NATIONAL HURRICANE CENTER
TROPICAL CYCLONE REPORT

TROPICAL STORM THETA

(AL302020)

10–15 November 2020

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National Hurricane Center
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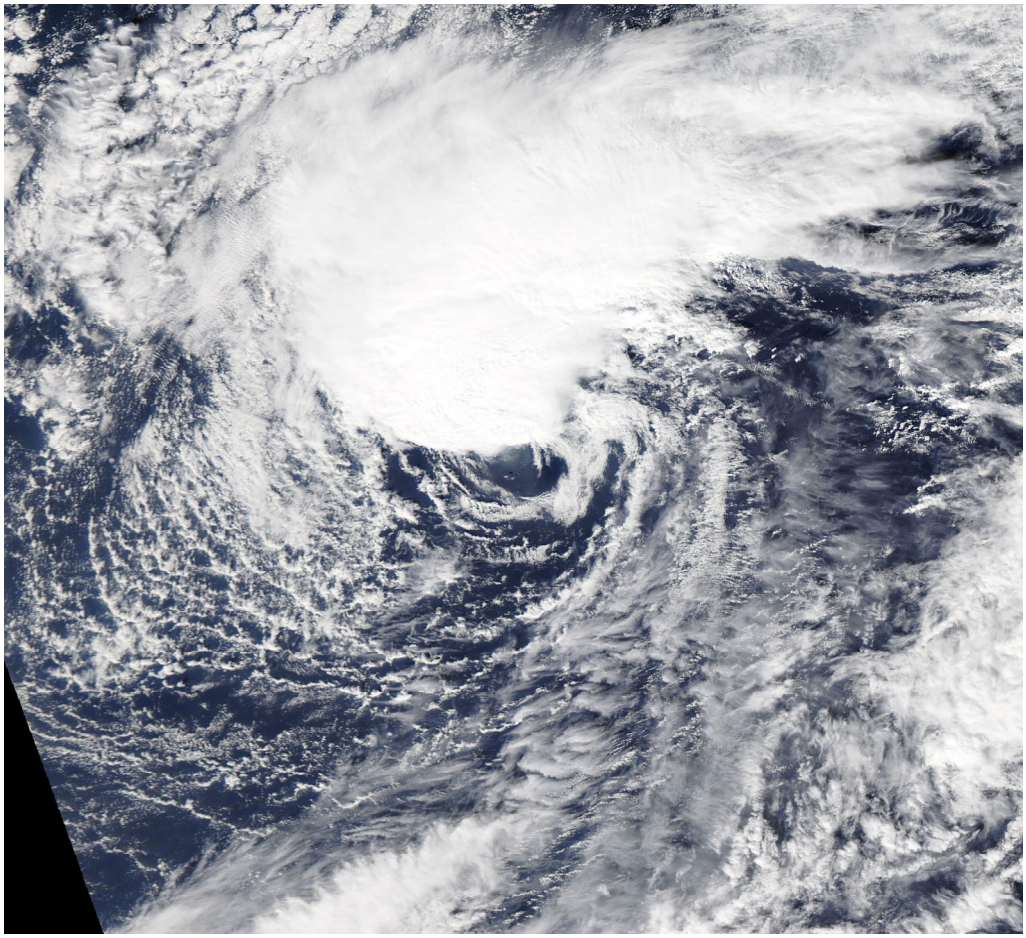

AQUA MODIS IMAGE OF THETA AT 1500 UTC 11 NOV 2020. IMAGE COURTESY OF NASA WORLDVIEW.

Theta had a subtropical origin and moved generally eastward across the northeastern Atlantic.

Tropical Storm Theta

10–15 NOVEMBER 2020

SYNOPTIC HISTORY

Theta had a subtropical origin. An upper-level trough first developed over the central Atlantic Ocean on 7 November, with its development partly aided by outflow from Tropical Storm Eta over the northwestern Caribbean Sea. As the upper-level trough intensified, a non-tropical surface low pressure area formed the next day along a weak frontal zone about 1130 n mi west-southwest of the Azores. On 9 November, while the low was moving generally eastward, the winds increased to gale force, and the associated convection became better organized. The system became non-frontal near 0000 UTC 10 November, and it is estimated that the low became a subtropical storm at that time while centered about 855 n mi southwest of the Azores. 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 1[1].

The cyclone moved eastward along the southern edge of the mid-latitude westerlies after genesis, and the maximum winds increased to an estimated peak intensity of 60 kt by 1200 UTC 10 November. Shortly thereafter, the system transitioned to a tropical storm as it moved into a light-shear region near the axis of the upper-level trough and developed a ragged central dense overcast. Theta subsequently turned east-northeastward on 11 November, and this was followed by a brief northeastward motion on 12 November due to interaction with a vorticity center in the upper-level trough. After that, the cyclone tracked generally eastward until 15 November. The intensity fluctuated between 55–60 kt on 11–12 November as dry air entrainment caused the convection to be sporadic and the low-level center to periodically become exposed outside of the convection. Steady weakening then occurred on 13–14 November as the upper-level trough axis moved south of Theta and exposed the storm to strong northerly vertical shear. The associated convection dissipated early on 15 November, and as a result Theta weakened to a tropical depression around 0600 UTC that day when centered about 105 n mi southwest of Madeira Island. The cyclone decayed to a remnant low 6 h later. The low turned north-northwestward on 16 November as a mid-latitude cyclone approached it from the northwest, and the remnants of Theta dissipated as they were absorbed into that system late that day.

METEOROLOGICAL STATISTICS

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

[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.

intensity estimates from the Tropical Analysis and Forecast Branch (TAFB) and the Satellite Analysis Branch (SAB), 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 Theta.

There were no surface observations of tropical-storm-force winds from Theta.

It should be noted that while Theta is shown as transitioning to a tropical storm at 1800 UTC 10 November, its location under the upper-level trough and north of the subtropical jet stream suggests that the cyclone kept some subtropical characteristics through its life cycle. The less-than-fully-tropical-character could also be the cause of a significant low bias in the Dvorak Technique-based satellite intensity estimates seen in Fig. 2.

CASUALTY AND DAMAGE STATISTICS

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

FORECAST AND WARNING CRITIQUE

The genesis of Theta was not well forecast overall (Table 2). While the formation of the non-tropical low that Theta formed from was anticipated more than three days before genesis, the potential for this low to become a subtropical or tropical cyclone was underestimated by forecasters. The system was given only a low chance (<40%) of developing until 24 h before genesis occurred, and the system was not given a high chance (>60%) of developing until 6–12 h before genesis.

A verification of NHC official track forecasts for Theta is given in Table 3a. Official forecast track errors were lower than the mean official errors for the previous 5-yr period, and the official errors were also lower than the climatology-persistence (OCD5) errors. Examination of the individual forecasts (not shown) indicates that the official forecasts captured the overall eastward motion of Theta well. A homogeneous comparison of the official track errors with selected guidance models is given in Table 3b. While the official forecast errors were generally lower than those of the guidance, the HFIP Corrected Consensus model (HCCA) had lower average track forecast errors at all forecast times, and the ECMWF dynamical model (EMXI) had lower errors at the 12–72-h period.

A verification of NHC official intensity forecasts for Theta is given in Table 4a. Official forecast intensity errors were lower than the mean official errors for the previous 5-yr period.

However, at the 36-, 48-, and 72-h forecast periods the official errors were larger than those for climatology-persistence, indicating these forecasts were not skillful. Examination of the individual forecasts (Fig. 4) shows that several of the forecasts had a high bias, with Theta weakening a bit faster than what was predicted. A homogeneous comparison of the official intensity errors with selected guidance models is given in Table 4b. Several of the intensity guidance models had lower errors than the official forecasts, with the best performers being HCCA and the Hurricanes in a Multi-scale Ocean-coupled Non-hydrostatic model (HMNI).

No formal coastal watches or warnings were issued for Theta. The Meteorological Service of Spain issued advisories for their marine forecast areas near the Canary and Madeira Islands.

Table 1. Best track for Tropical Storm Theta, 10–15 November 2020.

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
08 / 1200	28.4	47.5	1010	25	extratropical
08 / 1800	28.4	46.8	1010	25	"
09 / 0000	28.5	45.9	1010	25	"
09 / 0600	28.6	44.9	1007	30	"
09 / 1200	28.8	43.7	1005	35	"
09 / 1800	28.8	42.4	1003	40	"
10 / 0000	28.8	41.0	999	50	subtropical storm
10 / 0600	28.8	39.5	994	55	"
10 / 1200	28.9	38.0	989	60	"
10 / 1800	29.0	36.7	987	60	tropical storm
11 / 0000	29.2	35.8	988	55	"
11 / 0600	29.4	34.9	988	55	"
11 / 1200	29.6	33.8	989	55	"
11 / 1800	30.3	32.5	989	55	"
12 / 0000	31.1	31.9	987	60	"
12 / 0600	31.5	30.8	988	55	"
12 / 1200	31.5	29.4	989	55	"
12 / 1800	31.7	28.0	990	55	"
13 / 0000	31.9	26.7	992	50	"
13 / 0600	31.9	25.4	993	50	"
13 / 1200	31.9	24.2	994	45	"
13 / 1800	32.0	23.1	996	45	"
14 / 0000	32.0	22.1	997	40	"
14 / 0600	31.9	21.2	999	35	"
14 / 1200	31.8	20.4	1000	35	"
14 / 1800	31.7	19.6	1002	35	"
15 / 0000	31.7	18.9	1003	35	"
15 / 0600	31.6	18.5	1005	30	tropical depression
15 / 1200	31.4	18.3	1009	30	remnant low
15 / 1800	31.6	18.0	1012	30	"
16 / 0000	32.1	17.9	1013	30	"

16 / 0600	32.7	18.2	1014	25	"
16 / 1200	33.4	18.6	1014	25	"
16 / 1800					dissipated
10 / 1800	29.0	36.7	987	60	minimum pressure
10 / 1200	28.9	38.0	989	60	maximum wind

Table 2. Number of hours in advance of formation of Theta 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%)	30	78
Medium (40%-60%)	18	24
High (>60%)	6	12

Table 3a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) track forecast errors (n mi) for Tropical Storm Theta, 10–15 November 2020. 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	24.9	**34.5**	**46.1**	**51.5**	**59.7**	**76.3**	**114.5**	**121.8**
OCD5	37.2	68.3	131.5	189.2	268.4	345.1	496.6	629.6
Forecasts	20	18	16	14	12	10	6	2
OFCL (2015-19)	24.1	36.9	49.6	65.1	80.7	96.3	133.2	171.6
OCD5 (2015-19)	44.7	96.1	156.3	217.4	273.9	330.3	431.5	511.9

Table 3b. Homogeneous comparison of selected track forecast guidance models (in n mi) for Tropical Storm Theta, 10–15 November 2020. 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	24.8	35.5	48.8	50.9	55.3	71.9	114.9	114.6
OCD5	36.6	66.3	130.2	190.9	271.8	352.4	500.3	649.8
GFSI	**23.9**	41.2	60.0	72.5	84.1	94.7	179.7	254.7
HWFI	30.9	49.5	74.1	96.6	125.7	173.2	271.7	356.5
HMNI	29.4	45.3	72.1	92.9	129.6	173.1	269.9	439.2
EMXI	**20.5**	**24.6**	**33.4**	**40.8**	**51.2**	**59.8**	115.0	222.5
NVGI	25.7	38.6	**40.8**	54.1	94.2	135.5	169.9	176.9
CMCI	29.0	43.1	53.3	56.0	62.5	75.4	126.9	250.9
CTCI	**24.1**	36.1	50.3	57.7	58.5	**68.1**	129.8	154.6
TVCA	**23.4**	**33.5**	**48.0**	56.6	66.5	87.7	146.7	**100.8**
TVCX	**22.1**	**32.1**	**45.3**	50.9	59.3	80.8	137.1	**105.2**
GFEX	**21.8**	**30.1**	**40.8**	**38.9**	**39.8**	**49.4**	**111.4**	134.0
HCCA	**23.3**	**33.9**	**45.4**	**46.9**	**46.5**	**61.9**	**97.6**	**59.8**
AEMI	**24.4**	40.7	59.0	64.8	65.6	77.4	142.4	202.2
TABS	45.1	92.5	131.0	151.1	151.7	147.9	199.2	323.1
TABM	31.7	53.3	73.3	92.3	105.0	140.4	265.0	300.8
TABD	60.6	132.6	195.6	248.3	289.0	325.7	412.1	617.2
Forecasts	18	16	14	12	10	9	5	1

Table 4a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) intensity forecast errors (kt) for Tropical Storm Theta, 10–15 November 2020. 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	5.2	**5.8**	**7.8**	**6.4**	**5.4**	**6.0**	**10.0**	**15.0**
OCD5	5.8	5.7	5.4	5.4	4.8	5.7	15.3	15.5
Forecasts	20	18	16	14	12	10	6	2
OFCL (2015-19)	5.2	7.7	9.4	10.7	11.9	13.0	14.4	15.5
OCD5 (2015-19)	6.8	10.8	14.1	17.0	18.8	20.6	22.5	24.6

Table 4b. Homogeneous comparison of selected intensity forecast guidance models (in kt) for Tropical Storm Theta, 10–15 November 2020. 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	5.3	5.6	7.3	5.8	5.5	5.5	9.0	15.0
OCD5	6.0	5.9	**5.5**	**5.2**	**4.6**	6.2	14.6	17.0
HMNI	**5.2**	5.7	**5.1**	**4.8**	**4.4**	6.1	**5.8**	**6.0**
HWFI	5.5	5.8	**4.9**	**4.2**	**4.7**	7.1	**8.2**	**11.0**
DSHP	5.9	6.9	8.6	8.4	7.7	8.1	12.0	**14.0**
LGEM	6.2	6.8	9.7	10.4	9.0	8.0	**4.8**	**6.0**
ICON	5.5	5.8	**6.5**	6.0	**4.9**	**4.5**	**3.6**	**2.0**
IVCN	5.9	5.9	**6.3**	5.8	**4.5**	**4.5**	**3.2**	**5.0**
IVDR	6.1	5.9	**5.7**	**4.9**	**4.5**	5.5	**4.8**	**7.0**
CTCI	7.2	7.0	**6.7**	**4.9**	**4.4**	**4.8**	**5.8**	16.0
GFSI	6.9	7.0	**7.1**	5.9	7.5	9.5	9.0	**8.0**
EMXI	5.3	**5.4**	**5.9**	5.8	5.6	**5.1**	**3.6**	**4.0**
HCCA	5.6	**5.5**	**6.1**	**4.9**	**4.8**	6.0	**8.8**	18.0
Forecasts	19	17	15	13	11	10	5	1

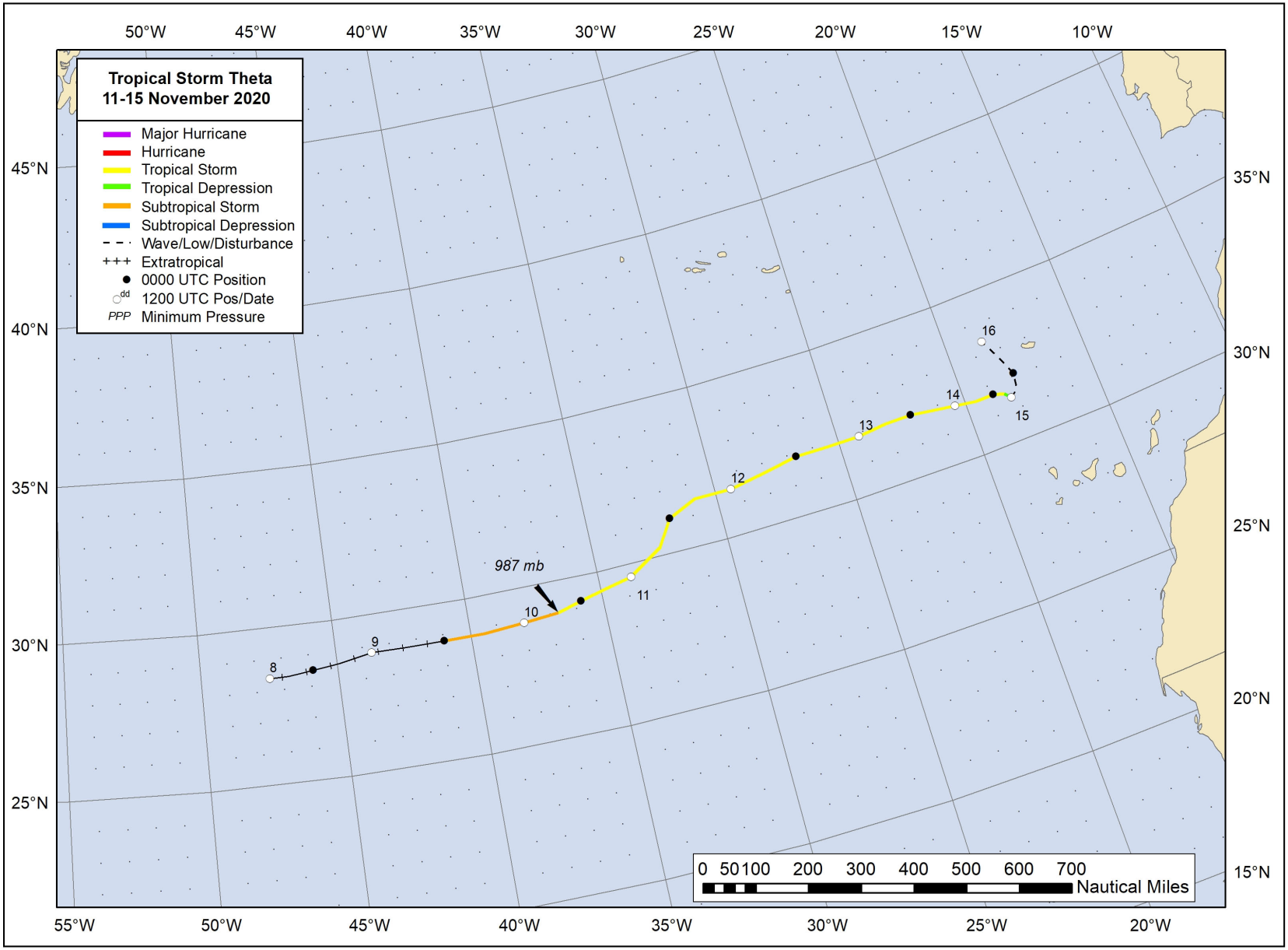

Figure 1. Best track positions for Tropical Storm Theta, 10–15 November 2020.

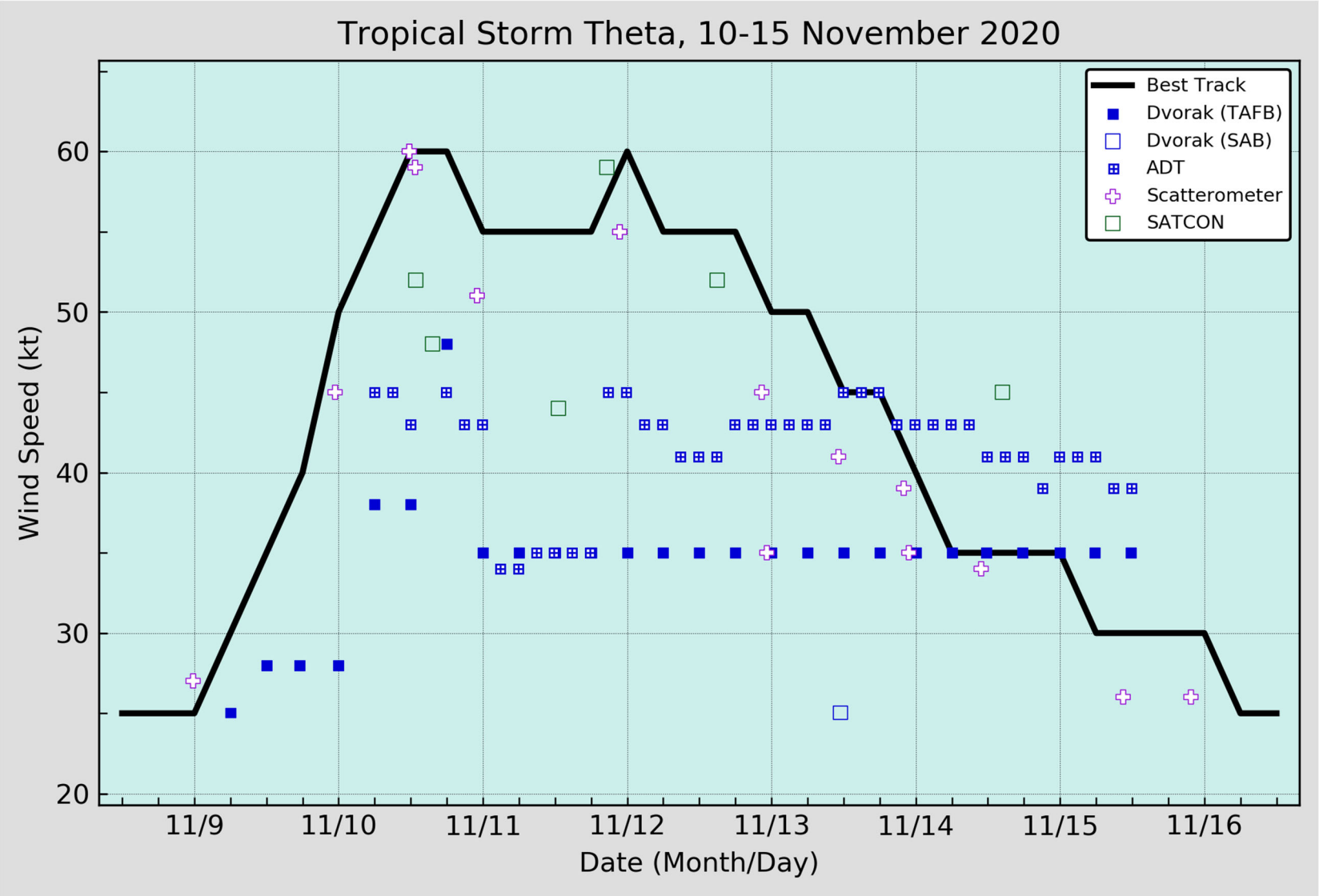

Figure 2. Selected wind observations and best track maximum sustained surface wind speed curve for Tropical Storm Theta, 10–15 November 2020. Advanced Dvorak Technique estimates represent the Current Intensity at the nominal observation time. SATCON intensity estimates are from the Cooperative Institute for Meteorological Satellite Studies. Dashed vertical lines correspond to 0000 UTC.

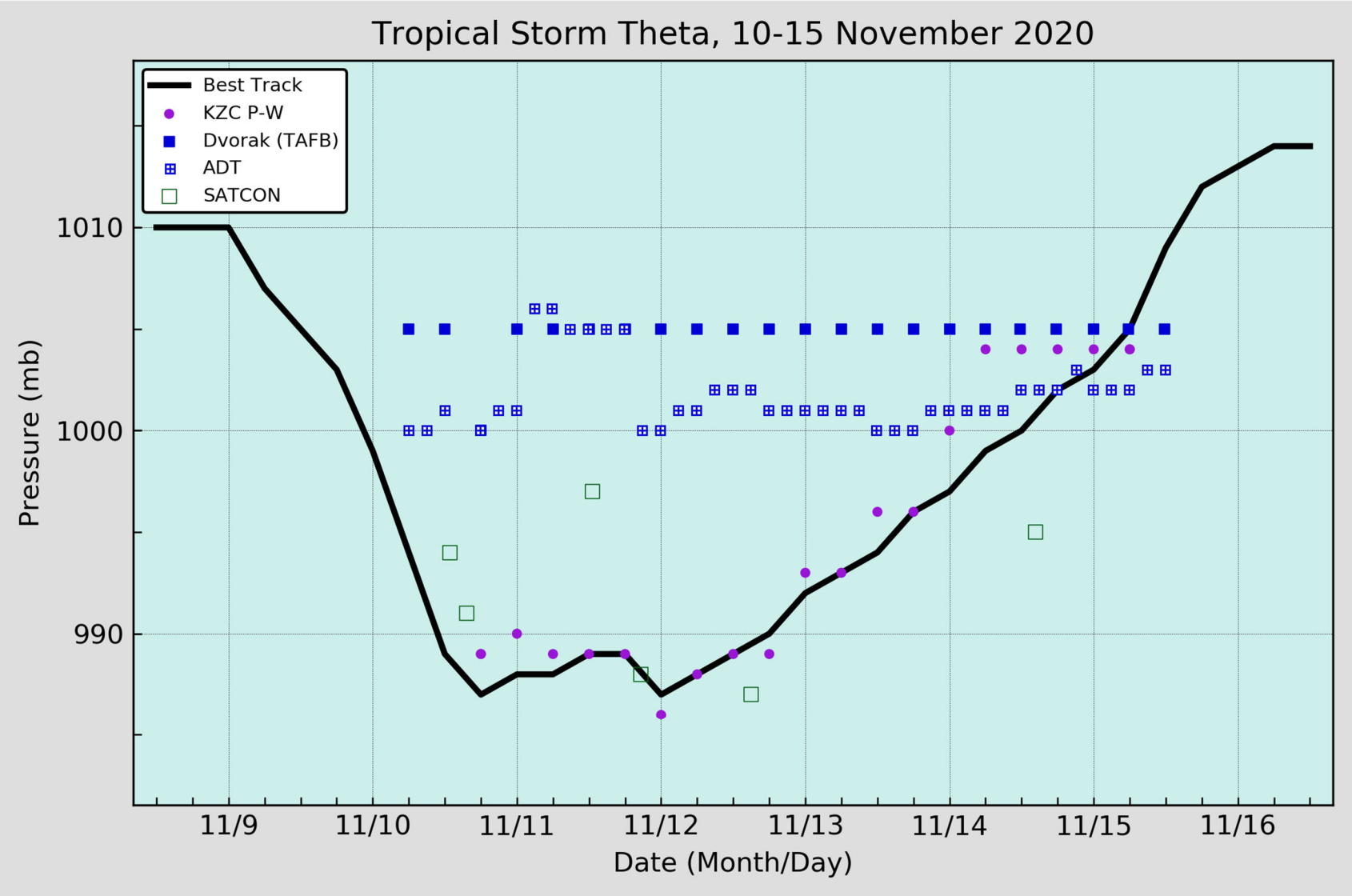

Figure 3. Selected pressure observations and best track minimum central pressure curve for Tropical Storm Theta, 10–15 November 2020. Advanced Dvorak Technique estimates represent the Current Intensity at the nominal observation time. SATCON intensity estimates are from the Cooperative Institute for 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.

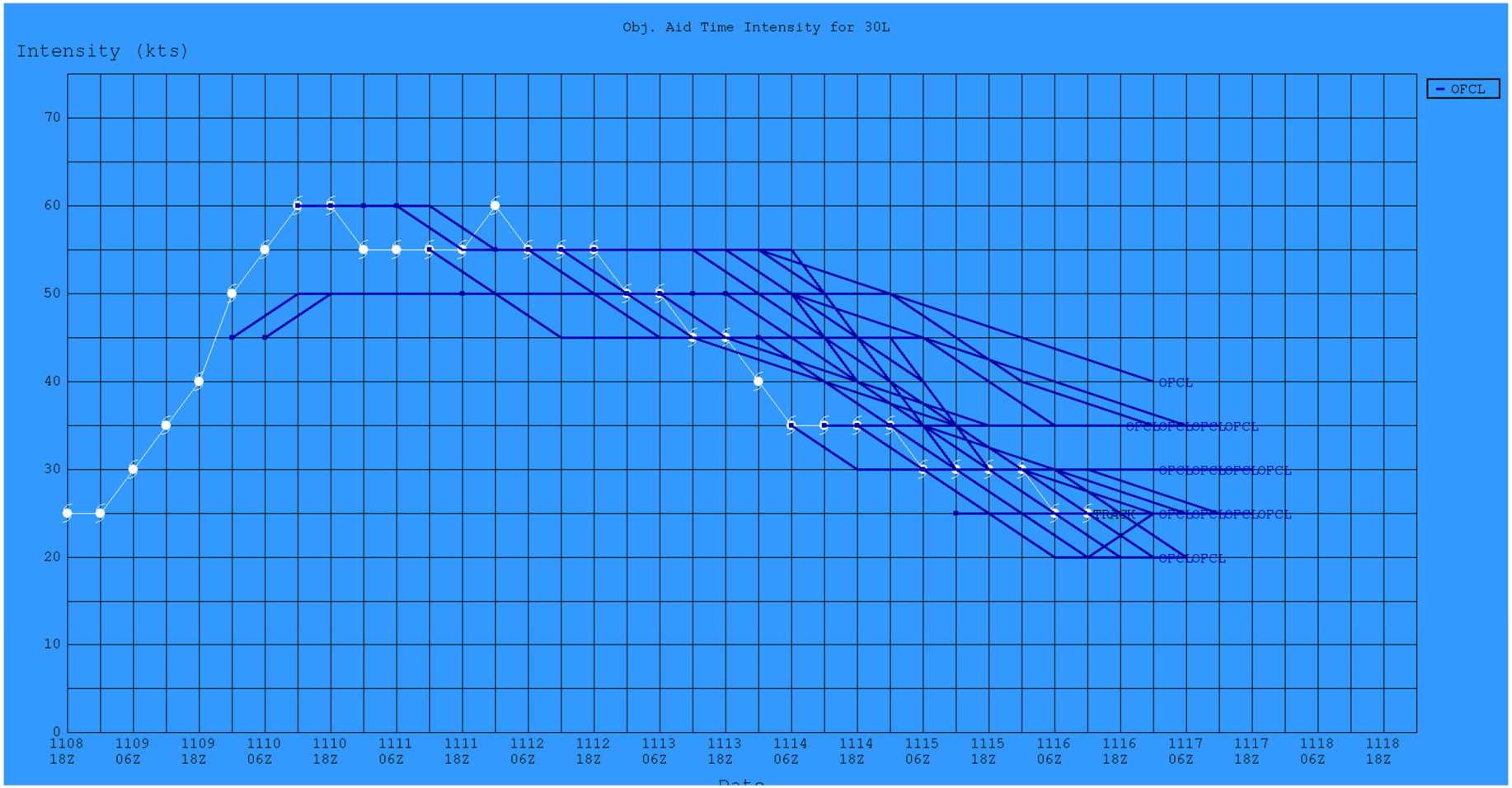

Figure 4. Selected official intensity forecasts (blue lines, kt) for Tropical Storm Theta, 10–15 November 2020. The best track is given by the white line with intensities (kt) given at 6-h intervals.