day, an aircraft measured a broad area of winds near  $40 \text{ m s}^{-1}$  and a highest wind of  $46 \text{ m s}^{-1}$ . This intensity lasted from 12 to 15 September. During this time, Earl's northward motion ceased and the hurricane drifted eastward. Then on 16 September, a northward motion

was resumed and, in response to an approaching frontal trough, Earl headed into the far North Atlantic where it became extratropical.

Earl was a hurricane for 7 days and was the longest-lasting, as well as the most intense, hurricane of the season.

*f. Hurricane Frances, 18–21 November*

Frances was a late November tropical cyclone that, like Earl, remained at sea. Frances reached hurricane status for 24 h while located several hundred kilometers southeast of Bermuda.

The disturbance which became Frances was observed on 15 November as a cloud system located near the Lesser Antilles and extending north and east into the Atlantic. On 17 November, a cloud circulation was detected, centered 500 km east-northeast of San Juan. The circulation moved north-northwestward and was estimated to have become a depression with a closed surface circulation at 1800 UTC 18 November.

A ship report of wind speeds of  $18 \text{ m s}^{-1}$  at 0600 UTC 19 November at a position 185 km southeast of the center indicated that the system was a tropical storm. Aircraft confirmed this 12 h later with a flight-level wind of  $25 \text{ m s}^{-1}$  and an estimated surface pressure of 1004 mb. On the next day, another aircraft reported flight-level winds of  $39 \text{ m s}^{-1}$  and a surface pressure of 1000 mb; this was the basis for upgrading Frances to a hurricane.

Frances accelerated north to northeastward on 19 and 20 November. Temporarily blocked by high pressure to its north, Frances decelerated and then quickly dissipated on 21 November as it merged with an extratropical low that was moving out to sea from the Canadian Maritime Provinces.

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