NATIONAL HURRICANE CENTER TROPICAL CYCLONE REPORT

HURRICANE ESTELLE

(EP062022)

15–21 July 2022

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National Hurricane Center
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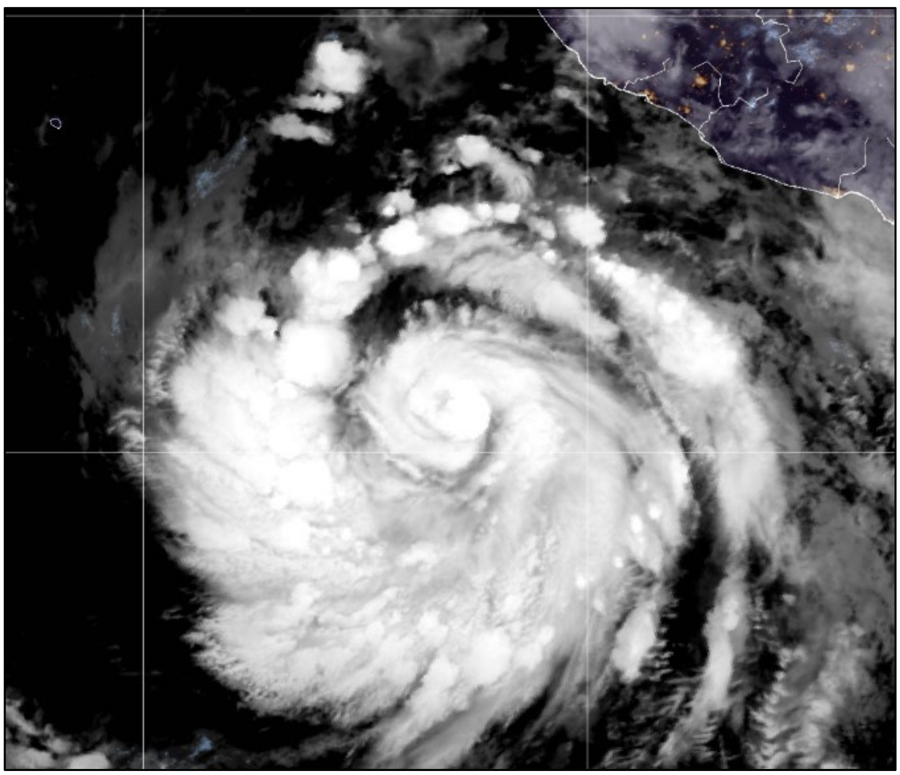

GOES-17 GEOCOLOR IMAGE OF HURRICANE ESTELLE AT 1220 UTC 17 JULY 2022 DURING THE TIME OF THE CYCLONE'S PEAK INTENSITY. IMAGE COURTESY OF NOAA/NESDIS/STAR.

Estelle was a category 1 hurricane (on the Saffir-Simpson Hurricane Wind Scale) that developed south of southwestern Mexico and remained well offshore. Estelle passed near Socorro and Clarion Islands before moving over the central portion of the eastern Pacific basin, where it dissipated.

Hurricane Estelle

15–21 JULY 2022

SYNOPTIC HISTORY

The origins of Estelle can be traced back to a tropical wave that departed the west coast of Africa on 4 July (Fig. 1). Deep convection associated with the wave was confined to the ITCZ through 8 July as the wave crossed the tropical Atlantic. A dry environment in the Caribbean limited convection as the wave crossed that region from 8–10 July. The wave emerged over the far eastern Pacific waters on 11 July and encountered a favorable environment with plenty of deep-layer moisture and weak vertical wind shear. This allowed for shower and thunderstorm activity to increase, and a trough of low pressure formed by late that day. Over the next few days, deep convection slowly became better organized as the system moved west-northwestward to the south of southern Mexico. By 1200 UTC 15 July, satellite data and passive microwave imagery indicated that the system had developed a well-defined area of low pressure and organized deep convection, marking the formation of a tropical depression about 300 n mi south of Acapulco, Mexico. The depression strengthened into Tropical Storm Estelle 12 h later. The "best track" chart of Estelle's path is given in Fig. 2, with the wind and pressure histories shown in Figs. 3 and 4, respectively. The best track positions and intensities are listed in Table 1[1].

Estelle was steered west-northwestward by a mid-level ridge to its north and northeast for much of its existence. This steering flow took the cyclone parallel to, but well offshore of, the southwestern Mexico coastline through 18 July. After formation, the environment surrounding Estelle was favorable for strengthening, and the cyclone underwent a period of rapid intensification. The system's intensity increased from 35 kt at 0000 UTC 16 July to 65 kt by 0000 UTC 17 July, at which time Estelle became a hurricane. Strengthening continued and the hurricane reached its peak intensity of 75 kt by 1200 UTC that day when it was located about 260 n mi southwest of Manzanillo. Despite the apparent favorable conditions for ongoing rapid intensification, Estelle began to struggle with dry air entrainment and exhibited a vertically tilted structure in microwave imagery (not shown) as it weakened slightly by 0000 UTC 18 July. This change in structure was due to the development of northerly to northwesterly vertical wind shear that ended up persisting over Estelle for the ensuing couple of days. Satellite imagery confirmed the tilted nature of the hurricane due to the shear by late 18 July, with the low-level center displaced to the northwest of the mid-level center and convection becoming confined to the southeast portion of the circulation. The cyclone continued weakening into 19 July, becoming a tropical storm at 0600 UTC that day while located about 360 n mi southwest of the southern tip of the Baja California peninsula.

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[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.

The weakening trend of Estelle temporarily paused by late morning on 19 July, as the vertical wind shear lessened and deep convection increased over the low-level center. However, the cyclone began moving over progressively cooler waters by early 20 July and Estelle’s deep convection diminished, which resulted in weakening once again. By 0600 UTC 21 July, the system became completely devoid of deep convection while over cool 21–22° C waters, and consequently, Estelle became a post-tropical cyclone while located about 800 n mi west of the southern tip of the Baja California peninsula. The cyclone moved westward in the prevailing low-level flow during the following few days. The system dissipated about midway between the Baja California peninsula and the Hawaiian Islands by 0600 UTC 24 July.

METEOROLOGICAL STATISTICS

Observations in Estelle (Figs. 3 and 4) 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 Estelle.

Ship reports of winds of tropical storm force associated with Estelle are given in Table 2.

Winds and Pressure

Estelle’s peak intensity of 75 kt at 1200 and 1800 UTC 17 July is primarily based on Dvorak intensity estimates from TAFB of T4.5/77 kt. The minimum pressure of 985 mb is based on the Knaff-Courtney-Zehr (KZC) pressure-wind relationship.

CASUALTY AND DAMAGE STATISTICS

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

FORECAST AND WARNING CRITIQUE

The genesis of Estelle was well anticipated. The potential for tropical cyclone formation was first introduced in the Tropical Weather Outlook with a low (<40%) chance of development over the next five days 174 h before formation (Table 3). The 5-day chance of development was raised to the medium (40-60%) category 120 h before formation, and the high category (>60%) 90 h before genesis occurred. The system was assigned a low 2-day probability of formation 90 h before development, and the probabilities were raised to the medium and high categories 42 and 24 h before formation, respectively. NHC accurately forecast the location of Estelle's formation, which was contained within all tropical cyclone genesis areas depicted in the Graphical Tropical Weather Outlook (Fig. 5).

A verification of NHC official track forecasts for Estelle is given in Table 4a. Official track forecast errors were lower than the mean official errors for the previous 5-yr period at all forecast times. The OCD5 errors were a little below the long-term mean through 96 h, suggesting that the forecasts for Estelle were a little easier than average during those time frames. A homogeneous comparison of the official track errors with selected guidance models is given in Table 4b. The official forecast performed reasonably well compared to the individual dynamical models. The Florida State Superensemble (FSSE) was the best performing model with lower errors than the official forecast at all times, except 36 h.

A verification of NHC official intensity forecasts for Estelle is given in Table 5a. Official intensity forecast errors were higher than the mean official errors for the previous 5-yr period at all verifying lead times. The OCD5 errors were lower than its 5-yr mean, suggesting that the intensity forecasts for Estelle were less difficult than average. A homogeneous comparison of the official intensity errors with selected guidance models is given in Table 5b. Every one of the individual models except for the SHIPS statistical guidance (DSHP) performed better than the official intensity forecasts at all verifying lead times. The SHIPS Rapid Intensification Indices were quite high for Estelle, and overall that model had a high bias and provided poor guidance for the event (Fig.6).

There were no coastal watches or warnings issued in association with Estelle.

Table 1. Best track for Hurricane Estelle, 15–21 July 2022.

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
15 / 1200	12.0	99.9	1007	30	tropical depression
15 / 1800	12.5	100.7	1007	30	"
16 / 0000	13.0	101.6	1006	35	tropical storm
16 / 0600	13.4	102.5	1003	45	"
16 / 1200	13.8	103.3	997	55	"
16 / 1800	14.1	103.9	993	60	"
17 / 0000	14.5	104.6	991	65	hurricane
17 / 0600	14.9	105.4	988	70	"
17 / 1200	15.3	106.4	985	75	"
17 / 1800	15.9	107.4	985	75	"
18 / 0000	16.6	108.3	986	70	"
18 / 0600	17.3	109.3	986	70	"
18 / 1200	17.8	110.6	986	70	"
18 / 1800	18.1	111.9	986	70	"
19 / 0000	18.2	113.1	988	65	"
19 / 0600	18.4	114.2	991	60	tropical storm
19 / 1200	18.8	115.2	993	55	"
19 / 1800	19.3	116.3	993	55	"
20 / 0000	19.9	117.4	994	55	"
20 / 0600	20.4	118.8	997	50	"
20 / 1200	20.9	120.2	997	50	"
20 / 1800	21.3	121.6	1002	45	"
21 / 0000	21.7	122.8	1004	40	"
21 / 0600	22.1	123.9	1007	35	low
21 / 1200	22.3	125.0	1007	30	"
21 / 1800	22.3	126.0	1008	30	"
22 / 0000	22.4	126.9	1009	25	"

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
22 / 0600	22.7	127.6	1009	25	"
22 / 1200	22.9	128.3	1009	25	"
22 / 1800	23.0	129.0	1009	25	"
23 / 0000	23.0	129.6	1009	25	"
23 / 0600	23.1	130.4	1010	20	"
23 / 1200	23.4	131.0	1010	20	"
23 / 1800	23.7	131.4	1010	20	"
24 / 0000	24.0	131.8	1010	20	"
24 / 0600					dissipated
17 / 1200	15.3	106.4	985	75	maximum winds and minimum pressure

Table 2. Selected ship reports with winds of at least 34 kt for Hurricane Estelle, 15—21 July 2022.

Date/Time (UTC)	Ship call sign	Latitude (°N)	Longitude (°W)	Wind dir/speed (kt)	Pressure (mb)
16 / 0600	3E3566	15.8	101.4	100 / 35	1009.0

Table 3. 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	174
Medium (40%-60%)	42	120
High (>60%)	24	90

Table 4a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) track forecast errors (n mi) for Hurricane Estelle, 15—21 July 2022. 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	**21.5**	**32.2**	**40.2**	**52.3**	**68.3**	**76.0**	**82.1**	**98.6**
OCD5	33.7	62.1	85.7	111.5	159.5	208.9	289.0	422.9
Forecasts	21	19	17	15	13	11	7	3
OFCL (2017-21)	21.9	33.8	45.6	56.9	74.8	79.9	99.5	121.3
OCD5 (2017-21)	35.8	72.3	112.7	155.0	198.7	239.0	309.2	372.2

Table 4b. Homogeneous comparison of selected track forecast guidance models (in n mi) for Hurricane Estelle, 15—21 July 2022. 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	20.9	33.3	43.2	56.0	69.9	74.0	87.5	109.3
OCD5	33.0	63.7	89.8	116.5	165.1	209.9	290.4	403.6
GFSI	21.0	38.4	59.9	83.6	97.5	102.6	108.2	186.7
HMNI	**18.3**	**32.2**	45.7	66.3	78.1	**72.3**	**84.9**	151.2
HWFI	22.0	43.2	64.7	94.4	112.1	129.8	134.0	172.2
EGRI	25.4	47.4	63.3	84.7	101.2	113.6	136.6	**90.2**
EMXI	23.7	42.9	55.5	67.8	80.2	88.8	121.1	**72.9**
CMCI	25.3	48.4	72.8	99.0	111.2	108.9	**75.8**	**63.2**
NVGI	22.7	39.6	46.5	**48.8**	**51.2**	**55.4**	**76.9**	**77.7**
CTCI	**20.5**	40.7	55.4	66.9	**62.6**	**57.1**	**44.4**	**100.3**
AEMI	**20.6**	36.0	53.0	75.0	91.5	96.0	115.4	183.5
HCCA	**19.5**	35.6	46.4	60.8	72.4	81.5	90.4	122.1
FSSE	**18.9**	**32.9**	45.1	**55.5**	**61.9**	**67.7**	**84.1**	**103.2**
TVCX	**17.9**	33.6	46.4	59.8	**68.7**	**73.2**	89.5	**98.2**
GFEX	**20.2**	36.4	53.5	70.9	82.2	84.1	97.0	**106.5**
TVCE	**17.8**	33.5	44.3	58.5	**67.0**	**69.8**	**81.6**	**95.1**
TVDG	**18.0**	33.9	44.6	58.1	**67.0**	74.0	89.2	**94.3**
TABD	22.9	39.7	57.3	73.6	78.4	**73.4**	**62.1**	140.4
TABM	22.1	38.6	55.3	67.5	70.8	**70.7**	123.2	145.0
TABS	26.2	55.5	89.4	118.6	146.2	170.1	210.4	202.6
Forecasts	19	17	15	13	11	9	5	1

Table 5a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) intensity forecast errors (kt) for Hurricane Estelle, 15—21 July 2022. 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	5.7	12.9	17.9	22.7	23.1	23.2	27.1	21.7
OCD5	4.6	6.6	8.9	11.1	12.5	14.9	11.1	9.0
Forecasts	21	19	17	15	13	11	7	3
OFCL (2017-21)	5.5	9.1	11.1	12.9	15.3	15.6	16.4	17.0
OCD5 (2017-21)	7.0	12.2	15.8	18.6	20.4	21.2	22.3	21.8

Table 5b. Homogeneous comparison of selected intensity forecast guidance models (in kt) for Hurricane Estelle, 15—21 July 2022. 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 5a due to the homogeneity requirement.

Model ID	Forecast Period (h)							
	12	24	36	48	60	72	96	120
OFCL	6.1	13.2	19.3	25.4	25.9	25.0	27.0	25.0
OCD5	**4.5**	**6.3**	**8.6**	**11.2**	**13.1**	**16.6**	**14.0**	**12.0**
GFSI	**3.4**	**7.4**	**11.9**	**15.7**	**19.1**	**22.3**	**20.4**	**18.0**
HMNI	**3.6**	**4.5**	**5.9**	**5.8**	**6.6**	**9.3**	**5.8**	**12.0**
HWFI	**4.3**	**4.2**	**6.0**	**9.0**	**15.0**	**17.6**	**20.8**	**20.0**
EMXI	**4.9**	**6.4**	**7.4**	**8.5**	**9.9**	**8.6**	**7.4**	**8.0**
CTCI	**4.2**	**7.5**	**13.6**	**18.4**	**20.2**	**17.2**	**12.8**	**17.0**
HCCA	**4.9**	**10.2**	**15.1**	**20.2**	**22.8**	**24.1**	**21.0**	**20.0**
FSSE	**4.7**	**8.4**	**11.8**	**13.9**	**16.5**	**17.8**	**17.8**	**15.0**
DSHP	**5.9**	**13.0**	20.1	28.0	30.4	32.8	28.4	27.0
LGEM	**5.5**	**10.6**	**16.3**	**20.2**	**22.3**	**22.4**	**17.2**	**14.0**
IVCN	**3.8**	**6.7**	**10.7**	**15.0**	**18.5**	**20.1**	**17.4**	**18.0**
IVDR	**3.4**	**5.9**	**9.7**	**13.3**	**17.1**	**18.8**	**16.6**	**17.0**
Forecasts	19	17	15	13	11	9	5	1

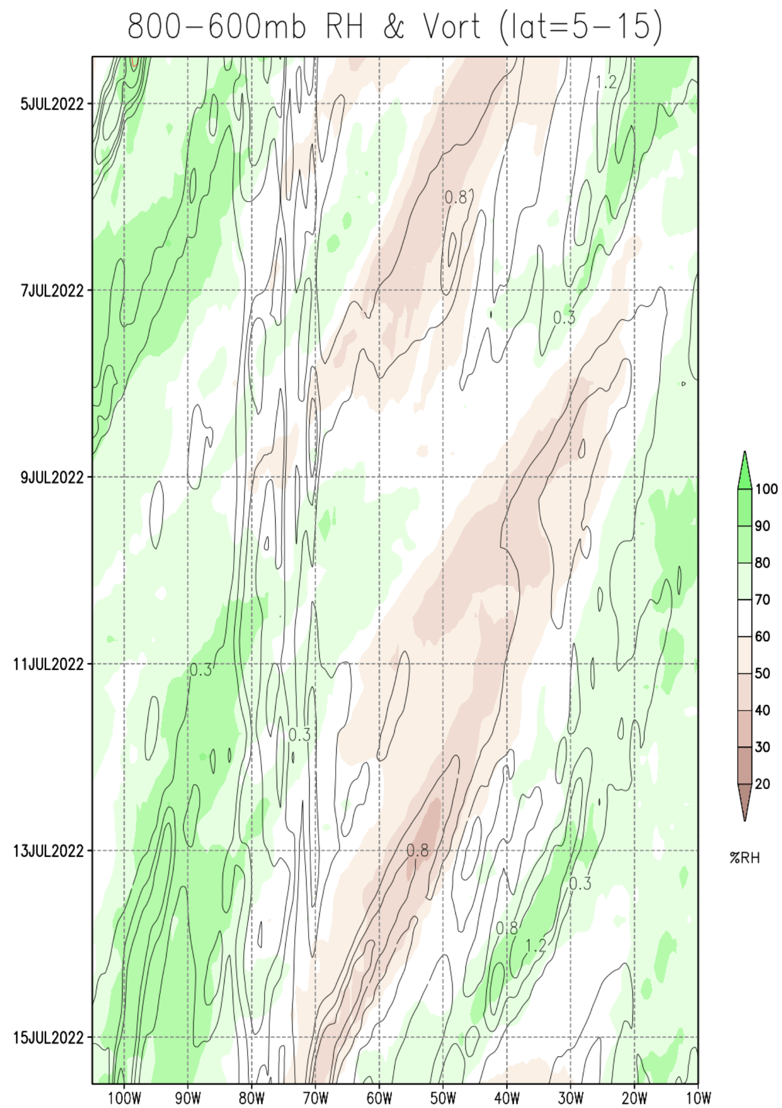

Figure 1. Hovmoller diagram showing the 800–600 mb relative humidity and vorticity from 5°–15°N between 10°–100°W from 4–15 July 2002. The moisture surge off Africa on 4 July moved across the Atlantic and reached 99°W by 15 July when Estelle formed.

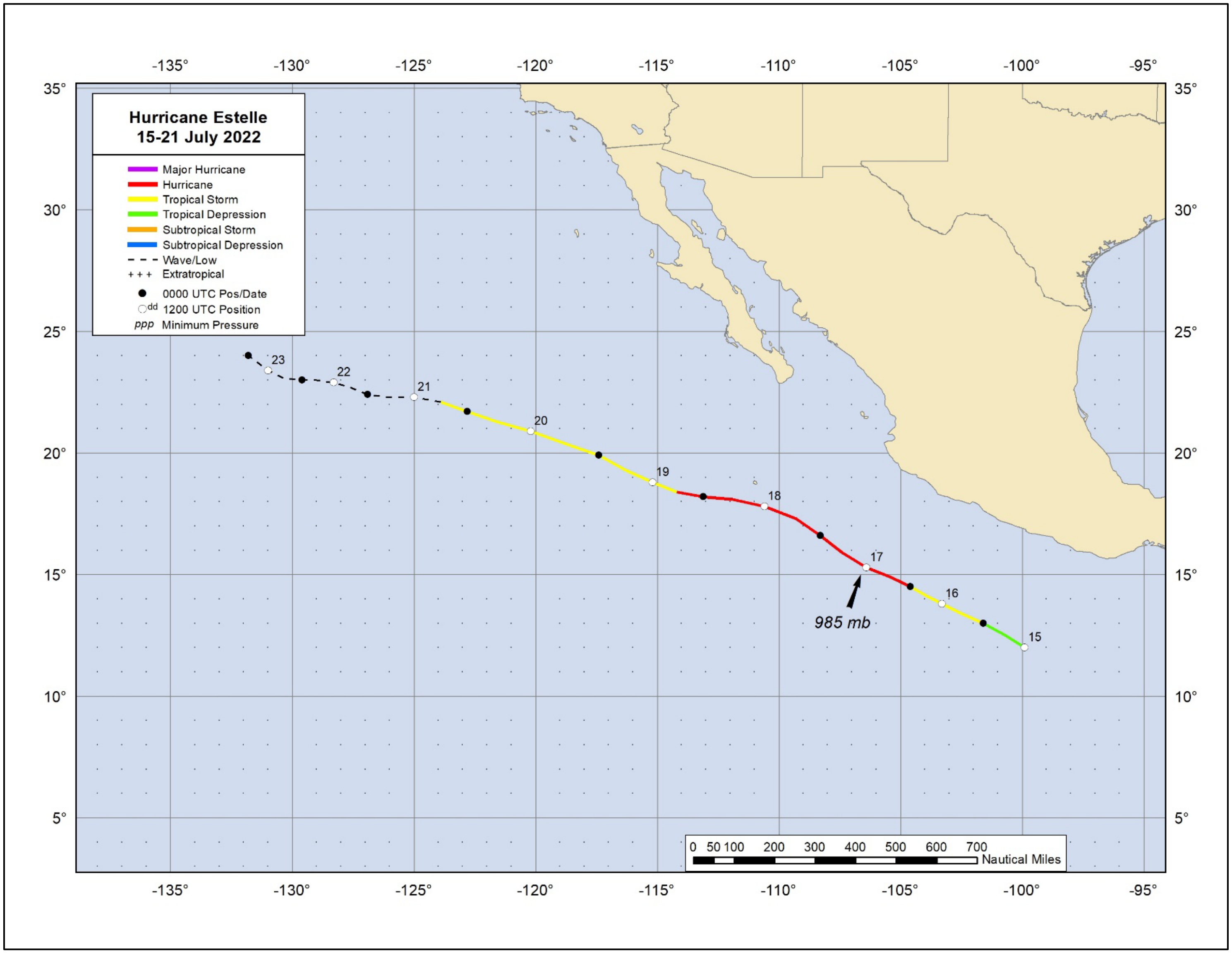

Figure 2. Best track positions for Hurricane Estelle, 15—21 July 2022.

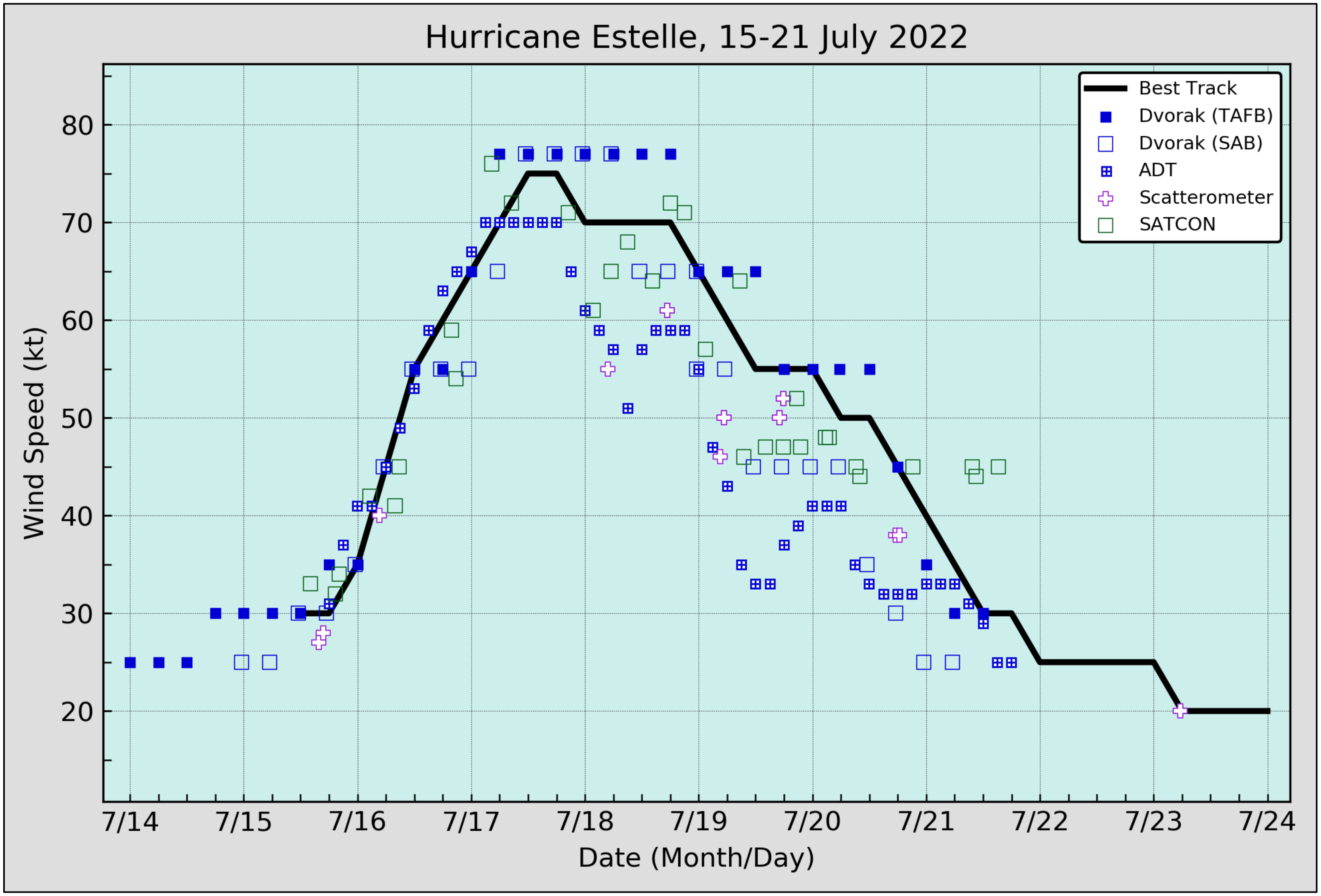

Figure 3. Selected wind observations and best track maximum sustained surface wind speed curve for Hurricane Estelle, 15–21 July 2022. Advanced Dvorak Technique estimates represent the Current Intensity at the nominal observation time. SATCON intensity estimates are from the Cooperative Institute for Meteorological Satellite Studies. Dashed vertical lines correspond to 0000 UTC.

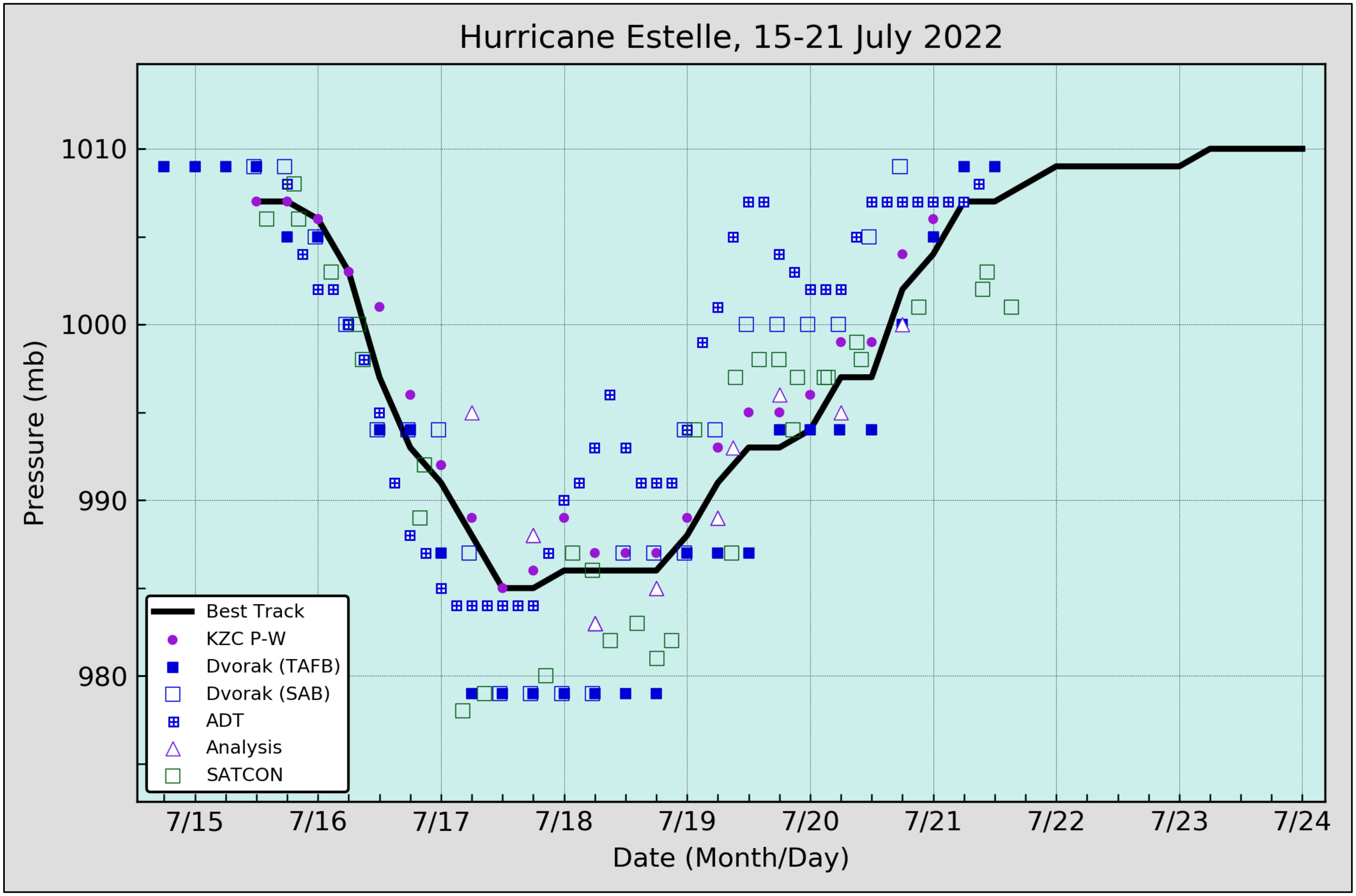

Figure 4. Selected pressure observations and best track minimum central pressure curve for Hurricane Estelle, 15—21 July 2022. Advanced Dvorak Technique estimates represent the Current Intensity at the nominal observation time. SATCON intensity estimates are from the Cooperative Institute for Meteorological 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.

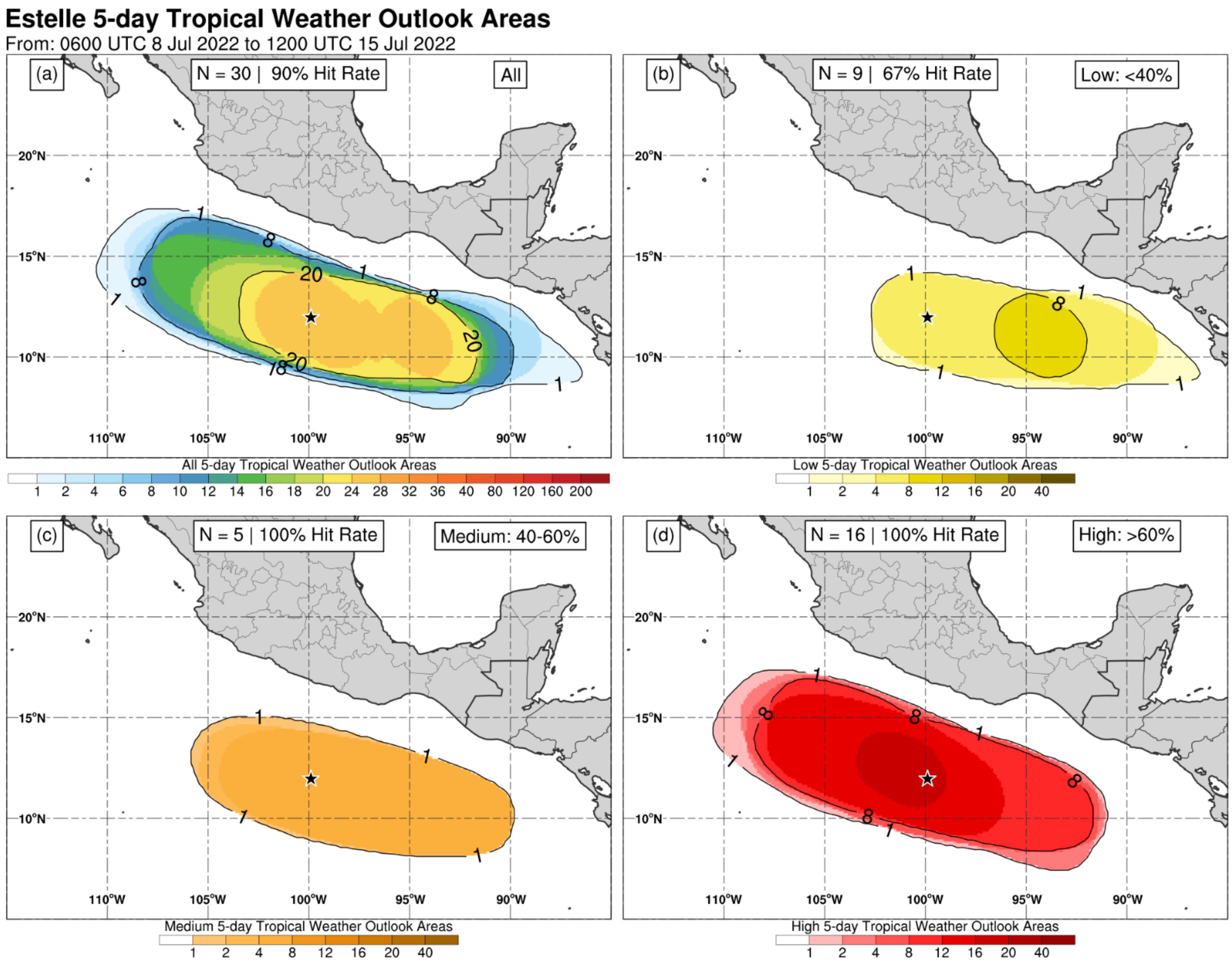

Figure 5. Composites of 5-day tropical cyclone genesis areas depicted in NHC's Tropical Weather Outlooks prior to the formation of Hurricane Estelle for (a) all probabilistic genesis categories, (b) the low (<40%) category, (c) medium (40-60%) category, and (d) high (>60%) category. Frank's location of genesis is indicated by the black star.

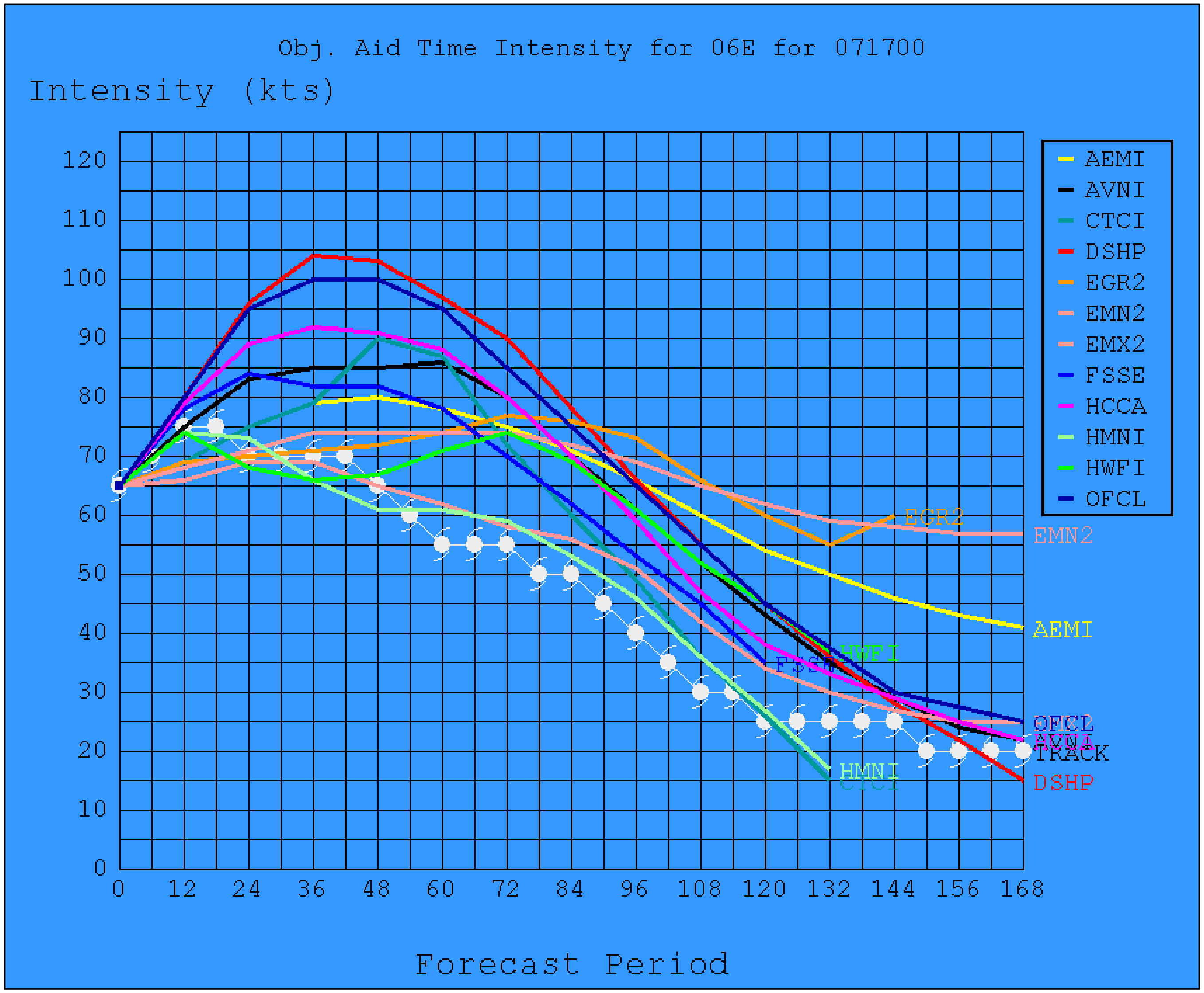

Figure 6. Intensity forecasts from 0000 UTC 17 July. The solid white line and storm symbols at 6-h intervals denote Estelle's actual intensity. Note the NHC and DSHP intensity forecasts predicted Estelle to become a major hurricane, which did not occur. Forecasts from other time periods (not shown) indicate a similar bias. This resulted in a high bias and lack of skill in the longer lead time forecasts for the hurricane.