

Tropical Cyclone Report
Hurricane Gabrielle
11-19 September 2001

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Gabrielle made landfall on the Florida west coast as a tropical storm with 60-knot sustained winds and then became a category one hurricane (on the Saffir-Simpson Hurricane Scale) as it moved across the northwest Atlantic Ocean. It produced major river floods over west-central Florida and at the lower St. Johns River and also caused heavy rain over southeastern Newfoundland.

a. Synoptic History

Gabrielle's origin was non-tropical. On 5 September, a weak low- to mid-level trough, and its associated cloudiness and showers, was nearly stationary and located just east of the southeastern U.S. coast. This feature persisted and gradually resulted in a low- to mid-level cut-off low over Florida by the 9th. Late on the 11th, a surface low formed over the southeastern Gulf of Mexico in association with the cut-off low and convection was sufficiently well-organized to classify the system as Tropical Depression Eight. The "best track" of the tropical cyclone begins at 1800 UTC on the 11th. The track is shown in Fig. 1 and six-hour center positions, wind speeds, and central pressures are listed in Table 1. Time series curves of best track wind speed and pressure are shown in Figs. 2 and 3.

Under weak steering currents, the cyclone moved in a small counterclockwise loop over the southeastern Gulf of Mexico for two and one-half days and gradually strengthened. It reached tropical storm strength mid-day on the 13th while located about 175 n mi southwest of Venice, Florida. By this time, a mid-level trough in the westerlies was moving into the eastern United States and Gabrielle began moving northeastward with increasing forward speed. Gabrielle's center made landfall on Florida's west coast near Venice at about 1200 UTC on the 14th. The storm strengthened to 60 knots just before landfall, even though a SHIPS analysis, based on the Aviation model, calculated about 25 knots of westerly vertical shear affecting the storm at this time.

The storm decelerated and its winds decreased to 40 knots during the center's 18-hour traverse across central Florida. The center moved offshore on the Florida east coast near Titusville and accelerated northeastward. Although the cyclone was highly sheared, winds strengthened to 70 knots on the 17th while it was located about 200 n mi northwest of Bermuda.

Continuing northeastward, Gabrielle weakened to 60 knots and, at 0600 UTC on the 19th, lost all deep convection near the center while located about 300 n mi south of Newfoundland. Gabrielle is assigned extratropical status at this time. Still moving northeastward, Gabrielle passed near southeastern Newfoundland and merged with another extratropical low on the 21st over the far north Atlantic Ocean.

b. Meteorological statistics

Data from reconnaissance aircraft and satellites that were used to estimate the maximum 1-minute surface wind speed and minimum central surface pressure are plotted in Figs. 2 and 3. Selected surface observations from Florida are listed in Table 2 and reports from ships encountering wind speeds greater than 33 knots are listed in Table 3.

On the 14th, when Gabrielle was nearing the west coast of Florida, aircraft 700-millibar flight-level winds suggest that surface winds were near 65 knots. But the Venice C-MAN station, almost beneath the location of the aircraft strong winds, reported a maximum surface wind of 50 knots (Table 2). At nearby New Pass, the highest measured surface wind was 51 knots and this was a 15-minute average (Table 2). The aircraft reported a dropsonde central pressure of 980 mb at 1009 UTC and 983 mb at 1132 UTC (Fig. 4). The aircraft weather officer also reported a 972-mb value extrapolated from flight level at 0850 UTC and associated with a temperature spike. The time scale of this pressure fluctuation is not represented in the best-track Table 1, which gives intensity and track values only every six hours.

The best-track wind speed of 60 knots at 1200 UTC is a compromise between these observations and represents an estimate of the strongest sustained winds that occurred on the southwest Florida coast. There is an uncertainty associated with official surface wind speed estimates and it is possible that Gabrielle was briefly a hurricane while making landfall. Inland winds ranged from 35-45 knots as the storm moved northeastward across Florida. A few tornados were reported from Brevard and Volusia Counties in northeast Florida.

The strengthening to 70 knots on the 17th is based on aircraft dropsonde and flight-level wind speeds. The maximum flight-level wind speed was 85 knots at 850 mb at about 1700 UTC. The standard reduction to the surface under deep convection is 90 percent, which yields a 77-knot surface wind. A few hours earlier, a GPS-dropsonde indicated a surface wind speed of 60 knots.

Florida rainfall totals were generally in the 4 to 7 inch range over a swath along the storm track. More than 12 inches fell on Volusia and Lake Counties in northeast Florida. This was from a combination of rainfall from Gabrielle and from a strong onshore flow prior to the storm. This flow, combined with the winds of the storm, high astronomical tides and rainfall, caused near record flooding of the lower St. Johns River. The rain over west-central Florida resulted in major floods on the Manatee River, Little Manatee River, Myakka River, Peace River, and Horse Creek. A river gage at Arcadia on Horse Creek reported a crest of 16.8 feet. Flood stage for this location is 12 feet. Minor river and urban flooding occurred elsewhere along the path of the storm across Florida.

Eighteen tornados were reported in Florida.

After becoming extratropical, the storm brought over 6 inches of rain in 12 hours or less to the Avalon Peninsula of Newfoundland. An impressive report was from Cape Race, where an automatic station reported 1.9 inches in 1 hour.

c. Casualty and damage statistics

The insured loss total of \$115,000,000 in Florida from wind and rain was reported by the

Property Claim Services of the American Insurance Services Group. The total damage estimate is \$230,000,000, pending additional information on flood damage.

A fifteen-year-old boy drowned in Gee Creek near Winter Springs in Seminole County, Florida. Gabrielle's swells contributed to a rip current death on September 13th at the Alabama coastline. One indirect death occurred in the Florida Keys when a person fell off a boat and drowned. This death is assigned an indirect status, since local officials determined that intoxication was more of a factor than high winds or seas.

d. Forecast and warning critique

Table 4 lists the watches and warnings issued for Gabrielle. Tropical storm warnings were issued for the Florida west coast at 2100 UTC on the 13th and landfall occurred at 1200 UTC on the 14th, or 15 hours later.

Thirty official track and wind speed forecasts were verified. The average track errors were 12, 49, 87, 128, 167, and 235 nautical miles for 0, 12, 24, 36, 48, and 72 hours. These errors are near or slightly above the previous ten year average official errors of 11, 44, 82, 118, 150, and 226 nautical miles. The guidance models used operationally had errors somewhat larger than the official errors, except for the UKMET model, whose errors were slightly smaller. The official forecasts with the largest track errors were made early on the 13th when the storm was finishing its slow loop in the southeastern Gulf of Mexico.

The official average wind speed forecast errors were 1, 6, 9, 8, 10, and 14 knots for 0, 12, 24, 36, 48, and 72 hours, considerably smaller than the 3, 7, 11, 14, 16, and 20 knots for the previous 10-year averages. These errors are also smaller than the SHIPS statistical-dynamical intensity forecast model errors for Gabrielle.

Table 1. Best track for Hurricane Gabrielle, 11-19 September 2001.

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (Millibar)	Wind Speed (kt)	Stage
11 /1800	25.8	84.1	1010	25	tropical depression
12 /0000	25.7	84.6	1009	25	"
12 /0600	25.7	85.0	1008	25	"
12 /1200	25.6	85.3	1008	25	"
12 /1800	25.4	85.4	1007	30	"
13 /0000	25.1	85.7	1005	30	"
13 /0600	25.2	85.3	1005	30	"
13 /1200	25.3	84.9	1003	35	tropical storm
13 /1800	25.4	84.5	998	40	"
14 /0000	25.4	84.1	997	45	"
14 /0600	25.8	83.6	992	50	"
14 /1200	27.1	82.6	983	60	"
14 /1800	28.0	81.8	994	45	"
15 /0000	28.6	81.4	995	40	"
15 /0600	28.6	80.9	995	40	"
15 /1200	28.9	80.1	998	40	"
15 /1800	29.8	79.0	999	45	"
16 /0000	30.4	77.9	998	50	"
16 /0600	30.8	76.8	998	50	"
16 /1200	31.6	74.9	995	55	"
16 /1800	32.3	72.8	995	55	"
17 /0000	33.1	70.7	991	65	hurricane
17 /0600	34.0	68.5	991	65	"
17 /1200	35.3	66.6	983	70	"
17 /1800	36.2	64.7	983	70	"
18 /0000	36.9	62.9	987	60	tropical storm
18 /0600	37.9	61.8	990	55	"
18 /1200	39.0	60.4	990	55	"

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (Millibar)	Wind Speed (kt)	Stage
18 /1800	40.2	58.9	980	60	tropical storm
19 /0000	41.5	57.5	975	60	"
19 /0600	42.8	55.5	976	55	extratropical
19 /1200	43.5	54.0	978	60	"
19/1800	46.5	52.0	986	60	"
20/0000	48.5	48.5	988	60	"
20/0600	50.0	46.0	986	60	"
20/1200	52.0	43.0	984	60	"
20/1800	54.0	40.0	981	65	"
21/0000	55.0	37.5	981	65	"
21/0600	55.0	35.0	981	65	"
21/1200	56.0	32.5	984	60	"
21/1800	57.5	31.0	987	55	"
22/0000	merged with another extratropical storm				
14/1200	27.1	82.6	983	60	landfall near Venice, FL
19 /0000	41.5	57.3	975	60	minimum pressure

Table 2. Selected surface observations for Hurricane Gabrielle, September 2001.

Location	Minimum Sea Level Pressure		Maximum Surface Wind Speed			Storm surge (ft) ^c	Storm tide (ft) ^d	Total rain (in)
	Date/time (UTC)	Press. (mb)	Date/time (UTC) ^a	Sustained (kt) ^b	Gust (kt)			
Florida								
C-MAN stations								
Sombrero Key	14/1000	1004.7	14/0600	40	45		1.1	
Dry Tortugas	14/0800	1001.7	14/0300	38	45			2.54
Sand Key	14/0800	1003.1	14/0900	36	53			
Molasses Reef	14/1000	1004.7	14/1200	36	42			
Long Key	14/1100	1005.1	14/1100	30	34		0.95	
Cedar Key	14/2000	1002.9	15/0100	17	25			
Venice	14/1200	983.1	14/1400	50	63			
Saint Augustine	14/2200	999.1	14/2220	51	65			
Buoys								
42036	14/1200	1005.2	14/1200	29	37			
42003	13/2100	1003.3	14/0200	27	35			
41009	15/0900	997.7	14/1500	33	44			
41010	15/2000	1000.7	15/1600	27	35			
CM3 (U. of S. FL)	14/0744	992.1	14/0429	36				
EGK (U. of S. FL)			14/1615	46				
NA2 (U. of S. FL)			14/1210	44	18			
Key West						0.5		
Key West Int. Airport	14/0929	1003.7	14/0929	36	42			0.95
NW FL Bay Comps	14/0900	1003.1	14/1400	33	42			0.95
Marathon Airport	14/1009	1005.4	14/1052	23	39			1.23
Tavernier								1.40
Everglades City	14/1200	1000.0	14/1200	44	61			
Naples	14/0950	999.4	14/1146	24	41			3.06
Flamingo	14/1000	1002.4	14/0900	45	54			
Ochopee								4.30
Miles City								2.32
Racoon Point								1.55
The Villages	14/2025	996.0	14/2325	26				
Brooksville	15/1845	998.6	15/0135	25	40			
New Pass	14/0125	996.1	14/1207	51				

Location	Minimum Sea Level Pressure		Maximum Surface Wind Speed			Storm surge (ft) ^c	Storm tide (ft) ^d	Total rain (in)
	Date/time (UTC)	Press. (mb)	Date/time (UTC) ^a	Sustained (kt) ^b	Gust (kt)			
St. Petersburg (PIE)	14/1321	998.3	14/1609	36	47			
St. Petersburg (SPG)	14/1446	995.9	14/1521	38	50			
Tampa	14/1525	997.0	14/1603	32	43			
Winter Haven	14/1752	992.6	14/1223	35	42			
Sarasota	14/1310	991.2	14/1528	41	54			8.29
Punta Gorda	14/1227	993.9	14/1212	42	49			
Fort Myers (FMY)	14/1046	996.3	14/1208	31	40			
Fort Myers (RSW)	14/1144	998.6	14/1007	27	38			
Macdill AFB	14/1458	996.3	14/1148	21	40			
Lakeland	14/1650	994.2	14/1450	20	45			
Pinellas County						1.0	2.9	
Charlotte County						5.1	6.2	
Lee county						3.4	3.8	
Daytona Beach	14/1647	998.6	14/1052	37	43			7.69
Vero Beach	15/0454	998.9	14/1346	29	37			2.15
Melbourne	15/0519	997.9	14/1623	25	35			4.18
Ft. Peirce	15/0504	999.6	15/0244	24	33			1.97
Orlando Int. Airport	14/1412	994.5	14/1254	31	39			4.02
Orlando Exec. Airport	14/1516	995.2	14/1326	27	36			4.74
Leesburg	14/1538	995.6	15/0045	31	39			7.98
Sanford	14/1522	995.9	14/1525	27	33			5.04
Titusville	14/1950	998.3						
Patrick AFB	15/0755	998.0	14/1421	39	86			6.26
Shuttle Landing	15/0755	998.0	15/1841	22	36			4.56
Pierson								13.6
Umatilla								12.7
Okahumpka								9.10
Tavares								8.26
Apopka								5.53
Avalon								4.45
Jacksonville	15/0459	1004.7	15/0412	29	36			
KCRG	15/0707	1003.7	15/0848	27	36			
KNRB	15/0507	1003.4	15/0402	41	47			
KNIP	15/0701	1003.0	15/0927	34	41			
Cecil Field	15/0039	1004.1	15/0906	30	39			
Kings Bay Naval Stn.	15/0627	1005.1	15/0413	23	35			

Location	Minimum Sea Level Pressure		Maximum Surface Wind Speed			Storm surge (ft) ^c	Storm tide (ft) ^d	Total rain (in)
	Date/time (UTC)	Press. (mb)	Date/time (UTC) ^a	Sustained (kt) ^b	Gust (kt)			
Gainesville	14/2331	1002.4	14/2044	24	29			
St. Simons Island	15/0449	1005.8	15/0532	34	42			
KAMG	15/0049	1009.1	15/1900	14	22			
Bunnell			15/0619	31	42			
Lake City	14/2356	1005.4	15/1617	20	29			
Fernandina Beach	15/0500	1005.2	15/1000	28	36			
Mayport	15/0600	1003.7	14/2300	36	46			
St. Augustine	15/0800	1003.2	14/2300	46	64			
Amelia Island				52				
Hastings			14/2100	20				
Flagler Bch Fire Stn.	15/0900	999.7						

^a Date/time is for sustained wind when both sustained and gust are listed.

^b Except as noted, sustained wind averaging periods for C-MAN and land-based ASOS reports are 2 min; NOAA buoy averaging periods are 8 min. U. of South Florida buoy averaging periods vary from 1 to 15 minutes.

^c Storm surge is water height above normal astronomical tide level.

^d Storm tide is water height above National Geodetic Vertical Datum (1929 mean sea level).

Table 3. Selected ship reports with winds of at least 34 kt for Hurricane Gabrielle, September 2001, including extratropical stage.

Date/Time (UTC)	Ship call sign	Latitude (°N)	Longitude (°W)	Wind dir/speed (kt)	Pressure (mb)
13/0600	DCUW	26.5	84.8	080/37	1010.0
13/1200	CZ523	24.0	83.5	170/35	1006.4
13/1200	DCUW	25.8	84.2	130/39	1007.2
13/1800	DCUW	25.3	83.9	160/45	1003.9
14/0600	DCUW	24.2	83.5	220/37	1004.3
14/0600	WGJT	29.5	80.0	060/36	1008.0
14/1200	DCUW	23.5	83.4	210/39	1007.0
14/1800	KRHX	28.1	80.1	180/37	1000.5
15/1800	DGSE	28.7	79.1	030/35	1005.0
15/1800	WGXO	30.4	80.4	030/40	1003.0
15/1800	WPKD	32.1	80.0	020/49	1009.0
15/1800	ELJJ5	33.9	76.2	030/40	1014.0
16/0000	WPGJ	29.5	80.1	050/37	1006.5
16/0000	DGSE	30.5	78.5	360/49	999.0
16/0000	WGXO	31.4	79.9	010/48	1006.0
16/0000	WPKD	32.5	78.7	030/50	1006.8
16/0000	ELJJ5	33.0	78.1	020/44	1010.3
16/0000	KRPDD	32.7	74.2	080/58	1008.1
16/0600	WPKD	33.3	77.6	020/46	1007.6
16/0600	PDHW	32.7	77.7	050/43	1007.0
16/0600	KRPDD	32.7	72.4	120/39	1008.1
16/0600	ELJJ5	33.2	77.8	010/44	1009.0
16/1200	KS004	24.9	75.4	280/45	-
16/1800	WPKD	35.0	75.2	010/43	1010.0
16/1800	KRPDD	32.8	68.3	140/58	1009.1
16/1800	KS004	23.7	73.6	280/40	-
16/1800	MZBM7	34.1	73.1	040/40	1003.1
17/0000	KIRF	29.3	69.8	200/36	1009.2
17/0000	MZBM7	35.6	73.8	040/40	1006.7
17/0000	KS004	22.4	71.8	300/38	-
17/0600	KRPDD	32.9	64.0	160/47	1009.1

Table 3 (cont.).

Date/Time (UTC)	Ship call sign	Latitude (°N)	Longitude (°W)	Wind dir/speed (kt)	Pressure (mb)
17/1800	PCTG	34.6	60.6	200/39	1006.9
18/1200	WMLH	41.4	57.2	100/36	1005.0
18/1200	WRYX	33.2	66.0	260/35	1009.0
18/1800	WMLH	41.4	59.7	090/35	984.5
19/0000	WMLH	41.4	61.7	010/41	1006.5
19/0600	LAVX4	36.1	53.4	290/36	1013.0
19/1200	DEDI	44.7	56.1	320/45	1002.2
19/1800	C6MS4	46.8	40.0	160/35	1019.0
19/1800	MYMX5	45.4	42.3	150/35	1010.8
19/1800	4XFE	44.6	42.6	150/40	1011.0
19/1800	4XGV	42.9	48.2	220/40	1012.5
20/0000	4XFE	44.5	40.0	160/35	1014.4
20/0000	C6MS4	46.2	41.6	170/56	1005.0
20/0000	4XGW	42.5	49.9	270/40	1024.0
20/0000	C6RM7	46.4	40.4	150/45	1008.4
20/0000	GBBA	47.7	37.7	180/40	1012.5
20/0600	C6MS4	45.6	42.7	270/39	1007.0
20/0600	S6TY	45.6	36.7	170/39	1014.0
20/0600	GBBA	47.8	36.0	130/40	1012.4
20/0600	V7CG8	47.6	36.4	190/37	1014.0
20/1800	ZCBE7	55.5	42.5	330/50	995.0
21/0600	OXTS2	58.5	42.4	010/38	1009.8

Table 4. Watch and warning summary for Hurricane Gabrielle, September 2001.

Date/Time (UTC)	Action	Location
13 / 2100	tropical storm warning issued	Craig Key - Dry Tortugas, FL
“	“	Flamingo - Suwanee River, FL
“	hurricane watch issued	Chokoloskee - Tarpon Springs, FL
14 / 0300	tropical storm watch issued	Jupiter Inlet - St. Augustine, FL
14 / 0900	tropical storm warning issued	Jupiter Inlet - St. Augustine, FL
“	tropical storm warning issued	Lake Okeechobee, FL
14 / 1500	hurricane watch removed	Chokoloskee - Tarpon Springs, FL
14 / 2100	tropical storm warning discontinued	Craig Key - Dry Tortugas, FL
“	tropical storm warning discontinued	Flamingo - Suwanee River, FL
“	tropical storm warning discontinued	Lake Okeechobee, FL
15 / 1500	tropical storm warning discontinued	St. Augustine - Sebastian Inlet, FL
16 / 0300	all warnings discontinued	

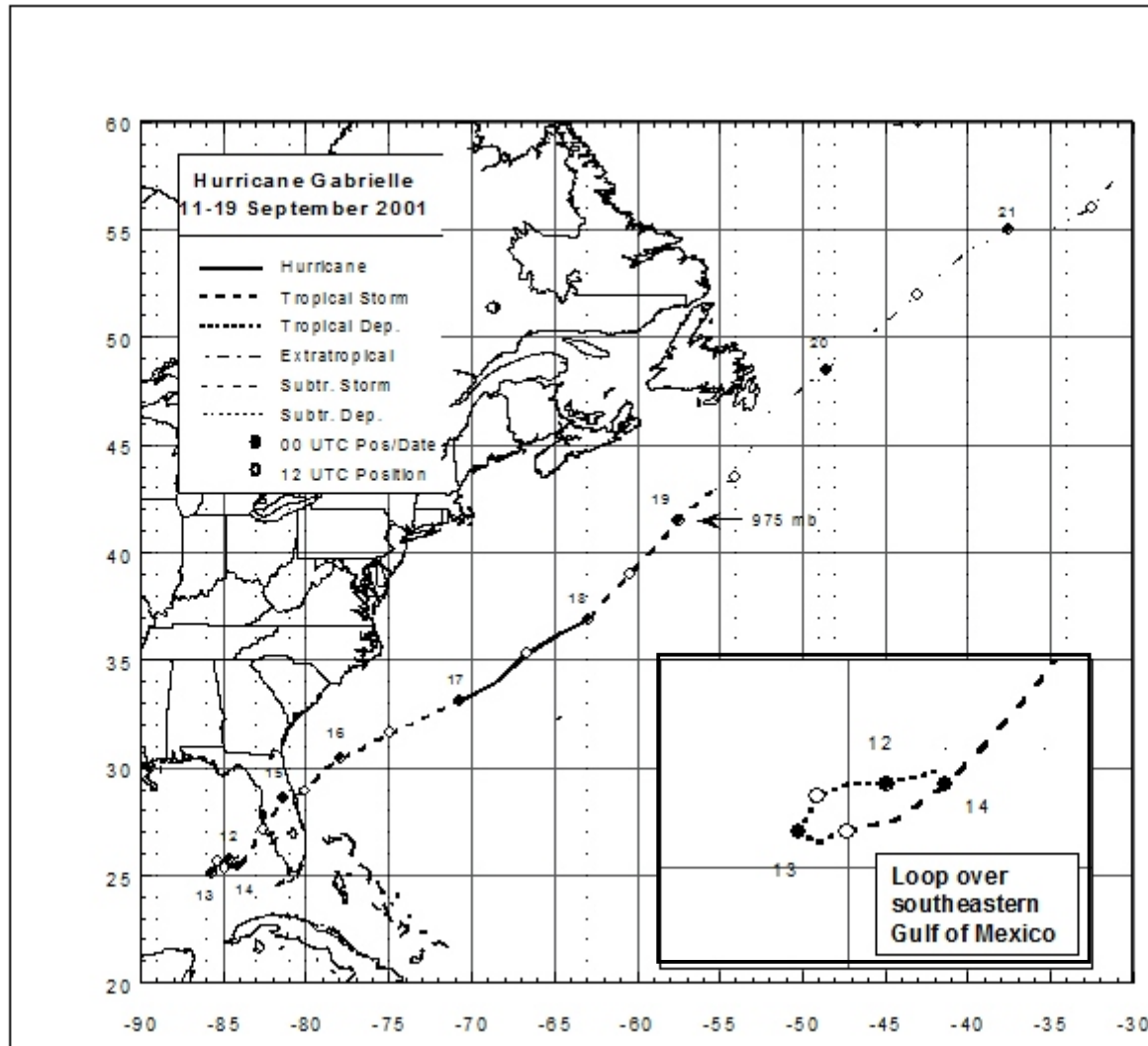


Figure 1. Best track positions for Hurricane Gabrielle, 11-19 September 2001. Track during the extratropical stage (after 19/0000 UTC) is based on analyses from the NOAA Marine Prediction Center. Inset is an enlargement of loop over southeastern Gulf of Mexico.

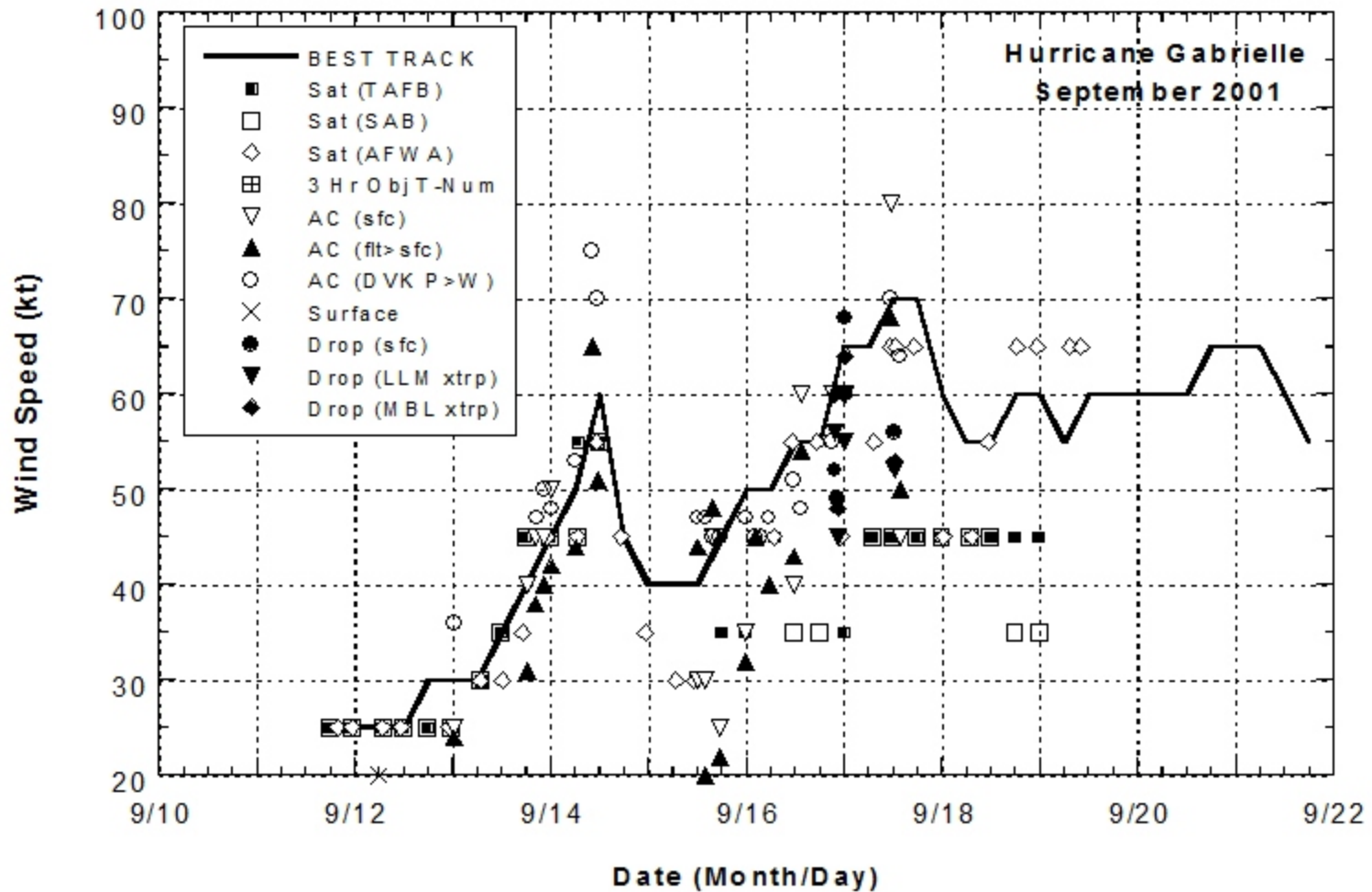


Figure 2. Best track maximum sustained surface wind speed curve for Hurricane Gabrielle, 11-19 September 2001, and the observations on which the best track curve is based. Aircraft observations have been adjusted for elevation using 90%, 80%, and 80% reduction factors for observations from 700 mb, 850 mb, and 1500 ft, respectively. Dropwindsonde observations include actual 10 m winds (sfc), as well as surface estimates derived from the mean wind over the lowest 150 m of the wind sounding (LLM), and from the sounding boundary layer mean (MBL). Estimates during the extratropical stage are from the NOAA Marine Prediction Center.

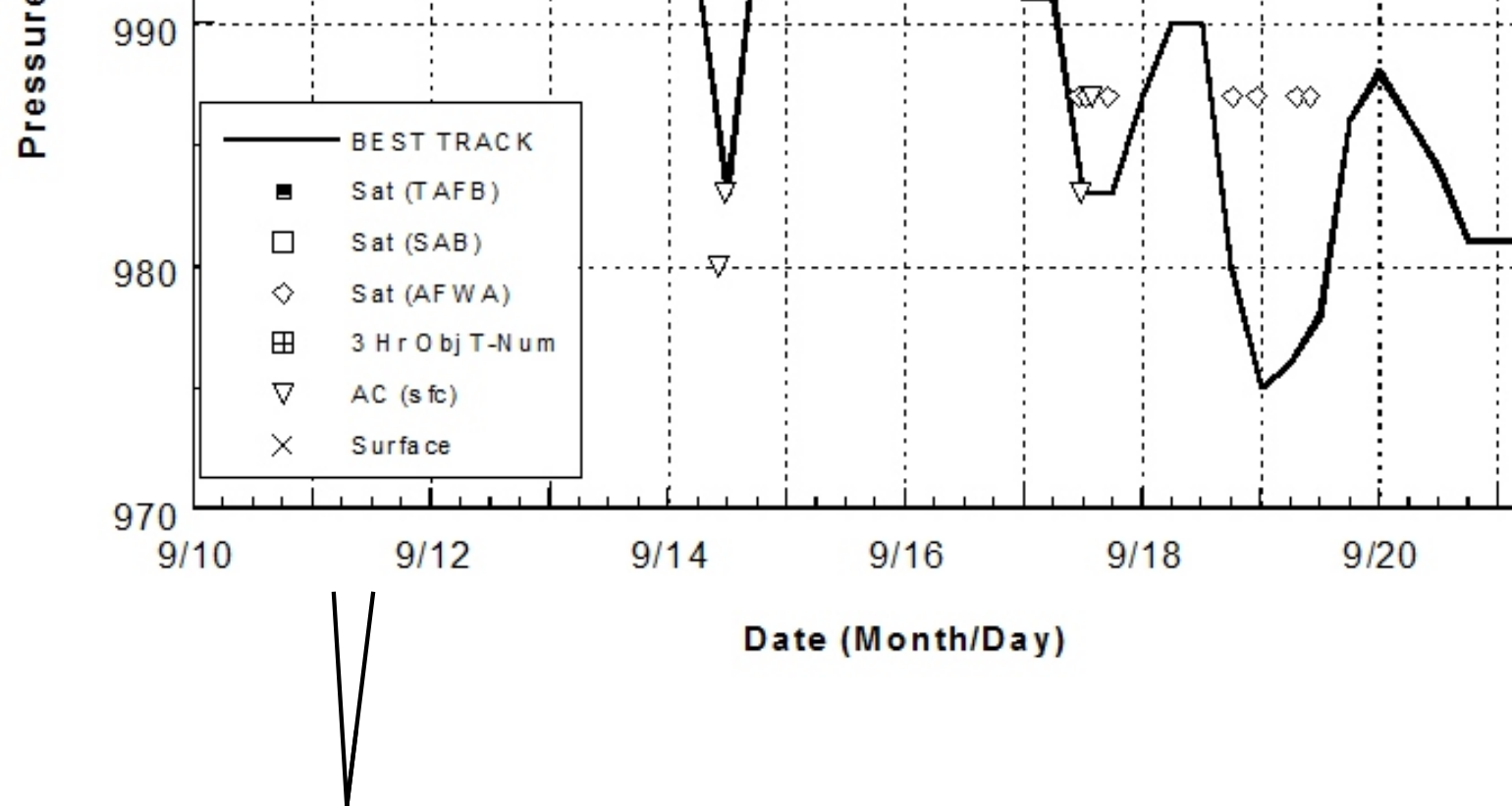


Figure 3. Best track minimum central pressure curve for Hurricane Gabrielle, 11-19 September 2001, and the observations on which the best track curve is based. Estimates during the extratropical stage are based on analyses from the NOAA Marine Prediction Center.