

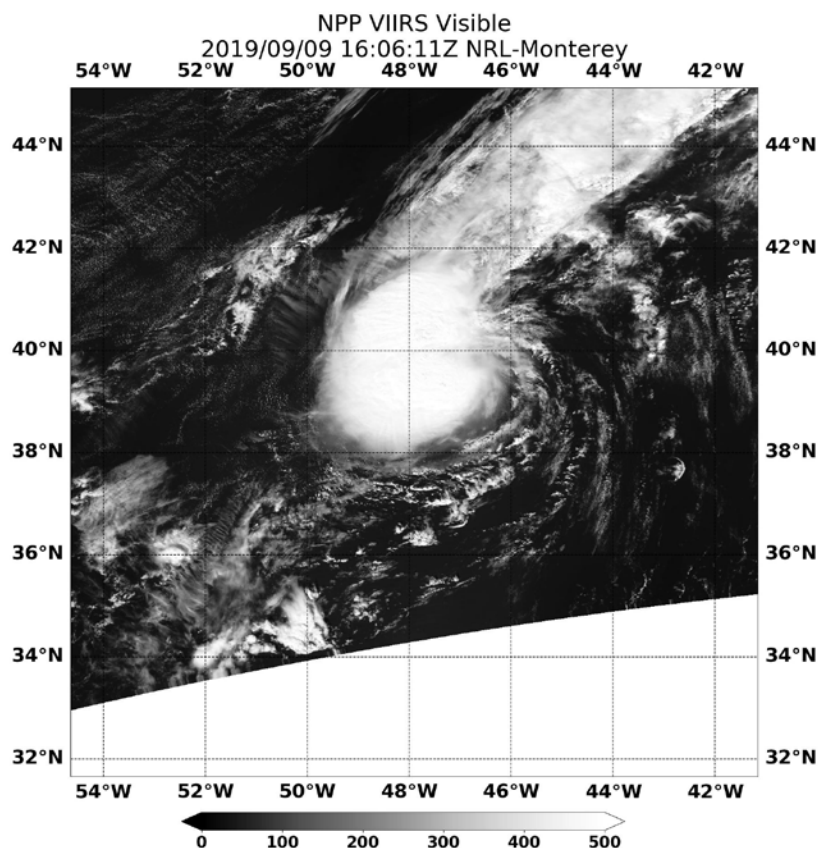


NATIONAL HURRICANE CENTER TROPICAL CYCLONE REPORT

TROPICAL STORM GABRIELLE (AL082019)

3–10 September 2019

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National Hurricane Center
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VIIRS VISIBLE IMAGE OF TROPICAL STORM GABRIELLE AT 1606 UTC 9 SEPTEMBER 2019. IMAGE COURTESY OF NAVAL RESEARCH LABORATORY, MONTEREY, CA.

Gabrielle was a tropical storm that existed for a week over the eastern Atlantic Ocean without affecting land.

Tropical Storm Gabrielle

3–10 SEPTEMBER 2019

SYNOPTIC HISTORY

A tropical wave moved westward from the coast of Africa on 30 August, and a broad low pressure area formed in association with the wave on 1 September while the system was located just southeast of the southern Cabo Verde Islands. Later that day, the associated convection began to show signs of organization. The system turned west-northwestward on 2 September, followed by a turn toward the northwest the next day. The circulation of the low became better defined on 3 September, and by 1800 UTC there was enough organized convection that a tropical depression formed about 395 n mi west of the northern Cabo Verde Islands. The “best track” chart of the tropical cyclone’s path is given in Fig. 1, with the wind and pressure histories shown in Figs. 2 and 3, respectively. The best track positions and intensities are listed in Table 1¹.

The cyclone was located within an environment of moderate southwesterly vertical wind shear and dry mid-level air. Despite these negative factors, intensification occurred, with the depression becoming a tropical storm 6 h after genesis and reaching a first estimated peak intensity of 45 kt 12 h later. During this time, the circulation of Gabrielle was elongated from south to north, and the strongest winds were generally 60–90 n mi from the center. Gabrielle moved northwestward toward a break in the ridge over the central Atlantic, which was partly due to the formation of a mid- to upper-level low to the northwest of the tropical cyclone. Interaction with the southeastern part of this low caused increased shear and dry air entrainment, which led to the convection dissipating on 5 September. The storm subsequently weakened as it lacked convection for almost 24 h.

Convection re-developed on 6 September, with the shear diminishing somewhat as Gabrielle moved to the northeast of the upper-level low. These developments allowed the cyclone to reach a second estimated peak intensity of 50 kt near 0000 UTC 7 September. Later that day, however, Gabrielle encountered strong upper-level easterly flow on the north side of the upper-level low, which produced significant shear. This flow also turned the storm west-northwestward at a forward speed of near 20 kt. On 8 September, the storm moved away from the upper-level low and toward the break in the subtropical ridge as it turned north-northwestward and northward at a slower forward speed. The shear decreased at the same time, and this allowed Gabrielle to slowly strengthen to its overall estimated peak intensity of 55 kt. During this time, Gabrielle had a more classical tropical cyclone structure, including a well-defined inner wind core and a radius of maximum winds of about 20 n mi.

The cyclone reached the mid-latitude westerlies north of the subtropical ridge on 9 September, recurving northeastward at that time. Slow weakening occurred as Gabrielle

¹ A digital record of the complete best track, including wind radii, can be found on line at <ftp://ftp.nhc.noaa.gov/atcf>. Data for the current year’s storms are located in the *btk* directory, while previous years’ data are located in the *archive* directory.

underwent extratropical transition, and the storm became extratropical near 1200 UTC 10 September about 425 n mi northwest of the western Azores Islands. The extratropical low lasted for about another 24 h before it weakened into a trough.

METEOROLOGICAL STATISTICS

Observations in Gabrielle (Figs. 2 and 3) include subjective satellite-based Dvorak technique intensity estimates from the Tropical Analysis and Forecast Branch (TAFB) and the Satellite Analysis Branch (SAB), and objective Advanced Dvorak Technique (ADT) estimates and Satellite Consensus (SATCON) estimates from the Cooperative Institute for Meteorological Satellite Studies/University of Wisconsin-Madison. Data and imagery from NOAA polar-orbiting satellites including the Advanced Microwave Sounding Unit (AMSU), the NASA Global Precipitation Mission (GPM), the European Space Agency's Advanced Scatterometer (ASCAT), and Defense Meteorological Satellite Program (DMSP) satellites, among others, were also useful in constructing the best track of Gabrielle.

There were no land or ship observations of tropical-storm-force winds from Gabrielle. The estimated peak intensity of 55 kt is based on a combination of subjective intensity estimates from TAFB and objective intensity estimates from the CIMSS SATCON technique.

CASUALTY AND DAMAGE STATISTICS

There were no reports of damage or casualties associated with Gabrielle.

FORECAST AND WARNING CRITIQUE

The genesis of Gabrielle was generally well forecast. The wave from which Gabrielle developed was introduced in the Tropical Weather Outlook 108 h prior to genesis (Table 2) with a low (<40%) chance of development during the 5-day time period. This was raised to a medium chance (40–60%) 90 h before genesis and a high (>60%) chance 54 h before genesis. The disturbance was introduced into the 2-day time period with a low chance 84 h before genesis, a medium chance 54 h before genesis, and a high chance 36 h before genesis. The long lead time for the 2-day forecasts was due to the broad low pressure area taking longer to consolidate than anticipated.

A verification of NHC official track forecasts for Gabrielle is given in Table 3a. Official forecast track errors were greater than the mean official errors for the previous 5-yr period. A homogeneous comparison of the official track errors with selected guidance models is given in Table 3b. Several of the consensus and dynamical models had lower overall errors than the official forecasts, with the Florida State Superensemble (FSSE) being the best overall performer.



Examination of selected individual track forecasts (Fig. 4) suggests that the official forecasts underestimated how much the upper-level low would affect the track of Gabrielle, with the early forecasts not showing enough northward motion and later forecasts not showing as much of a westward turn as actually occurred.

A verification of NHC official intensity forecasts for Gabrielle is given in Table 4a. Official forecast intensity errors were lower than the mean official errors for the previous 5-yr period. However, the official errors were higher than those of climatology/persistence (OCD5) at 72 and 120 h, indicating these forecasts lacked skill compared to climatology/persistence. A homogeneous comparison of the official intensity errors with selected guidance models is given in Table 4b. The official forecast errors were greater than the consensus and statistical dynamical models at many forecast times. However, the official forecast outperformed the dynamical models at 72–120 h. Examination of selected individual forecasts (Fig. 5) indicates that many official forecasts called for too much intensification when Gabrielle reached the north side of the upper-level low, with the storm never encountering as favorable of an environment as originally anticipated.

Operationally, Gabrielle was designated a remnant low for a short time on 6 September due to lack of convection. Post-analysis indicates that the system remained a tropical cyclone during this time since the convective hiatus was relatively short-lived.

No coastal watches or warnings were issued for Gabrielle.



Table 1. Best track for Tropical Storm Gabrielle, 3–10 September 2019.

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
03 / 0000	16.1	30.1	1007	25	low
03 / 0600	16.8	30.9	1007	25	"
03 / 1200	17.5	31.6	1007	25	"
03 / 1800	18.1	32.1	1006	30	tropical depression
04 / 0000	18.7	32.6	1005	35	tropical storm
04 / 0600	19.5	33.2	1004	40	"
04 / 1200	20.1	33.6	1003	45	"
04 / 1800	20.5	33.7	1002	45	"
05 / 0000	20.8	33.9	1002	45	"
05 / 0600	21.5	34.5	1001	45	"
05 / 1200	22.3	35.2	1000	45	"
05 / 1800	22.9	35.6	1002	40	"
06 / 0000	23.8	36.2	1004	35	"
06 / 0600	25.0	37.1	1005	35	"
06 / 1200	26.2	38.0	1004	40	"
06 / 1800	27.4	39.0	1002	45	"
07 / 0000	29.0	40.1	999	50	"
07 / 0600	30.5	41.6	1002	45	"
07 / 1200	31.0	43.9	1003	45	"
07 / 1800	31.5	45.8	1003	45	"
08 / 0000	31.8	47.4	1002	45	"
08 / 0600	32.3	48.4	1000	50	"
08 / 1200	33.2	49.0	999	50	"
08 / 1800	34.5	49.3	995	55	"
09 / 0000	35.8	49.3	995	55	"
09 / 0600	37.1	48.9	996	50	"
09 / 1200	38.4	48.0	997	50	"
09 / 1800	40.0	46.3	998	50	"
10 / 0000	41.4	44.2	999	45	"
10 / 0600	42.4	41.7	999	45	"



Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
10 / 1200	43.3	39.1	999	45	extratropical
10 / 1800	44.1	36.4	1000	45	"
11 / 0000	45.5	33.5	1002	40	"
11 / 0600	47.0	30.0	1003	40	"
11 / 1200	49.0	26.4	1005	35	"
11 / 1800					dissipated
08 / 1800	34.5	49.3	995	55	minimum pressure



Table 2. Number of hours in advance of formation associated with the first NHC Tropical Weather Outlook forecast in the indicated likelihood category. Note that the timings for the “Low” category do not include forecasts of a 0% chance of genesis.

	Hours Before Genesis	
	48-Hour Outlook	120-Hour Outlook
Low (<40%)	84	108
Medium (40%-60%)	54	90
High (>60%)	36	54



Table 3a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) track forecast errors (n mi) for Tropical Storm Gabrielle, 3–10 September 2019. Mean errors for the previous 5-yr period are shown for comparison. Official errors that are smaller than the 5-yr means are shown in boldface type.

	Forecast Period (h)						
	12	24	36	48	72	96	120
OFCL	28.3	42.8	60.1	78.8	112.5	160.4	184.5
OCD5	63.1	144.0	233.7	314.8	353.0	452.4	472.5
Forecasts	25	23	21	19	15	11	7
OFCL (2014-18)	23.6	35.5	47.0	61.8	96.0	136.0	179.6
OCD5 (2014-18)	44.8	97.6	157.4	220.1	340.7	446.6	536.6

Table 3b. Homogeneous comparison of selected track forecast guidance models (in n mi) for Tropical Storm Gabrielle, 3–10 September 2019. Errors smaller than the NHC official forecast are shown in boldface type. The number of official forecasts shown here will generally be smaller than that shown in Table 3a due to the homogeneity requirement.

Model ID	Forecast Period (h)						
	12	24	36	48	72	96	120
OFCL	26.8	40.5	62.8	83.4	118.7	145.8	183.4
OCD5	59.5	139.7	234.3	325.7	387.6	480.0	471.4
GFSI	30.3	45.4	69.9	94.0	142.6	149.0	198.1
HWFI	31.1	50.2	73.9	99.3	138.0	133.0	237.3
HMNI	29.2	40.1	58.0	76.9	119.1	187.9	360.0
EGRI	23.9	36.3	64.6	91.2	127.0	181.3	212.0
EMXI	30.8	45.4	64.1	83.2	117.2	114.1	149.1
NVGI	39.7	59.4	90.7	120.1	167.8	184.7	220.7
CMCI	35.9	60.3	77.8	87.6	111.9	137.9	101.9
TVCA	26.0	38.9	58.0	78.8	124.2	152.5	229.1
HCCA	27.0	41.5	59.7	77.2	101.0	108.0	179.3
FSSE	25.5	39.3	55.1	74.6	91.3	95.4	148.2
AEMI	35.2	52.5	74.0	94.9	141.8	161.7	235.0
TABS	44.7	97.3	153.1	204.3	274.4	359.0	351.6
TABM	36.9	68.7	105.8	146.0	279.5	307.0	200.7
TABD	51.8	115.3	178.5	278.1	629.5	1119.1	1375.1
Forecasts	20	18	16	15	12	7	6



Table 4a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) intensity forecast errors (kt) for Tropical Storm Gabrielle, 3–10 September 2019. Mean errors for the previous 5-yr period are shown for comparison. Official errors that are smaller than the 5-yr means are shown in boldface type.

	Forecast Period (h)						
	12	24	36	48	72	96	120
OFCL	4.4	6.5	6.9	7.4	10.3	7.3	10.0
OCD5	4.7	7.7	8.3	9.2	9.7	8.0	7.6
Forecasts	25	23	21	19	15	11	7
OFCL (2014-18)	5.3	7.9	9.9	11.2	13.3	14.4	14.2
OCD5 (2014-18)	6.9	10.9	14.3	17.4	20.9	22.0	22.8

Table 4b. Homogeneous comparison of selected intensity forecast guidance models (in kt) for Tropical Storm Gabrielle, 3–10 September 2019. Errors smaller than the NHC official forecast are shown in boldface type. The number of official forecasts shown here will generally be smaller than that shown in Table 4a due to the homogeneity requirement.

Model ID	Forecast Period (h)						
	12	24	36	48	72	96	120
OFCL	4.3	6.8	7.6	6.9	9.6	8.0	10.0
OCD5	4.8	8.1	8.7	9.5	9.1	7.9	8.0
HWFI	3.7	4.2	4.6	6.9	12.5	15.9	20.7
HMNI	4.0	4.1	3.6	5.5	13.2	15.6	14.3
DSHP	4.2	5.9	5.4	5.4	7.9	8.7	6.0
LGEM	4.9	7.1	7.2	7.4	12.8	10.6	8.2
ICON	3.7	4.6	4.6	5.2	7.8	8.2	6.3
IVCN	3.6	4.4	4.4	5.6	9.5	8.8	8.2
GFSI	4.0	3.9	5.5	6.6	12.7	17.2	16.8
EMXI	5.1	5.2	6.2	9.0	12.2	15.0	17.5
HCCA	3.1	4.2	5.3	7.8	13.2	13.5	12.0
FSSE	3.3	5.1	6.8	7.8	9.4	8.3	6.8
Forecasts	21	19	17	16	13	10	6

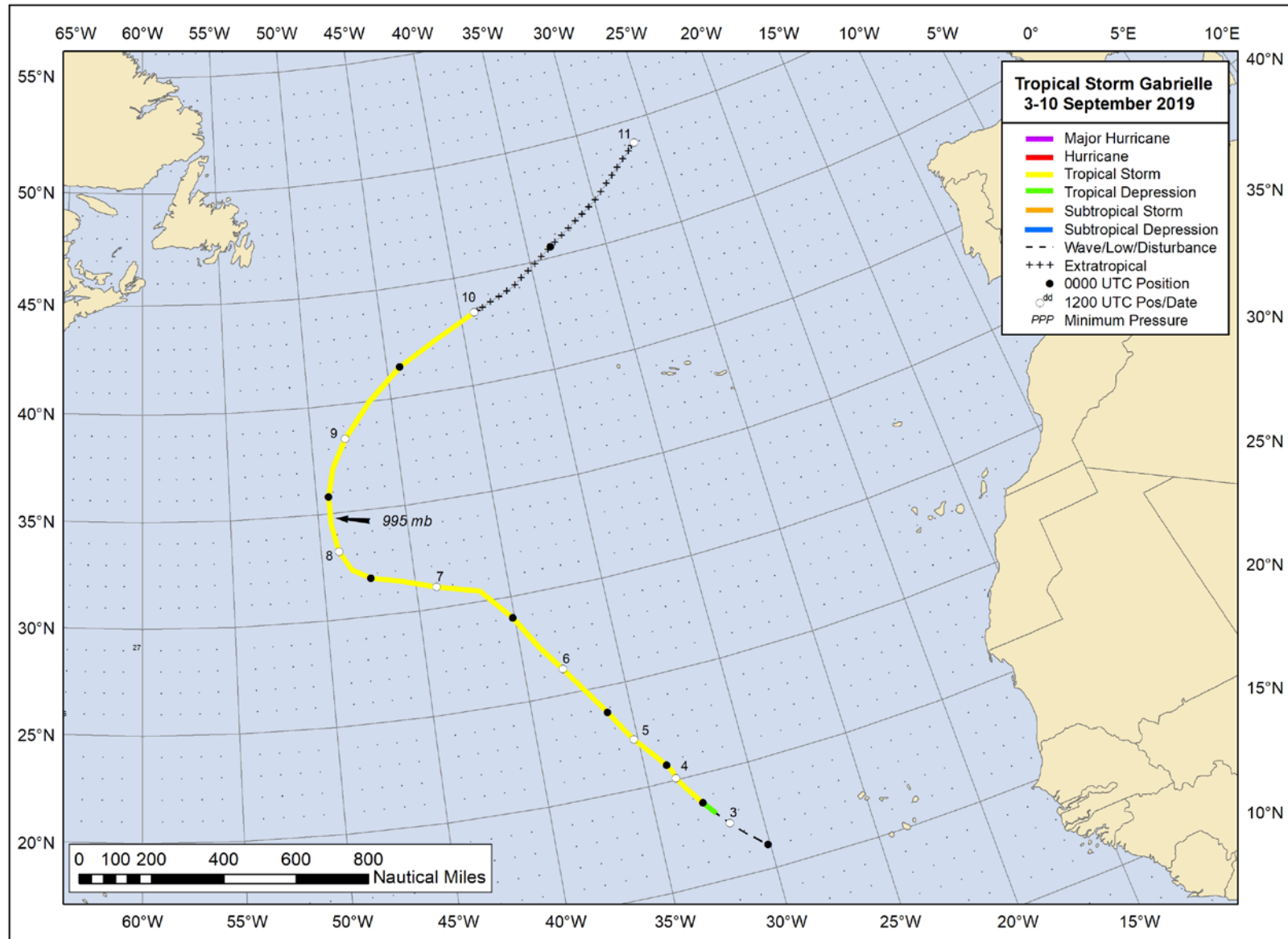


Figure 1. Best track positions for Tropical Storm Gabrielle, 3–10 September 2019. Track during the extratropical stage are partially based on analyses from the NOAA Ocean Prediction Center.

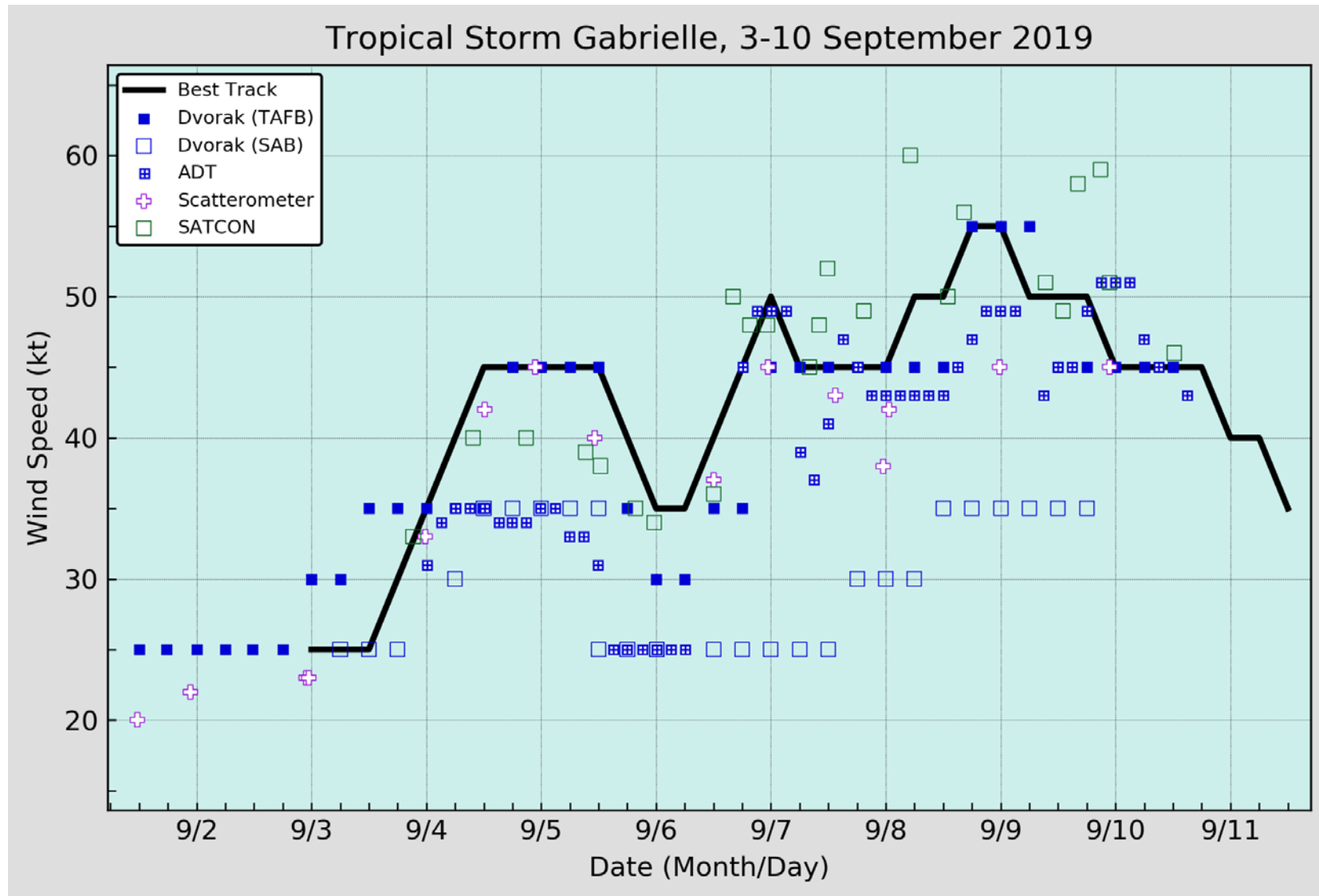


Figure 2. Selected wind observations and best track maximum sustained surface wind speed curve for Tropical Storm Gabrielle, 3–10 September 2019. Advanced Dvorak Technique estimates represent the Current Intensity at the nominal observation time. SATCON intensity estimates are from the Cooperative Institute for Meteorological Satellite Studies. Dashed vertical lines correspond to 0000 UTC.

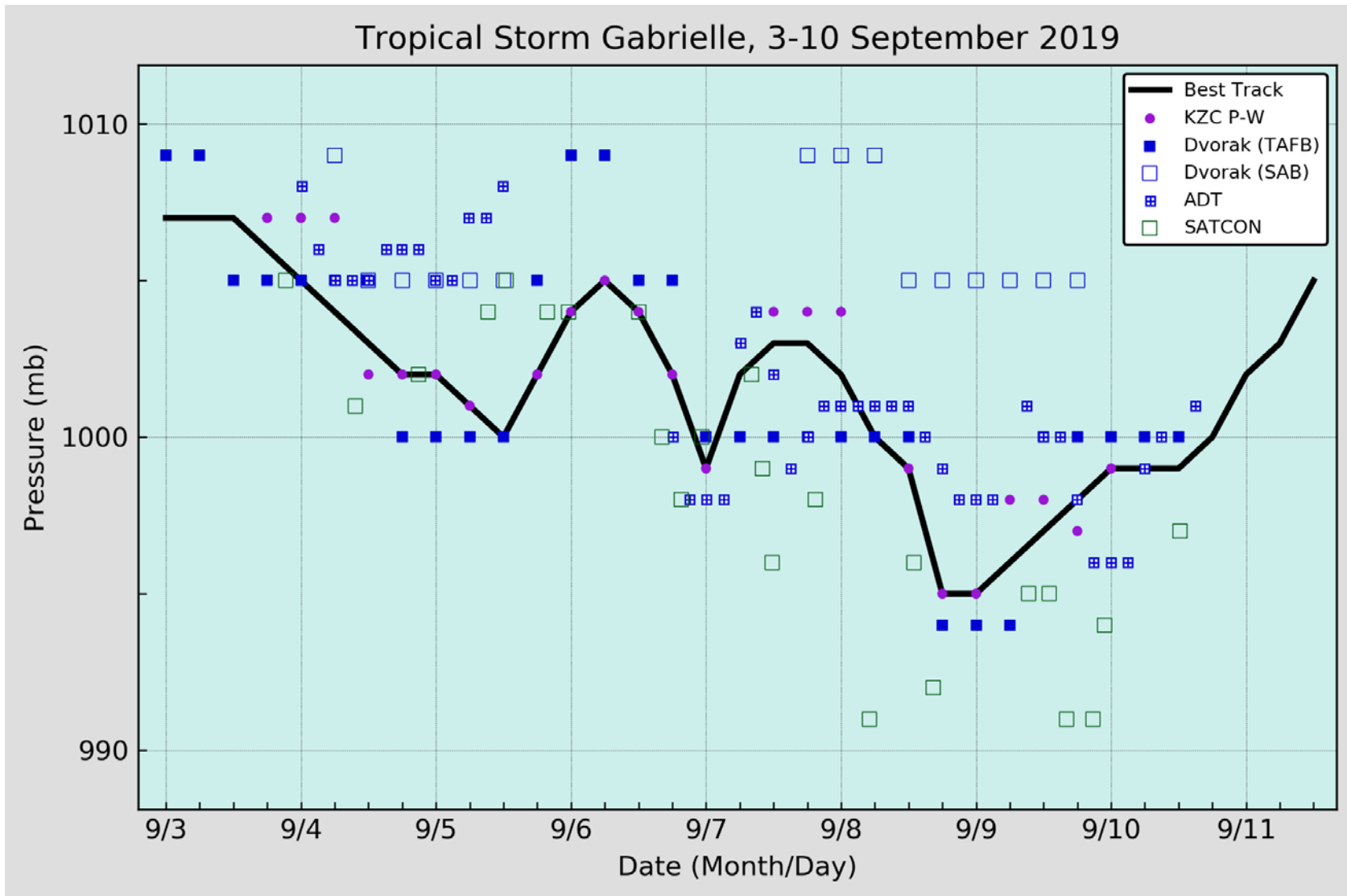


Figure 3. Selected pressure observations and best track minimum central pressure curve for Tropical Storm Gabrielle, 3–10 September 2019. Advanced Dvorak Technique estimates represent the Current Intensity at the nominal observation time. SATCON intensity estimates are from the Cooperative Institute for Meteorological Satellite Studies. KZC P-W refers to pressure estimates derived using the Knaff-Zehr-Courtney pressure-wind relationship. Dashed vertical lines correspond to 0000 UTC.

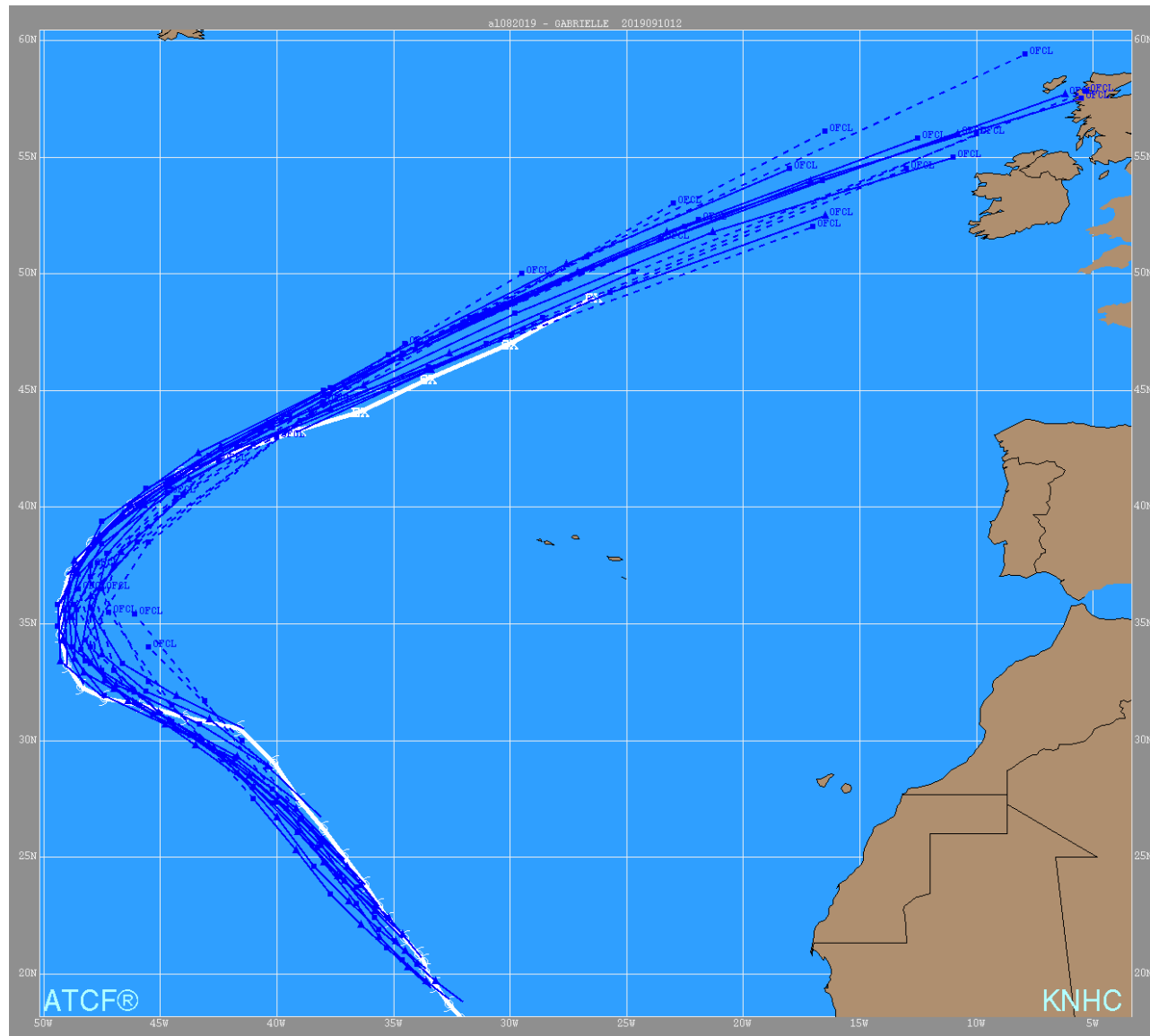


Figure 4. Selected official track forecasts (blue lines, with 0, 12, 24, 36, 48, 72, 96, and 120 h positions indicated) for Tropical Storm Gabrielle, 3–10 September 2019. The best track is given by the white line with positions given at 6 h interval.

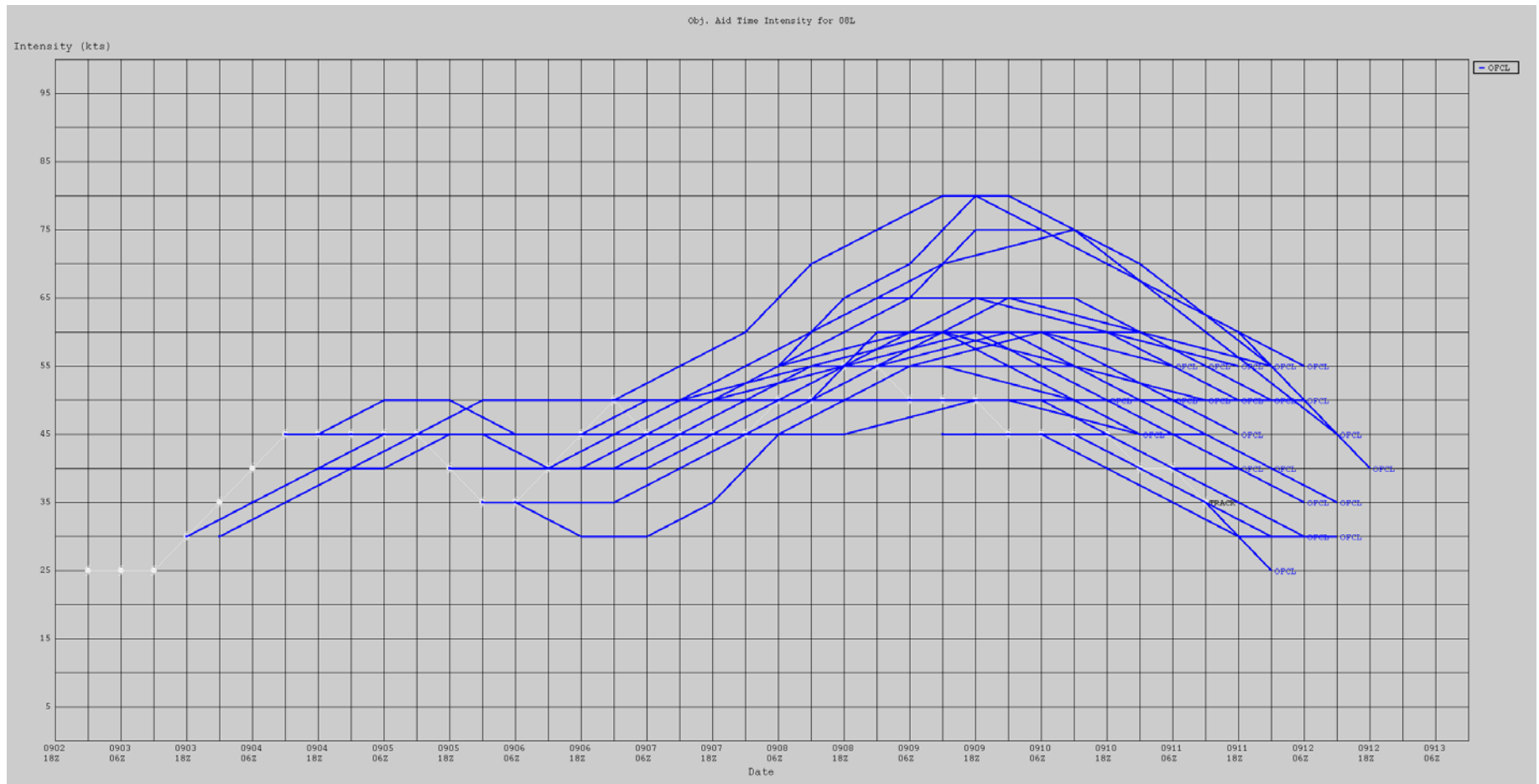


Figure 5. Selected official intensity forecasts (blue lines, kt) for Tropical Storm Gabrielle, 3–10 September 2019. The best track intensity (kt) is given by the white line at 6 h interval.