NATIONAL HURRICANE CENTER
TROPICAL CYCLONE REPORT

HURRICANE MARIE

(EP182020)

29 September–6 October 2020

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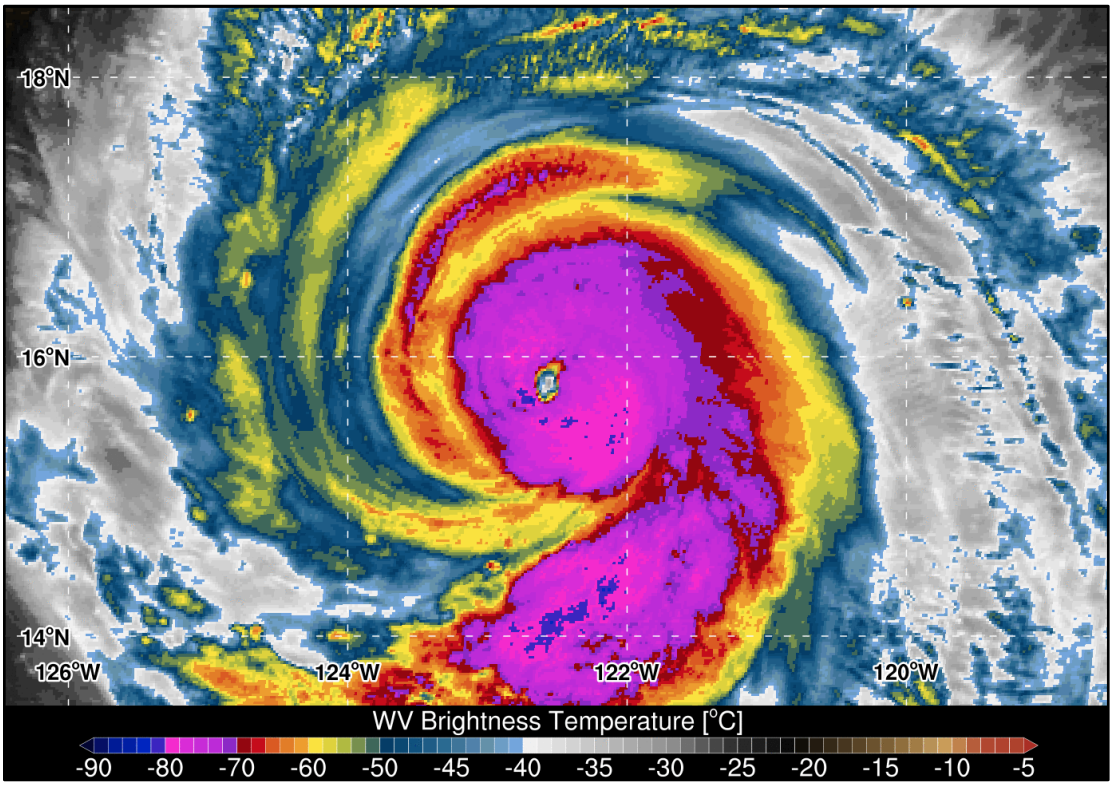

GOES-17 WATER VAPOR IMAGE AT 0520 UTC 2 OCTOBER 2020, SHOWING HURRICANE MARIE NEAR ITS PEAK INTENSITY. DATA USED TO CREATE THIS SATELLITE IMAGE COURTESY OF THE NOAA BIG DATA PROJECT.

Marie rapidly intensified into a category 4 hurricane on the Saffir-Simpson Hurricane Wind Scale over the eastern Pacific Ocean. The storm did not threaten land as it moved generally northwestward before becoming a remnant low over the northwest portion of the eastern North Pacific basin.

Hurricane Marie

29 SEPTEMBER–6 OCTOBER 2020

SYNOPTIC HISTORY

The origins of Marie appear to be tied to a broad disturbance that formed several hundred miles south of the coast of Mexico on 24 September, within the larger monsoonal trough that was prevalent across the east Pacific during the latter days of September. A tropical wave crossing Central America on 23–24 September may have also contributed to the system's initial organization. Over the next several days, this area of disturbed weather moved gradually westward while producing a large region of disorganized convection. Enhancement of this disorganized convection may have also been influenced by the eastward propagation of a convectively-coupled Kelvin wave over this time period. On 27 September, scatterometer data indicated an area of low pressure had formed within this disorganized convective activity, although convection fluctuated and did not improve in organization over the following day. Finally, early on 29 September, a significant burst of deep convection developed and persisted, becoming sufficiently organized near the low-level vortex to designate the formation of a tropical depression by 0600 UTC 29 September approximately 360 n mi southwest of the Manzanillo, Mexico. Later that day, the depression intensified into Tropical Storm Marie. The "best track" chart of Marie'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 1[1].

Marie initially moved westward but began to gain latitude on 30 September while being steered by a persistent mid-level subtropical ridge anchored over the southwestern United States. Over this time, the tropical storm steadily intensified as moderate northeasterly vertical wind shear subsided while the cyclone traversed 28°–29°C sea surface temperatures (SSTs) in an environment of enhanced deep-layer moisture. Marie became a hurricane at 0000 UTC 1 October and then began a period of rapid intensification as its inner core became established. By 0600 UTC 2 October, Marie reached an estimated peak intensify of 120 kt with a well-defined eye present on geostationary satellite imagery surrounded by cold cloud tops between -70 and -75°C (cover photo). Over the next day, the hurricane maintained category 4 intensity despite its fluctuating satellite presentation due to inner core processes.

On 4 October, Marie crossed the 26°C-SST isotherm into cooler waters as it moved into a drier and more stable air mass. In addition, deep-layer southwesterly vertical wind shear increased over the major hurricane. Consequently, the cyclone's convective structure began a pronounced decay and rapid weakening commenced. Marie dropped below hurricane intensity

[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.

by 0000 UTC 5 October as the low-level center became exposed and convection decreased in coverage and intensity. Further weakening continued over the next 48 h, and Marie is estimated to have degenerated into a 35 kt post-tropical cyclone by 1800 UTC 6 October as convection had mostly dissipated near its center. One final short-lived burst of deep convection occurred on 7 October, along the north side of the post-tropical cyclone. This convective burst resulted in a northward bend in track and a brief increase in winds over gale force on the convectively active side of the cyclone. However, this convection was poorly organized and did not persist long enough to result in the regeneration of a tropical cyclone, and convection dissipated again that evening. The post-tropical cyclone became a remnant low when its winds dropped below 35 kt on 1200 UTC 8 October. Over the next few days the remnant low's motion shifted back towards the west and then west-southwest, embedded within the low-level trade wind flow. The remnant low finally opened up into a trough on 10 October more than 850 n mi east-northeast of Hilo, Hawaii.

METEOROLOGICAL STATISTICS

Observations in Hurricane Marie (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 Marie.

Marie's estimated peak intensity of 120 kt from 0600–1200 UTC 2 October is based on a blend of subjective Dvorak peak satellite intensity estimates from TAFB (T6.5/127 kt) and SAB (T6.0/115 kt), in addition to the University of Wisconsin CIMSS ADT, which provided a 3-6 h period of 130-kt and greater estimates between 0600–1200 UTC. The estimated minimum pressure of 945 mb is based on the Knaff-Zehr-Courtney pressure wind relationship blended with lower TAFB and ADT estimates.

There were no observations from ships or land stations of winds of tropical storm force associated with Marie.

CASUALTY AND DAMAGE STATISTICS

There were no reports of damage or casualties associated with Hurricane Marie.

FORECAST AND WARNING CRITIQUE

The genesis of Maire was well anticipated at long range (Table 2). The system attributed to Marie's development was introduced in the Tropical Weather Outlook 114 h prior to genesis with a low (<40%) chance of formation during the next 5 days. The 5-day probabilities were increased to the medium (40–60%) and high (>60%) categories 90 h and 42 h before Marie formed, respectively. At shorter ranges there was a little more uncertainty on when Marie would undergo genesis. This is reflected in the 2-day genesis probabilities, as a low chance of genesis was introduced 36 h, a medium chance 30 h, and a high chance 18 h before the system developed, respectively.

A verification of NHC official track forecasts for Marie is given in Table 3a. Official forecast track errors (OFCL) were much lower than mean official errors for the previous 5-yr period at all forecast times. In fact, OFCL track forecast errors were 25–35% lower at shorter lead times (12–60 h) with somewhat less track error improvement (5–20% lower) at longer lead times (72–120 h). Climatology-persistence track errors (OCD5) were also smaller than the long-term mean OCD5 errors, suggesting that Marie's track was easier to forecast than that of a typical system. These lower-than-normal track errors may be related to the persistent synoptic pattern with a large subtropical ridge located north and east of Marie that maintained the tropical cyclone on a consistent west-northwest to northwest heading in both OFCL and the verifying best track (Fig. 4). A homogeneous comparison of the OFCL track errors with selected guidance models is given in Table 3b. For lead times of 12–36 h, OFCL outperformed all of the deterministic track guidance, though the HFIP Corrected Consensus Aid (HCCA) and GEFS ensemble mean (AEMI) bested OFCL at 24 h and the TVCX and TVCE consensus track guidance had smaller errors than OFCL at 36 h. At longer lead times, the NHC forecast continued to outperform most of the individual model guidance with the exception of HWRF (HWFI) between 48–72 h and COAMPS-TC (CTCI) between 96–120 h. A simple consensus of the GFS and ECMWF track guidance (GFEX) also performed well at longer lead times.

A verification of NHC official intensity forecasts for Marie is given in Table 4a. Official forecast intensity errors were also much lower than the mean official errors for the previous 5-yr period. While the first few NHC intensity forecasts were low biased, overall the rapid intensification of Marie was well anticipated and explicitly forecasted on 30 September–1 October (Fig. 5). A homogeneous comparison of the official intensity errors with selected guidance models is given in Table 4b. At lead times at or less than 60 h and at 120 h OFCL had smaller average intensity errors than nearly all of the intensity guidance, with the exception of a few forecast lead times of the HCCA and the FSU Superensemble (FSSE). It is worth noting that several reliable intensity models also explicitly forecasted rapid intensification, such as the logistic growth equation model (LGEM) and CTCI, though the HWFI under-predicted Marie's peak intensity (Fig. 5). The SHIPS rapid intensification index on 30 September also indicated rapid intensification probabilities up to ten times the climatological mean, helping lend confidence in the official forecast explicitly forecasting Marie's rapid intensification. Between 72–96 h, a larger fraction of the intensity guidance suite outperformed OFCL but only slightly with average errors only 1–2 kt lower.

There were no coastal watches and warnings associated with Marie.

Table 1. Best track for Hurricane Marie, 29 September–6 October 2020.

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
27 / 1200	12.4	103.4	1009	20	low
27 / 1800	12.5	103.7	1009	20	"
28 / 0000	12.7	104.0	1008	20	"
28 / 0600	13.1	104.3	1008	20	"
28 / 1200	13.4	104.7	1007	20	"
28 / 1800	13.5	105.2	1007	25	"
29 / 0000	13.5	106.0	1006	25	"
29 / 0600	13.5	107.0	1005	30	tropical depression
29 / 1200	13.5	108.0	1005	30	"
29 / 1800	13.6	109.0	1004	35	tropical storm
30 / 0000	13.8	110.3	1003	40	"
30 / 0600	14.0	111.7	1002	45	"
30 / 1200	14.1	113.1	1000	50	"
30 / 1800	14.2	114.6	994	55	"
01 / 0000	14.4	116.1	988	65	hurricane
01 / 0600	14.6	117.6	984	75	"
01 / 1200	14.8	119.0	977	85	"
01 / 1800	15.0	120.3	969	95	"
02 / 0000	15.4	121.5	961	105	"
02 / 0600	15.9	122.6	945	120	"
02 / 1200	16.3	123.8	945	120	"
02 / 1800	16.7	124.6	948	115	"
03 / 0000	17.2	125.4	948	115	"
03 / 0600	17.6	126.1	948	115	"
03 / 1200	18.1	126.7	952	110	"
03 / 1800	18.6	127.2	955	105	"
04 / 0000	19.0	127.6	960	100	"
04 / 0600	19.5	128.0	967	90	"
04 / 1200	19.8	128.5	975	80	"

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
04 / 1800	20.1	129.2	981	70	"
05 / 0000	20.4	129.9	988	60	tropical storm
05 / 0600	20.6	130.7	993	55	"
05 / 1200	20.8	131.5	996	50	"
05 / 1800	21.0	132.3	998	45	"
06 / 0000	21.2	133.1	999	45	"
06 / 0600	21.5	133.9	1001	45	"
06 / 1200	21.9	134.7	1003	40	"
06 / 1800	22.2	135.4	1005	35	low
07 / 0000	22.3	136.0	1005	35	"
07 / 0600	22.5	136.5	1005	35	"
07 / 1200	23.0	136.6	1004	40	"
07 / 1800	23.5	136.6	1003	45	"
08 / 0000	24.0	136.5	1004	40	"
08 / 0600	24.5	136.6	1005	35	"
08 / 1200	24.7	137.1	1007	30	"
08 / 1800	24.7	137.6	1008	25	"
09 / 0000	24.7	138.1	1009	25	"
09 / 0600	24.7	138.7	1009	25	"
09 / 1200	24.4	139.2	1009	25	"
09 / 1800	24.1	139.6	1009	25	"
10 / 0000	24.0	140.3	1009	20	"
10 / 0600					dissipated
02 / 0600	15.9	122.6	945	120	maximum wind 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.

	Hours Before Genesis	
	48-Hour Outlook	**120-Hour Outlook**
Low (<40%)	36	114
Medium (40%-60%)	30	90
High (>60%)	18	42

Table 3a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) track forecast errors (n mi) for Marie. 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	60	72	96	120
OFCL	**14.8**	**23.5**	**32.0**	**38.6**	**47.5**	**60.2**	**92.7**	**122.8**
OCD5	32.0	70.0	115.4	154.5	177.1	194.0	224.6	218.9
Forecasts	28	26	24	22	20	18	14	10
OFCL (2015-19)	21.8	34.0	44.9	55.3	66.2	77.1	99.1	123.2
OCD5 (2015-19)	34.3	69.9	108.7	146.8	181.4	216.0	268.7	328.0

Table 3b. Homogeneous comparison of selected track forecast guidance models (in n mi) for Marie. 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	60	72	96	120
OFCL	14.8	23.0	31.2	38.3	45.6	57.3	93.0	125.7
OCD5	32.6	70.3	114.5	148.0	159.3	164.4	186.3	170.7
GFSI	17.6	29.1	40.7	51.9	55.4	60.6	**88.1**	149.9
HWFI	20.6	29.1	32.2	**36.9**	**44.2**	**51.5**	107.3	158.2
HMNI	19.7	31.8	36.2	42.6	57.7	76.4	144.0	210.8
EMXI	20.3	33.9	44.0	52.7	63.6	76.9	151.2	182.5
CMCI	27.1	41.4	50.2	61.1	77.9	87.2	135.2	149.1
NVGI	22.0	38.3	55.3	75.5	95.8	111.8	145.8	175.0
CTCI	17.8	23.8	33.0	46.0	57.7	69.9	**78.0**	**95.8**
AEMI	16.6	23.3	34.8	47.6	56.9	64.2	94.6	139.2
HCCA	15.1	**22.5**	31.3	41.7	51.6	66.7	108.7	138.9
FSSE	14.9	23.3	**30.3**	42.8	52.0	61.7	101.0	132.3
TVCX	15.4	**22.7**	**29.1**	**37.4**	47.0	59.1	102.6	135.7
GFEX	16.6	25.4	32.2	38.3	46.7	**54.3**	**86.3**	131.6
TVCE	14.8	**22.8**	**29.3**	**37.7**	48.2	61.0	103.1	145.4
TABD	37.2	71.9	100.9	135.5	153.7	175.6	207.9	202.5
TABM	23.4	38.5	49.7	64.5	83.0	96.5	94.4	**121.4**
TABS	38.8	84.5	119.6	144.4	167.0	185.9	163.8	**110.8**
Forecasts	23	21	19	18	16	14	10	6

Table 4a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) intensity forecast errors (kt) for Marie. 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	60	72	96	120
OFCL	**3.9**	**4.2**	**4.0**	**6.1**	**7.8**	**10.0**	**11.4**	**6.5**
OCD5	6.2	11.2	16.4	20.1	23.1	24.7	21.0	11.1
Forecasts	28	26	24	22	20	18	14	10
OFCL (2015-19)	6.0	9.9	12.1	13.5	14.5	15.4	15.6	16.4
OCD5 (2015-19)	7.8	13.0	16.6	18.9	20.2	21.4	22.6	22.4

Table 4b. Homogeneous comparison of selected intensity forecast guidance models (in kt) for Marie. 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	60	72	96	120
OFCL	4.1	4.8	3.9	5.6	5.9	7.5	8.0	3.3
OCD5	6.7	11.3	17.2	19.3	21.4	21.9	17.9	7.3
HWFI	7.3	9.7	12.6	12.3	13.0	13.6	11.1	8.0
HMNI	5.7	8.8	13.3	13.5	15.9	18.2	14.4	6.3
DSHP	5.2	5.7	5.4	6.9	6.9	**6.9**	**6.7**	10.0
LGEM	5.5	6.4	8.4	8.3	6.8	**5.9**	10.3	6.5
ICON	4.4	6.0	9.2	9.7	10.0	10.2	8.1	6.0
IVCN	4.3	6.0	8.4	8.1	7.6	7.8	**7.6**	5.8
CTCI	4.8	5.9	7.0	7.7	7.0	**5.6**	**6.4**	5.3
GFSI	7.6	12.0	18.8	21.8	23.2	20.5	14.3	7.0
EMXI	9.6	18.5	28.5	33.1	36.8	36.1	19.3	7.3
HCCA	4.8	6.5	6.4	6.2	**4.9**	**5.9**	**7.1**	5.0
FSSE	4.3	4.9	5.3	**5.3**	6.4	7.6	8.4	15.5
Forecasts	23	21	19	18	16	14	10	6

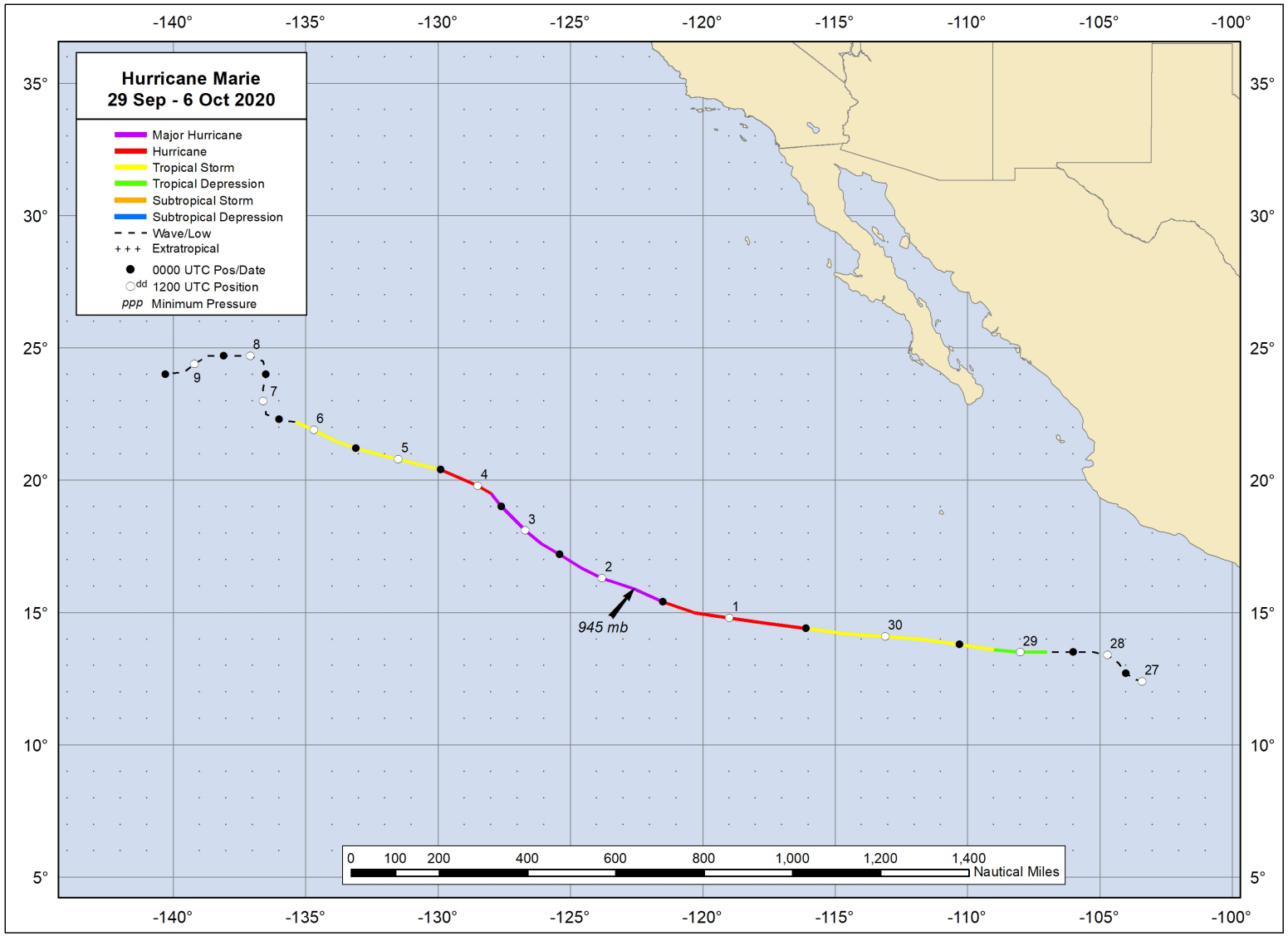

Figure 1. Best track positions for Hurricane Marie, 29 September–6 October 2020.

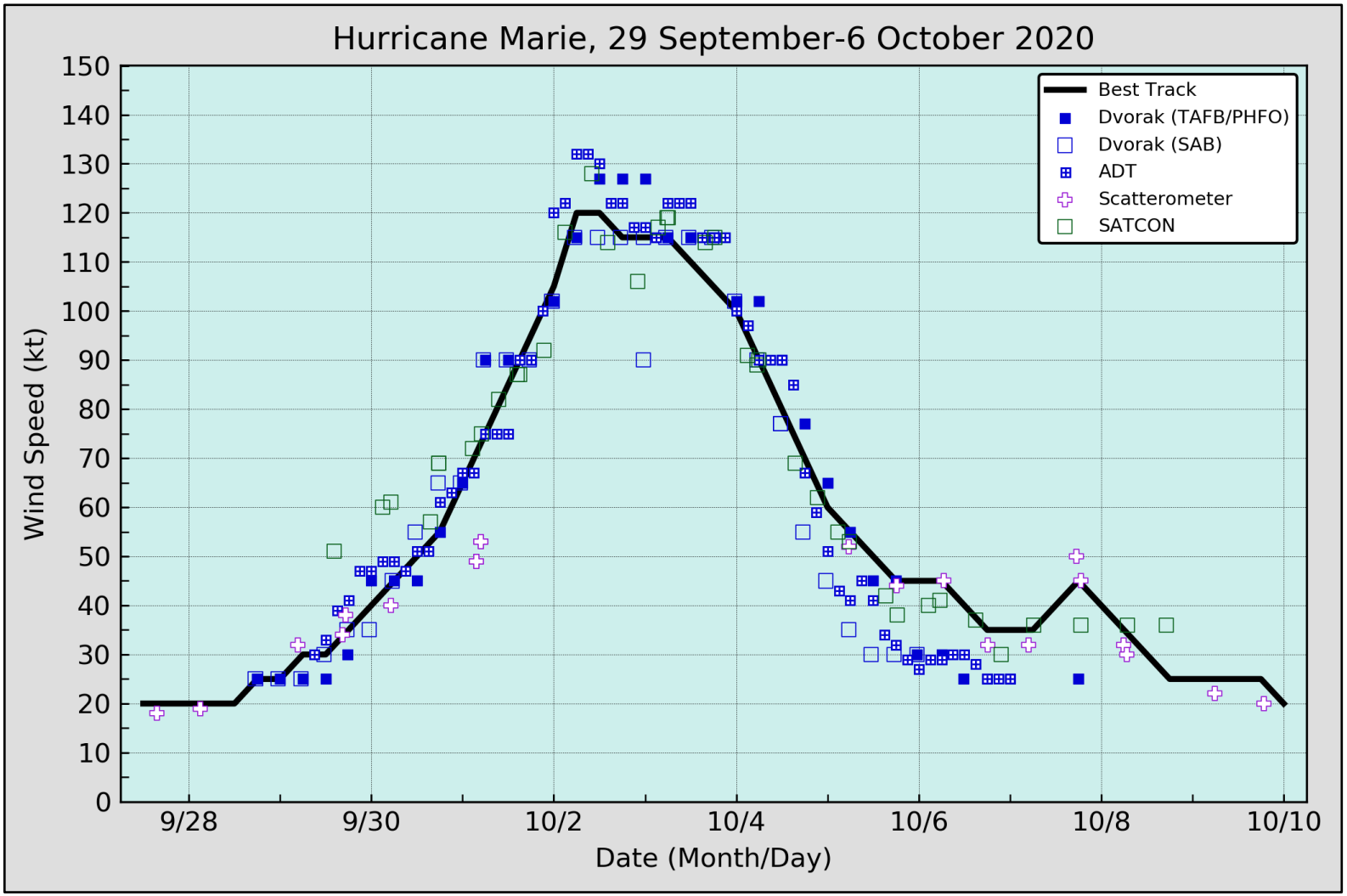

Figure 2. Selected wind observations and best track maximum sustained surface wind speed curve for Hurricane Marie 29 September–6 October. Advanced Dvorak Technique estimates represent the Current Intensity at the nominal observation time. SATCON intensity estimates are from the Cooperative Institute for Meteorological Satellite Studies. Dashed vertical lines correspond to 0000 UTC.

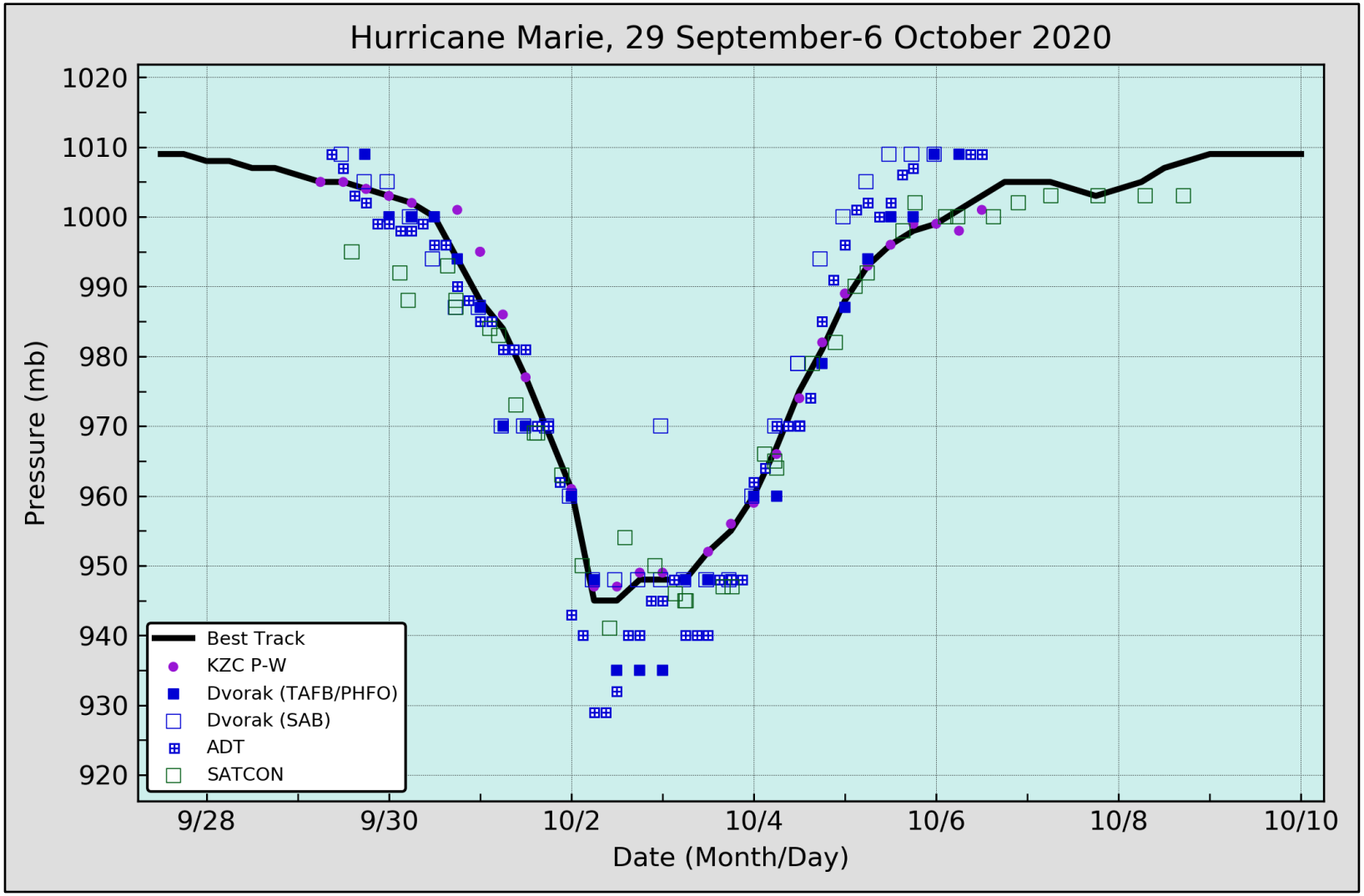

Figure 3. Selected pressure observations and best track minimum central pressure curve for Hurricane Marie 29 September–6 October. Advanced Dvorak Technique estimates represent the Current Intensity at the nominal observation time. SATCON intensity estimates are from the Cooperative Institute for Meteorological 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.

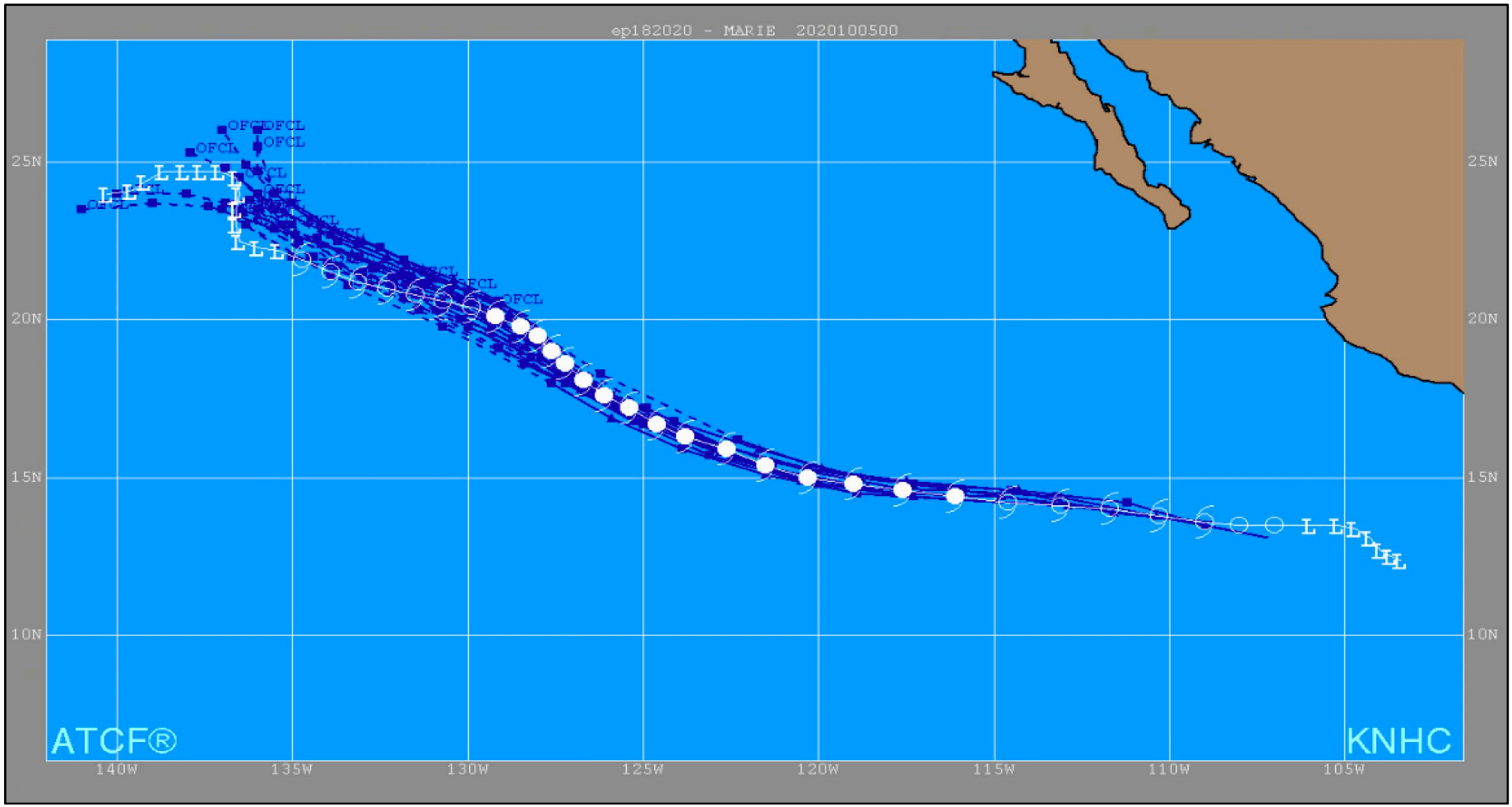

Figure 4. Selected official track forecasts (blue lines, with 0, 12, 24, 36, 48, 60, 72, 96, and 120 h positions indicated) for Hurricane Marie from 0600 UTC 29 September to 0000 UTC 5 October. The best track is given by the white line with positions shown at 6-h intervals.

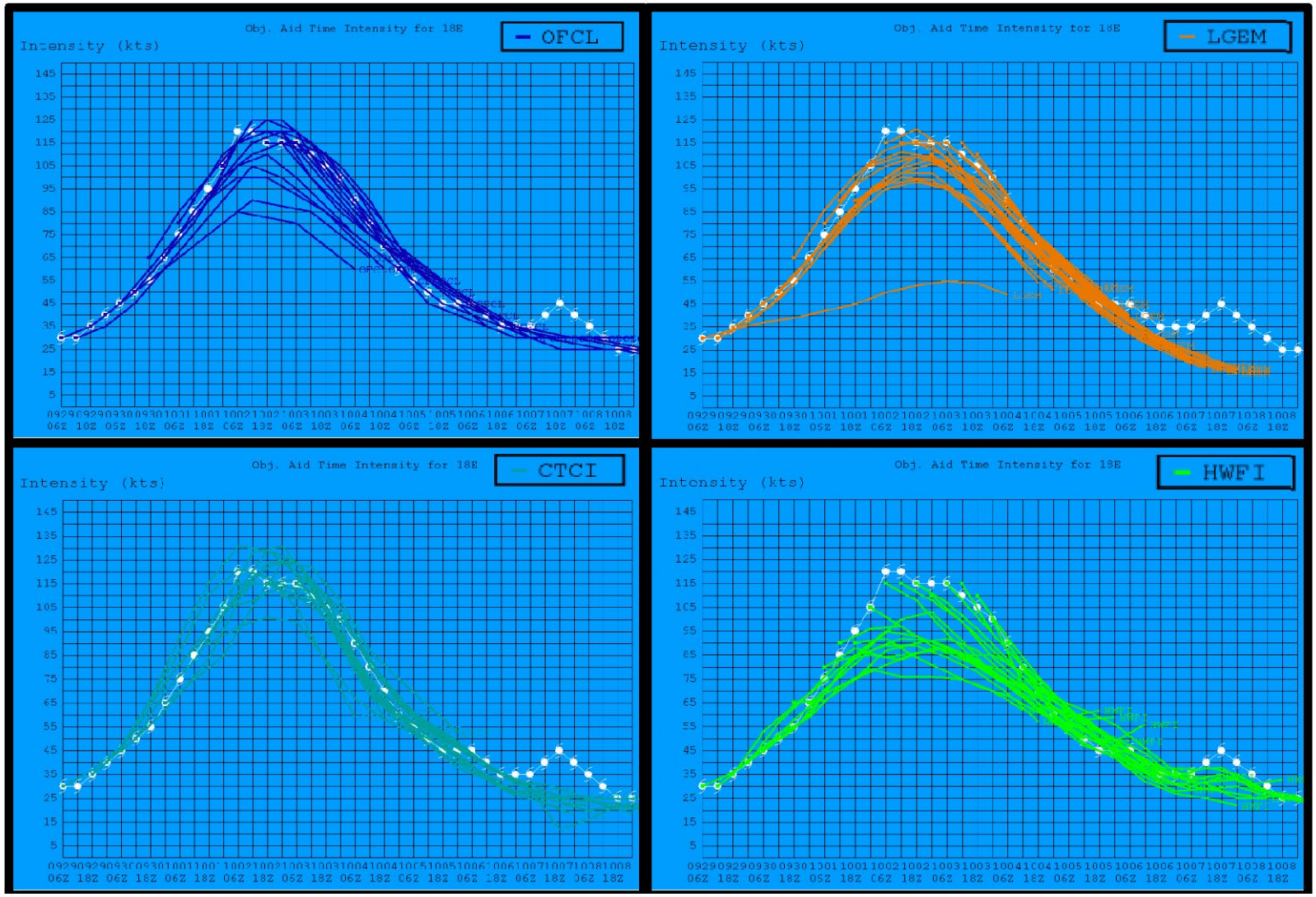

Figure 5. NHC official intensity forecasts (upper left, blue lines), LGEM intensity forecast (upper right, orange lines), CTCI intensity forecast (lower left, teal lines), and HWRF intensity forecast (lower right, green lines) in knots for Hurricane Marie from 0600 UTC 29 September to 0000 UTC 7 October. The best track is given by the solid white line with verifying intensity (kt) given at 6-h intervals. Note the low forecast bias for rapid intensification in the official forecast (OFCL), LGEM, and CTCI compared to the under-forecast bias of the HWFI.