NATIONAL HURRICANE CENTER
TROPICAL CYCLONE REPORT

TROPICAL STORM ERIN

(AL062019)

26–29 August 2019

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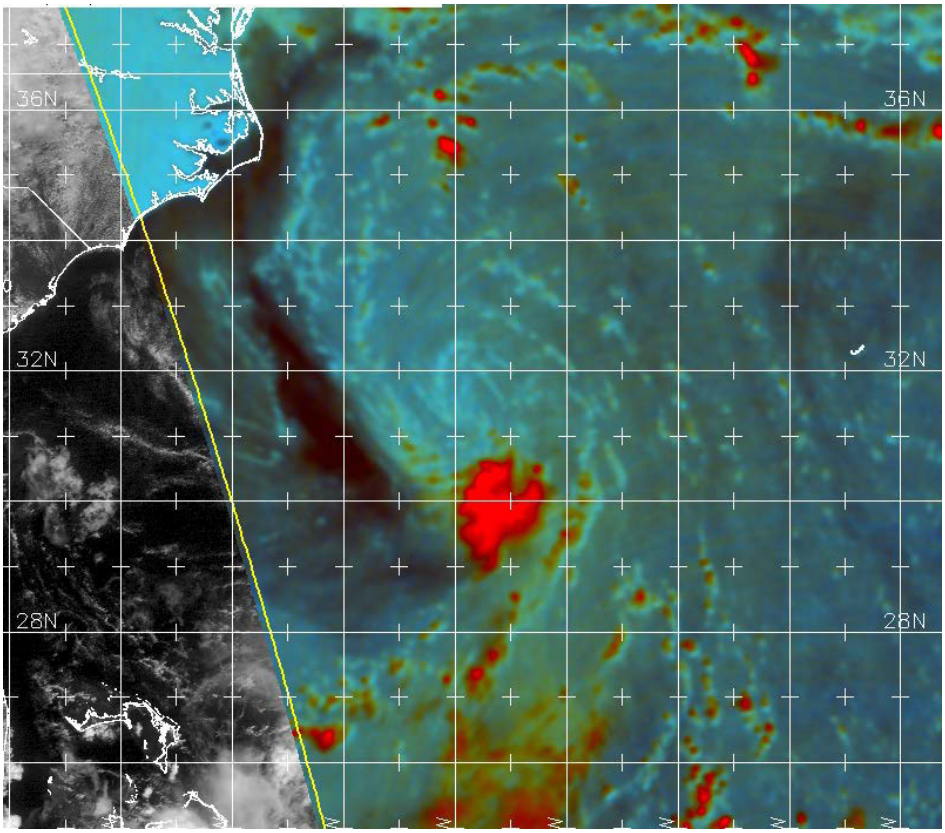

AMSR-2 89-GHZ IMAGE OF ERIN AT 1742 UTC 27 AUGUST 2019 FROM THE JAPAN AEROSPACE EXPLORATION AGENCY GCOM-W1 SATELLITE (COURTESY OF THE NAVAL RESEARCH LABORATORY).

Erin was a weak tropical storm that formed a few hundred miles east of the southeastern United States and recurved away from the United States before dissipating well south of Nova Scotia.

Tropical Storm Erin

26–29 AUGUST 2019

SYNOPTIC HISTORY

Erin was primarily of non-tropical origin. On 20 August, a large upper-level trough was situated over the southwestern Atlantic, causing a large area of disorganized showers and thunderstorms near the central Bahamas and Cuba. Some of this moisture was associated with the northern edge of a tropical wave that moved into Central America on that day. While the upper trough weakened over the Atlantic, a new shortwave moved into the western side of the trough over the northeastern Gulf of Mexico. This feature induced a broad area of low pressure near Andros Island early on 22 August. The low drifted northwestward, producing disorganized areas of convection near and east of the center during the next 2 days due to moderate shear. The system moved over southeastern Florida on 24 August with a broad and elongated surface circulation. A continuation of the shear caused the low to degenerate into a trough of low pressure on the next day, extending from near Lake Okeechobee, Florida, northeastward across the western Atlantic for a few hundred miles. Deep convection re-intensified along the trough early on 26 August, leading to the formation of a new low with convective bands by 1200 UTC that day, marking the formation of a tropical depression about 300 n mi south-southeast of Cape Hatteras, North Carolina. The "best track" chart 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].

Initially, the system moved southeastward due to the northwesterly flow around a mid-level high near Florida. The center of the depression was exposed within a moderate-to-high shear environment and had a large radius of maximum winds, which inhibited much intensification. However, a large burst of convection formed early on 27 August, resulting in the cyclone becoming a tropical storm by 1800 UTC that day, although almost all of the deep convection was still displaced southeast of the center (cover). Around that time, the track of Erin turned sharply northwestward due to both the mid-level high over Florida weakening and a strengthening subtropical ridge to the northeast. The upper-level winds persisted from the north, causing stronger shear, and the system weakened back to a tropical depression near 1800 UTC 28 August. The depression moved faster to the north and northeast after that time due to flow from the subtropical ridge and an approaching mid-latitude trough. Early on 29 August, Erin moved into a more baroclinic environment over the northwestern Atlantic, and transitioned into an extratropical cyclone around 1200 UTC 29 August about 250 n mi east of Norfolk, Virginia. The

[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.

system was absorbed by a larger extratropical low by the end of the day several hundred miles south of Nova Scotia, Canada.

METEOROLOGICAL STATISTICS

Observations in Erin (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 Erin.

The peak intensity of Erin from 1800 UTC 27 August to 1200 UTC 28 August of 35 kt is based on estimates from TAFB, SAB and the UW-CIMSS ADT. It is somewhat uncertain because around the time of peak satellite presentation and estimates, early on 28 August, scatterometer data was either not available or missed the maximum winds. In general, the maximum winds of Erin likely fluctuated by several knots, up or down, based on the bursting convective patterns that characterized the storm.

CASUALTY AND DAMAGE STATISTICS

There were no reports of deaths or damage associated with Erin.

FORECAST AND WARNING CRITIQUE

The genesis of Erin was well anticipated, although it happened a bit later than expected in short-range outlooks. The disturbance from which Erin developed was introduced into the Tropical Weather Outlook 120 h prior to genesis with a low chance (<40%) of formation during the next 5 days (Table 2), and the 5-day formation chance was raised to the high category (>60%) 72 h before genesis. The system first received 2-day probabilities with a low chance of development 90 h before formation, and it entered the high category 66 h before genesis. It was anticipated that a tropical cyclone could form before the system reached Florida, but instead it did not develop until about a day later.

A verification of NHC official track forecasts for Erin is given in Table 3a. Official track forecast errors were much higher than the mean official errors for the previous 5-yr period for all times. This can be traced to a large bias toward the north and east in the first forecasts (Fig. 4). None of the model guidance (Fig. 5) anticipated Erin's motion toward the southeast, which

resulted in the large errors. A homogeneous comparison of the official track errors with selected guidance models is given in Table 3b. While all of the guidance had large errors at 12 h, the GFS ensemble mean (AEMI) had the lowest errors after that time, especially after 24 h, with the ECMWF (EMXI) model also having a relatively good performance. The HWRF (HWFI) model had very large track errors for this cyclone.

A verification of NHC official intensity forecasts for Erin is given in Table 4a. Official intensity forecast errors were much lower than the mean official errors for the previous 5-yr period at all forecast times, correctly anticipating that little intensity change would generally occur. A homogeneous comparison of the official intensity errors with selected guidance models is given in Table 4b. The official forecast errors were generally about the same or better than the guidance through 36 h, with the notable exceptions of the ECMWF model and the LGEM model (at long range). The official forecasts at 48 h were a little too high, expecting more intensification before extratropical transition than what occurred.

There were no watches or warnings required for land areas.

Table 1. Best track for Tropical Storm Erin, 26–29 August 2019.

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
26 / 1200	31.7	72.7	1010	30	tropical depression
26 / 1800	31.5	72.5	1010	30	"
27 / 0000	31.2	72.2	1010	30	"
27 / 0600	30.9	71.7	1010	30	"
27 / 1200	30.9	71.1	1008	30	"
27 / 1800	31.3	71.6	1005	35	tropical storm
28 / 0000	31.7	72.0	1004	35	"
28 / 0600	32.2	72.4	1002	35	"
28 / 1200	33.0	72.9	1002	35	"
28 / 1800	33.9	73.0	1003	30	tropical depression
29 / 0000	34.8	72.6	1003	30	"
29 / 0600	35.6	72.1	1003	30	"
29 / 1200	36.9	70.9	1002	35	extratropical
29 / 1800	38.5	68.5	1002	35	"
30 / 0000					dissipated
28 / 0600	32.2	72.4	1002	35	minimum pressure and maximum wind

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%)	90	120
Medium (40%-60%)	72	84
High (>60%)	66	72

Table 3a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) track forecast errors (n mi) for Tropical Storm Erin. 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	43.4	61.6	89.4	104.3			
OCD5	60.7	136.6	213.8	253.3			
Forecasts	9	7	5	3			
OFCL (2014-18)	23.6	35.5	47.0	61.8			
OCD5 (2014-18)	44.8	97.6	157.4	220.1			

Table 3b. Homogeneous comparison of selected track forecast guidance models (in n mi) for Tropical Storm Erin. Errors smaller than the NHC official forecast are shown in boldface type.

Model ID	Forecast Period (h)						
	12	24	36	48	72	96	120
OFCL	43.4	61.6	89.4	104.3			
OCD5	60.7	136.6	213.8	253.3			
GFSI	**38.7**	**59.3**	**85.6**	138.1			
HMNI	43.4	**55.4**	**80.7**	113.5			
HWFI	55.1	92.5	146.6	188.0			
EGRI	**41.0**	**61.2**	101.5	115.9			
EMXI	50.5	68.8	**78.9**	**70.3**			
CMCI	44.5	74.7	120.2	154.1			
NVGI	54.0	74.3	105.2	132.0			
CTCI	**36.1**	**54.2**	**86.2**	**96.2**			
AEMI	**35.1**	**38.8**	**39.4**	**62.3**			
HCCA	**40.7**	**60.8**	**88.6**	**104.2**			
TVCX	**43.3**	63.0	**86.8**	**99.2**			
TVCA	**42.4**	**61.3**	**89.2**	106.7			
TVDG	**42.6**	**59.8**	**87.5**	104.8			
GFEX	43.9	62.2	**80.2**	**103.1**			
TABD	49.2	81.5	123.4	163.0			
TABM	**42.2**	73.5	118.7	170.4			
TABS	43.4	76.1	117.0	152.0			
Forecasts	9	7	5	3			

Table 4a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) intensity forecast errors (kt) for Tropical Storm Erin. 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	**3.9**	**2.9**	**3.0**	**10.0**			
OCD5	4.4	8.7	13.2	20.3			
Forecasts	9	7	5	3			
OFCL (2014-18)	5.3	7.9	9.9	11.2			
OCD5 (2014-18)	6.9	10.9	14.3	17.4			

Table 4b. Homogeneous comparison of selected intensity forecast guidance models (in kt) for Tropical Storm Erin. Errors smaller than the NHC official forecast are shown in boldface type.

Model ID	Forecast Period (h)						
	12	24	36	48	72	96	120
OFCL	3.9	2.9	3.0	10.0			
OCD5	4.4	8.7	13.2	20.3			
GFSI	**3.7**	5.3	3.6	**2.0**			
HMNI	4.3	7.0	3.4	**2.7**			
HWFI	4.0	5.6	4.0	**4.3**			
EGRI	**3.0**	4.0	3.0	**8.7**			
EMXI	**2.6**	**2.4**	**0.8**	**2.3**			
CMCI	**3.4**	5.0	**2.6**	**3.7**			
NVGI	**3.1**	5.1	3.2	**1.0**			
CTCI	4.4	6.0	4.2	**6.3**			
AEMI	**3.4**	5.4	4.0	**1.3**			
HCCA	3.9	4.7	3.0	**8.0**			
IVCN	**3.7**	5.0	**2.2**	**3.7**			
DSHP	**3.3**	3.7	4.8	10.7			
LGEM	**3.7**	5.0	**1.8**	**4.3**			
IVDR	**3.7**	5.1	**2.2**	**2.3**			
Forecasts	9	7	5	3			

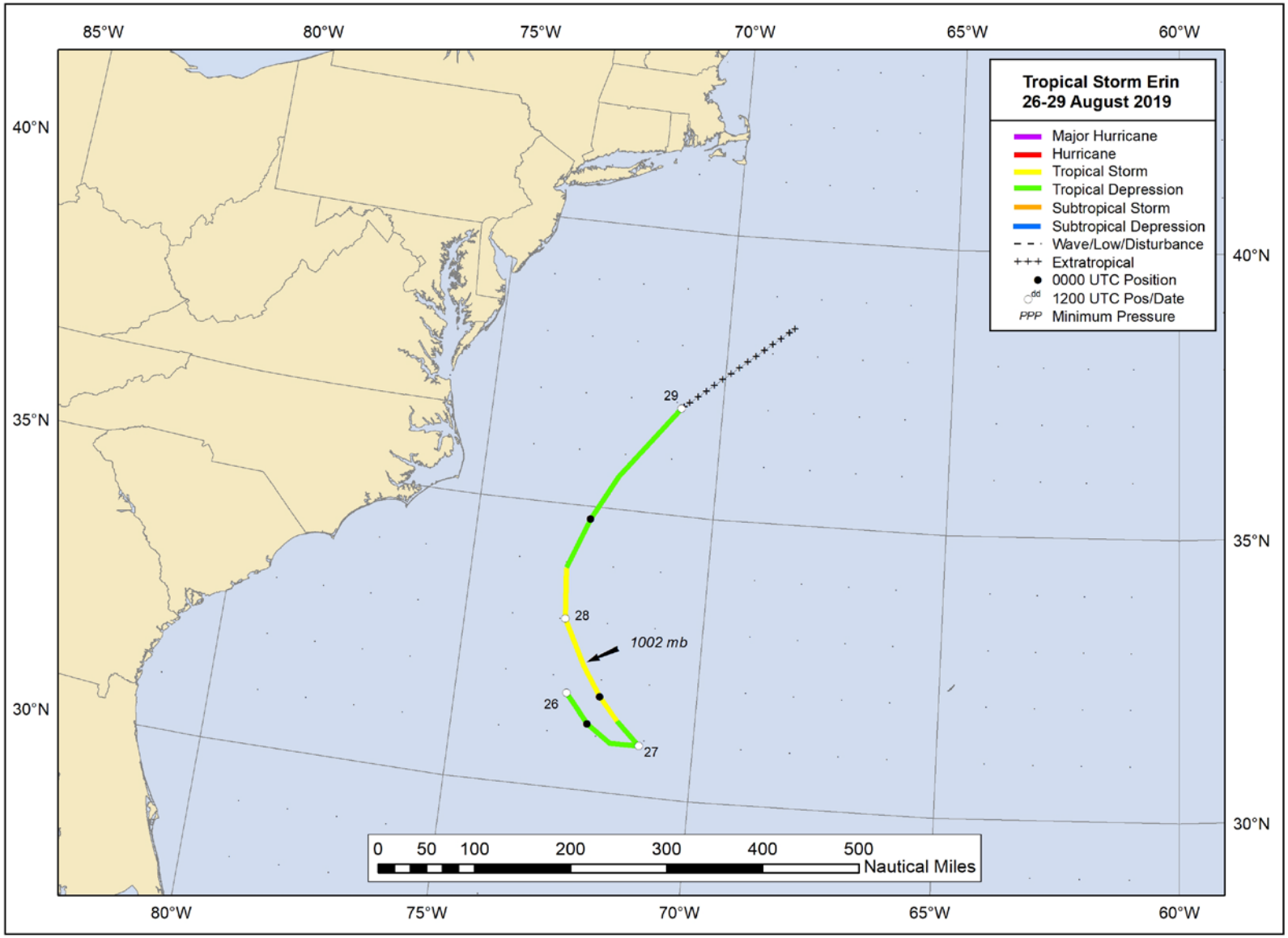

Figure 1. Best track positions for Tropical Storm Erin, 26–29 August 2019.

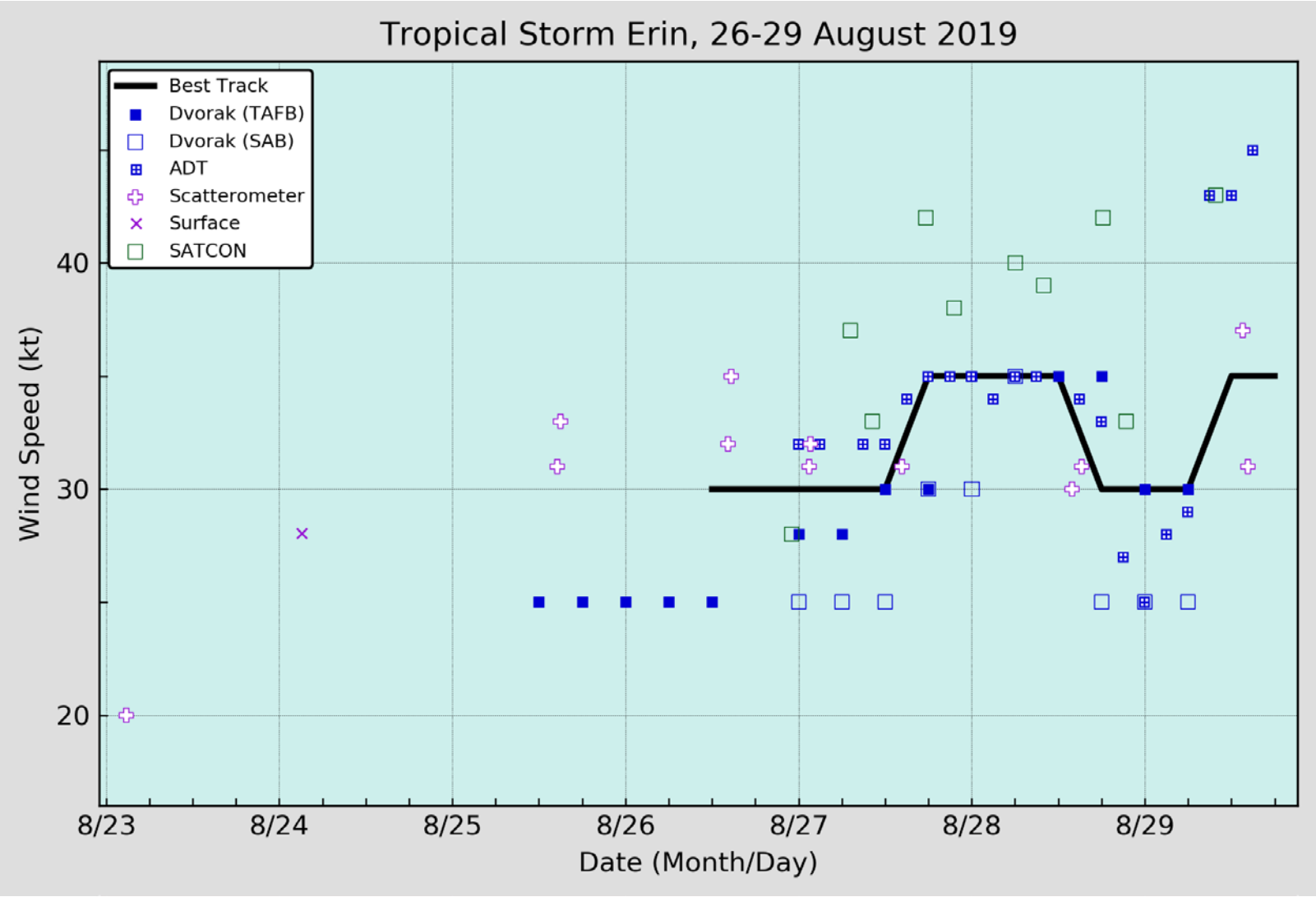

Figure 2. Selected wind observations and best track maximum sustained surface wind speed curve for Tropical Storm Erin. Advanced Dvorak Technique estimates represent the Current Intensity at the nominal observation time. SATCON intensity estimates are from the Cooperative Institute for Meteorological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

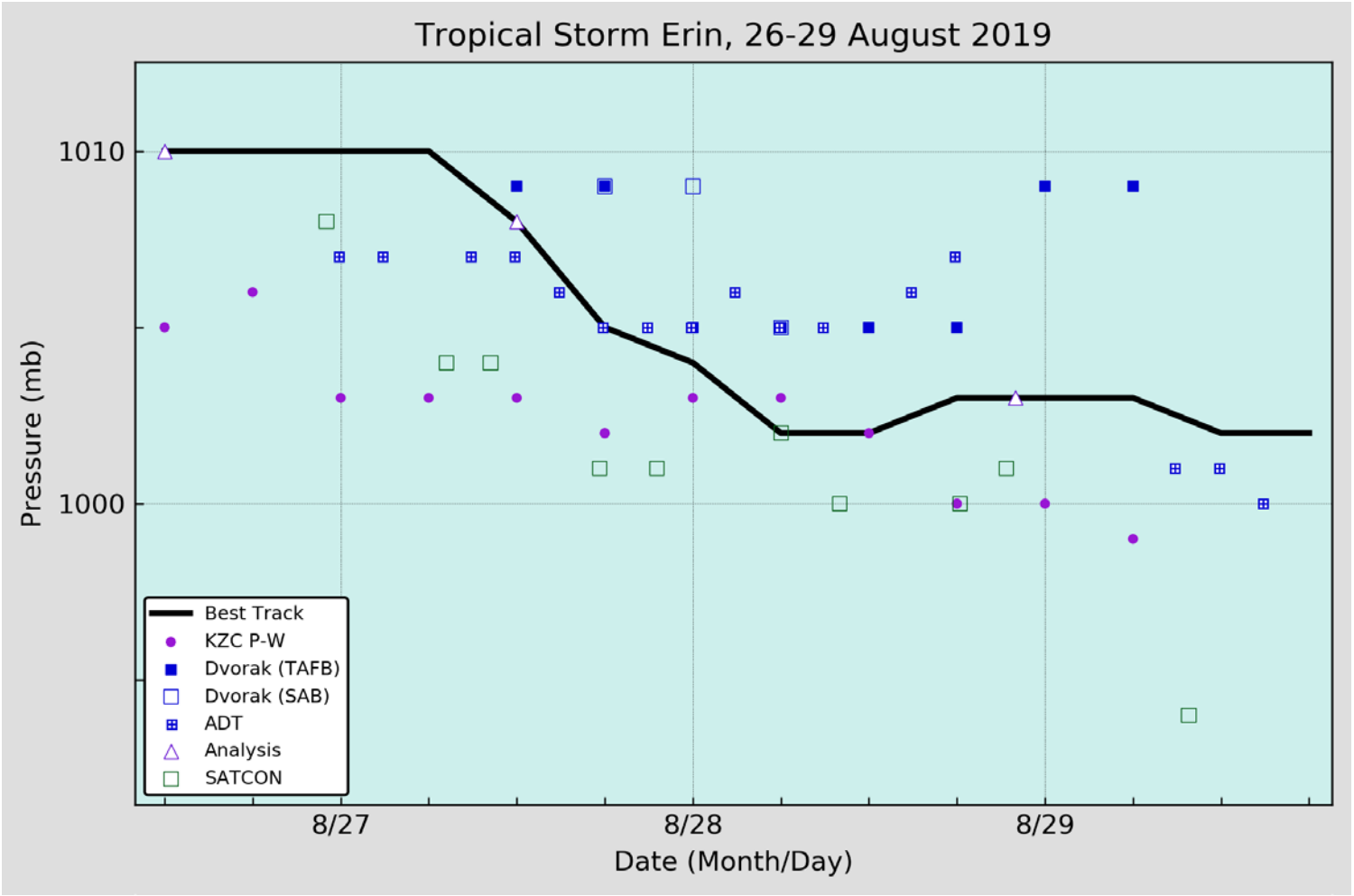

Figure 3. Selected pressure observations and best track minimum central pressure curve for Tropical Storm Erin. Advanced Dvorak Technique estimates represent the Current Intensity at the nominal observation time. SATCON intensity estimates are from the Cooperative Institute for Meteorological Satellite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

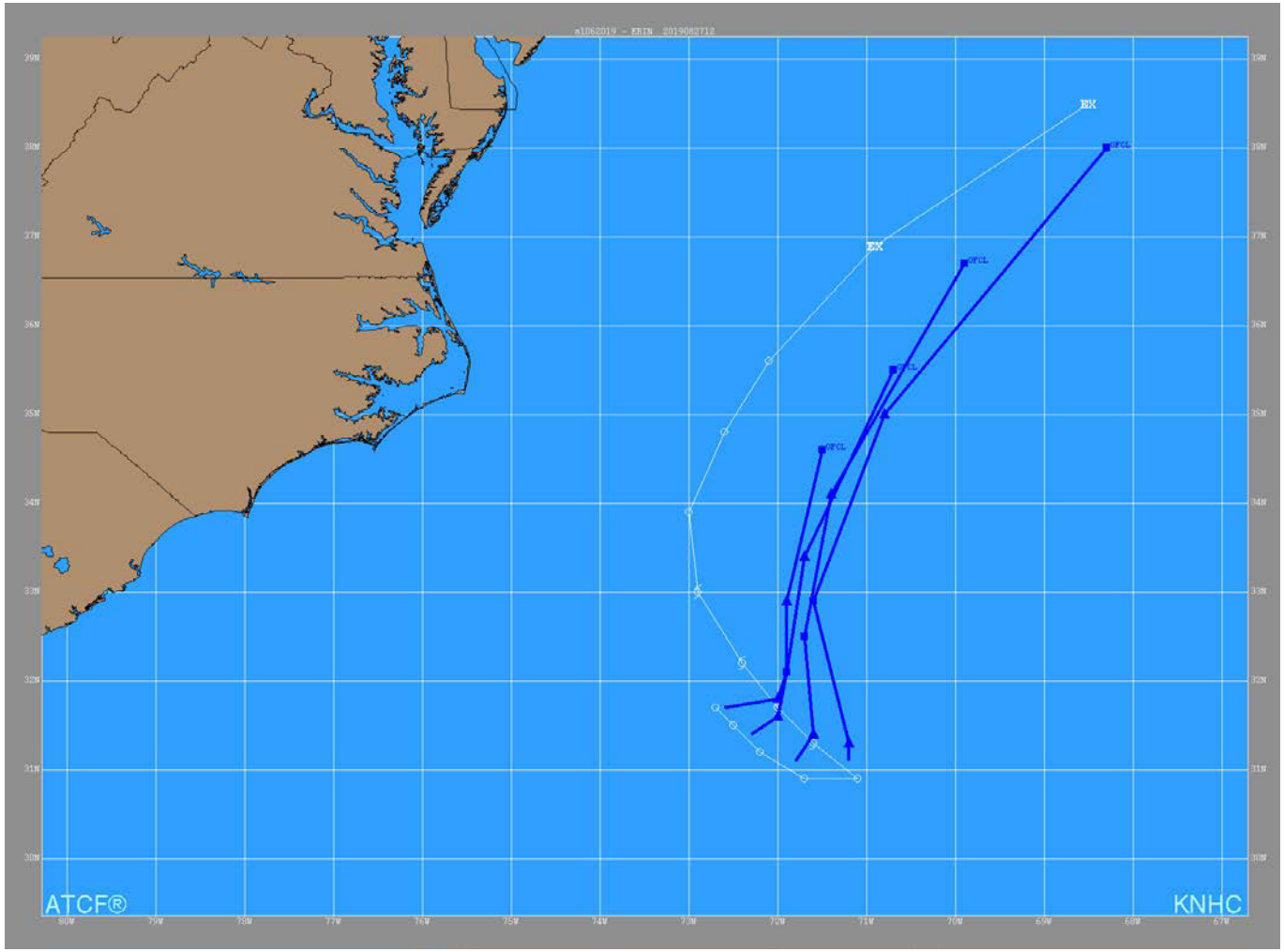

Figure 4. First 4 official (OFCL) 36 h forecasts (in blue) for Tropical Storm Erin, issued from 26 August 1800 UTC to 27 August 1200 UTC, with the verifying best track in white.

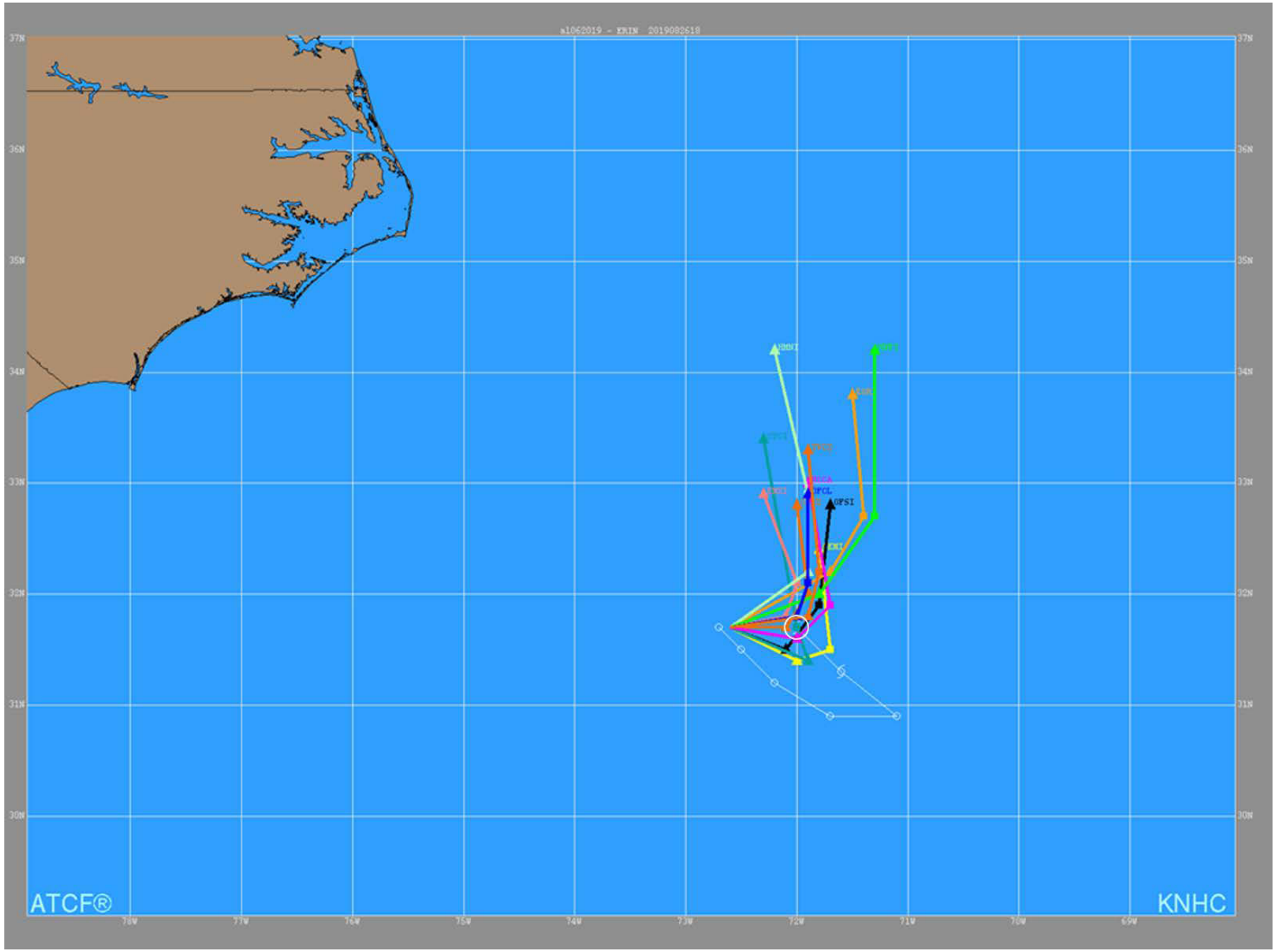

Figure 5. Model guidance for the first 36 h forecast on Tropical Storm Erin (26 August 1800 UTC), with the verifying best track in white and the verifying location at 36 h at the final white circle. Note that all of the models had a large bias to the north.