NATIONAL HURRICANE CENTER TROPICAL CYCLONE REPORT

HURRICANE BARBARA

(EP022019)

30 June – 5 July 2019

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VISIBLE SATELLITE MODIS IMAGE OF HURRICANE BARBARA AROUND THE TIME OF ITS PEAK INTENSITY. IMAGE COURTSEY OF NASA.

Barbara was a category 4 hurricane (on the Saffir-Simpson Hurricane Wind Scale) that rapidly intensified and remained out at sea. The hurricane then rapidly weakened and became a post-tropical cyclone just east of the central North Pacific basin.

Hurricane Barbara

30 JUNE – 5 JULY 2019

SYNOPTIC HISTORY

The genesis of Barbara appears to be associated with a tropical wave that moved off the west coast of Africa on 18 June. This disturbance produced disorganized deep convection while it was travelling across the Atlantic Ocean, especially when it interacted with an upper-level trough near the Lesser Antilles on 22 and 23 June. Showers and thunderstorms remained disorganized near the wave axis as it entered the far eastern North Pacific basin on 26 June, but the convective activity gradually increased during the next couple of days while the disturbance passed well south of Mexico. Environmental low-level southwesterly flow helped the wave establish a broad circulation on 29 June. Deep convection continued to increase later that day, and the system developed a well-defined center by 0600 UTC 30 June, marking the formation of a tropical cyclone about 550 n mi south-southwest of Manzanillo, Mexico. Since scatterometer data indicated that winds were already near 35 kt, tropical storm status is shown at the time of genesis. The "best track" chart of Barbara'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].

After genesis, Barbara strengthened slowly at first due to moderate northwesterly wind shear and some nearby dry air as it moved quickly westward steered by a strong mid-level ridge to its north. The shear decreased early on 1 July, which allowed the convective pattern of the tropical storm to become more symmetric. In favorable oceanic and atmospheric conditions, Barbara began to rapidly strengthen while it moved at a slower pace toward the west-northwest. The cyclone reached hurricane intensity by 1800 UTC 1 July when it was located about 800 n mi south-southwest of Cabo San Lucas, Mexico, at which time an eye feature became evident in satellite images. The hurricane continued to rapidly intensify, becoming a major hurricane by 1200 UTC 2 July, and it reached its peak intensity of 135 kt, at the upper end of category 4 on the Saffir-Simpson Hurricane Wind Scale, at 0000 UTC 3 July when the cyclone was centered about 1000 n mi southwest of Cabo San Lucas. When Barbara was at its peak intensity, its satellite appearance was quite impressive with a circular 15 n mi diameter eye, an intense symmetric eyewall, and well-established rainbands and outflow in all quadrants (cover image).

Later on 3 July, Barbara moved west-northwestward to northwestward on the southwestern periphery of the mid-level ridge and began its trek toward cooler waters and a more stable air mass. The cloud tops gradually warmed in the eyewall through 4 July, but the hurricane maintained an eye during that time. Barbara crossed the 26°C isotherm by 5 July, and these unfavorable oceanic conditions and an increase in southwesterly wind shear caused the inner core of the system to collapse. During this time, Barbara weakened nearly as fast as it had

[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.

strengthened a few days prior, falling below major hurricane intensity by 1800 UTC 4 July and below hurricane intensity shortly after 1200 UTC 5 July. The wind shear increased even more later that day, which caused all of Barbara's deep convection to be stripped away from the circulation. This caused Barbara to become a gale-force post-tropical cyclone by 0000 UTC 6 July when it was located about 1100 n mi east of Hilo, Hawaii.

The post-tropical cyclone gradually weakened during the next several days as it moved westward at 15 to 20 kt, steered by the low-level trade wind flow. The cyclone opened into a trough by 1200 UTC 8 July when it was located about 250 n mi east-southeast of Hilo, and the remnant trough produced disorganized showers and thunderstorms over the Hawaiian Islands a day or two later.

METEOROLOGICAL STATISTICS

Observations in Barbara (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 Barbara.

Barbara's estimated peak intensity of 135 kt at 0000 and 0600 UTC 3 July is based on a blend of objective and subjective satellite intensity estimates that ranged between 127 and 140 kt. The estimated minimum pressure of 930 mb is based on the Knaff-Zehr-Courtney pressure-wind relationship.

There were no ship or surface observations from land stations of winds of tropical storm force associated with Barbara.

CASUALTY AND DAMAGE STATISTICS

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

FORECAST AND WARNING CRITIQUE

The genesis of Barbara was adequately forecast, but the system formed a little sooner than anticipated (Table 2). The wave from which Barbara developed was introduced in the

Tropical Weather Outlook 84 h prior to genesis with a low (<30%) chance of formation during the next 5 days. The 5-day chance of genesis was increased to the medium (40–60%) and high (>60%) categories 66 h and 48 h before Barbara formed, respectively. The 2-day genesis probabilities were quite good, with a low chance of genesis shown 54 h, a medium chance 42 h, and a high chance 24 h before the system developed.

A verification of NHC official track forecasts for Barbara is given in Table 3a. Official forecast track errors were much lower (about 50%) than the mean official errors for the previous 5-yr period, except at 120 h. These track forecasts were quite accurate and had little bias (Fig. 4). The CLIPER (OCD5) errors were also notably lower than their 5-yr means, indicative that Barbara's track was easier to forecast than average. A homogeneous comparison of the official track errors with selected guidance models is given in Table 3b. The only model that consistently beat the NHC forecasts was the multi-model consensus TVCX.

A verification of NHC official intensity forecasts for Barbara is given in Table 4a. Official forecast intensity errors were lower than the mean official errors for the previous 5-yr period at 12 h, 72 h and 96 h, but higher than the means at the other forecast times. Although the official forecasts captured the strengthening and weakening phases of Barbara, they did not predict the fast rate of both the intensification and weakening periods. A homogeneous comparison of the official intensity errors with selected guidance models is given in Table 4b. The consensus aids HCCA and FSSE and the statistical-dynamical model DSHP performed the best and beat the official forecast at several time periods. On the other hand, the dynamical models, both regional and global, had the largest errors. In particular, HWFI suffered from a significant low bias as it failed to capture Barbara's rapid intensification phase.

There were no coastal watches and warnings associated with Barbara.

Table 1. Best track for Hurricane Barbara, 30 June–5 July 2019.

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
30 / 0600	10.4	108.2	1006	35	tropical storm
30 / 1200	10.5	109.7	1006	35	"
30 / 1800	10.7	111.4	1003	40	"
01 / 0000	10.9	113.2	1000	45	"
01 / 0600	11.1	115.0	998	55	"
01 / 1200	11.3	116.6	992	60	"
01 / 1800	11.4	118.0	985	70	hurricane
02 / 0000	11.6	119.3	981	80	"
02 / 0600	11.9	120.4	973	90	"
02 / 1200	12.3	121.6	948	115	"
02 / 1800	12.6	122.8	941	125	"
03 / 0000	13.0	124.0	930	135	"
03 / 0600	13.3	125.1	930	135	"
03 / 1200	13.7	126.2	935	130	"
03 / 1800	14.1	127.1	941	120	"
04 / 0000	14.6	128.0	947	115	"
04 / 0600	15.1	128.8	956	105	"
04 / 1200	15.7	129.6	960	100	"
04 / 1800	16.3	130.4	968	90	"
05 / 0000	16.9	131.2	971	85	"
05 / 0600	17.4	132.1	980	75	"
05 / 1200	18.1	133.1	987	65	"
05 / 1800	18.6	134.3	997	50	tropical storm
06 / 0000	18.7	135.6	998	45	low
06 / 0600	18.7	137.0	999	45	"
06 / 1200	18.6	138.4	1001	40	"
06 / 1800	18.6	139.9	1003	40	"
07 / 0000	18.5	141.5	1005	40	"
07 / 0600	18.4	143.2	1007	35	"
07 / 1200	18.0	145.1	1008	30	"

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
07 / 1800	17.6	147.0	1008	30	"
08 / 0000	17.2	148.8	1008	30	"
08 / 0600	16.8	150.7	1010	30	"
08 / 1200					dissipated
03 / 0000	13.0	124.0	930	135	minimum pressure

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%)	54	84
Medium (40%-60%)	42	66
High (>60%)	24	48

Table 3a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) track forecast errors (n mi) for Hurricane Barbara. 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	**10.1**	**13.9**	**15.6**	**21.6**	**40.9**	**76.8**	151.1
OCD5	23.5	52.1	84.8	122.2	188.9	263.2	166.0
Forecasts	20	18	16	14	10	6	2
OFCL (2014-18)	21.1	32.2	41.8	51.8	75.7	101.1	133.7
OCD5 (2014-18)	34.0	69.7	109.0	148.4	223.5	285.5	356.7

Table 3b. Homogeneous comparison of selected track forecast guidance models (in n mi) for Hurricane Barbara. 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	72	96	120
OFCL	8.5	12.1	15.5	19.8	35.1	72.2	155.9
OCD5	23.9	53.5	89.0	130.5	211.3	293.0	**137.1**
GFSI	12.0	22.4	40.9	53.6	89.1	123.3	178.5
HMNI	12.2	16.0	24.0	26.7	41.0	**45.8**	**25.8**
HWFI	11.3	18.9	24.6	24.6	46.6	73.4	**81.9**
EGRI	10.0	19.4	25.8	29.2	**31.1**	**42.2**	**108.6**
EMXI	12.8	19.1	24.9	33.1	51.8	99.3	174.2
CMCI	16.6	26.1	31.5	41.1	60.0	99.9	**82.5**
NVGI	19.8	34.3	33.5	38.7	69.2	**57.8**	187.7
AEMI	13.1	18.1	24.4	31.1	56.4	82.1	**116.5**
HCCA	**8.4**	**11.8**	17.9	24.2	39.3	**66.1**	**121.5**
FSSE	**8.4**	14.7	19.0	24.2	51.4	90.8	**123.4**
TVCX	**7.8**	**11.3**	**13.7**	**17.5**	**27.6**	**54.6**	**106.7**
TVCE	**7.0**	12.2	15.9	**16.7**	**27.0**	**49.8**	**98.5**
TABD	23.2	56.0	91.6	126.7	198.8	265.2	189.5
TABM	12.8	22.2	47.3	70.2	111.0	128.6	157.5
TABS	30.9	61.9	84.8	109.0	111.9	134.5	207.6
Forecasts	16	14	12	10	7	4	1

Table 4a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) intensity forecast errors (kt) for Hurricane Barbara. 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	**6.0**	10.8	14.7	17.1	**12.5**	**10.8**	25.0
OCD5	6.8	14.7	22.6	28.0	28.7	18.7	7.5
Forecasts	20	18	16	14	10	6	2
OFCL (2014-18)	6.1	10.0	12.2	13.7	15.5	15.4	15.7
OCD5 (2014-18)	7.9	13.1	16.7	19.2	21.8	22.9	22.1

Table 4b. Homogeneous comparison of selected intensity forecast guidance models (in kt) for Hurricane Barbara. 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	72	96	120
OFCL	5.3	10.3	16.1	18.8	13.3	10.8	25.0
OCD5	5.4	13.8	23.6	31.0	30.3	18.7	**7.5**
HMNI	7.6	15.3	22.4	27.4	17.2	11.8	**13.0**
HWFI	6.2	14.9	22.6	27.8	22.9	**9.8**	**0.5**
DSHP	**3.9**	**6.2**	**10.2**	**14.6**	13.8	**9.2**	**14.0**
LGEM	5.7	11.5	17.1	19.2	**10.4**	**8.7**	**5.5**
HCCA	**3.6**	**6.1**	**10.0**	**17.0**	13.9	**8.8**	**10.0**
FSSE	**3.8**	**6.2**	**11.1**	**14.8**	15.9	16.7	**17.5**
IVCN	**4.9**	10.6	16.5	21.1	14.0	**9.2**	**12.0**
GFSI	10.8	20.2	27.6	33.7	27.0	13.0	**7.5**
EMXI	14.1	26.2	36.8	45.0	37.4	18.0	**13.0**
Forecasts	18	16	14	12	9	6	2

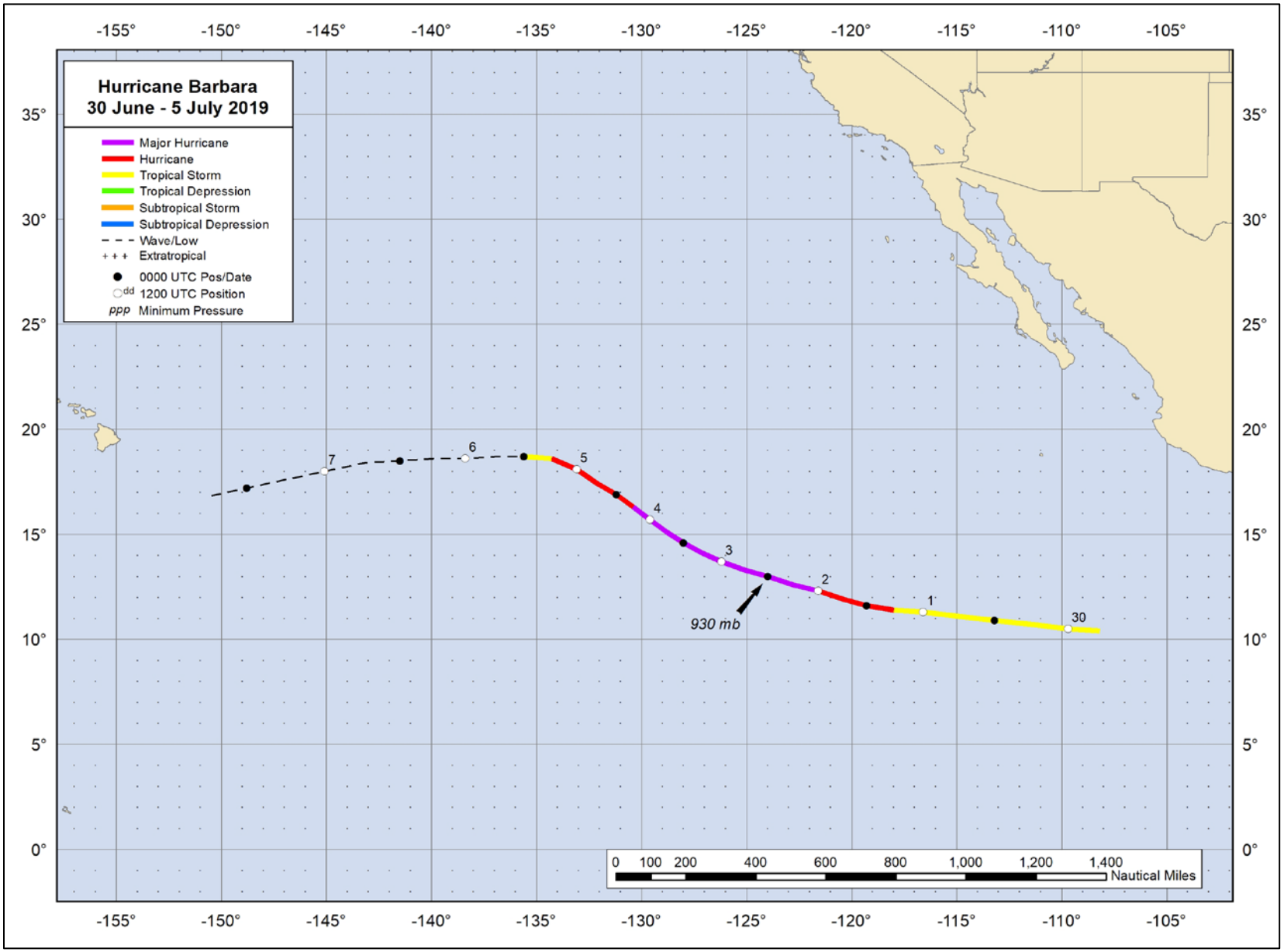

Figure 1. Best track positions for Hurricane Barbara, 30 June–5 July 2019.

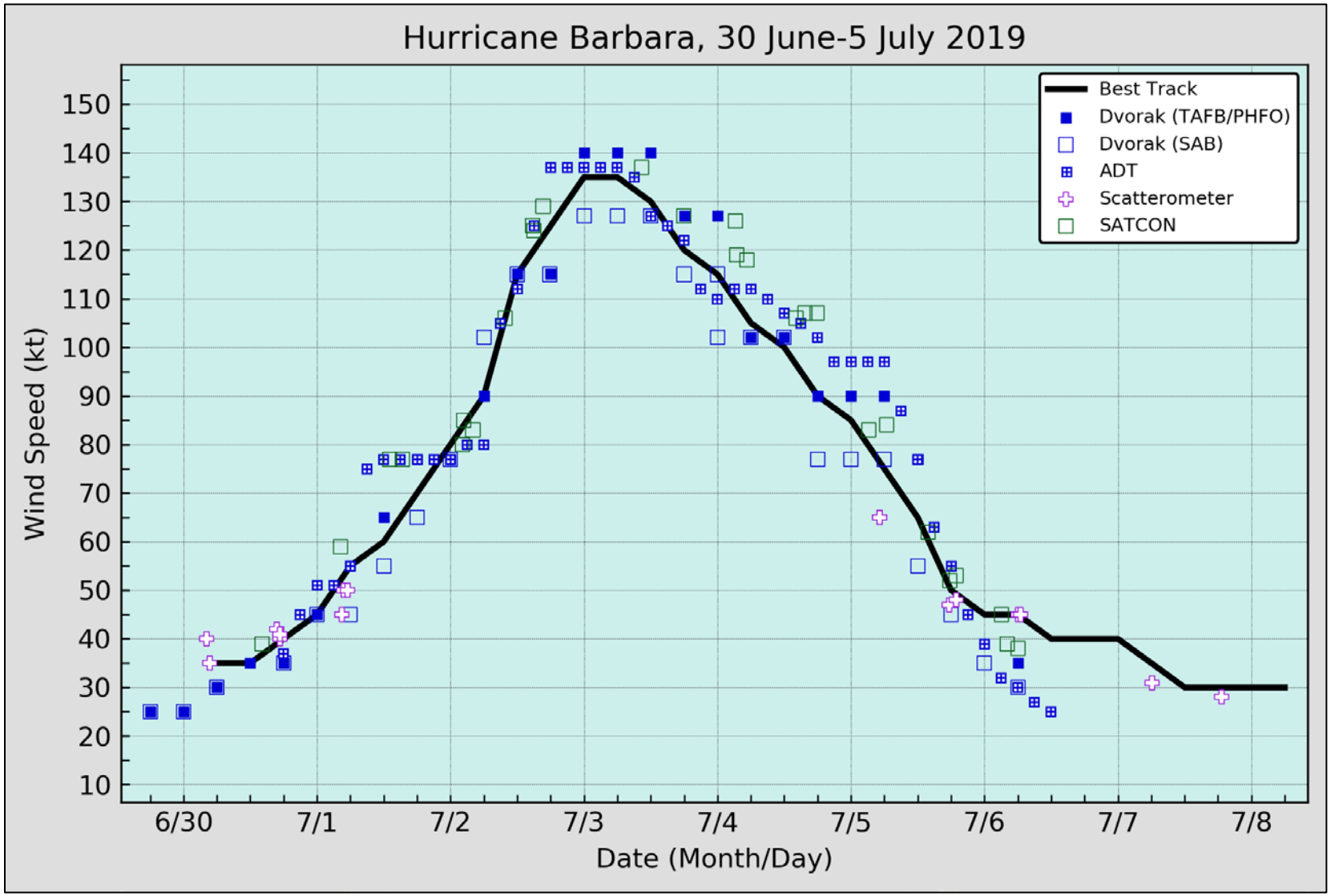

Figure 2. Selected wind observations and best track maximum sustained surface wind speed curve for Hurricane Barbara, 30 June–5 July 2019. Advanced Dvorak Technique estimates represent the Current Intensity at the nominal observation time. SATCON intensity estimates are from the Cooperative Institute for Meteorological Satellite Studies. Dashed vertical lines correspond to 0000 UTC.

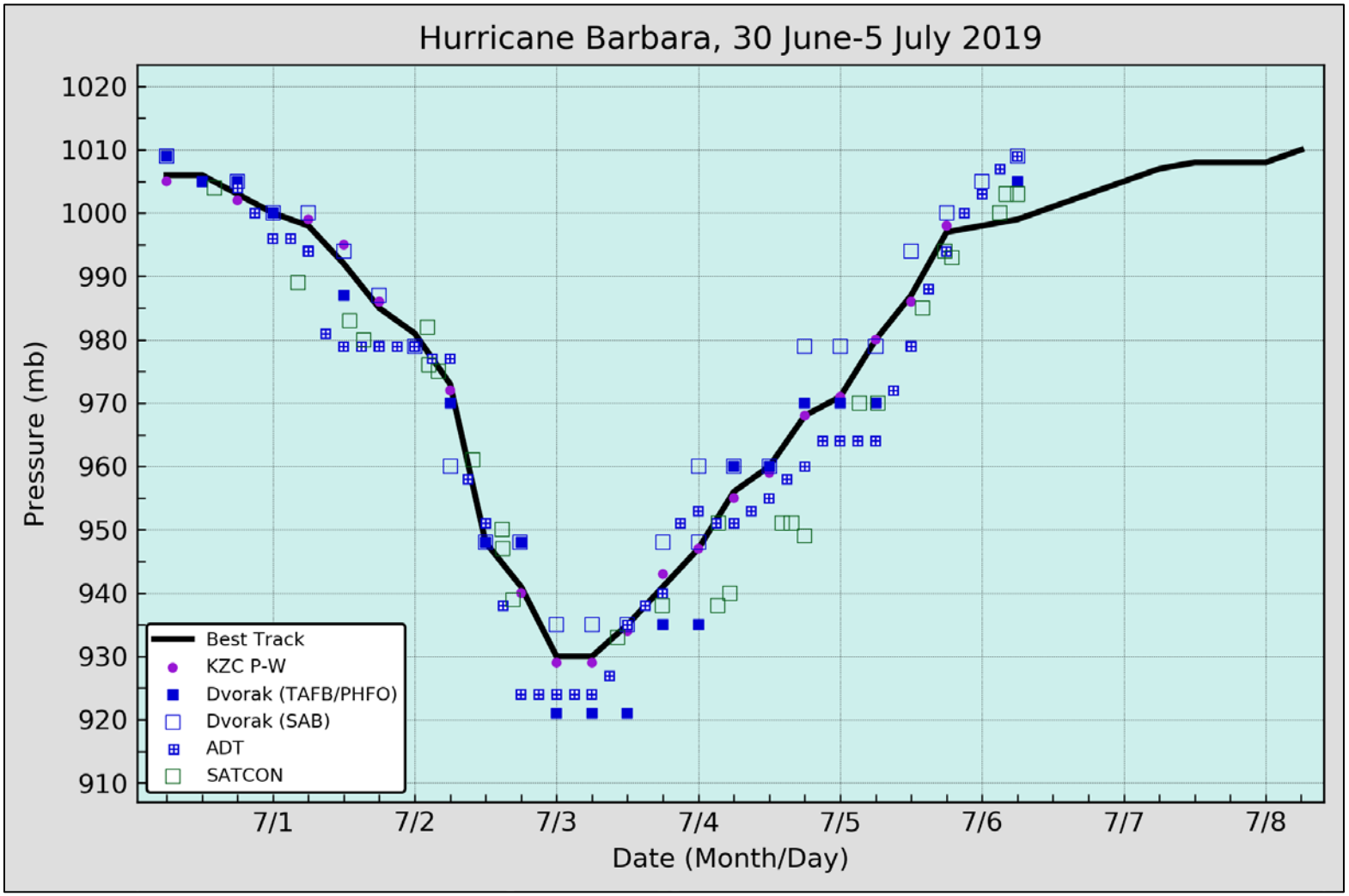

Figure 3. Selected pressure observations and best track minimum central pressure curve for Hurricane Barbara, 30 June–5 July 2019. Advanced Dvorak Technique estimates represent the Current Intensity at the nominal observation time. SATCON intensity estimates are from the Cooperative Institute for Meteorological 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.

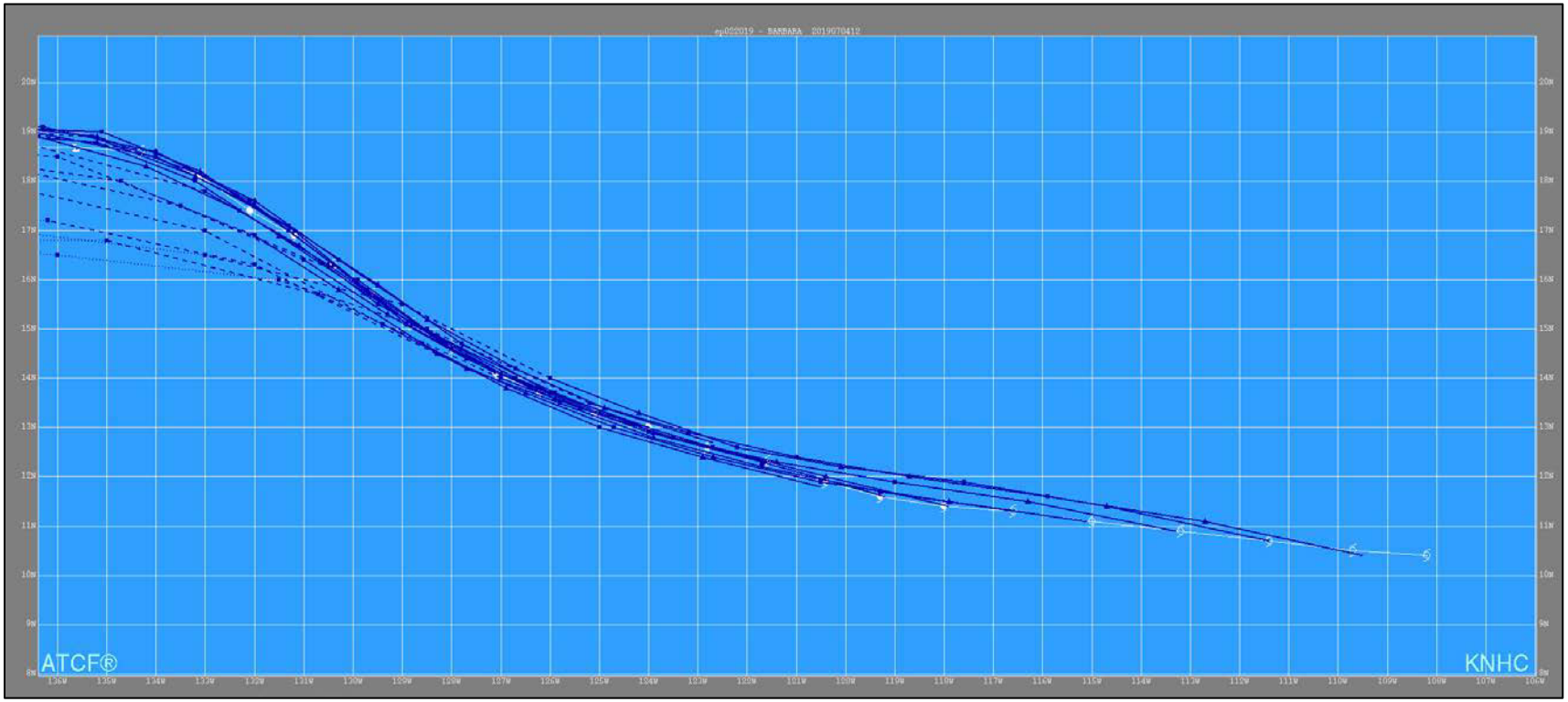

Figure 4. Selected official track forecasts (blue lines, with 0, 12, 24, 36, 48, 72, 96, and 120 h positions indicated) for Hurricane Barbara from 1200 UTC 30 June to 1200 UTC 4 July. The best track is given by the white line with positions shown at 6 h intervals.