NATIONAL HURRICANE CENTER TROPICAL CYCLONE REPORT

HURRICANE DARBY

(EP052022)

9–16 July 2022

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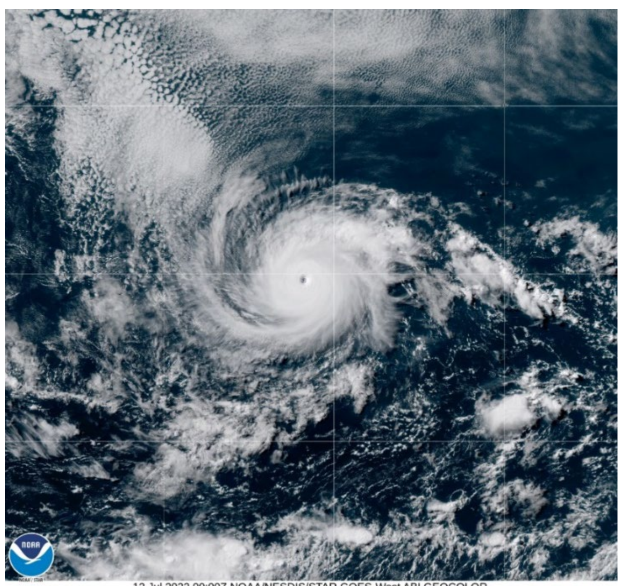

GOES-16 TRUE COLOR VISIBLE SATELLITE IMAGE OF HURRICANE DARBY AROUND THE TIME OF ITS PEAK INTENSITY AT 0000 UTC 12 JULY. IMAGE COURTESY OF NOAA/NESDIS/STAR.

Darby was a powerful and compact category 4 hurricane (on the Saffir-Simpson Hurricane Wind Scale) that originated in the eastern Pacific, crossed into the central Pacific basin and opened up into a trough south of the island of Hawaii.

[1] Original report released on 27 February 2023. Updated 19 February 2025 to include best track analysis, map, and summary from the Central Pacific Hurricane Center.

Hurricane Darby

9–16 JULY 2022

SYNOPTIC HISTORY

The tropical wave that led to the development of Darby emerged off the African coast on 26-27 June, reached the Windward Islands on 1 July and then crossed Central America on 5-6 July and was accompanied by disorganized showers and thunderstorms for this entire period. Convection associated with the wave pulsed in sequence with the diurnal cycle over the next three days or so while the system gradually became more organized as it moved westward away from the Mexican coastline. On 9 July, deep convection became persistent around a well-defined surface center, and it is estimated that a tropical depression formed by 1200 UTC 9 July when the system was located about 500 n mi southwest of the southwestern coast of Mexico. The "best track" chart of the tropical cyclone's path is given in Figure 1, with the wind and pressure histories shown in Figures 2 and 3, respectively. The best track positions and intensities are listed in Table 1[2].

Darby steadily intensified after formation and the system became a tropical storm 6 h after genesis in an environment with low vertical wind shear and over sufficiently warm sea surface temperatures. After a dry air intrusion that briefly caused the intensification to level off, Darby began to rapidly strengthen and became a hurricane by 0000 UTC 11 July while moving westward along the south side of a mid-level ridge. Darby continued to rapidly intensify until reaching a peak intensity of 120 kt at 1800 UTC 11 July when it was located about 985 n mi west-southwest of the southern tip of the Baja California Peninsula. It is estimated that Darby strengthened by an impressive 65 kt over the 24-hour period ending at 0000 UTC 12 July (cover photo). Though the storm reached Category 4 status on the Saffir-Simpson Hurricane Wind Scale, Darby had a very compact wind field. The tropical-storm-force winds are estimated to have only extended outward up to 50 n mi from the center and the hurricane-force-winds only up to 10 n mi (based largely on satellite-derived surface wind data) at the time of peak intensity.

The tiny hurricane maintained its peak intensity for about 12 h before weakening over the next 24 h as satellite imagery showed the eye becoming less distinct and cloud-filled. By 13 July, Darby reached a weakness in the mid-level ridge, turned west-northwestward, and began to re-intensify as a well-defined eye re-emerged. This re-intensification happened despite the hurricane moving over marginal sea surface temperatures (estimated between 25-26°C) while embedded in a dry, stable environment and was likely aided by a weaker-than-predicted vertical wind shear environment. Darby became a major hurricane (100 kt; Category 3) for a second time at 1800 UTC 13 July. The hurricane maintained this intensity for another 6 h before encountering

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[2] 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.

an even less favorable environmental and oceanic conditions that resulted in gradual weakening as the storm crossed 140°W into the Central Pacific basin around 1200 UTC 13 July.

Shortly after crossing into the central Pacific, Darby moved over cooler waters while encountering increasing vertical wind shear associated with an upper-level trough, which led to rapid weakening of the cyclone. The storm weakened below hurricane intensity by 1200 UTC 15 July when it was located about 530 n mi east-southeast of the Big Island of Hawaii. The increasingly shallow system was then steered westward by surface high pressure to the north and Darby moved on a path that took the center about 100 n mi south of the Big Island of Hawaii. During this time the system continued to produced enough bursts of deep convection to classify the system as a tropical cyclone. However, shortly before 0000 UTC 17 July, satellite-derived winds indicated that Darby had opened up into a trough just south of the Big Island. The low-level trough continued to produce occasional thunderstorms for a couple of days while tracking westward away from the Hawaiian Islands.

METEOROLOGICAL STATISTICS

Observations in Darby (Figs. 2 and 3) include subjective satellite-based Dvorak technique intensity estimates from the Tropical Analysis and Forecast Branch (TAFB), the Satellite Analysis Branch (SAB), the Central Pacific Hurricane Center (PHFO), and the Joint Typhoon Warning Center (JTWC) , as well as 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), Defense Meteorological Satellite Program (DMSP) satellites, and the Synthetic Aperture Radar (SAR) were also useful in constructing the best track of Darby.

There were no ship or buoy reports of tropical-storm-force winds associated with Darby.

Darby's peak intensity of 120 kt at 1800 UTC 11 July and 0000 UTC 12 July is primarily based on the T6.1/117 kt ADT Dvorak and SATCON intensity estimates which likely underestimated Darby's intensity given the cyclone's small size. The estimated minimum pressure of 953 mb is based on a blend of the Knaff-Zehr-Courtney and Dvorak pressure-wind relationships.

CASUALTY AND DAMAGE STATISTICS

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

FORECAST AND WARNING CRITIQUE

The possibility of Darby's genesis was identified several days in advance but the timing of formation was not well forecast. Table 2 provides the number of hours in advance of formation with the first NHC Tropical Weather Outlook (TWO) forecast in each likelihood category. A low chance (<40%) was introduced in the 5-day forecast period 96 h before Darby formed. The probabilities were raised to the medium (40-60%) and high (>60%) categories 78 h and 66 h before genesis, respectively. Regarding the 2-day forecast period, a low chance of genesis was introduced in the TWO well in advance of formation (78 h), but the probabilities only reached the medium category 18 h prior to formation and there was no lead time in the high category based on the final best track. NHC forecast the location of formation fairly accurately, with an 82% hit rate, though the genesis location occurred on the east side of the majority of the outlooks in the high category (Fig. 4) due to Darby forming a little sooner than anticipated.

A verification of NHC official track forecasts for Darby is given in Table 3a. Official track forecast errors (OFCL) were less than the mean official errors for the previous 5-yr period for the short-term forecast periods (12 and 24 h) and greater than the mean errors for all other forecast times. However, the climatology and persistence (OCD5) errors values were lower than its 5-yr averages, indicating Darby's track should have been easier than average to forecast. A homogeneous comparison of the official track errors with selected guidance models is given in Table 3b, and forecast skill against OCD5 is illustrated in Figure 5. The NHC OFCL track forecasts were not as skillful as the best performing European (EMXI) or Canadian (CMCI) deterministic models, in addition to most of the consensus aids at all lead times. In comparison, the GFS (GFSI), COAMPS-TC (CTCI), and GFS Ensemble mean (AEMI) were the poorest performing models for the track predictions of Darby.

A verification of NHC official intensity forecasts for Hurricane Darby is given in Table 4a. Official intensity forecast errors were greater than the mean official errors for the previous 5-yr period, due to Darby's rapid intensification period and the unexpected re-strengthening into a major hurricane. While early official intensity forecasts showed steady strengthening, they did not explicitly show rapid intensification (not shown). A homogeneous comparison of the official intensity errors with selected guidance models is given in Table 4b with intensity skill provided in Figure 6. Despite the rapid intensification, the official forecast was the most skillful intensity prediction at the 12, 36, and 48 h forecast periods, as most of the intensity guidance also failed to indicate Darby would rapidly intensity. The consensus aid HCCA performed best at 24 h, while the statistical model DSHP had the lowest errors at 60 h. HWFI was notably the best performing model at longer lead times (72 h and beyond).

A verification of the CPHC official track forecasts for Darby is given in Table 5a. CPHC official track errors were lower than the mean official errors for the previous 5-yr period. A homogeneous comparison of the CPHC official track errors with selected guidance models is given in Table 5b. While CPHC forecasts had relatively low errors, various consensus aids outperformed the official forecast at all forecast lead times. Notably the GFEX, a blend of the GFS and ECMWF forecasts, consistently had the lowest errors, although the number of forecasts were rather small.

A verification of the CPHC official intensity forecasts for Darby is given in Table 6a. CPHC official forecast intensity errors were lower than the mean official errors for the previous 5-yr period. A homogeneous comparison of the CPHC official intensity errors with selected guidance models is given in Table 6b. Similar to the track errors and despite the relatively low CPHC official errors, there were regional (HMNI, HWFI, CTCI) and statistical models (DSHP, LGEM), as well as consensus aids (ICON, IVCN, IVDR, FSSE) that had even lower errors at various lead times.

There were no watches and warnings associated with Hurricane Darby.

Table 1. Best track for Hurricane Darby, 9-16 July 2022.

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
09 / 1200	13.8	111.0	1008	30	tropical depression
09 / 1800	14.2	112.8	1006	35	tropical storm
10 / 0000	14.3	114.2	1004	40	"
10 / 0600	14.3	115.5	1004	40	"
10 / 1200	14.3	116.8	1002	50	"
10 / 1800	14.4	118.3	999	55	"
11 / 0000	14.5	119.9	991	65	hurricane
11 / 0600	14.5	121.3	979	85	"
11 / 1200	14.5	122.8	966	105	"
11 / 1800	14.6	124.3	953	120	"
12 / 0000	14.8	125.9	953	120	"
12 / 0600	14.7	127.4	957	115	"
12 / 1200	14.7	129.0	957	115	"
12 / 1800	14.6	130.5	966	105	"
13 / 0000	14.6	132.0	972	95	"
13 / 0600	14.6	133.3	978	85	"
13 / 1200	14.8	134.7	977	90	"
13 / 1800	15.1	136.0	968	100	"
14 / 0000	15.6	137.5	968	100	"
14 / 0600	16.0	138.9	971	95	"
14 / 1200	16.5	140.2	977	90	"

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
14 / 1800	16.9	141.5	980	85	"
15 / 0000	17.2	142.7	984	75	"
15 / 0600	17.4	143.9	990	65	"
15 / 1200	17.5	145.3	996	60	tropical storm
15 / 1800	17.5	146.7	1002	50	"
16 / 0000	17.6	148.4	1006	40	"
16 / 0600	17.7	150.3	1006	40	"
16 / 1200	17.7	152.3	1006	40	"
16 / 1800	17.7	154.4	1007	35	"
17 / 0000					dissipated
11 / 1800	14.6	124.3	953	120	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%)	78	96
Medium (40%-60%)	18	78
High (>60%)	0	66

Table 3a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) track forecast errors (n mi) for Hurricane Darby, 9–16 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	**17.8**	**33.2**	49.9	66.9	83.1	102.0	136.2	187.7
OCD5	19.7	40.7	63.3	89.6	117.7	136.2	176.4	298.6
Forecasts	19	19	19	19	19	18	14	10
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 3b. Homogeneous comparison of selected track forecast guidance models (in n mi) for Hurricane Darby, 9–16 July 2022 in the eastern North Pacific basin. 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	18.0	33.9	52.3	69.1	83.5	100.9	139.1	190.7
OCD5	20.3	43.3	69.0	92.4	112.4	130.4	181.1	296.3
GFSI	22.4	43.8	67.2	93.6	122.3	149.8	221.3	286.2
EMXI	**16.2**	**24.8**	**35.7**	**50.7**	**69.0**	**83.3**	**101.7**	**124.0**
CMCI	**15.1**	**25.7**	**36.7**	**46.9**	**60.7**	**78.9**	**110.4**	**158.9**
HWFI	**15.2**	**32.4**	**51.1**	72.2	92.3	109.1	158.7	227.2
HMNI	18.4	39.8	62.9	84.9	101.1	117.3	152.5	**189.6**
CTCI	23.5	45.2	71.3	95.9	118.6	137.3	148.9	**159.2**
AEMI	21.8	40.6	59.7	77.4	94.3	110.3	147.5	**181.0**
HCCA	**17.4**	**29.0**	**41.2**	**55.1**	**72.9**	**85.4**	**111.2**	**154.1**
FSSE	**17.2**	**31.0**	**45.1**	**62.9**	**77.4**	**98.9**	**136.8**	**177.8**
GFEX	18.1	**32.0**	**48.3**	70.0	91.8	111.1	158.5	205.1
TVCE	**16.6**	**30.5**	**47.5**	**63.3**	**80.6**	**98.8**	**131.7**	**173.7**
TVCX	**16.8**	**28.7**	**43.2**	**58.6**	**76.2**	**94.7**	**129.1**	**173.0**
TVDG	**17.0**	**28.9**	**43.4**	**58.7**	**73.7**	**93.8**	**134.4**	191.0
TABD	18.2	43.5	82.9	137.6	202.9	283.6	402.7	573.2
TABM	20.2	44.7	69.8	98.3	132.9	172.0	242.4	348.7
TABS	22.5	49.3	78.4	103.6	123.3	130.4	154.5	**179.8**
Forecasts	17	17	17	17	17	17	12	8

Table 4a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) intensity forecast errors (kt) for Hurricane Darby, 9–16 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	10.0	18.4	20.5	19.5	18.4	20.8	23.2	18.0
OCD5	12.4	23.1	30.2	27.7	21.8	18.2	23.1	16.3
Forecasts	19	19	19	19	19	18	14	10
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 4b. Homogeneous comparison of selected intensity forecast guidance models (in kt) for Hurricane Darby, 9–16 July 2022 in the eastern North Pacific basin. 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	11.2	20.0	22.4	20.9	20.3	21.8	26.2	21.2
OCD5	13.2	24.0	31.4	27.9	22.3	**18.4**	**23.7**	**15.6**
HWFI	13.9	21.1	24.7	24.1	**20.0**	**18.3**	**20.8**	**13.0**
HMNI	13.6	23.4	25.6	23.4	21.5	**19.5**	**24.7**	21.5
CTCI	13.1	20.9	24.8	26.5	27.9	28.6	38.0	36.8
DSHP	12.2	**19.8**	23.6	21.2	**19.5**	**18.9**	**24.5**	22.6
LGEM	11.8	21.6	28.1	29.6	28.0	26.1	34.0	31.6
ICON	12.1	20.9	24.9	24.1	21.9	**20.2**	**25.8**	22.2
IVCN	12.1	20.8	24.8	24.4	23.0	**21.7**	28.1	25.1
IVDR	12.6	21.1	24.9	24.5	22.8	**21.3**	27.2	24.2
HCCA	11.2	**18.9**	24.0	23.9	21.6	**20.4**	**25.9**	23.1
FSSE	11.9	20.5	24.6	24.2	24.9	26.5	31.2	24.9
GFSI	14.4	23.6	26.9	27.4	23.8	**19.9**	**25.1**	**21.0**
EMXI	13.0	20.8	23.7	22.1	**20.2**	**18.6**	**23.9**	**20.1**
Forecasts	17	17	17	17	17	17	12	8

Table 5a. CPHC official (OFCL) and climatology-persistence skill baseline (OCD5) track forecast errors (n mi) for Hurricane Darby, 9–16 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				
OFCL	**12.6**	**19.0**	**24.2**	**46.3**				
OCD5	34.8	84.5	137.0	184.9				
Forecasts	8	6	4	2				
OFCL (2017-21)	22.7	34.7	42.3	54.7				
OCD5 (2017-21)	37.6	83.8	139.2	203.1				

Table 5b. Homogeneous comparison of selected track forecast guidance models (in n mi) for Hurricane Darby, 9–16 July 2022 in the central North Pacific basin. Errors smaller than the CPHC 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	12.6	19.0	24.2	46.3				
OCD5	34.8	84.5	137.0	184.9				
GFSI	15.9	33.7	49.8	83.3				
EMXI	21.5	32.3	41.5	56.1				
HWFI	16.7	24.5	34.7	62.1				
HMNI	14.9	35.1	66.1	106.5				
CTCI	16.7	45.4	88.1	124.8				
AEMI	14.8	28.6	48.7	88.0				
FSSE	**12.4**	**17.1**	36.0	60.9				
GFEX	**11.4**	**16.0**	**22.1**	**46.0**				
TVCE	**11.2**	**18.6**	37.3	63.6				
TVDG	**10.9**	**17.0**	36.9	63.6				
TABD	57.0	143.1	240.5	345.0				
TABM	31.1	71.8	117.8	172.1				
TABS	16.8	25.1	28.0	35.3				
Forecasts	8	6	4	2				

Table 6a. CPHC official (OFCL) and climatology-persistence skill baseline (OCD5) intensity forecast errors (kt) for Hurricane Darby, 9–16 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				
OFCL	**4.4**	**5.8**	**7.5**	**2.5**				
OCD5	5.5	7.8	11.8	13.0				
Forecasts	8	6	4	2				
OFCL (2017-21)	5.6	8.4	11.1	12.6				
OCD5 (2017-21)	7.8	12.8	17.4	21.8				

Table 6b. Homogeneous comparison of selected intensity forecast guidance models (in kt) for Hurricane Darby, 9–16 July 2022 in the central North Pacific basin. Errors smaller than the CPHC official forecast are shown in boldface type. The number of official forecasts shown here will generally be smaller than that shown in Table 6a due to the homogeneity requirement.

Model ID	Forecast Period (h)							
	12	24	36	48	60	72	96	120
OFCL	4.4	5.8	7.5	2.5				
OCD5	5.5	7.8	11.8	13.0				
HWFI	**2.6**	**5.0**	**3.0**	3.0				
HMNI	**2.6**	**2.8**	**3.8**	**1.5**				
CTCI	4.4	6.0	**6.3**	**0.5**				
DSHP	**3.9**	**5.2**	**5.0**	**3.0**				
LGEM	4.4	**5.0**	**6.0**	4.0				
ICON	**3.0**	**4.2**	**4.3**	2.5				
IVCN	**3.1**	**3.8**	**4.3**	**2.0**				
IVDR	**3.1**	**4.0**	**4.5**	**2.0**				
FSSE	**2.9**	**3.8**	**3.0**	4.0				
GFSI	5.8	8.5	12.8	12.5				
EMXI	7.0	14.0	19.5	19.5				
OFCL	4.4	5.8	7.5	2.5				
Forecasts	8	6	4	2				

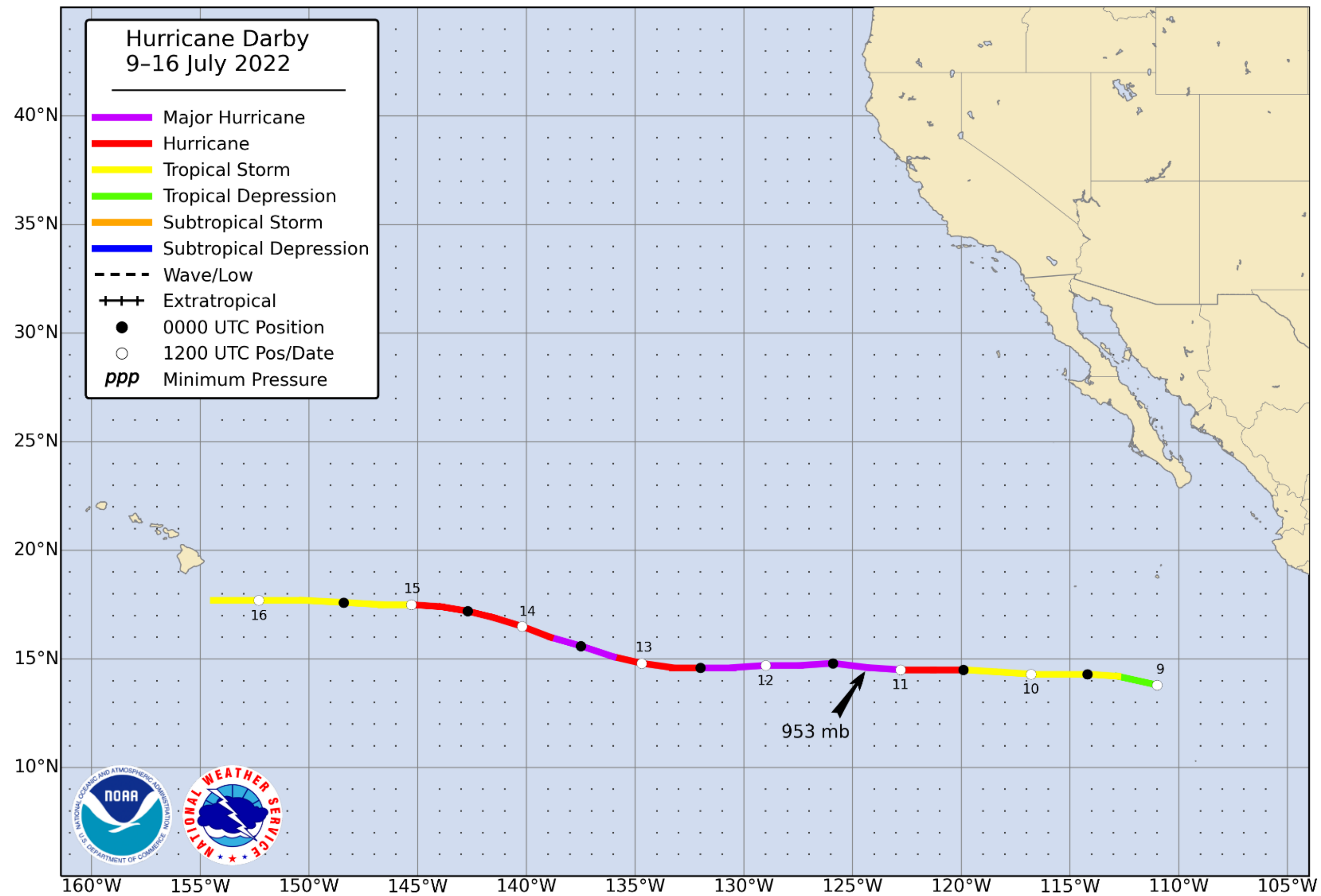

Figure 1. Best track positions for Hurricane Darby, 9–16 July 2022.

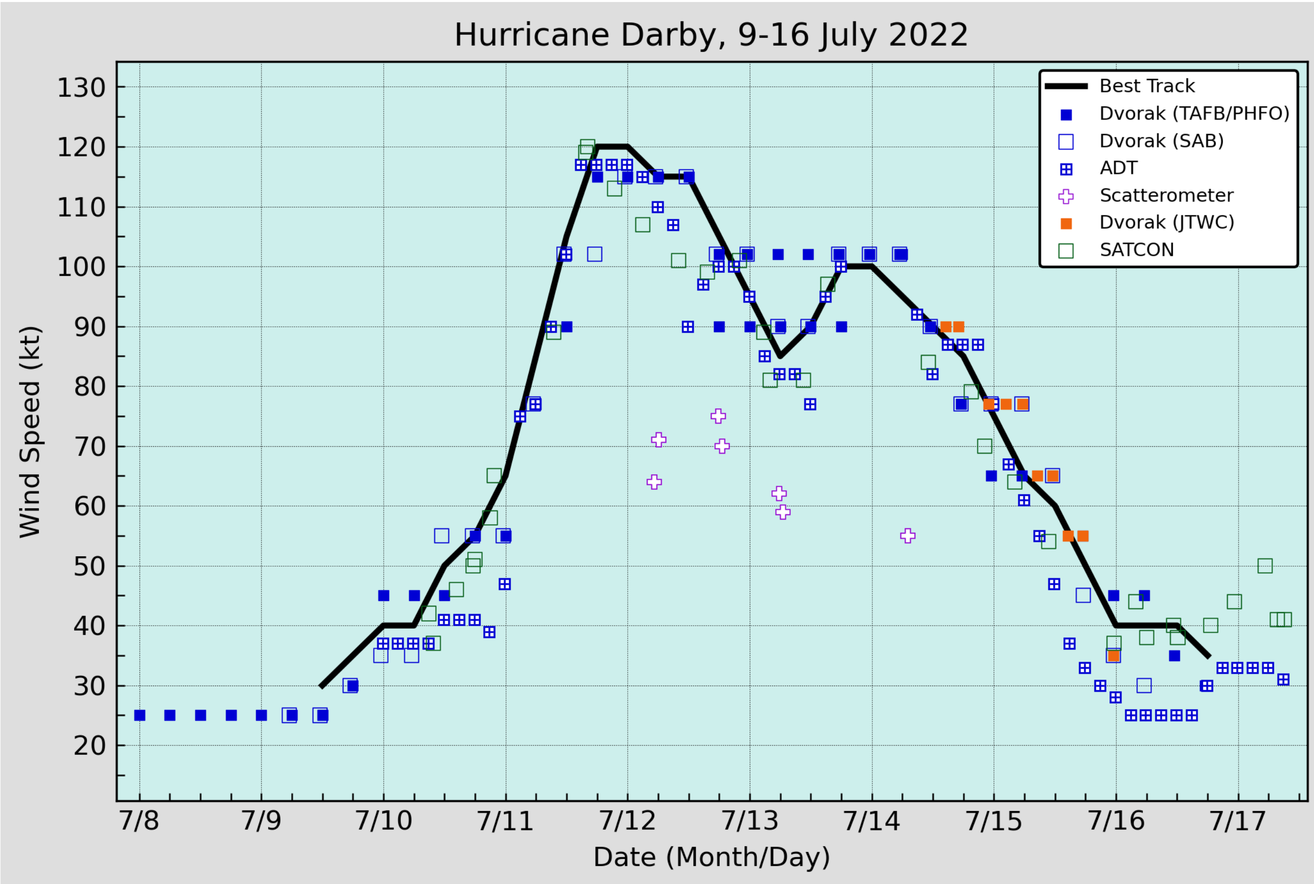

Figure 2. Selected wind observations and best track maximum sustained surface wind speed curve for Hurricane Darby, 9–16 July 2022. Advanced Dvorak Technique estimates represent the Current Intensity at the nominal observation time. SATCON intensity estimates are from the Cooperative Institute for Meteorological Satellite Studies. Dashed vertical lines correspond to 0000 UTC.

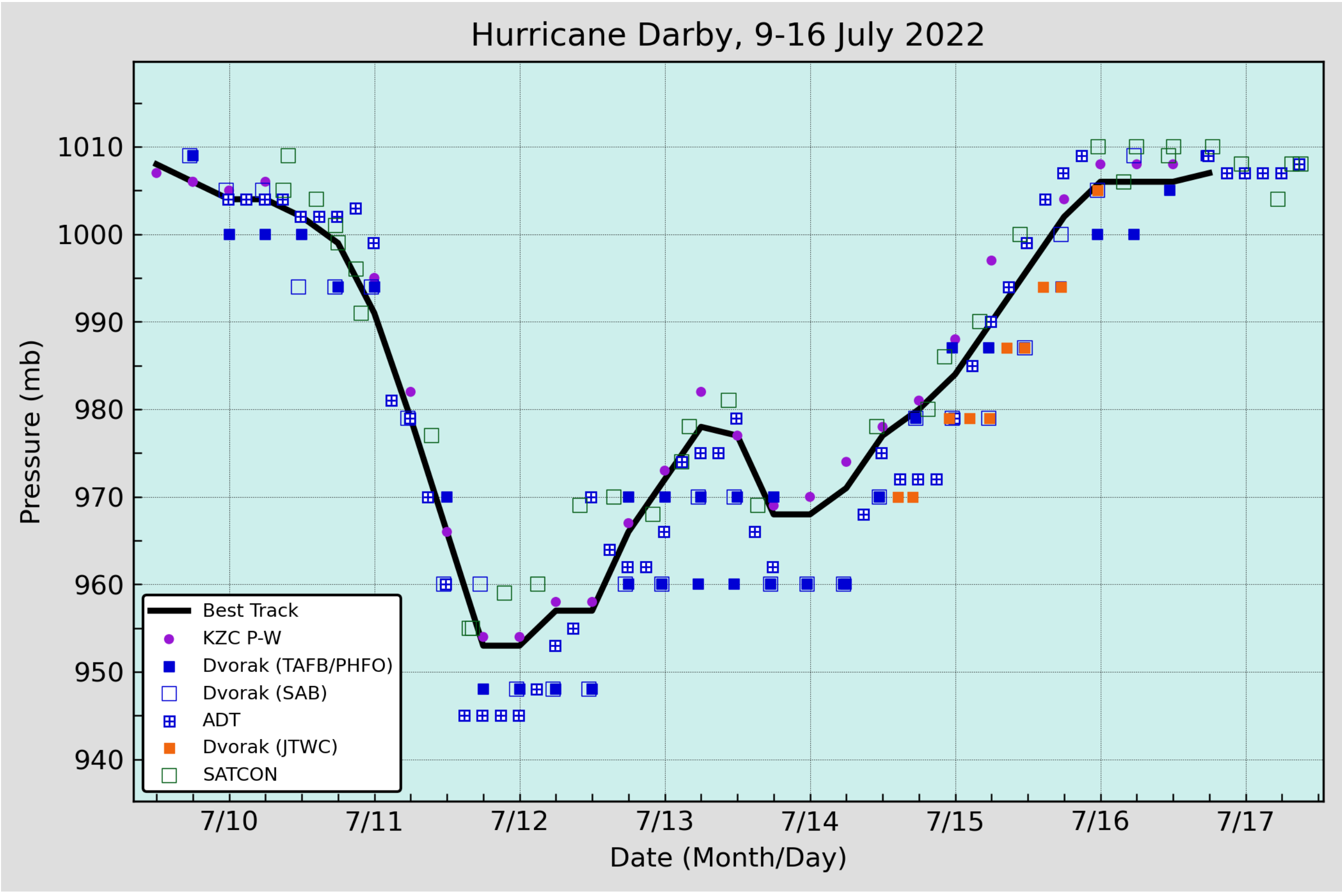

Figure 3. Selected pressure observations and best track minimum central pressure curve for Hurricane Darby, 9–16 July 2022. Advanced Dvorak Technique estimates represent the Current Intensity at the nominal observation time. SATCON intensity estimates are from the Cooperative Institute for Meteorological 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.

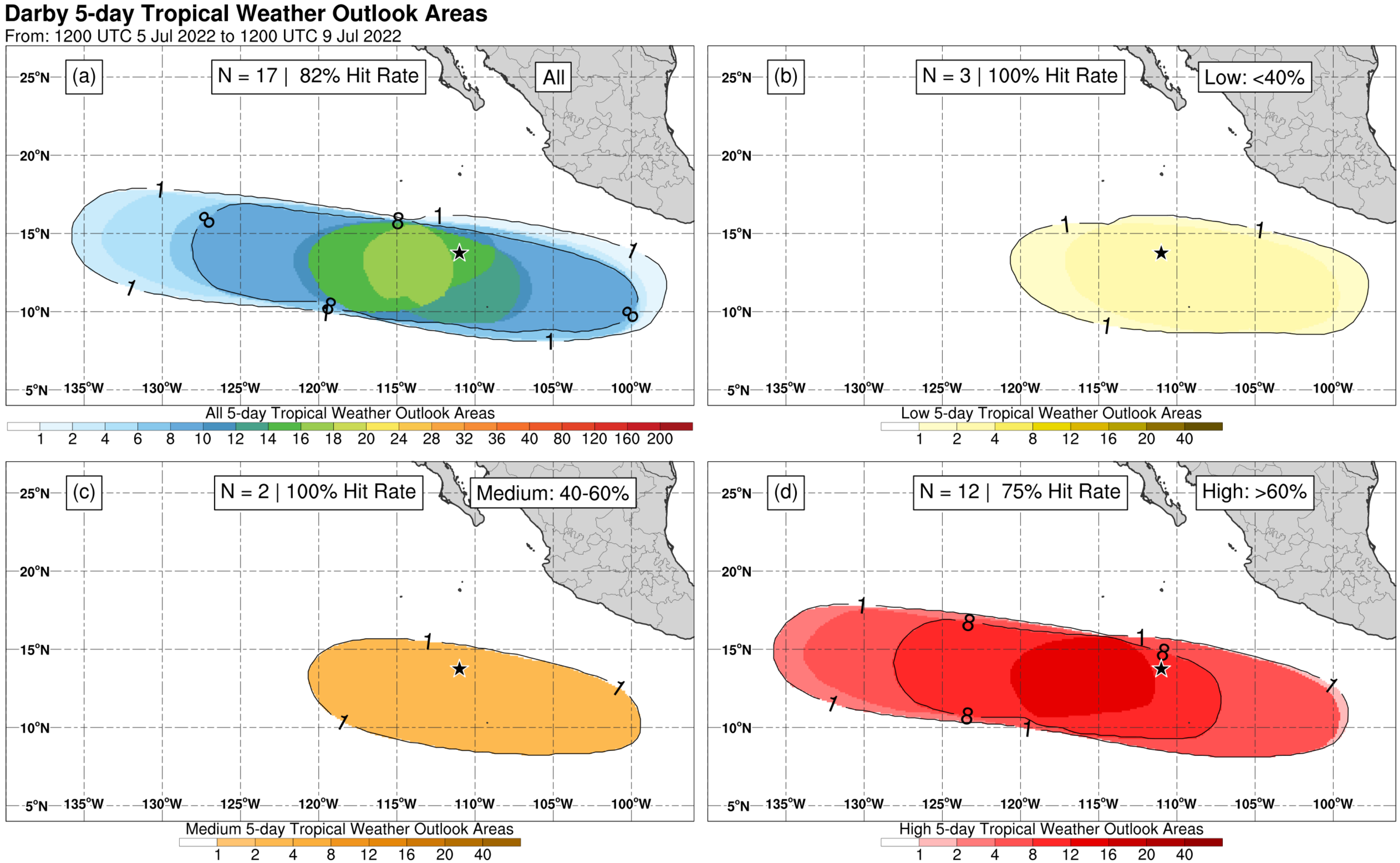

Figure 4. 5-day Tropical Weather Outlook genesis areas associated with the disturbance that developed into Hurricane Darby for (a) all probability areas (10–100%, multi-color shading), (b) low probability areas (< 40%, yellow shading), (c) medium probability areas (40–60%, orange shading), and (d) high probability areas (> 60%, red shading). The black star in each panel indicates the genesis location of Darby. Hit rate indicates the percentage of outlook areas where the genesis location was captured within. Courtesy of Philippe Papin.

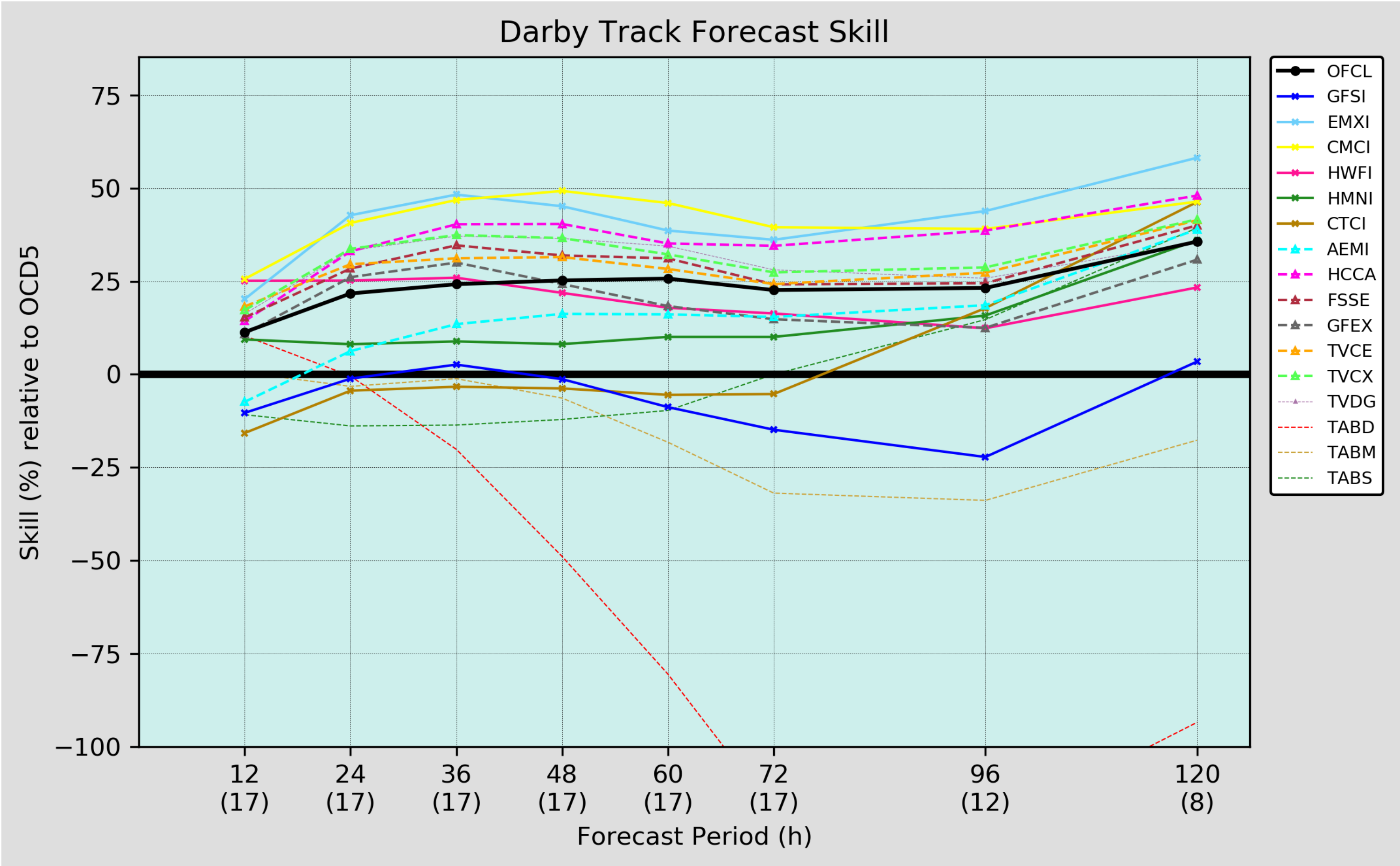

Figure 6. Track forecast skill of the NHC official forecasts and selected models for Hurricane Darby, 9–16 July 2022.

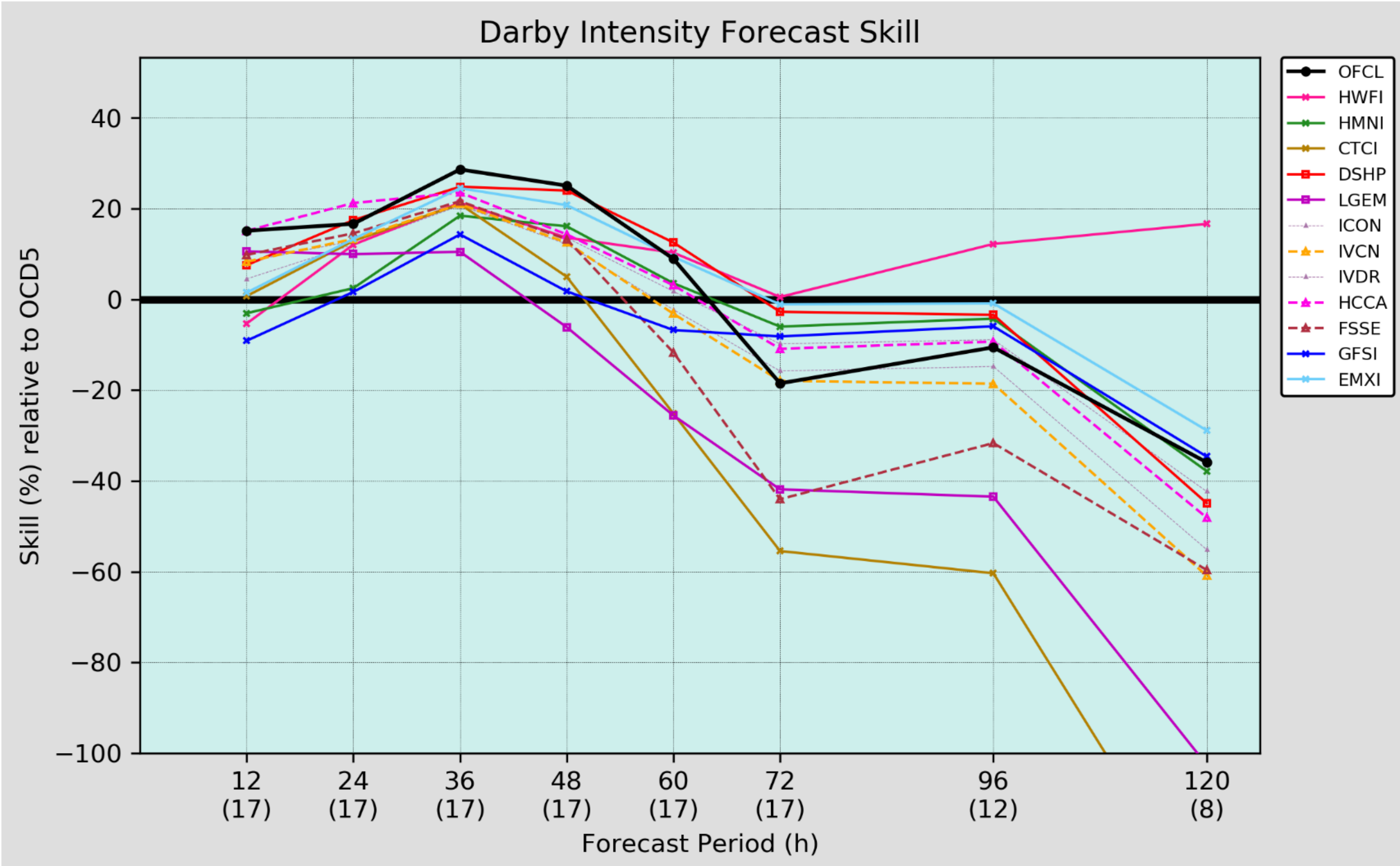

Figure 6. Intensity forecast skill of the NHC official forecasts and selected models for Hurricane Darby, 9–16 July 2022.