

PRELIMINARY REPORT

Hurricane Florence (7 - 11 September 1988)

a. Synoptic history

The first eleven days of September were quite active meteorologically over the western Gulf of Mexico. Hurricane Debbie passed across the Bay of Campeche from 1 to 2 September and made landfall in Mexico. Tropical Depression Ten formed and made landfall over east Texas/western Louisiana on 3 September, ahead of a cold front which would serve as the catalyst for Florence. The next day, the cloud band accompanying the cold front had left the Texas coast and was entirely over the Gulf of Mexico. On 5 September the convective band moved southeastward and was located from Vera Cruz, Mexico to Tampa, Florida. The next day the band remained nearly stationary but began to split over the central Gulf as a frontal wave developed over the northern portion and began moving northeastward. Concurrently, the southern portion began showing signs of tropical organization. The surface pressures associated with the southern portion of the frontal trough were generally low as indicated by a sampling of ship observations shown in Table 1. By 7 September convection had organized a spiral band structure but deep convection was for the most part transitory. A surface circulation appeared to have formed by 0600 UTC, 7 September while centered about 180nm northwest of Merida, Mexico. Tropical depression advisories were began at 1600 UTC on that day and at 1800 UTC the depression was upgraded to Tropical Storm Florence when Air Force reconnaissance and satellite imagery analysis estimated that the surface wind speed associate with the system reached 35 knots.

Figure 1 shows Florence's best track and Table 2 lists the best track statistics. Tropical Storm Florence drifted generally eastward on 7 September, following the remains of the frontal trough and then became stationary the next day as the Atlantic ridge built strongly northwestward, bridging the frontal remnants. The steering currents were weak during this period but the mean mid to upper level trough position was forecast to remain essentially stationary over the lower Mississippi Valley. Thus on 9 September due to the position of the trough and the strengthening of the Atlantic ridge, the northward movement of Florence began.

The forward speed of Florence averaged 10 knots for the first half of 9 September and 13 knots for the second half, as the system accelerated northward. The maximum intensity of was reached just before landfall at 2300 UTC 9 September with landfall occurring over the western Mississippi Delta 3 hours later. Figures 2 and 3 give the best track wind and pressure curves as a function of time along with the data on which they are based. Florence weakened quickly, losing all its deep convection as it passed across New Orleans and over the west half of Lake Pontchartrain. Maximum sustained winds were reduced below tropical storm strength by 1200 UTC 10 September when the system was centered just northwest of Baton Rouge. The remnants of Florence could be followed for one more day to extreme northeast Texas where it could no longer be defined.

b. Meteorological statistics

Florence was a hurricane for only about 12 hours. The highest surface wind estimated by Air Force reconnaissance was 85 knots at 2310 UTC on 9 September just before landfall. The highest sustained wind speed near the surface was 70 knots measured on oil platform, MP73 (height unknown), located near 29.3N 88.9W at 0511 UTC 10 September. The lowest surface pressure reported by Air Force reconnaissance was 982mb near the time of landfall. An automatic Coast Guard weather station (8R3) located at the Southwest Pass of the Mississippi Delta reported a surface pressure of 987mb with a calm wind as the eye of the hurricane passed. The closeness of reliable observations within and surrounding New Orleans, showed that the center of Florence passed directly over the city and the western portion of Lake Pontchartrain. Table 3 contains selected surface landfall observations.

Rainfall amounts were generally light for a hurricane making landfall in southeastern Louisiana. The 24 hour rainfall amounts ending at 1200 UTC, 10 September, ranged from 1.50 to 3.50 inches within 50 miles of Florence's track. The greatest amounts were concentrated in the extreme southeast portion of the state near the landfall area at the Jean Lafitte National Wildlife Refuge which received a 24-hour total of 3.25 inches. Another area of large rainfall totals was centered northwest of Baton Rouge, where most stations reported totals near 2.50 inches for the 24-hour period. It was in this area that the largest 24-hour rainfall total, 4.05 inches, was reported by a cooperative observer at Watson, Louisiana.

Highest storm tides were reported at the same time east of New Orleans on the Bayou Benvenue which reached 7.5 feet above Mean Sea Level (MSL) and on the Industrial Canal where the maximum height reached 6.5 feet above MSL. As the storm passed across the western portion of Lake Pontchartrain the high water changed rapidly across the Lake from 5.0 feet above MSL at the West End Marina at 0800 UTC to 4.8 feet above MSL near the north end of the Lake Pontchartrain Causeway at 1200 UTC, 10 September.

There were no reports of tornadoes over southeastern Louisiana where Florence made landfall, giving an indication of the weak convective activity associated with the center of the storm. Nevertheless, nine tornadoes were reported in Walton County and one waterspout was reported in Bay County over the Florida panhandle, far from the center of the hurricane. Satellite imagery showed a significant convective band associated with Florence, moving across the western Florida panhandle at this time. In general little to no wind or storm surge damage occurred along the Mississippi and Alabama Gulf coasts and the 24-hour rainfall totals in this area were less than 3 inches.

c. Casualty and damage statistics

There were no deaths or injuries attributed to Hurricane Florence in Louisiana, however, one man died in Alabama while attempting to secure a boat in Mobile Bay. An estimated 20,000 people were evacuated from the coastal Parishes of Louisiana, including nearly all 2000 Grand Isle residents. Minor storm surge flooding occurred mostly outside the levee system of Plaquemines, St. Bernard, and St. Tammany Parishes. Grand Isle suffered extensive beach erosion, losing approximately 40 feet of beach. Light to moderate wind damage was mostly confined to trees throughout the parishes of Orleans, Jefferson, Plaquemines, St. Tammany, and St. Bernard, causing extensive electrical power outages. It is estimated that 150,000 people were without power for some period of time during the storm. Total damage from Hurricane Florence in southeast Louisiana is estimated to range between 2.0 and 2.5 million dollars.

Besides Louisiana, the states of Mississippi and Alabama were affected slightly by Florence. Minor evacuations occurred in each state for residents living in low-lying or coastal areas, but no reports of damage were received. The panhandle of Florida, however, was an exception. The worse flooding in ten years occurred when rainfall from Florence was adding to the already swollen rivers of Coldwater and Blackwater in Santa Rosa County. Thirty homes were destroyed and fifty more were damaged along their banks with uninsured losses of \$320,000. Damage was estimated at \$100,000 due to the tornadoes in Walton County and the waterspout in Bay County.

d. Warning and forecast critique

A summary of the watches and warnings associated with Florence are listed in Table 4. The warnings and their adjustments as the hurricane approached the coast were appropriate as information concerning the storm was received from various sources. Issuing tropical storm warnings from Pensacola to Apalachicola was particularly good because of the strong convective band located outside the Hurricane Warning area. The warning was fortuitous since some of the most severe weather associated with Florence occurred over the western Florida panhandle. Table 5 lists the probabilities computed for the public advisories during Florence.

The numerical forecast guidance was poor in the early stages of Florence when the system was quite weak and then nearly stationary. The first Quasi-Lagrangian Hurricane Model (QLM) forecast was run at 0000 UTC 8 September and predicted a northward motion until landfall and then a track to the northwest afterwards. Meanwhile the other numerical forecast guidance, most of which is highly dependent on the initial motion (in this case, a 100 degree heading at 5 knots), diverged widely. Although the forecast verification statistics were unavailable at the time of this writing, NMC's QLM appeared to have performed the best during Florence, consistently forecasting a northward motion until landfall and then a track to the northwest.

Figure captions:

Figure 1. Best track of Hurricane Florence, 7 - 11 September, 1988.

Figure 2. Maximum one-minute surface wind speed versus time for Hurricane Florence, 7 - 11 September, 1988.

Figure 3. Minimum central surface pressure versus time for Hurricane Florence, 7 - 11 September, 1988.

TABLE 1. Surface Reports Associated with Hurricane Florence

<u>DATE</u>	<u>TIME</u> (UTC)	STATION	<u>POSITION</u>		<u>PRESSURE</u> (MB)	<u>WIND</u> (DIR/KT)
			<u>LATITUDE</u>	<u>LONGITUDE</u>		
9/06	0600	SHIP	26.0	93.4	1009.2	NNE/20
9/06	0600	SHIP	22.4	90.6	1005.7	SE/20
9/06	1200	SHIP	22.4	88.1	1006.0	S/20
9/06	1800	SHIP	21.7	93.6	1000.7	WNW/30
9/09	0600	42001	25.9	89.7	1002.4	
9/09	1200	42001	25.9	89.7	997.3	

FLORENCE

- Tropical depression stage
- Tropical storm stage
- Hurricane stage
- +++++ Extratropical stage
- △△△△ Subtropical depression stage
- ▽▽▽▽ Subtropical storm stage
- Position and date at 0000 GMT
- Position at 1200 GMT
- 982 Lowest central pressure in millibars
- 6 Initial position of system "Number 6"
- H HURRICANE
- T TROPICAL STORM
- ST SUBTROPICAL STORM

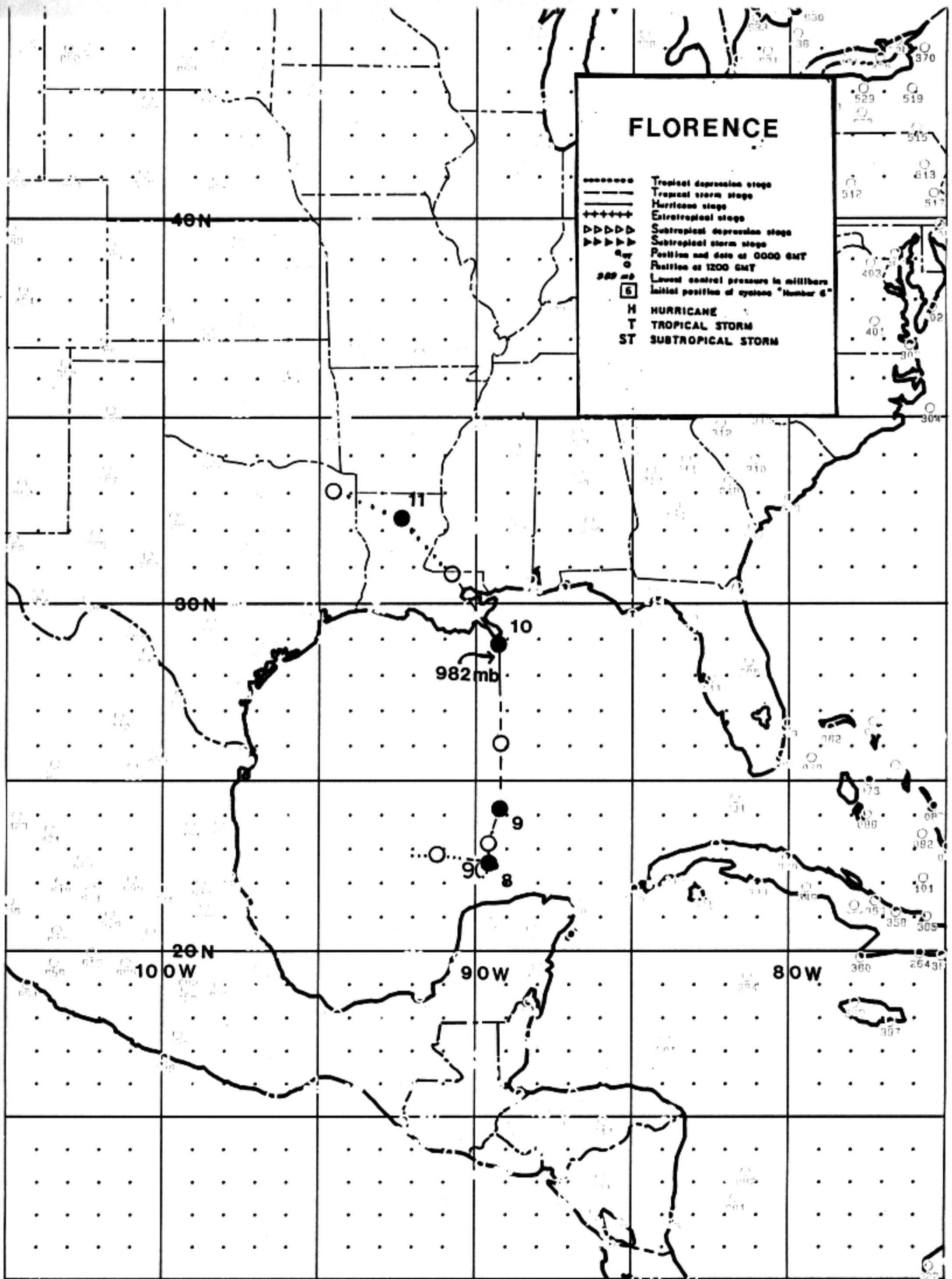
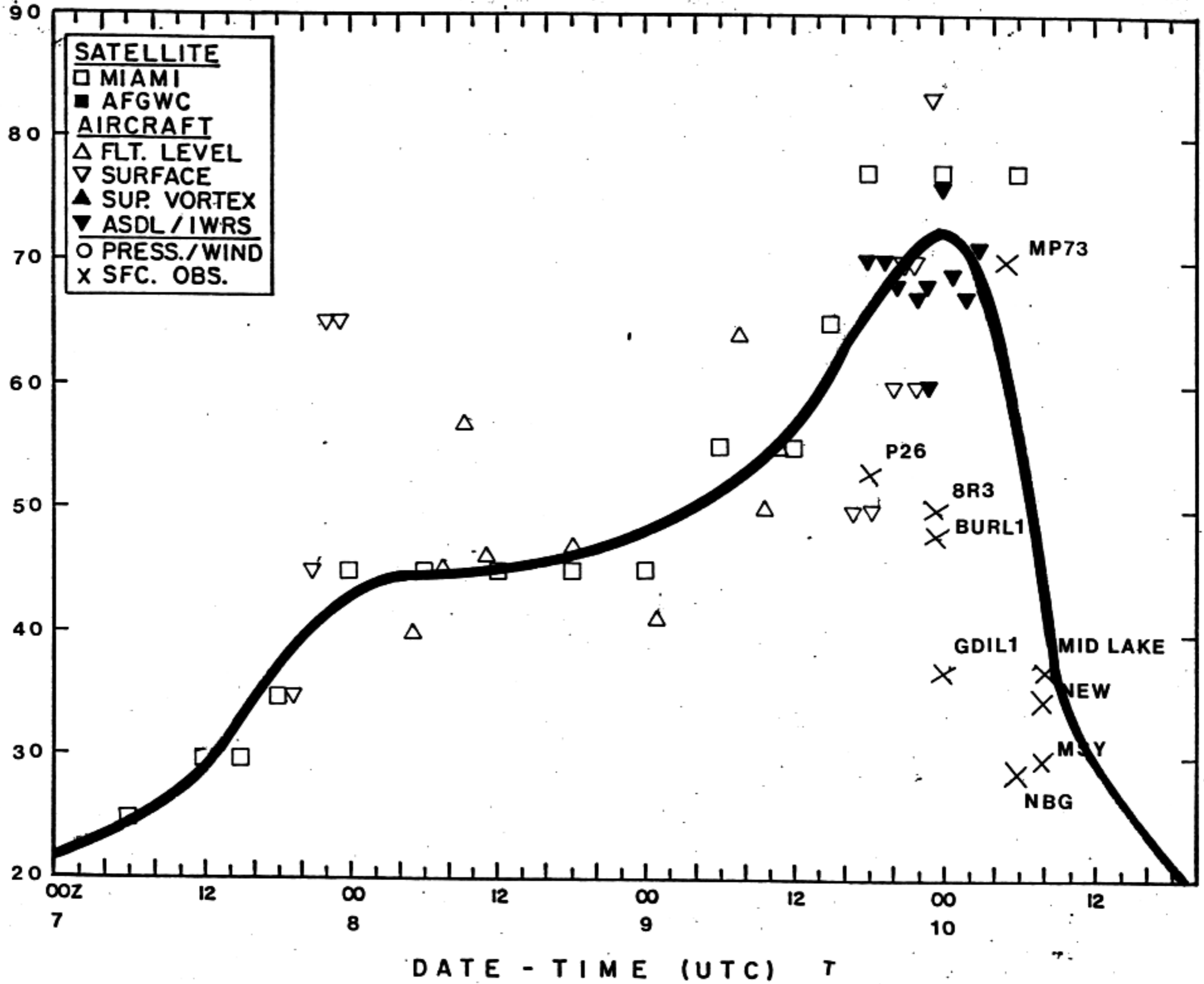


TABLE 2. Preliminary Best Track -- Hurricane Florence

DATE	TIME (UTC)	POSITION		PRESSURE (MB)	WIND (KT)	STAGE
		LATITUDE	LONGITUDE			
9/07	0600	22.8	92.0	1000	25	Tropical Depression
"	1200	22.8	91.2	998	30	" "
"	1800	22.7	90.2	996	40	Tropical Storm
9/08	0000	22.6	89.6	993	45	" "
"	0600	22.7	89.8	990	45	" "
"	1200	23.1	89.7	990	45	" "
"	1800	23.4	89.5	992	45	" "
9/09	0000	24.2	89.2	992	50	" "
"	0600	25.0	89.2	991	50	" "
"	1200	26.1	89.2	988	55	" "
"	1800	27.4	89.2	985	65	Hurricane
9/10	0000	28.7	89.3	983	70	"
"	0600	29.7	89.7	988	60	Tropical Storm
"	1200	30.7	90.7	998	30	Tropical Depression
"	1800	31.8	91.5	1003	20	" "
9/11	0000	32.4	92.3	1007	15	" "
"	0600	32.7	93.3	1009	15	" "
"	1200	33.0	94.5	1010	15	" "
<hr/>						
9/09	2300	28.5	89.3	982	70	Minimum Pressure
9/10	0200	29.1	89.3	984	70	Landfall

WIND SPEED (KTS.)



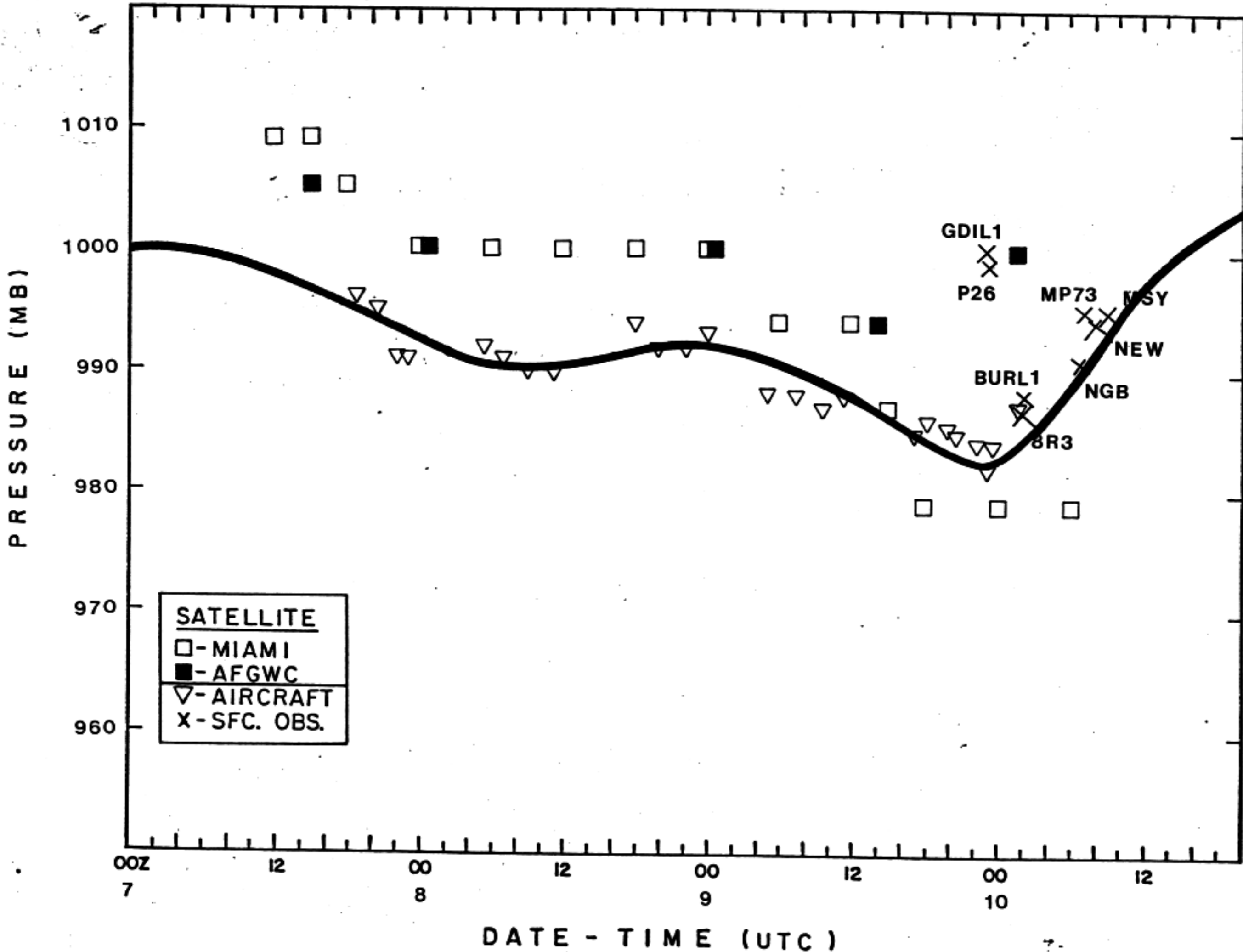


TABLE 3. Hurricane Florence selected surface landfall observations

Location	Minimum sea level pressure(mb)		Maximum surface wind speed(kt)			Storm surge(ft)	Rain (in)
	Pressure	Date/time (UTC)	1-minute average	Peak Gust	Date/time (UTC) ¹	Tide height above normal	Storm total
Louisiana							
Tower (GDIL1) *	999.5	09/2300	37	41	09/2200		
Tower (P26) *	999.0	09/2311	53		09/1711		
Tower (BURL1) *	988.0	10/0200	56	66	09/2300		
Coast Guard (8R3)	987.0	10/0200	50	56	09/2300		
Belle Chase (NBG)	990.9	10/0755	29	43	10/0555		
Tower (MP73) *	995.0	10/0711	70		10/0511		
New Orleans (NEW)	994.3	10/0751	35	53	10/0725		
Moisant (MSY)	994.5	10/0851	34	46	10/0750		0.99
Mid Lake Causeway			37	50	10/0800		
Paris Road					10/0620	+4.5 **	
Bayou Bienvenue					10/0800	+6.0	
Industrial Canal					10/0800	+5.5	
West End Marina					10/0800	+3.5 - +4.0	
Rigolets					10/0900	+3.0	
North Lake Causeway					10/1200	+3.5	

¹ - Time of 1-minute wind, except when only a gust is given.

* - Height unknown

** - Gage failed

TABLE 3. Hurricane Florence selected surface landfall observations
(cont.)

Location	Minimum sea level pressure(mb)		Maximum surface wind speed(kt)			Storm surge(ft)	Rain (in)
	Pressure	Date/time (UTC)	1-minute average	Peak Gust	Date/time (UTC) ¹	Tide height above normal	Storm total
Mississippi							
Kessler AFB	1005.8	10/0530	15	20	10/0003		1.71
Hancock Co EOC	1005.8	10/0730	48 *		10/1000		5.20
McComb (MCB)	1005.2	10/1200	15		10/0750		
Jackson (JAN)			18		10/2057		
Pass Christian						+5.1	
Jackson Co						+3.0	
Alabama							
Dauphin Island	1008.1	09/2330	35	42	10/0012		
Mobile (MOB)	1008.8	10/0043	23		09/2352	+2.0	2.88
Florida							
Pensacola NAS (NPA)	1008.8	09/2255	20		09/0245		5.15
Pensacola (PNS)	1009.4	10/0748	16		10/0450		2.76
Santa Rosa Co						+2.0 - +1.0	

¹ - Time of 1-minute wind, except when only a gust is given.

* - Estimated

TABLE 4. Watches and Warnings issued for Hurricane Florence

LOCATION	TYPE	EFFECTIVE (day/time UTC)	DISCONTINUED (day/time UTC)
Port Arthur, TX to Pensacola, FL	Hurricane Watch	09/1000	09/1300
Cameron, LA to Pensacola, FL	Hurricane Warning	09/1300	10/0400
Cameron, LA to Port Arthur, TX	Hurricane Watch	09/1300	10/0400
Pensacola, FL to Apalachicola, FL	Tropical Storm Warning	09/1300	10/1000
Morgan City, LA to Pensacola, FL	Hurricane Warning	10/0400	10/1000
Grand Isle, LA to Mobile, AL	Tropical Storm Warning	10/1000	10/1200

TABLE 5. 72-Hour probability, in per cent, of center of Hurricane Florence passing within 65 miles of listed locations.
(Time - Day/Hour (CDT))

ADVISORY ISSUANCE TIME:	07/05PM	07/930PM	08/05AM	08/11PM	08/05PM
PROBABILITY END TIME:	<u>10/1PM</u>	<u>10/7PM</u>	<u>11/1AM</u>	<u>11/7AM</u>	<u>11/1PM</u>
MUCF 221N 805W	X	X	2	X	X
MUSN 216N 826W	X	X	3	X	X
MUHA 230N 824W	X	4	5	X	X
MUAN 219N 850W	5	8	8	X	X
MMCZ 205N 869W	5	11	8	X	X
MZBZ 175N 883W	X	X	2	X	X
MYAK 241N 776W	X	X	2	X	X
MYNN 251N 775W	X	X	2	X	X
MGYF 266N 787W	X	3	3	X	X
MMSO 238N 982W	3	2	4	4	4
MMIM 222N 979W	2	2	4	4	3
MMTX 210N 974W	2	X	4	3	X
MMVR 192N 961W	X	X	4	X	X
MMFR 185N 926W	X	X	4	X	X
MMD 210N 897W	22	42	19	6	4
MARATHON FL	3	4	5	2	2
MIAMI FL	3	4	4	X	2
KEY WEST FL	3	5	5	3	2
MARCO ISLAND FL	5	7	6	4	4
FT MYERS FL	6	8	7	5	4
VENICE FL	7	10	8	6	6
TAMPA FL	8	10	8	7	7
CEDAR KEY FL	9	11	8	8	8
ST MARKS FL	11	12	8	9	9
APALACHICOLA FL	12	13	8	10	11
PANAMA CITY FL	12	13	8	11	11
PENSACOLA FL	12	12	8	11	12
MOBILE AL	12	12	7	11	12
GULFPORT MS	12	12	8	12	12
BURAS LA	13	12	9	13	14
NEW ORLEANS LA	12	11	8	12	13
NEW IBERIA LA	10	9	7	11	11
PORT ARTHUR TX	8	7	5	8	9
GALVESTON TX	7	6	5	8	9
FREEPORT TX	7	6	5	8	8
PORT O CONNOR TX	6	5	4	7	7
CORPUS CHRISTI TX	5	4	4	6	6
BROWNSVILLE TX	4	4	5	4	6

X MEANS LESS THAN 2 PER CENT

TABLE 5. 72-Hour probability, in per cent, of center of Hurricane
(cont.) Florence passing within 65 miles of listed locations.
(Time - Day/Hour (CDT))

ADVISORY ISSUANCE TIME:	08/0930PM	09/05AM	09/11AM	09/05PM
PROBABILITY END TIME:	<u>11/7PM</u>	<u>12/1AM</u>	<u>12/7AM</u>	<u>12/1PM</u>
MUCF 221N 805W	X	X	X	X
MUSN 216N 826W	X	X	X	X
MUHA 230N 824W	X	X	X	X
MUAN 219N 850W	X	X	X	X
MMCZ 205N 869W	X	X	X	X
MZBZ 175N 883W	X	X	X	X
MYAK 241N 776W	X	X	X	X
MYNN 251N 775W	X	X	X	X
MGYF 266N 787W	X	X	X	X
MMSO 238N 982W	3	4	X	X
MMTM 222N 979W	X	2	X	X
MMTX 210N 974W	X	X	X	X
MMVR 192N 961W	X	X	X	X
MMFR 185N 926W	X	X	X	X
MMMD 210N 897W	X	X	X	X
MARATHON FL	2	X	X	X
MIAMI FL	2	X	X	X
KEY WEST FL	2	X	X	X
MARCO ISLAND FL	4	X	X	X
FT MYERS FL	5	2	X	X
VENICE FL	6	2	X	X
TAMPA FL	7	3	X	X
CEDAR KEY FL	9	5	X	X
ST MARKS FL	11	8	X	X
APALACHICOLA FL	13	9	X	X
PANAMA CITY FL	13	11	2	X
PENSACOLA FL	14	15	18	16
MOBILE AL	14	17	33	45
GULFPORT MS	14	19	45	66
BURAS LA	16	24	59	80
NEW ORLEANS LA	14	20	45	58
NEW IBERIA LA	12	17	23	21
PORT ARTHUR TX	9	13	3	12
GALVESTON TX	9	12	X	9
FREEPORT TX	8	11	X	7
PORT O CONNOR TX	7	10	X	5
CORPUS CHRISTI TX	5	8	X	X
BROWNSVILLE TX	5	4	X	X

X MEANS LESS THAN 2 PER CENT