

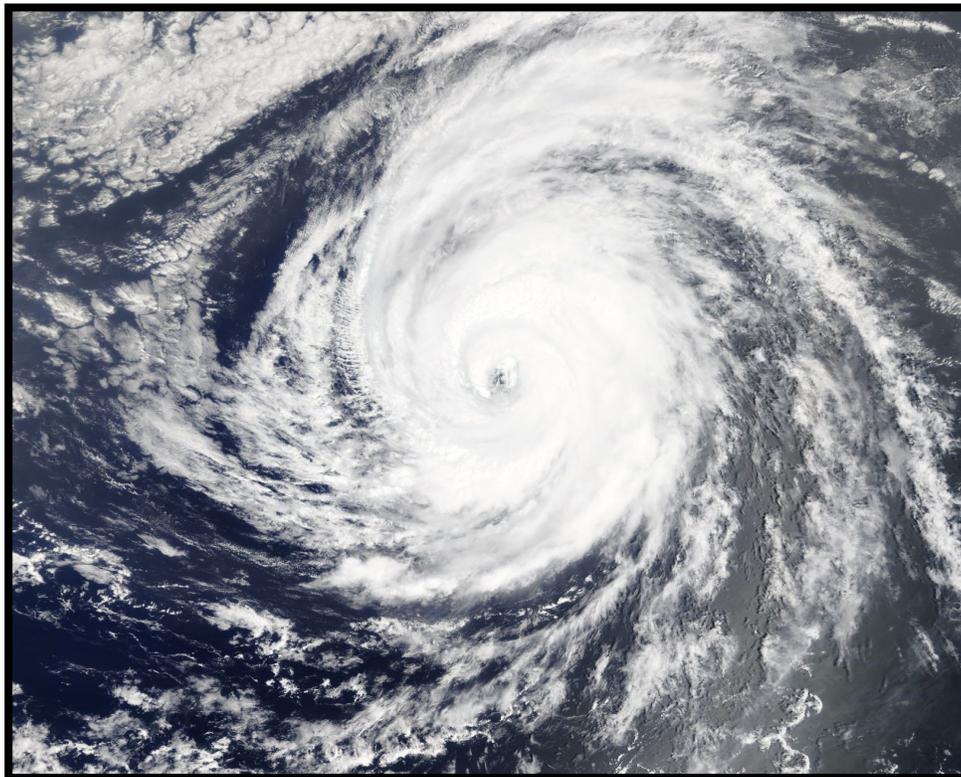


NATIONAL HURRICANE CENTER TROPICAL CYCLONE REPORT

HURRICANE HELENE (AL082018)

7–16 September 2018

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National Hurricane Center
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NASA TERRA/MODIS VISIBLE SATELLITE IMAGE OF HELENE AT 1215 UTC 11 SEPTEMBER 2018.

Helene passed south of the Cabo Verde Islands as a tropical storm before it strengthened into a category two hurricane (on the Saffir-Simpson Hurricane Wind Scale). Helene recurved over the eastern Atlantic and passed near the western islands of the Azores as a tropical storm.

¹ Original report dated 13 December 2018. This version corrects best track data in Table 1.

Hurricane Helene

7–16 SEPTEMBER 2018

SYNOPTIC HISTORY

The genesis of Helene was associated with a vigorous tropical wave. This wave produced a large area of deep convection while it moved across portions of western Africa, and a broad surface low pressure system developed in association with the wave while it was still inland on 6 September. The low moved off the west coast of Africa around 0600 UTC 7 September, and satellite images indicated that it developed a well-defined center and had sufficiently organized deep convection by 1200 UTC that day to mark the formation of a tropical depression when it was located just off the west coast of Africa near Banjul, the Gambia. Helene's formation near the coast of Africa is rare, but not unprecedented since ten tropical cyclones on record have formed farther east. The "best track" chart of the 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 1².

After genesis, the depression moved westward, steered by a subtropical ridge to its north, and the cyclone gradually strengthened. The system became a tropical storm by 0000 UTC 8 September when it was located about 225 n mi east-southeast of Praia in the Cabo Verde Islands. Helene's outer banding features became better established and an inner core formed, which resulted in continued steady strengthening. The cyclone reached hurricane intensity around 1800 UTC 9 September when it was about 100 n mi south-southwest of Brava in the southernmost Cabo Verde Islands. Although the core of Helene stayed south of the Cabo Verde Islands, some of the northern rain bands moved across portions of those islands on 9 September. Helene's strengthening trend continued into 10 September with a banded eye feature evident in satellite images that day. While the hurricane was intensifying, it turned toward the west-northwest on the southwestern periphery of the subtropical ridge. Helene reached its peak intensity of 95 kt, just shy of category 3 strength, around 0000 UTC 11 September when it was located about 425 n mi west of Brava, and it held that peak intensity for about 18 h. During that time, Helene turned toward the northwest as the ridge eroded due to a large deep-layer trough over the central Atlantic.

The hurricane began to weaken late on 11 September due to the combined influences of cool waters and dry air. These more stable conditions caused Helene's deep convection to decrease and the overall convective pattern became increasingly ragged. The eye of the hurricane filled around 1200 UTC 12 September when Helene was a category one hurricane, and the system weakened to a tropical storm 24 h later. While the cyclone was weakening, it turned northward in the flow between a trough over the central Atlantic and a subtropical ridge over the

² 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.

far eastern Atlantic. Southerly vertical wind shear increased over the circulation of Helene on 13 September, which caused the deep convection to be confined to the north of the center. Although this would typically result in weakening, baroclinic influences from the nearby trough caused Helene to maintain its strength as a high end tropical storm for a couple of days. Meanwhile, Helene accelerated toward the north-northeast as it moved into the mid-latitudes and its easternmost outer bands affected a portion of the Azores from late 15 September to early 16 September.

Helene's cloud pattern became increasingly asymmetric when it passed to the west of the Azores, and the storm lost its tropical characteristics and developed frontal features by 1200 UTC 16 September about 250 n mi north of those islands. The extratropical low moved quickly to the northeast and merged with another extratropical cyclone by 0000 UTC 18 September near the United Kingdom.

METEOROLOGICAL STATISTICS

Observations in Helene (Figs. 2 and 3) include subjective satellite-based Dvorak technique 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 Helene.

Helene's peak intensity of 95 kt from 0000 UTC to 1200 UTC 11 September is based on a blend of Dvorak classifications from TAFB and SAB and ADT and SATCON values. The estimated minimum pressure of 967 mb is based on the Knaff-Zehr-Courtney pressure-wind relationship.

There were no ship or land-based reports of winds of tropical storm force associated with Helene. Although no surface data are available, Helene is estimated to have produced tropical storm force winds over the far western Azores on 15–16 September.

CASUALTY AND DAMAGE STATISTICS

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

FORECAST AND WARNING CRITIQUE

The genesis forecasts for Helene were not very accurate as the tropical cyclone formed much sooner than anticipated. Table 2 provides the number of hours in advance of formation associated with the NHC's Tropical Weather Outlook (TWO) forecast in each likelihood category. The precursor tropical wave that became Helene was introduced in NHC's five-day TWO 60 h before formation, two days before the wave moved off the coast, and its formation chances were raised to the medium (40–60%) category 36 h before genesis. A Special TWO was issued to raise the 5-day genesis chance to the high (>60%) category 15 h before the cyclone formed. A two-day formation chance was first included in the TWO 24 h before genesis and it was raised to the medium category in the Special TWO issued 15 h before formation occurred. The two-day genesis chances were raised to the high category only 12 h before Helene developed. The short lead times of genesis are not surprising given that Helene formed so close to the coast of Africa.

A verification of NHC official track forecasts for Helene is given in Table 3a. Official forecast track errors were higher than the mean official errors for the previous 5-yr period at all forecast times, and they were about twice the size of the 5-yr mean at 120 h. Helene's long range track predictability was lower than that of most Atlantic tropical cyclones, with climatology and persistence model (OCD5) errors being notably higher than their respective mean errors during the previous 5-yr period from 72 to 120 h. A homogeneous comparison of the official track errors with selected guidance models is given in Table 3b. The consensus of GFS and ECMWF (GFEX) was the best performing aid, and the only model that consistently beat the official forecasts. Among the individual models, GFSI and HMON (HMNI) had lower errors than the official forecasts in the short term, and ECMWF (EMXI) and UKMET (EGRI) had lower errors than the official forecasts at the longer forecast lead times. The NHC forecasts and the GFSI and EMXI models had a large slow and left-of-track bias for Helene, with less bias noted in the EGRI (Fig. 4). It appears that the trough in the central Atlantic was stronger than expected, which resulted in a faster and more eastward track of Helene than predicted.

A verification of NHC official intensity forecasts for Helene is given in Table 4a. Unlike the track forecasts, the official forecast intensity errors were lower than the mean errors for the previous 5-yr period at all forecast times. In addition, OCD5 errors were higher than their respective 5-yr means from 72 to 120 h, indicating that Helene's intensity at those ranges was challenging to predict, which makes the official intensity forecasts extremely skillful at the longer forecast times. A homogeneous comparison of the official intensity errors with selected guidance models is given in Table 4b. The NHC intensity forecasts were outstanding as they were only bested by HWRF (HWF1) at 72 h and the HFIP Corrected Consensus (HCCA) at 96 h. With the exception of the first forecast, NHC correctly anticipated Helene's intensification and weakening periods (Fig. 5).

Coastal wind watches and warnings associated with Helene are given in Table 5.



Table 1. Best track for Hurricane Helene, 7–16 September 2018.

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
07 / 1200	13.4	16.8	1004	30	tropical depression
07 / 1800	13.5	17.4	1003	30	"
08 / 0000	13.6	18.0	1002	35	tropical storm
08 / 0600	13.7	18.9	1002	40	"
08 / 1200	13.5	19.9	1001	45	"
08 / 1800	13.3	21.0	1000	45	"
09 / 0000	13.2	22.2	999	50	"
09 / 0600	13.1	23.4	998	55	"
09 / 1200	13.2	24.5	996	60	"
09 / 1800	13.4	25.6	992	65	hurricane
10 / 0000	13.7	26.7	984	75	"
10 / 0600	14.0	28.0	980	80	"
10 / 1200	14.4	29.4	977	85	"
10 / 1800	14.8	30.8	973	90	"
11 / 0000	15.3	32.1	969	95	"
11 / 0600	15.7	33.2	968	95	"
11 / 1200	16.2	34.0	967	95	"
11 / 1800	16.8	34.6	970	90	"
12 / 0000	17.6	35.3	973	85	"
12 / 0600	18.7	35.8	976	80	"
12 / 1200	19.8	36.3	976	80	"
12 / 1800	20.8	36.7	979	75	"
13 / 0000	21.9	37.1	982	70	"
13 / 0600	22.9	37.3	985	65	"
13 / 1200	24.1	37.4	988	60	tropical storm
13 / 1800	25.4	37.4	988	60	"
14 / 0000	27.2	37.4	989	60	"
14 / 0600	29.4	37.3	989	60	"
14 / 1200	31.8	37.2	988	60	"
14 / 1800	33.7	37.0	987	60	"



Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
15 / 0000	35.2	36.5	986	60	"
15 / 0600	36.9	35.7	986	60	"
15 / 1200	38.4	34.5	987	55	"
15 / 1800	39.6	32.9	989	55	"
16 / 0000	40.6	31.5	992	50	"
16 / 0600	41.8	29.6	993	45	"
16 / 1200	43.1	27.1	993	45	extratropical
16 / 1800	44.1	24.0	993	45	"
17 / 0000	45.2	20.0	992	50	"
17 / 0600	46.7	16.0	992	50	"
17 / 1200	48.0	12.5	992	50	"
17 / 1800	49.5	10.0	995	45	"
18 / 0000					dissipated
11 / 1200	16.2	34.0	967	95	maximum winds and 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. An asterisk indicates that the given probability range was first reached in a Special Tropical Weather Outlook.

	Hours Before Genesis	
	48-Hour Outlook	120-Hour Outlook
Low (<40%)	24	60
Medium (40%-60%)	15*	36
High (>60%)	12	15*

Table 3a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) track forecast errors (n mi) for Hurricane Helene, 7–16 September 2018. 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	25.5	45.1	68.0	94.2	150.7	231.3	357.9
OCD5	40.7	89.1	139.6	200.1	359.4	510.3	634.0
Forecasts	34	32	30	28	24	20	16
OFCL (2013-17)	24.1	37.4	50.5	66.6	98.4	137.4	180.7
OCD5 (2013-17)	44.7	95.8	153.2	211.2	318.7	416.2	490.6



Table 3b. Homogeneous comparison of selected track forecast guidance models (in n mi) for Hurricane Helene, 7–16 September 2018. 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	25.0	45.2	65.8	90.7	148.0	233.5	373.0
OCD5	35.4	86.6	139.6	203.4	384.9	566.4	743.4
GFSI	24.7	40.3	58.0	90.2	169.7	256.1	364.8
HMNI	23.2	39.4	64.3	103.0	226.2	419.6	600.0
HWFI	25.3	43.8	63.6	92.8	173.0	290.4	453.9
EGRI	27.3	45.6	67.2	93.4	134.6	217.1	316.3
EMXI	27.8	49.0	68.8	88.0	130.5	192.9	280.3
CMCI	35.8	66.9	96.3	132.5	176.6	203.7	330.5
NVGI	29.9	51.6	75.6	100.1	186.1	345.4	588.5
AEMI	25.8	43.3	68.6	106.2	198.0	319.2	464.8
HCCA	25.5	44.5	62.5	91.3	151.9	240.5	373.3
FSSE	24.7	41.4	57.7	83.8	131.1	227.3	379.8
TVCX	23.8	41.9	60.7	90.6	149.3	232.7	358.6
TVCA	23.4	40.7	60.6	90.7	153.5	246.1	378.7
GFEX	24.9	43.1	60.5	86.3	145.8	212.6	305.3
TABS	44.6	101.4	157.8	197.5	235.9	326.3	434.1
TABM	34.1	64.6	87.6	108.9	169.3	237.3	333.4
TABD	43.4	98.9	154.5	200.7	214.1	274.9	370.7
Forecasts	29	28	27	25	21	17	13

Table 4a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) intensity forecast errors (kt) for Hurricane Helene, 7–16 September 2018. 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	4.0	4.8	4.5	4.8	7.9	9.5	7.5
OCD5	5.9	10.0	14.3	17.4	23.9	25.9	24.5
Forecasts	34	32	30	28	24	20	16
OFCL (2013-17)	5.5	8.0	10.1	11.4	12.7	14.5	15.0
OCD5 (2013-17)	7.1	11.1	14.4	17.4	20.6	22.3	23.7

Table 4b. Homogeneous comparison of selected intensity forecast guidance models (in kt) for Hurricane Helene, 7–16 September 2018. 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	3.6	4.6	4.4	4.0	5.2	6.5	5.4
OCD5	5.9	10.2	14.4	17.0	21.5	24.1	23.2
HMNI	5.8	8.1	9.3	11.0	11.4	11.8	11.8
HWF1	7.2	7.6	8.2	7.9	5.0	7.9	11.2
DSHP	4.9	6.5	8.0	8.2	14.4	15.2	7.5
LGEM	5.0	6.0	7.4	8.0	10.2	10.6	9.8
HCCA	4.9	6.4	7.8	6.3	6.3	6.2	6.5
FSSE	4.7	5.5	6.3	6.2	8.0	7.5	5.7
IVCN	4.4	5.2	6.0	5.7	7.7	9.1	8.4
GFSI	4.4	7.1	9.9	12.0	13.8	15.2	10.4
EMXI	6.5	10.1	12.0	13.0	12.0	11.4	8.7
Forecasts	29	28	27	25	21	17	13



Table 5. Coastal wind watch and warning summary for Hurricane Helene, 7–16 September 2018.

Date/Time (UTC)	Action	Location
7 / 1500	Tropical Storm Warning issued	Santiago, Fogo, Brava in the Cabo Verde Islands
8 / 0900	Hurricane Watch issued	Santiago, Fogo, Brava in the Cabo Verde Islands
9 / 2100	Tropical Storm Warning and Hurricane Watch discontinued	All
13 / 2100	Tropical Storm Watch issued	Azores
14 / 0900	Tropical Storm Watch changed to Tropical Storm Warning	Azores
16 / 0300	Tropical Storm Warning discontinued	All

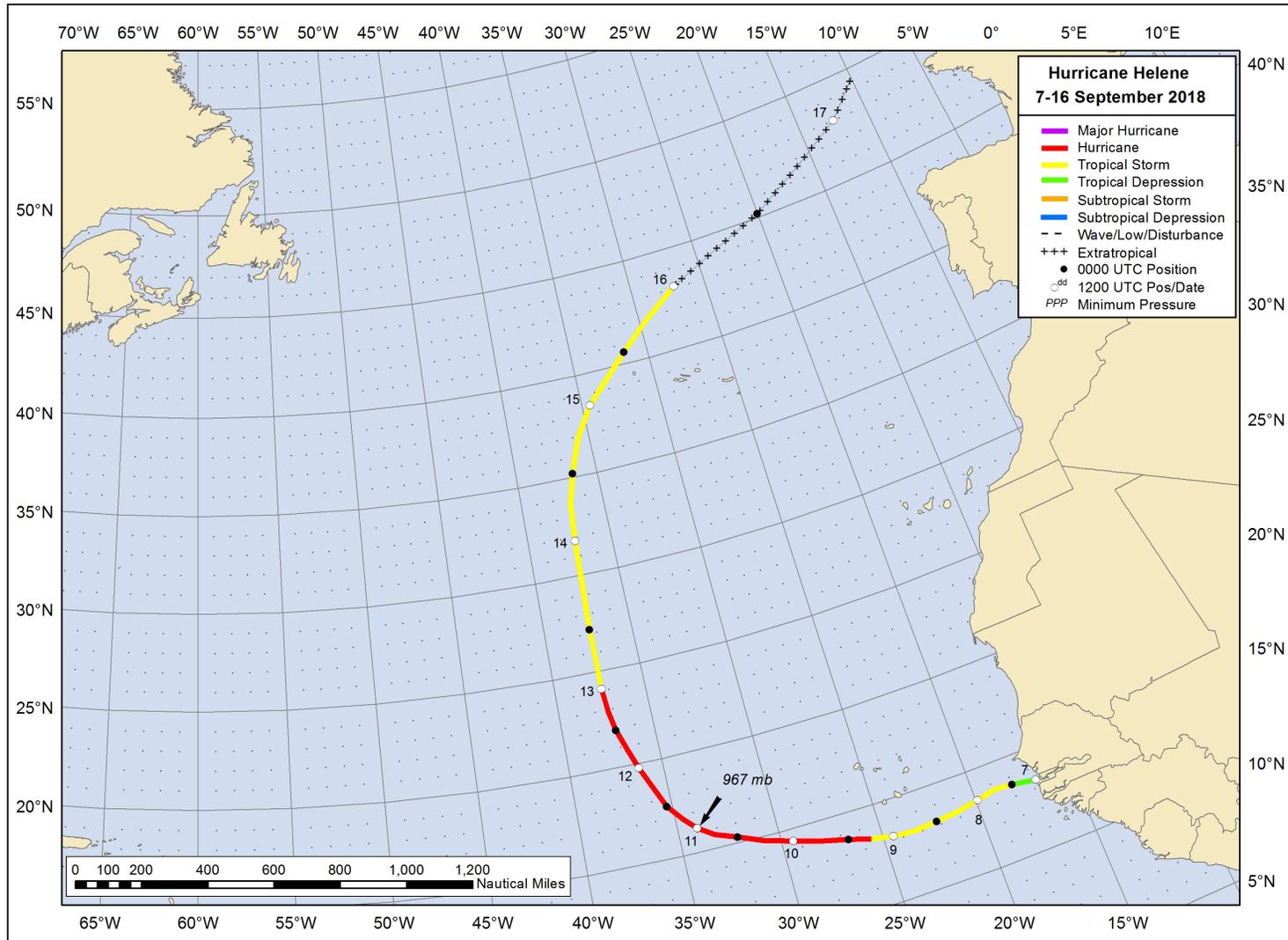


Figure 1. Best track positions for Hurricane Helene, 7–16 September 2018.

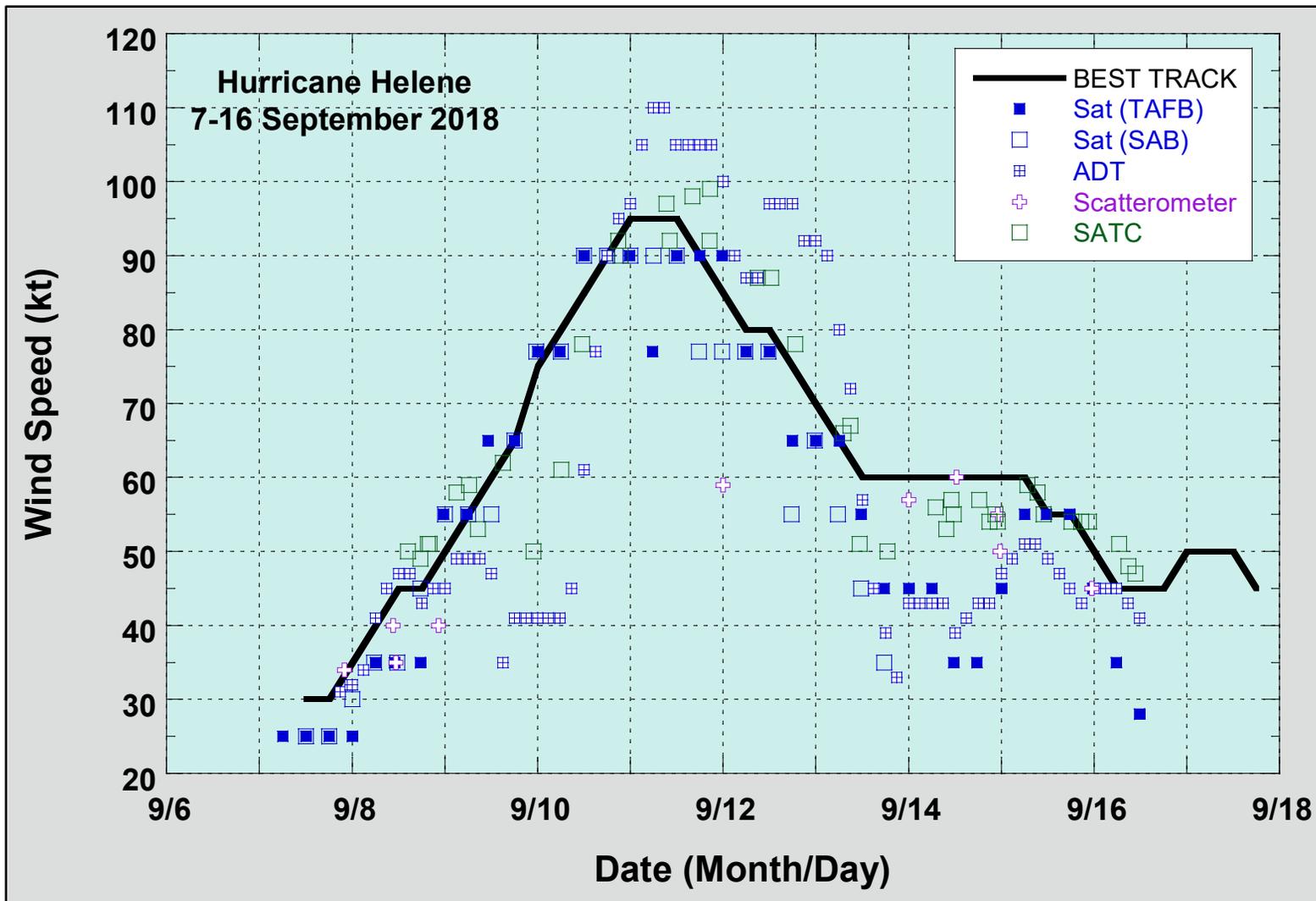


Figure 2. Selected wind observations and best track maximum sustained surface wind speed curve for Hurricane Helene, 7–16 September 2018. Advanced Dvorak Technique estimates represent the Current Intensity at the nominal observation time. SATCON intensity estimates are from the Cooperative Institute for Meteorological Satellite Studies. Dashed vertical lines correspond to 0000 UTC.

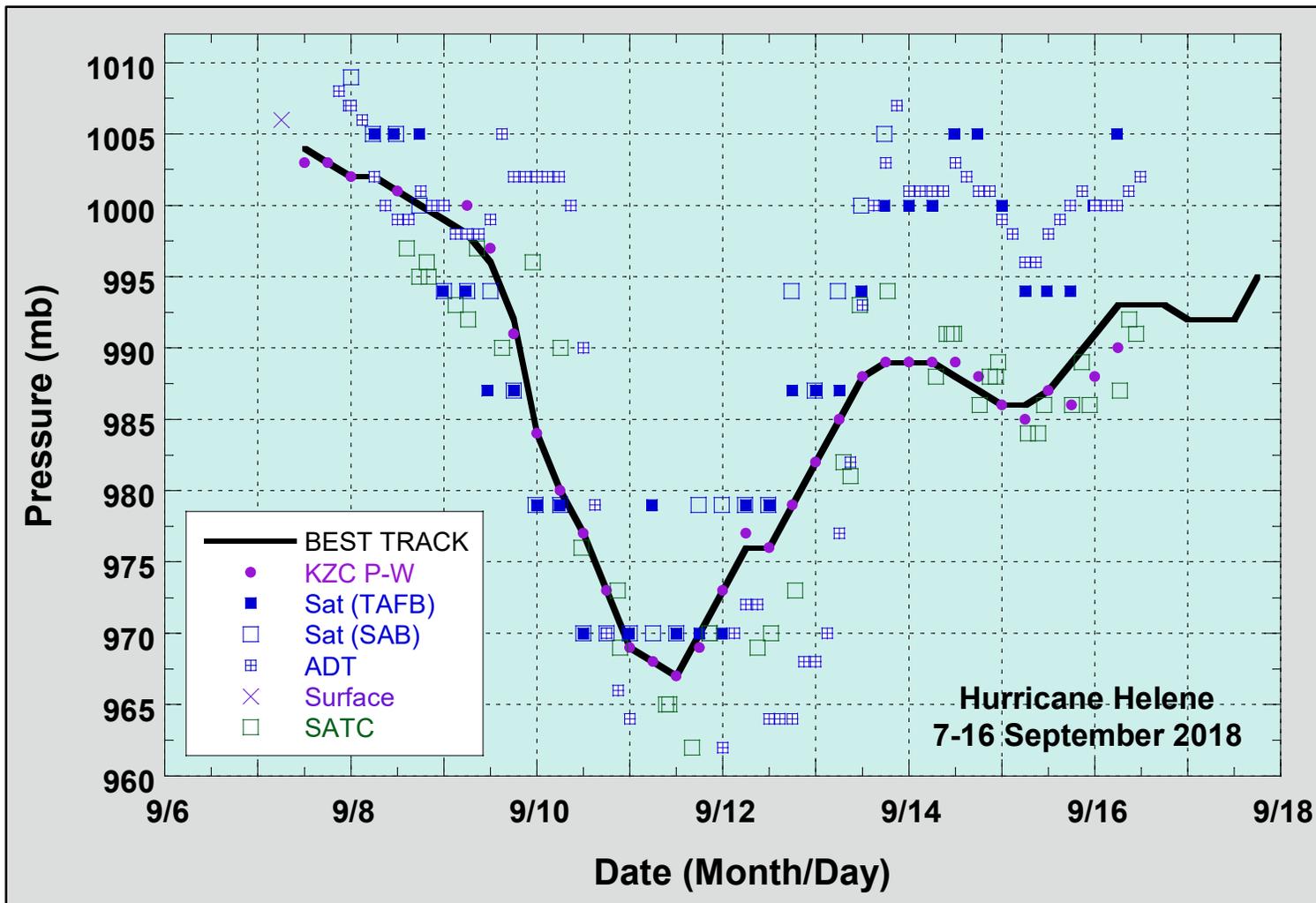


Figure 3. Selected pressure observations and best track minimum central pressure curve for Hurricane Helene, 7–16 September 2018. Advanced Dvorak Technique estimates represent the Current Intensity at the nominal observation time. SATCON intensity estimates are from the Cooperative Institute for Meteorological 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.

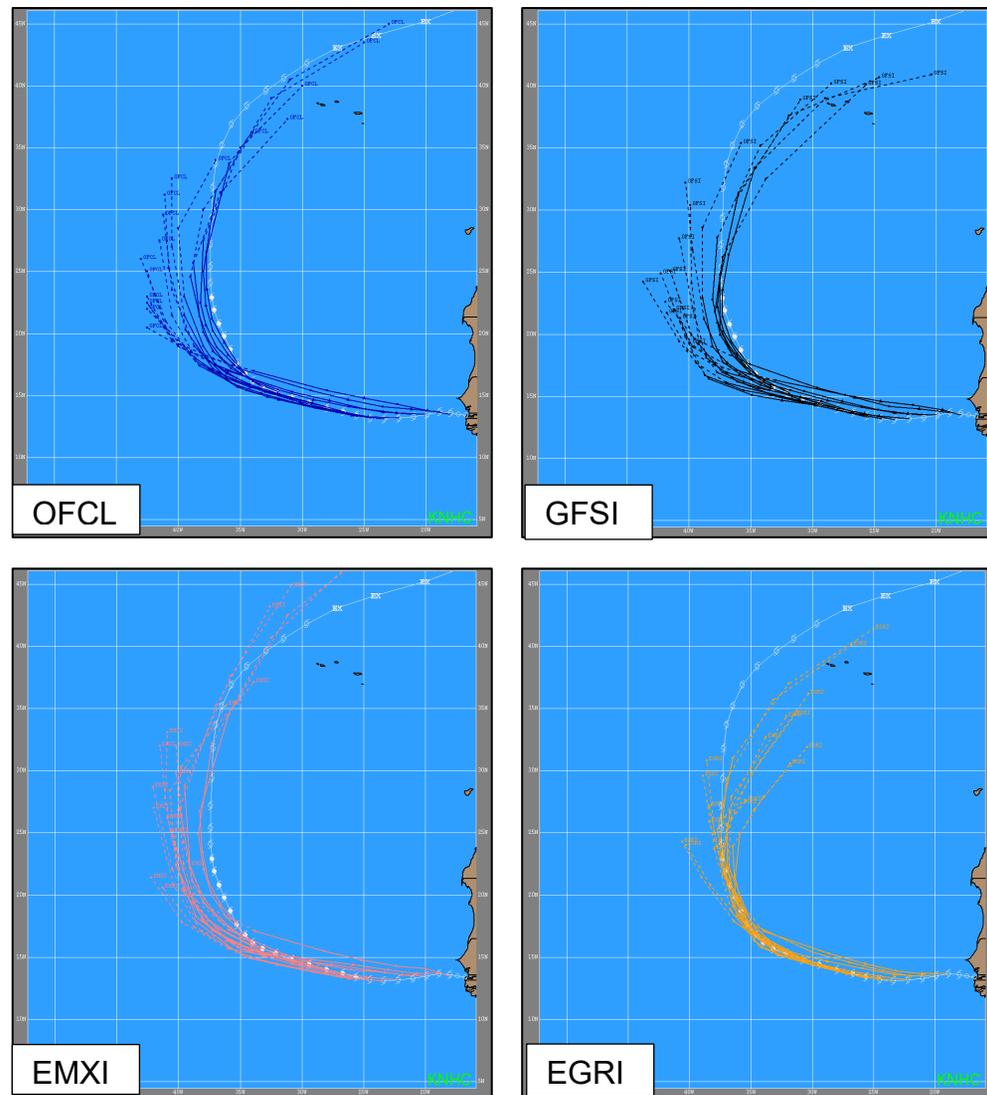


Figure 4. NHC official and selected model tracks from 0000 UTC 8 September to 0000 UTC 12 September for Hurricane Helene. The best track is given by the white line with positions shown at 6 h intervals.

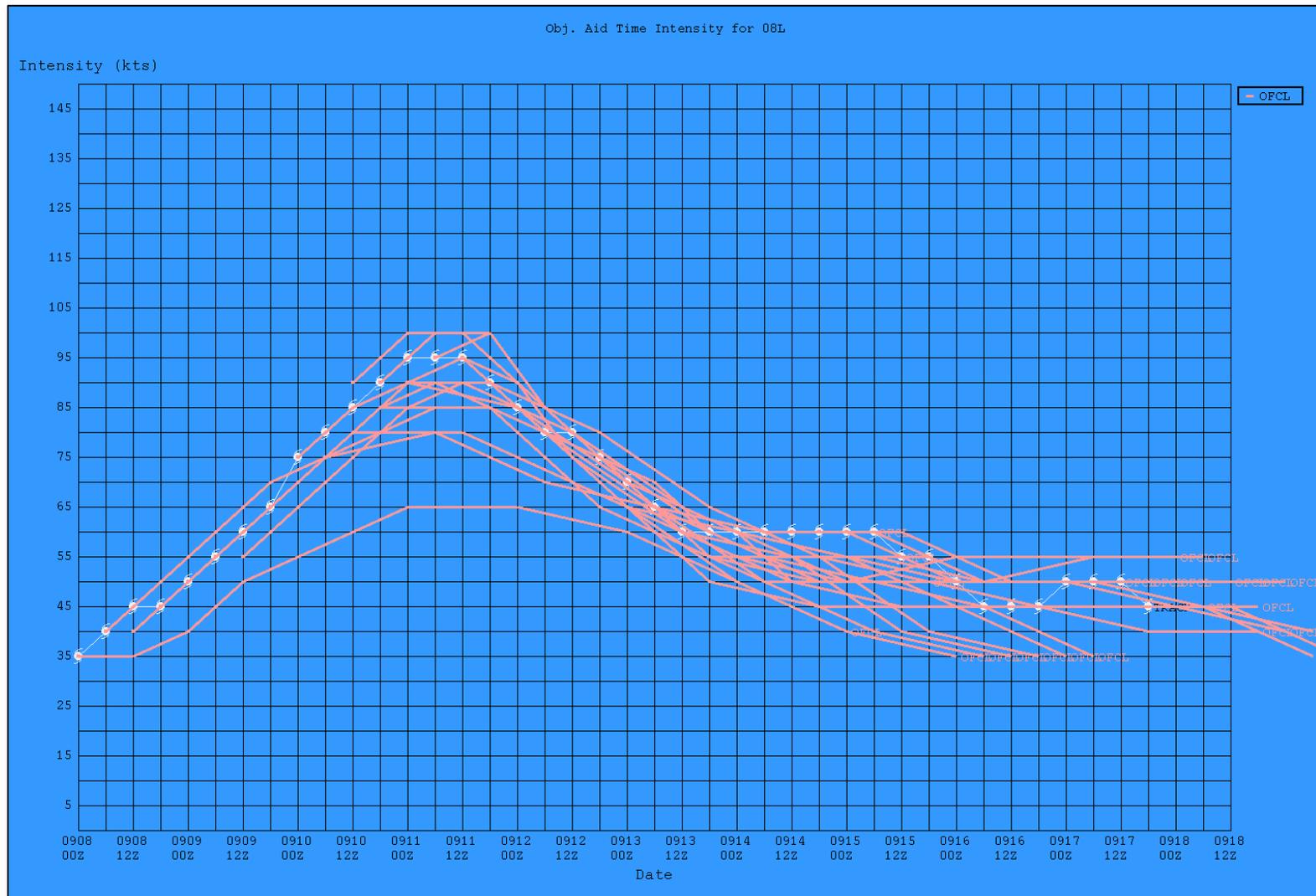


Figure 5. NHC official intensity forecasts (kt, orange lines) from 0000 UTC 8 September to 0000 UTC 15 September 2018 for Hurricane Helene. The verifying intensity is shown in white.