NATIONAL HURRICANE CENTER
TROPICAL CYCLONE REPORT

TROPICAL STORM NORBERT

(EP192020)

5–14 October 2020

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National Hurricane Center
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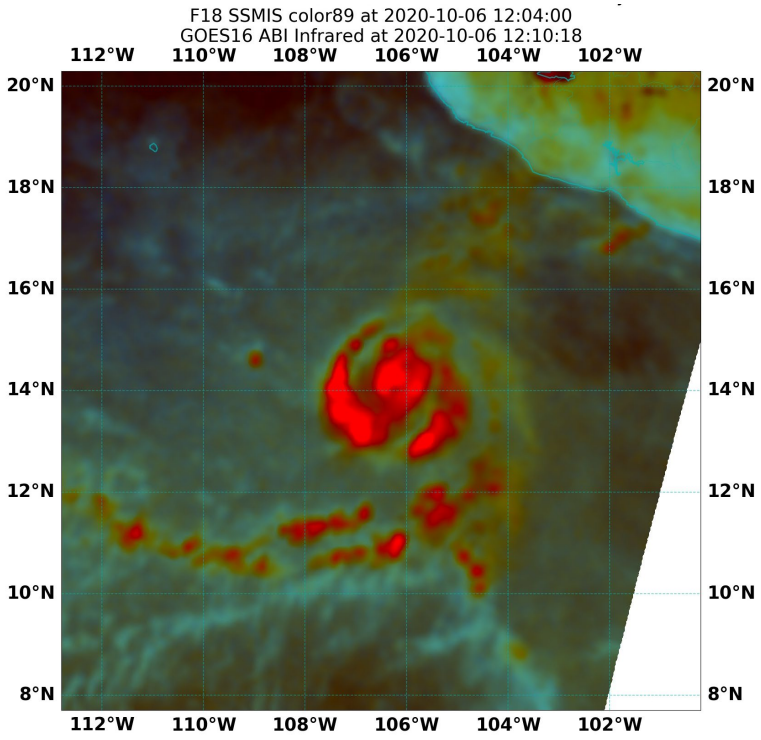

COLOR COMPOSITE 89-GHZ SSMI/S MICROWAVE IMAGE OF TROPICAL STORM NORBERT NEAR PEAK INTENSITY (NRL).

Norbert was a slow-moving October tropical storm that performed a small cyclonic loop well southwest of Mexico, opened up into a trough, then re-formed near Socorro Island a few days later. The storm then paralleled the west coast of the Baja California peninsula for a day or so before dissipating.

Tropical Storm Norbert

5–14 OCTOBER 2020

SYNOPTIC HISTORY

The genesis of Norbert was associated with a tropical wave that moved off the west coast of Africa on 19 September. The weak wave produced little deep convection during the next week or so, passing the Lesser Antilles on 26 September and moving over Central America 3 days later. Only isolated thunderstorms were noted near the wave axis during the next few days while it continued moving westward over the eastern Pacific, but a more concentrated area of thunderstorm activity formed on 3 October several hundred miles south of Acapulco, Mexico. This area of convection led to the development of a small area of low pressure late on 4 October, although the thunderstorm activity weakened that evening. An increase in coverage and persistence of convection early on 5 October marked the development of a tropical depression near 0600 UTC that day about 550 n mi southwest of Acapulco. 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 depression initially moved north-northwestward to northwestward, steered by the flow between a distant mid-level ridge over Mexico and a mid-level trough near Socorro Island. Convective bands continued to increase around the circulation, along with deeper core convection, and the depression became a tropical storm 12 h after genesis. Norbert steadily strengthened early on 6 October within an environment of low vertical shear and warm water, and reached its peak intensity of 50 kt near 1200 UTC that day about 400 n mi south of Manzanillo, Mexico. However, the storm weakened shortly thereafter due to an increase in westerly shear and entrainment of dry air. A brief resumption of deep convection on 7 October maintained Norbert as a tropical storm, but the low-level center became exposed by that afternoon, and the cyclone decayed into a tropical depression by 0000 UTC 8 October. As the system weakened, it was steered more by the low-level flow, and underwent a small cyclonic loop due to increasing westerly flow from an enhanced eastern Pacific monsoon trough (partially aided by Hurricane Delta in the Gulf of Mexico). The system barely sustained enough deep convection to maintain tropical depression status during that time, and scatterometer data indicated that the depression decayed into a trough near 0000 UTC 10 October roughly 450 n mi south of Manzanillo.

The remnants of Norbert were pulled northward for about a day, then westward around a re-strengthened low- to mid-level ridge over Mexico. Deep convection increased on 11 October, causing the formation of a broad area of low pressure, a mid-level circulation and stronger surface winds. However, southeasterly wind shear prevented much organization of the system on 12 October while the low moved northwestward, and the thunderstorm activity remained

[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.

disorganized. The low- and mid-level centers became more aligned the next day, and a convective burst that morning led to the generation of a well-defined low and the re-formation of a tropical depression near 1800 UTC 13 October, just northwest of Socorro Island.

The depression moved faster toward the northwest ahead of an upper-level low over the far northeast Pacific and the semi-permanent mid-level Mexican ridge. The cyclone strengthened again to a tropical storm 6 h after re-formation and reached a secondary peak intensity of 40 kt at 0600 UTC 14 October. This intensity, however, did not last long as Norbert encountered moderate southwesterly shear and crossed over the typical warm-to-cool SST gradient in that region. Thus, the storm weakened that afternoon and lost all deep convection late that day. Norbert transitioned into a remnant low near 0000 UTC 15 October about 160 n mi south of Punta Eugenia, Mexico, and the low-level circulation quickly dissipated less than 12 h later under increasingly hostile conditions.

METEOROLOGICAL STATISTICS

Observations in Norbert (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), 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 Norbert.

The 50-kt peak intensity of Norbert is based on a blend of subjective and objective Dvorak estimates, and is closest to the SATCON value midday on 6 October. A scatterometer pass early on 6 October showed winds to 44 kt, and 50 kt was chosen as the peak intensity since Norbert's satellite organization continued to increase after that pass.

The minimum central pressure of 1000 mb is based on the Knaff-Zehr-Courtney pressure-wind relationship.

There were no reports of winds of tropical storm force associated with Norbert.

CASUALTY AND DAMAGE STATISTICS

There were no deaths or damage reported due to Norbert.

FORECAST AND WARNING CRITIQUE

Genesis

The initial genesis of Norbert was fairly well forecast (Table 2a), especially considering the model guidance. The tropical wave that became Norbert was first included in the Tropical Weather Outlook (TWO) 126 h before genesis occurred, giving the system a low (<40%) chance of tropical cyclone formation during the next five days. The probability of genesis reached the medium category (40–60%) 102 h before genesis occurred but never reached the high (>60%) category. Regarding the 2-day genesis probabilities, a low (medium) chance of genesis was shown 36 (24) h before Norbert formed. Inconsistent model guidance was the primary factor why the genesis probabilities never reached the high category until the time of genesis, with many skillful models (such as the ECMWF) just showing a trough, and others only latching onto genesis a day or less before it occurred.

The re-formation of Norbert was also well forecast (Table 2b). The remnants of Norbert entered the 5-day TWO 66 h before it re-formed (only 12 h after the last advisory), and the system was given a medium 2-day chance of genesis 42 h before its second life. The system reached the high category in the 2-day TWO 12 h before genesis, which was a good performance considering that NHC's outlook had much higher genesis probabilities than the Halperin/Hart objective model-based probabilistic genesis guidance from Florida State University (http://moe.met.fsu.edu/modelgen/).

Track

A verification of NHC official track forecasts for Norbert is given in Table 3a. Official forecast track errors were higher than the mean official errors for the previous 5-yr period from 12–72 h, which isn't too surprising given the unusual looping track and the high OCD5 errors (almost double the long-term average). A homogeneous comparison of the official track errors with selected guidance models is given in Table 3b. The ECMWF (EMXI) was very difficult to beat for this storm, with the HCCA model close behind. The GFSI model generally struggled during Norbert. Figure 4 shows one case where the ECMWF model more correctly showed Norbert turning to the south, while all of the other guidance showed a more northward course.

Intensity

A verification of NHC official intensity forecasts for Norbert is given in Table 4a. Official forecast intensity errors were well above the mean official errors for the previous 5-yr period at all times, consistent with the high OCD5 errors, which usually signify a "difficult" storm to forecast. A homogeneous comparison of the official intensity errors with selected guidance models is given in Table 4b. Most of the models beat the NHC forecasts for Norbert due to the early NHC intensity predictions leaning closer to the statistical/dynamical models DSHP and LGEM, which ending up having the worst skill with large high biases for this storm. The regional hurricane models HMON and HWRF were outstanding performers for Norbert.

There were no watches or warnings issued for land areas due to Norbert.

Table 1. Best track for Tropical Storm Norbert, 5–14 October 2020.

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
04 / 1800	11.1	104.2	1007	30	low
05 / 0000	11.2	104.6	1007	30	"
05 / 0600	11.4	105.0	1006	30	tropical depression
05 / 1200	11.9	105.2	1006	30	"
05 / 1800	12.5	105.3	1005	35	tropical storm
06 / 0000	13.2	105.6	1004	40	"
06 / 0600	13.6	106.1	1002	45	"
06 / 1200	13.9	106.4	1000	50	"
06 / 1800	14.3	106.6	1002	45	"
07 / 0000	14.2	106.9	1003	40	"
07 / 0600	14.0	107.1	1005	35	"
07 / 1200	13.8	107.0	1005	35	"
07 / 1800	13.5	107.0	1005	35	"
08 / 0000	13.3	106.8	1006	30	tropical depression
08 / 0600	13.2	106.4	1007	25	"
08 / 1200	13.2	106.2	1007	25	"
08 / 1800	13.1	106.1	1007	25	"
09 / 0000	13.0	106.0	1007	25	"
09 / 0600	13.1	105.9	1007	25	"
09 / 1200	13.3	106.0	1007	25	"
09 / 1800	13.4	106.2	1007	25	"
10 / 0000	13.5	106.4	1008	25	disturbance
10 / 0600	13.7	106.5	1009	25	"
10 / 1200	14.1	106.5	1009	20	"
10 / 1800	14.7	106.3	1009	20	"
11 / 0000	15.3	106.3	1008	20	"
11 / 0600	16.0	106.6	1008	20	"
11 / 1200	16.7	107.0	1007	25	"
11 / 1800	17.2	107.5	1007	30	"
12 / 0000	17.3	107.9	1007	30	"
12 / 0600	17.3	108.1	1007	30	"
12 / 1200	17.4	108.4	1007	30	"

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
12 / 1800	17.5	108.8	1007	30	"
13 / 0000	17.7	109.3	1007	30	"
13 / 0600	17.9	109.8	1007	30	"
13 / 1200	18.3	110.4	1007	30	"
13 / 1800	19.3	111.3	1006	30	tropical depression
14 / 0000	20.5	112.2	1005	35	tropical storm
14 / 0600	21.8	113.1	1004	40	"
14 / 1200	23.1	114.0	1004	40	"
14 / 1800	24.3	114.8	1005	35	"
15 / 0000	25.0	115.3	1008	25	low
15 / 0600	25.6	115.7	1011	20	"
15 / 1200					dissipated
06 / 1200	13.9	106.4	1000	50	minimum pressure and maximum winds

Table 2a. Number of hours in advance of the first formation of Norbert associated with 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	126
Medium (40%-60%)	24	102
High (>60%)	-	-

Table 2b. Number of hours in advance of the second formation of Norbert associated with 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, and the maximum potential lead time for this case is 72 h.

	Hours Before Genesis	
	48-Hour Outlook	**120-Hour Outlook**
Low (<40%)	60	66
Medium (40%-60%)	42	54
High (>60%)	12	42

Table 3a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) track forecast errors (n mi) for Norbert. 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	34.5	56.3	76.0	89.8	102.7	107.4	**44.6**	
OCD5	55.2	116.6	185.4	258.3	344.6	421.5	441.0	
Forecasts	12	10	9	9	7	5	1	0
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 Norbert. 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	30.0	53.4	76.0	89.8	102.7	107.4	44.6	
OCD5	50.5	110.3	185.4	258.3	344.6	421.5	441.0	
GFSI	40.0	78.4	111.0	133.2	148.6	164.6	97.0	
HMNI	31.8	58.5	88.0	109.7	128.6	145.9	258.5	
HWFI	**28.3**	57.4	87.7	117.3	145.1	127.9	147.1	
EGRI	**29.0**	55.1	78.3	100.1	112.9	120.6	117.6	
EMXI	**24.2**	**44.9**	**61.7**	**85.5**	**92.3**	**99.0**	137.4	
CMCI	43.8	71.4	88.6	101.5	**99.3**	107.9	136.8	
NVGI	54.5	106.8	153.7	193.2	215.1	213.0	**29.8**	
AEMI	38.3	74.7	105.7	128.0	135.1	144.8	94.0	
HCCA	**28.5**	**49.3**	**67.0**	**84.2**	**98.5**	**100.3**	50.0	
TVCX	**28.5**	**52.8**	76.8	95.5	106.4	**102.4**	59.6	
TVCA	**29.6**	55.4	79.9	99.0	111.7	108.2	52.5	
TVDG	**29.7**	56.2	78.5	99.8	107.7	**105.2**	**42.4**	
GFEX	30.2	56.3	78.9	96.9	**98.1**	**92.8**	**16.7**	
TABS	37.0	65.1	85.4	99.0	**100.9**	**86.2**	111.9	
TABM	32.3	59.5	80.3	96.8	**95.7**	**92.2**	**23.3**	
TABD	33.2	64.8	89.6	111.4	120.1	127.2	91.0	
Forecasts	9	9	9	9	7	5	1	0

Table 4a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) intensity forecast errors (kt) for Norbert. 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	7.1	11.0	13.3	16.1	20.0	23.0	20.0	
OCD5	8.6	13.8	21.9	27.6	30.7	32.0	31.0	
Forecasts	12	10	9	9	7	5	1	0
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 Norbert. 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	7.1	11.0	13.3	16.1	20.0	23.0	20.0	
OCD5	8.6	13.8	21.9	27.6	30.7	32.0	31.0	
HMNI	**6.3**	**5.7**	**6.1**	**4.9**	**3.9**	**4.6**	**4.0**	
HWFI	8.2	**7.6**	**6.6**	**5.7**	**2.4**	**3.4**	**2.0**	
DSHP	7.7	**10.7**	15.3	20.4	26.9	32.4	32.0	
LGEM	8.0	**10.2**	**10.9**	**12.6**	**16.6**	**21.4**	**12.0**	
GFSI	7.5	**6.5**	**6.3**	**7.1**	**6.0**	**6.2**	**5.0**	
EMXI	**7.0**	**5.7**	**6.0**	**4.6**	**3.4**	**5.6**	**2.0**	
HCCA	7.1	**9.5**	**10.4**	**9.0**	**9.1**	**7.2**	**2.0**	
IVCN	7.2	**8.1**	**8.9**	**10.2**	**12.1**	**13.6**	**10.0**	
IVDR	7.1	**7.5**	**7.8**	**9.1**	**8.7**	**9.4**	**6.0**	
Forecasts	12	10	9	9	7	5	1	0

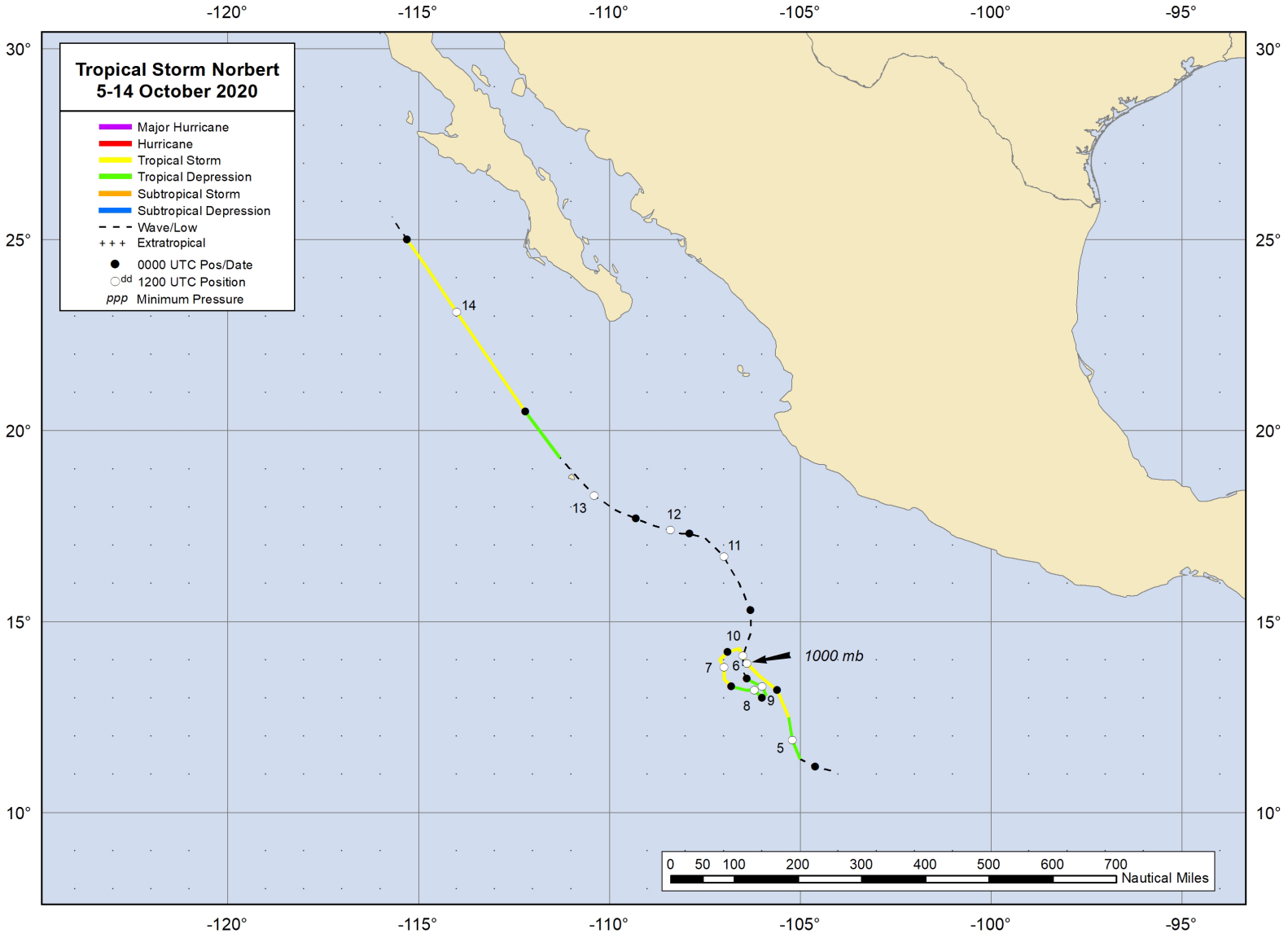

Figure 1. Best track positions for Tropical Storm Norbert, 5–14 October 2020.

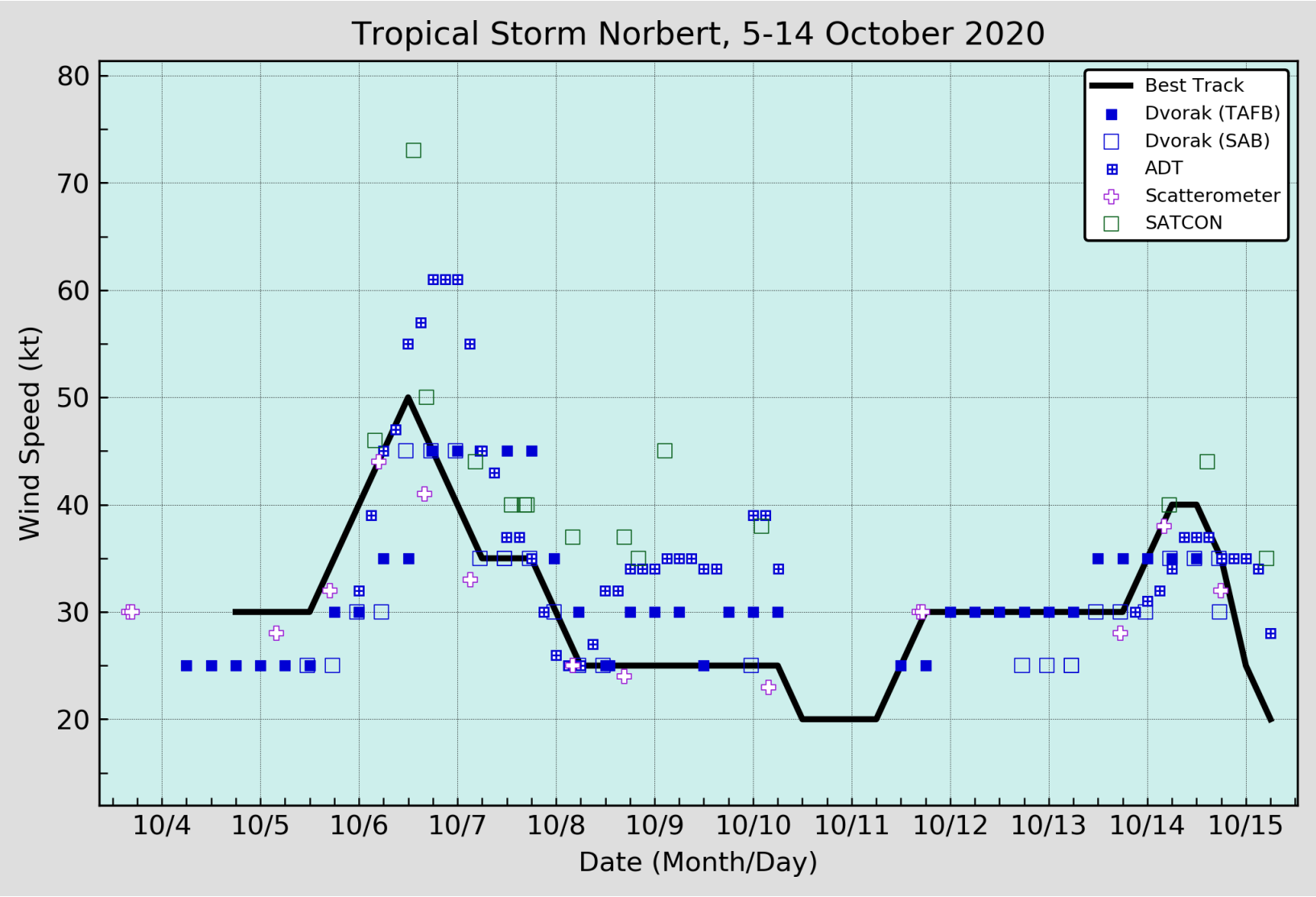

Figure 2. Selected wind observations and best track maximum sustained surface wind speed curve for Norbert. Advanced Dvorak Technique estimates represent the Current Intensity at the nominal observation time. SATCON intensity estimates are from the Cooperative Institute for Meteorological Satellite Studies.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

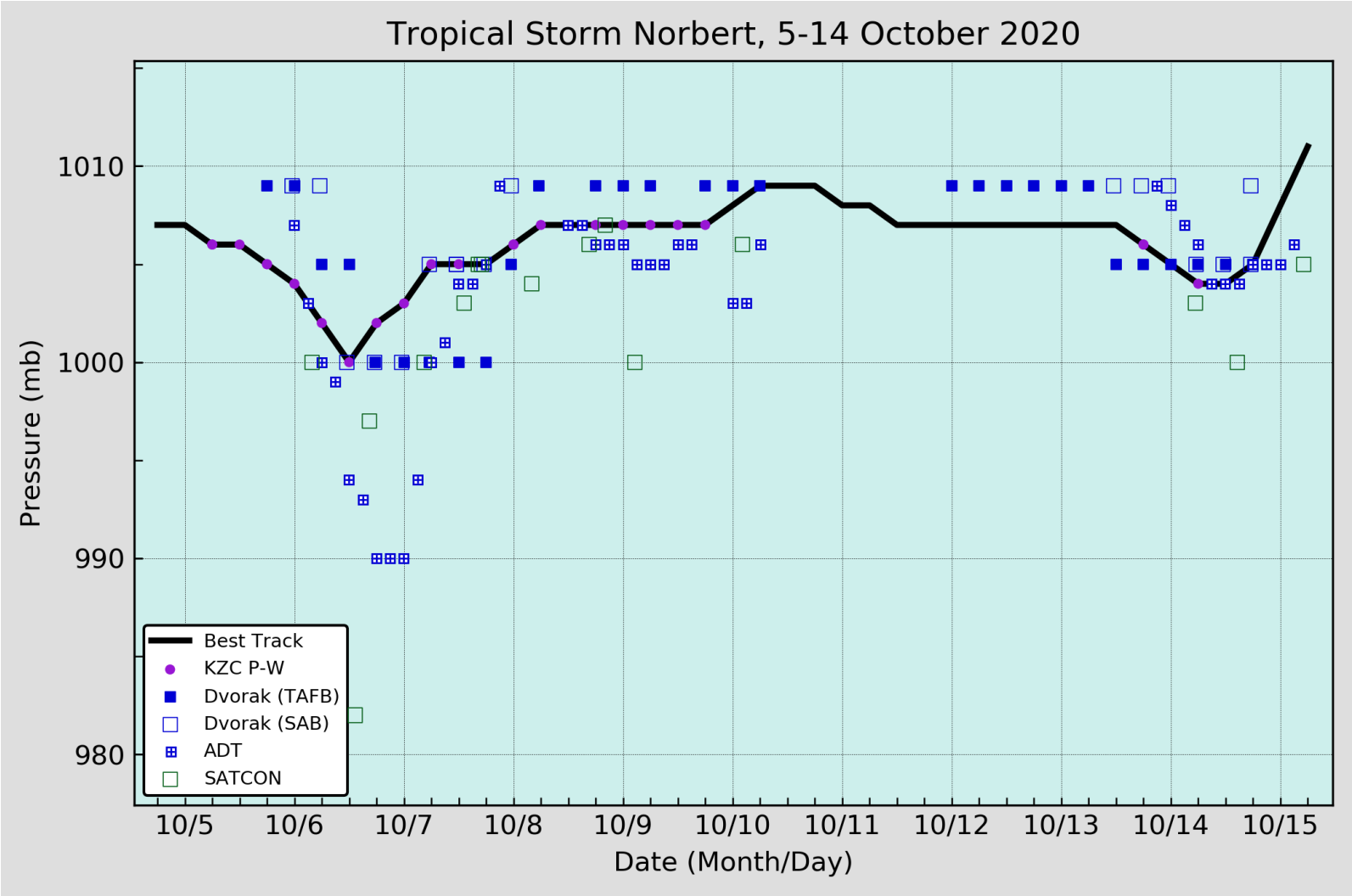

Figure 3. Selected pressure observations and best track minimum central pressure curve for Norbert. Advanced Dvorak Technique estimates represent the Current Intensity at the nominal observation time. SATCON intensity estimates are from the Cooperative Institute for Meteorological Satellite Studies.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

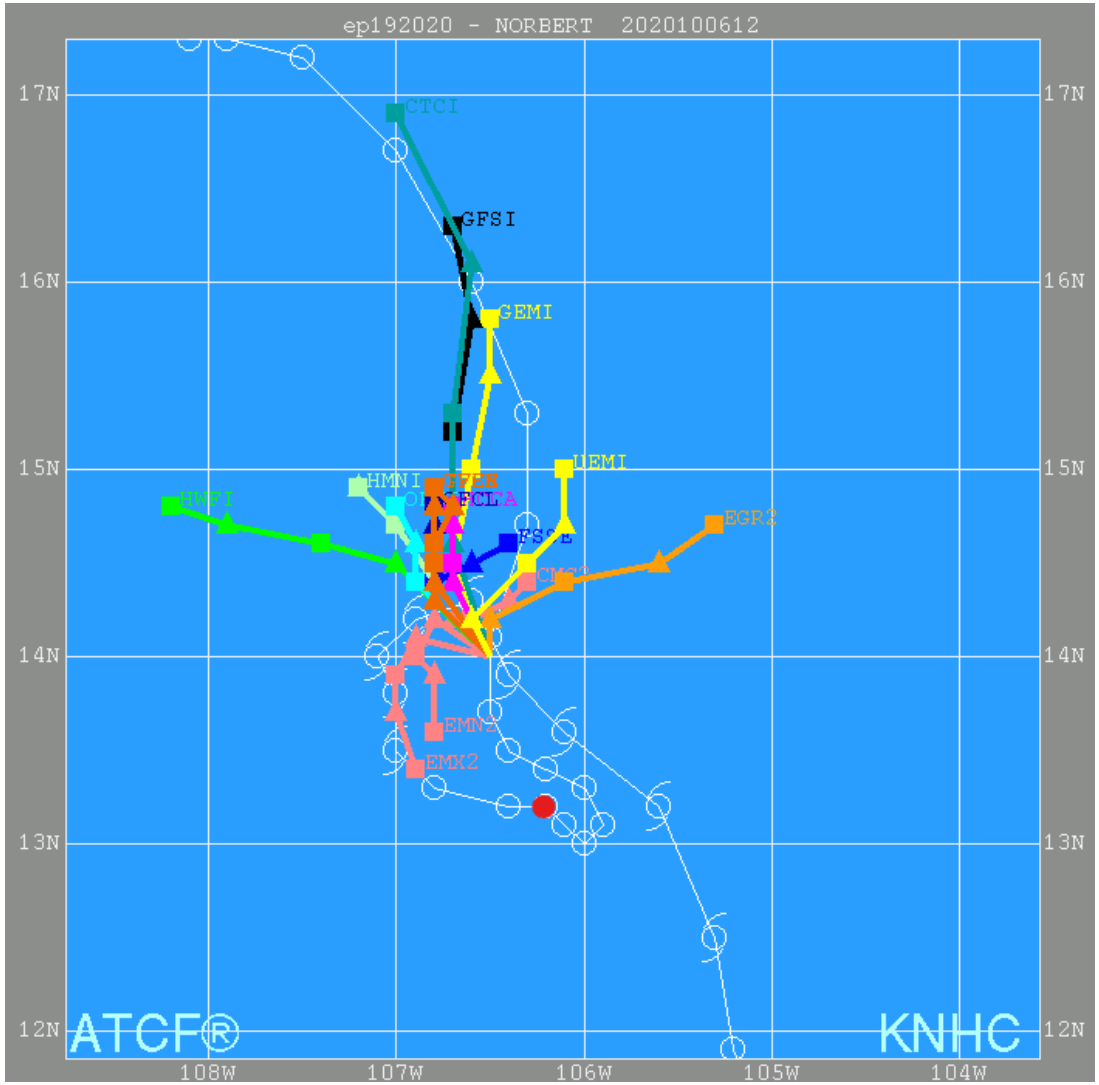

Figure 4. NHC track model guidance for Norbert from 1200 UTC 6 October for a 48-h forecast. The verifying 48-h position of Norbert is shown by the red dot.