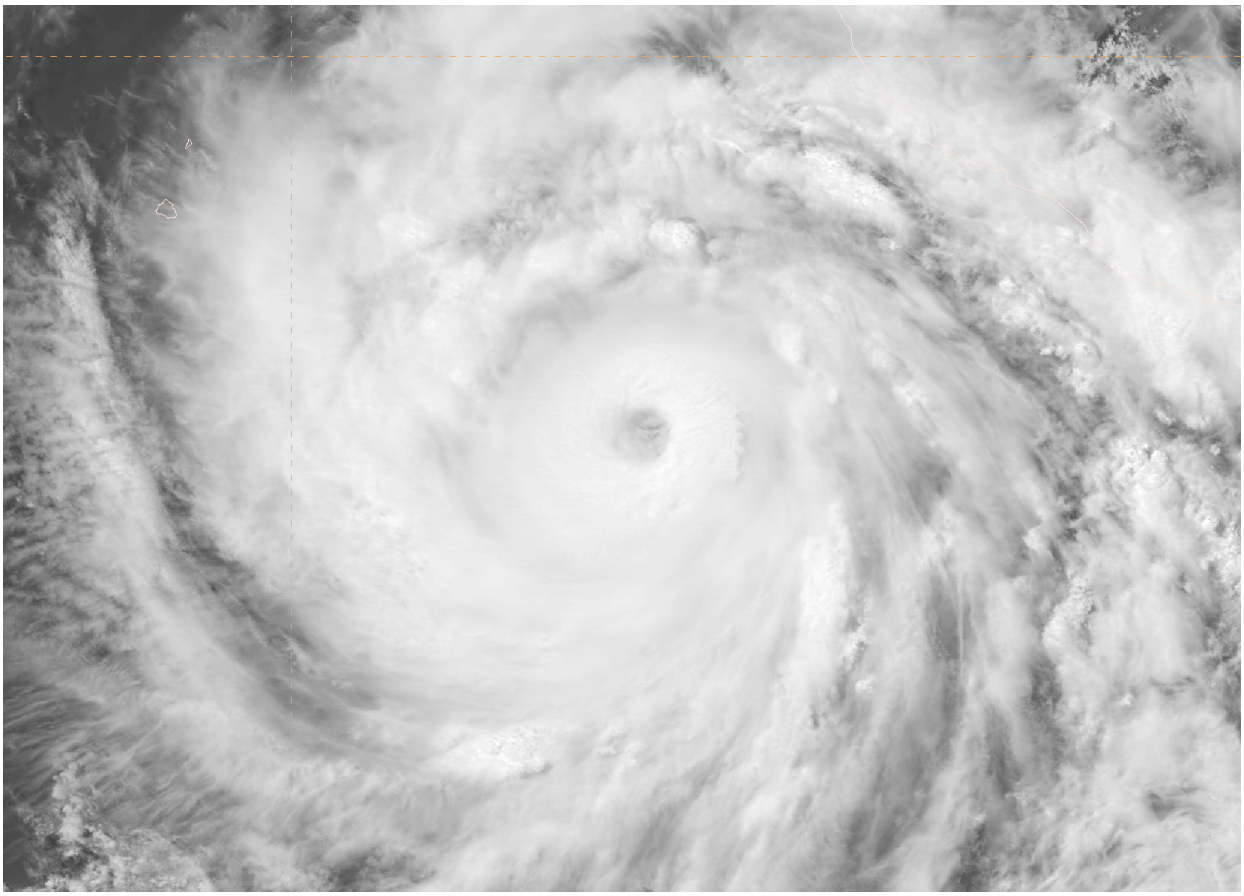
NATIONAL HURRICANE CENTER TROPICAL CYCLONE REPORT

HURRICANE BUD

(EP032018)

9–15 June 2018

Eric S. Blake
National Hurricane Center
24 October 2018



GOES-16 VISIBLE SATELLITE IMAGE OF HURRICANE BUD AT 2100 UTC 11 JUNE 2018.

Bud rapidly intensified into a category four (on the Saffir-Simpson Hurricane Wind Scale) hurricane over the eastern Pacific Ocean. However, it rapidly weakened before making landfall as a low-end tropical storm over Baja California Sur, then dissipated over the Gulf of California.

Hurricane Bud

9–15 JUNE 2018

SYNOPTIC HISTORY

The precursor to Bud was a tropical wave that emerged off the west coast of Africa on 29 May and moved quickly westward. The wave had little convection as it headed westward across the low-latitude Atlantic Ocean for the next several days. After moving over northern South America, the wave entered the far eastern North Pacific Ocean late on 6 June. Convection increased somewhat the next day, but the cloud pattern had little structure, with only a small amount of curvature noted on satellite images. On 8 June, thunderstorm activity notably increased a few hundred miles south-southwest of the Gulf of Tehuantepec, likely due to the passage of a convectively coupled Kelvin wave, and a broad low pressure area formed early the next day. Satellite and microwave data indicate that a well-defined low pressure area formed by 1800 UTC 9 June with ample deep convection, marking the formation of a tropical depression about 285 n mi south of Acapulco, Mexico. The depression became a tropical storm 6 h after genesis, moving to the northwest and west-northwest around a mid-level ridge over Mexico. The "best track" chart of Bud'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].

Bud began to rapidly intensify shortly after genesis in an environment of low shear, high mid-level moisture and very warm sea-surface temperatures (SSTs). Bud reached hurricane strength only 24 h after formation and became a major hurricane 18 h later. The hurricane reached a peak intensity of 120 kt around 0000 UTC 13 June, about 175 n mi southwest of Manzanillo, Mexico. Bud turned toward the north-northwest and began to rapidly weaken as it moved across cooler waters. The cyclone quickly dropped below hurricane strength on the morning of 13 June, but its intensity levelled off for the next few days while it moved over marginally warm SSTs. Although there was little change in the maximum winds, the structure of Bud changed during that time, with inner-core convection decreasing and convection only remaining in bands roughly 75–90 n mi from the large circulation center. Bud made landfall over Baja California Sur near San Jose del Cabo at 0200 UTC 15 June with an intensity of 40 kt and a central pressure of 999 mb. The cyclone moved across Baja California Sur for about 9 hours, then emerged over the Gulf of California. While the SSTs increased markedly, the storm's circulation had become disrupted by the terrain of the Baja California peninsula, and the vertical wind shear was higher. Consequently, deep convection faded, and Bud degenerated into a convection-free post-tropical cyclone by 1200 UTC 15 June, about 120 n mi south-southwest of Huatabampito, Mexico. The low continued to weaken and opened up into a trough a little over 12 h later, still offshore about 30 n mi southwest of Huatabampito.

[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.

METEOROLOGICAL STATISTICS

Observations in Bud (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), and the objective Advanced Dvorak Technique (ADT) estimates and Satellite Consensus (SATCON) estimates from CIMSS at the University of Wisconsin. 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 Bud.

The estimated peak intensity of 120 kt at 0000 UTC 12 June is based on a blend of lower TAFB/SAB subjective Dvorak estimates and higher ADT/SATCON estimates from UW-CIMSS.

The estimated landfall intensity of Bud is 40 kt, but this is fairly uncertain. In downtown Cabo San Lucas, an automated weather observation (SEMAR Capitania de Puerto) recorded sustained winds of 51 kt with a gust to 67 kt on 14 June. However, it is unknown what the height of the anemometer was, as these winds were significantly higher than another nearby station downtown, which only recorded sustained winds of 34 kt. Since the satellite-based estimates were also 35 kt or less, the operational landfall intensity of 40 kt is retained. The minimum pressure recorded was 1000.7 mb with 10 kt of wind at San Jose del Cabo Airport, which is the basis for the 999 mb estimate. This value also is uncertain, because observations were only available at most every 3 hours from that station.

No rainfall amounts are available from Mexico.

CASUALTY AND DAMAGE STATISTICS

No damage or deaths occurred in association with Bud. Only minor impacts were noted in Baja California Sur and northwestern Mexico, generally due to locally heavy rain and flooding.

FORECAST AND WARNING CRITIQUE

The genesis forecasts for Bud (Table 2) had longer lead times than average. The system was introduced into the Tropical Weather Outlook (TWO) 120 h before genesis occurred with a low (< 40% chance) of genesis within 5 days, and reached the high (>60%) category 78 h before genesis occurred. For the 2-day genesis predictions, the system was given a medium (40–60% chance) 54 h before it formed, and was given a high probability 36 h before formation. Bud formed from a relatively large system and almost all the model guidance, and the NHC forecast, had a good prediction for the genesis of this system.

A verification of NHC official track forecasts for Bud is given in Table 3a. Official forecast track errors were lower than the mean official errors for the previous 5-yr period at all time periods.

A homogeneous comparison of the official track errors with selected guidance models is given in Table 3b. The official forecast (OFCL) beat the bulk of the model guidance, with the dynamical track model consensus aids (TVCN, TVCE and TVCX) occasionally slightly outperforming the NHC forecast. Among the other aids, the GFS-ensemble mean (AEMI) did well for Bud, while the HWRF had a poorer performance than average for this cyclone.

A verification of NHC official intensity forecasts for Bud is given in Table 4a. Official forecast intensity errors were generally above the mean official errors for the previous 5-yr period through 48 h, then close to or below the 5-yr average thereafter. Bud's rapid intensification and subsequent weakening on 10–12 June were not well forecast, featuring the typical model and NHC biases of not forecasting a rapid enough strengthening and then keeping the intensity too high for too long after peak intensity (Figs. 4,5). A homogeneous comparison of the official intensity errors with selected guidance models is given in Table 4b. The NHC intensity forecast had a high bias at long range, leading to much of the guidance besting the official forecast at that time frame. The corrected-consensus models for intensity (HCCA and FSSE) were the best overall performers, while the SHIPS (DSHP) model had particularly high errors for this hurricane.

A summary of land-based watches and warnings issued for Bud are in Table 5.

Table 1. Best track for Hurricane Bud, 9–15 June 2018.

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
09 / 1800	12.1	100.5	1006	30	tropical depression
10 / 0000	12.7	101.3	1003	35	tropical storm
10 / 0600	13.5	102.1	1000	45	"
10 / 1200	14.4	102.9	996	55	"
10 / 1800	15.1	103.8	990	65	hurricane
11 / 0000	15.7	104.6	981	75	"
11 / 0600	16.1	105.6	970	90	"
11 / 1200	16.4	106.4	960	100	"
11 / 1800	16.8	106.9	952	110	"
12 / 0000	17.3	107.4	943	120	"
12 / 0600	17.7	107.8	947	115	"
12 / 1200	18.0	108.1	951	110	"
12 / 1800	18.3	108.3	960	100	"
13 / 0000	18.6	108.5	970	85	"
13 / 0600	18.9	108.6	983	70	"
13 / 1200	19.2	108.7	990	60	tropical storm
13 / 1800	19.7	108.9	995	45	"
14 / 0000	20.3	109.1	998	45	"
14 / 0600	20.8	109.3	999	40	"
14 / 1200	21.3	109.5	999	40	"
14 / 1800	21.9	109.6	999	40	"
15 / 0000	22.7	109.7	999	40	"
15 / 0200	23.0	109.7	999	40	"
15 / 0600	23.8	109.9	1001	35	"
15 / 1200	24.7	110.1	1002	35	low
15 / 1800	25.5	110.2	1002	35	"

16 / 0000	26.4	110.1	1002	30	"
16 / 0600					dissipated
12 / 0000	17.3	107.4	943	120	minimum pressure and maximum winds
15 / 0200	23.0	109.7	999	40	landfall near San Jose del Cabo, Mexico

Table 2. Number of hours in advance of the formation of Bud 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%)	54	102
High (>60%)	36	78

Table 3a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) track forecast errors (n mi) for Bud. 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	**19.4**	**24.1**	**26.8**	**30.3**	**37.5**	**56.1**	**106.7**
OCD5	39	71.1	112.8	156	265.4	341.1	494.9
Forecasts	21	19	17	15	11	7	3
OFCL (2013-17)	21.8	33.2	43.0	53.9	80.7	111.1	150.5
OCD5 (2013-17)	34.9	70.7	109.1	146.1	213.8	269.0	339.7

Table 3b. Homogeneous comparison of selected track forecast guidance models (in n mi) for Bud. 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	18.0	22.3	25.8	29.9	35.6	52.2	98.8
OCD5	36.2	68.5	111.3	157.1	269.5	338.8	483.2
GFSI	20.8	30.0	35.2	41.0	41.6	78.3	116.0
HMNI	26.4	36.6	47.7	56.9	77.5	97.5	198.7
HWFI	20.0	31.7	48.7	67.1	100.5	147.2	191.5
EMXI	21.4	26.3	29.2	40.4	65.4	107.9	135.2
CMCI	27.4	39.2	53.6	71.2	79.5	121.5	212.7
NVGI	28.2	41.2	50.9	51.7	94.4	174.6	151.9
AEMI	19.2	24.9	30.9	38.3	48.1	63.9	112.1
HCCA	18.0	**19.5**	**22.3**	**28.8**	37.0	**51.8**	**79.8**
FSSE	19.8	24.7	31.2	41.4	61.3	93.1	117.7
TVCN	**17.3**	**21.5**	26.1	30.5	36.7	**49.7**	**70.6**
TVCE	18.4	**22.1**	27.1	33.1	41.8	**52.0**	**72.1**
TVCX	18.3	**20.6**	**24.1**	31.7	39.6	57.8	**80.5**
GFEX	20.1	24.9	28.3	36.6	48.1	83.4	106.2
TABD	26.9	47.4	68.1	73.3	47.4	129.2	125.6
TABM	26.3	55.0	77.8	82.3	66.7	122.5	117.4
TABS	30.1	52.7	71.5	80.6	70.2	108.8	137.2
Forecasts	19	18	16	14	10	6	2

Table 4a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) intensity forecast errors (kt) for Bud. 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	6.4	13.2	16.8	16.0	**13.6**	16.4	**10.0**
OCD5	8.9	17.6	25.5	27.0	17.9	8.3	11.0
Forecasts	21	19	17	15	11	7	3
OFCL (2013-17)	5.8	9.6	11.8	13.2	15.1	15.1	14.6
OCD5 (2013-17)	7.6	12.4	15.6	17.7	19.8	20.8	19.6

Table 4b. Homogeneous comparison of selected intensity forecast guidance models (in kt) for Bud. 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	6.8	13.1	16.2	15.0	14.0	13.3	7.5
OCD5	9.4	17.4	24.8	25.2	15.3	**8.5**	11.0
GFSI	11.5	18.8	24.8	25.6	20.7	13.7	**4.0**
HMNI	8.9	15.5	19.1	17.9	**8.6**	**8.5**	**4.5**
HWFI	11.4	19.1	22.2	20.3	**12.3**	**3.8**	**1.5**
EMXI	15.3	24.9	29.5	29.9	17.7	**3.2**	**4.5**
HCCA	**6.7**	**12.3**	**14.8**	**14.9**	**8.8**	**9.0**	**7.0**
FSSE	7.1	**12.7**	**14.6**	**11.2**	**9.2**	**12.3**	**5.5**
IVCN	8.6	15.6	18.9	18.7	**10.8**	**10.3**	8.0
DSHP	8.9	16.8	22.3	22.8	22.0	21.3	18.0
LGEM	7.8	15.1	20.1	18.4	**11.8**	13.3	9.0
Forecasts	19	18	16	14	10	6	2

Table 5. Watch and warning summary for Hurricane Bud, 9–15 June 2018.

Date/Time (UTC)	Action	Location
10 / 2100	Tropical Storm Watch issued	Manzanillo to Cabo Corrientes, Mexico
11 / 2100	Tropical Storm Watch discontinued	All
13 / 0300	Tropical Storm Watch issued	Santa Fe to La Paz
13 / 1500	Tropical Storm Watch changed to Tropical Storm Warning	Santa Fe to La Paz
14 / 2100	Tropical Storm Watch issued	La Paz to San Evaristo
14 / 2100	Tropical Storm Watch issued	Altata to Huatabampito
15 / 0900	Tropical Storm Watch discontinued	La Paz to San Evaristo
15 / 0900	Tropical Storm Warning discontinued	All
15 / 1500	Tropical Storm Watch discontinued	All

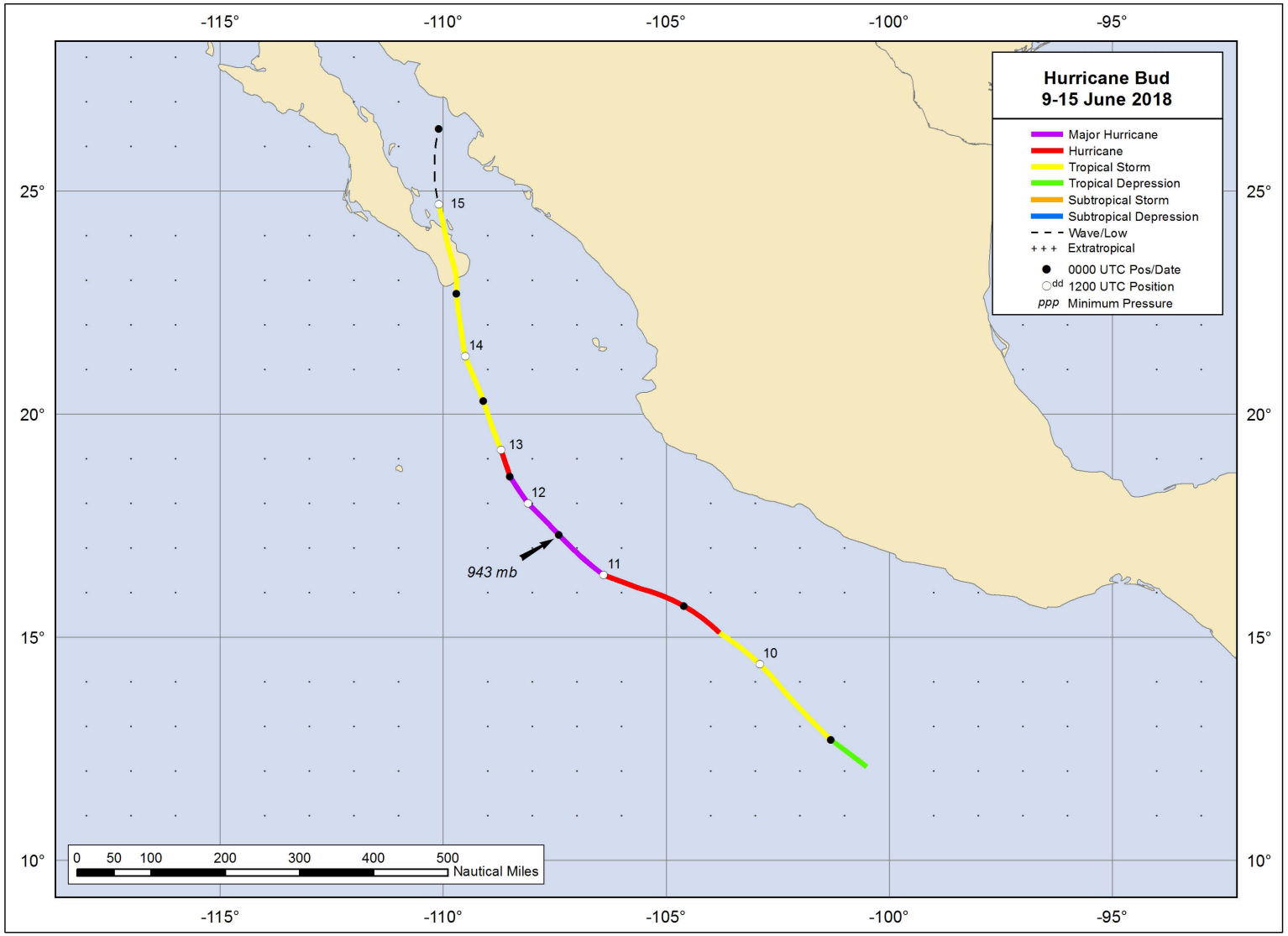


Figure 1. Best track positions for Hurricane Bud, 9–15 June 2018.

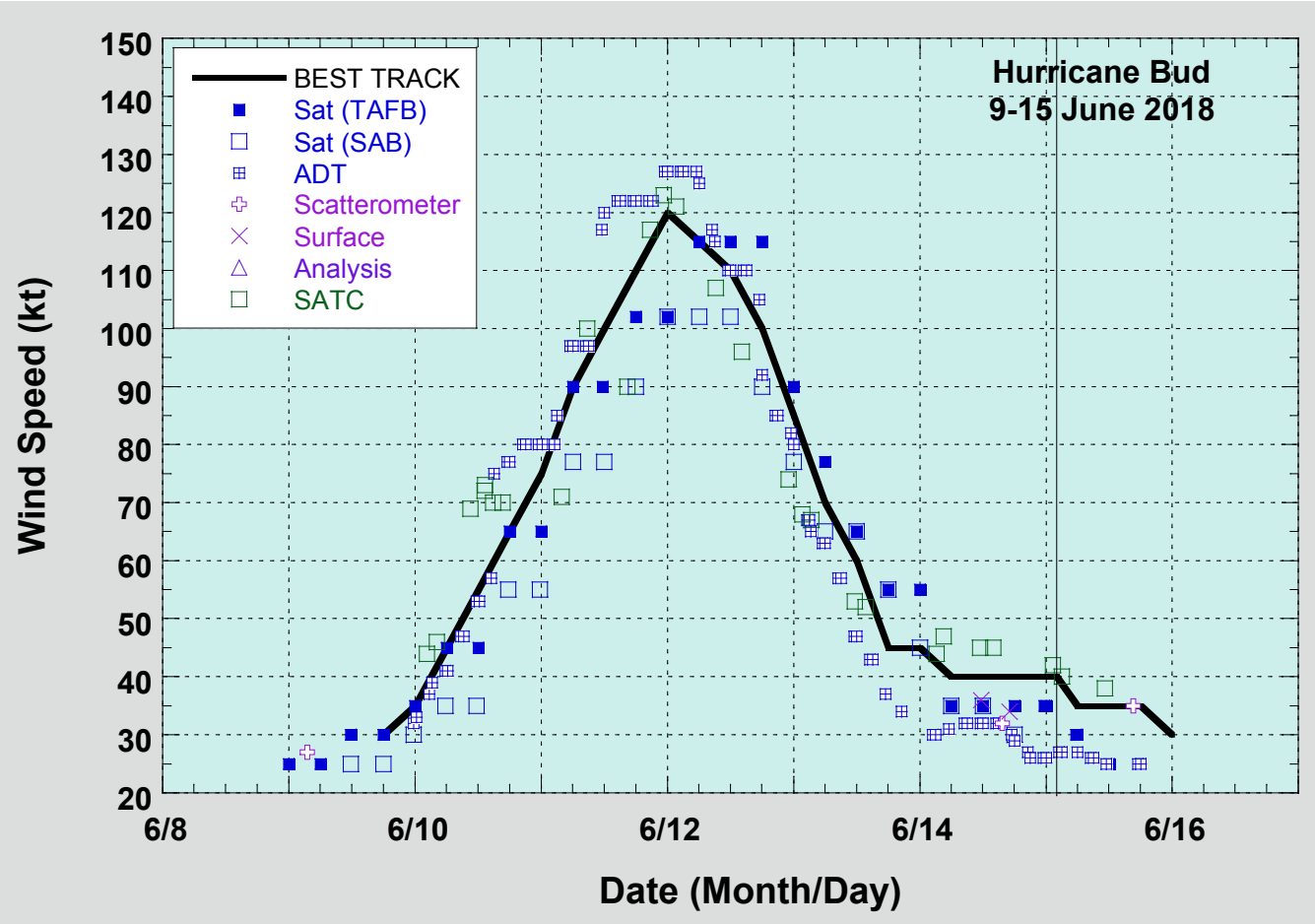


Figure 2. Selected wind observations and best track maximum sustained surface wind speed curve for Bud. Advanced Dvorak Technique estimates represent the Current Intensity at the nominal observation time. SATC intensity estimates are the satellite consensus estimates from the Cooperative Institute for Meteorological Satellite Studies. Dashed vertical lines correspond to 0000 UTC, and the solid vertical line refers to landfall.

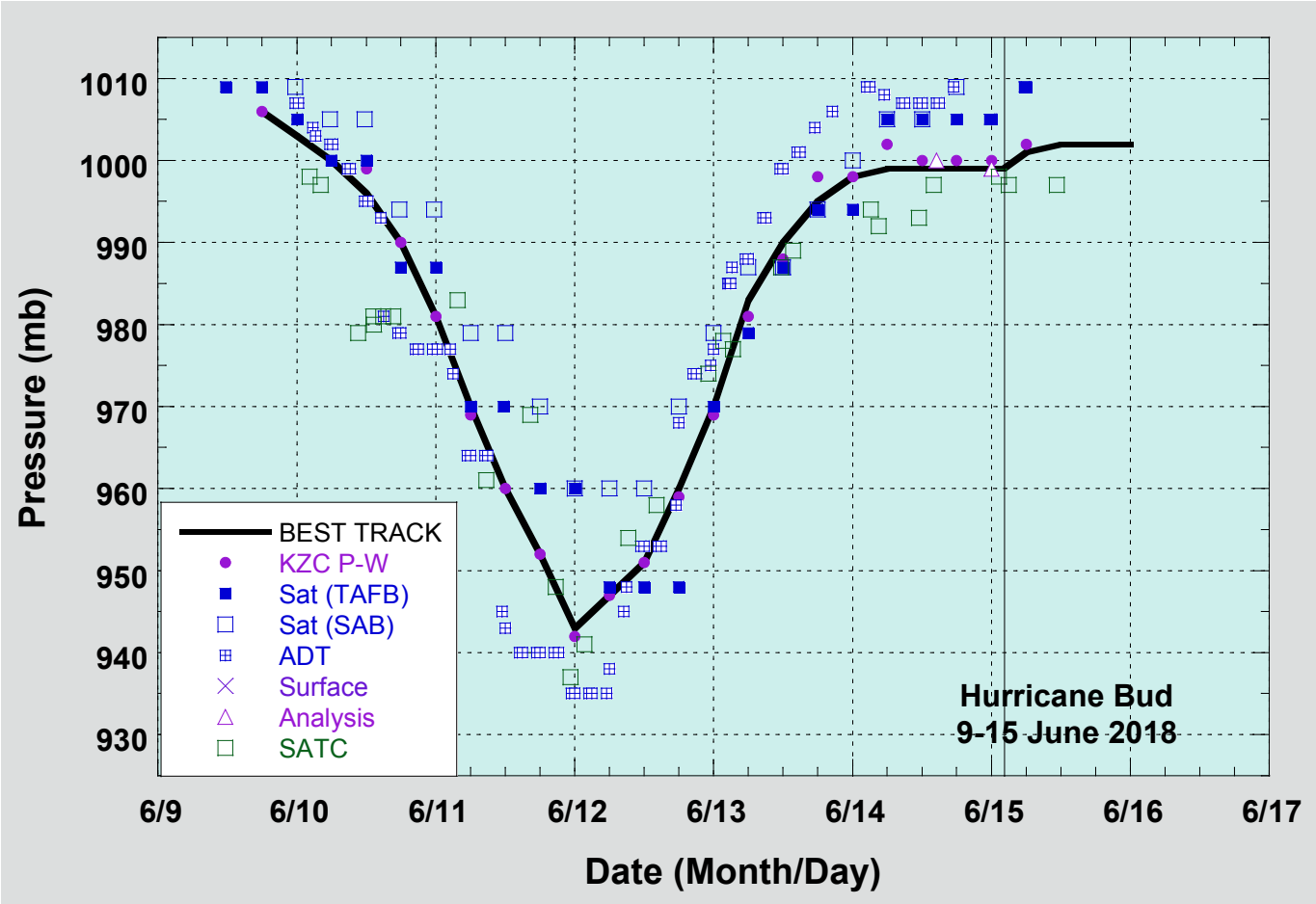


Figure 3. Selected pressure observations and best track minimum central pressure curve for Bud. Advanced Dvorak Technique estimates represent the pressure from the Current Intensity at the nominal observation time. SATC pressures estimates are the satellite consensus estimates from the Cooperative Institute 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, and the solid vertical line refers to landfall.

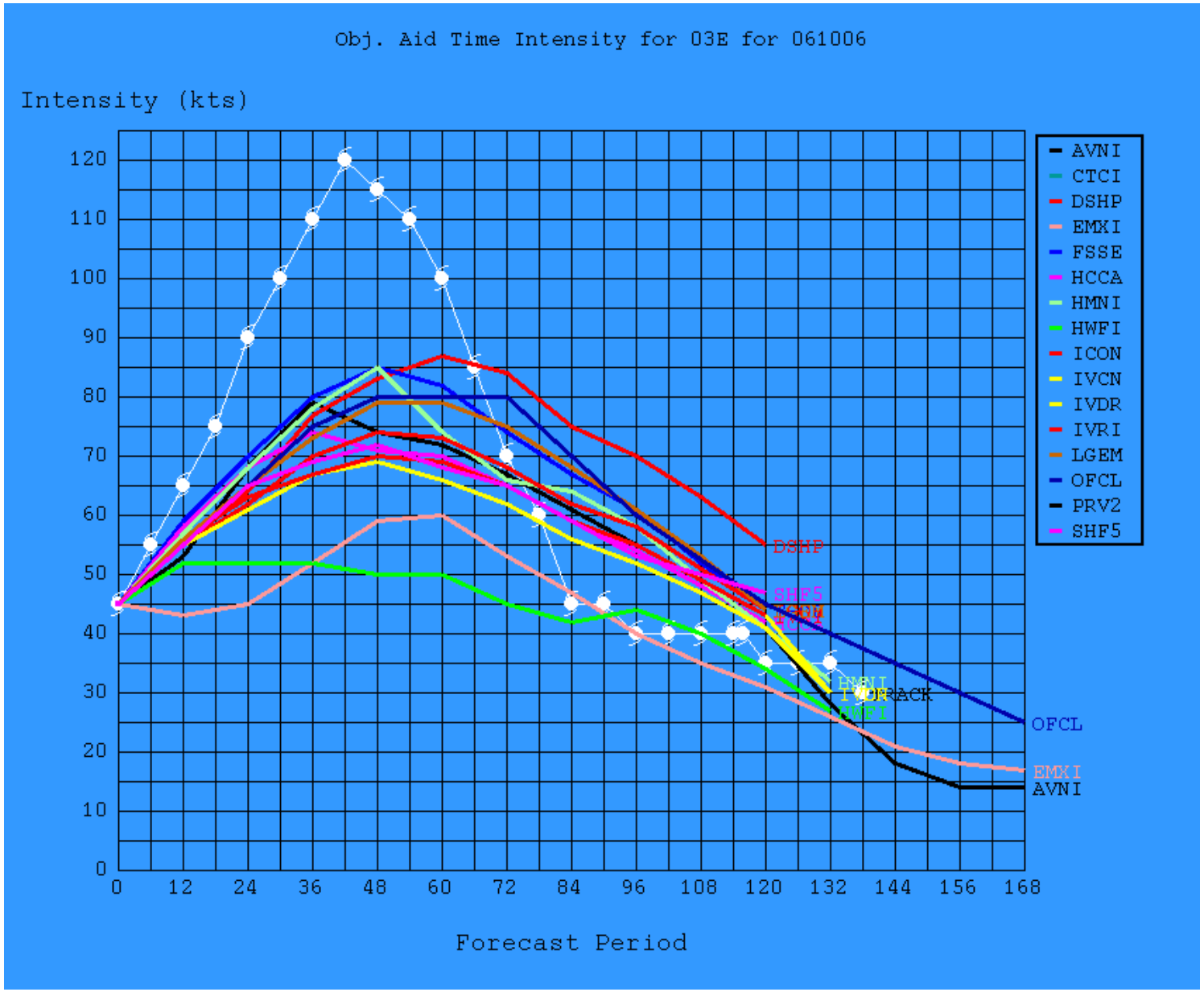


Figure 4. NHC intensity aids (kt, colored lines) for the 0600 UTC 10 June 2018 Bud forecast package (verifying intensity in white).

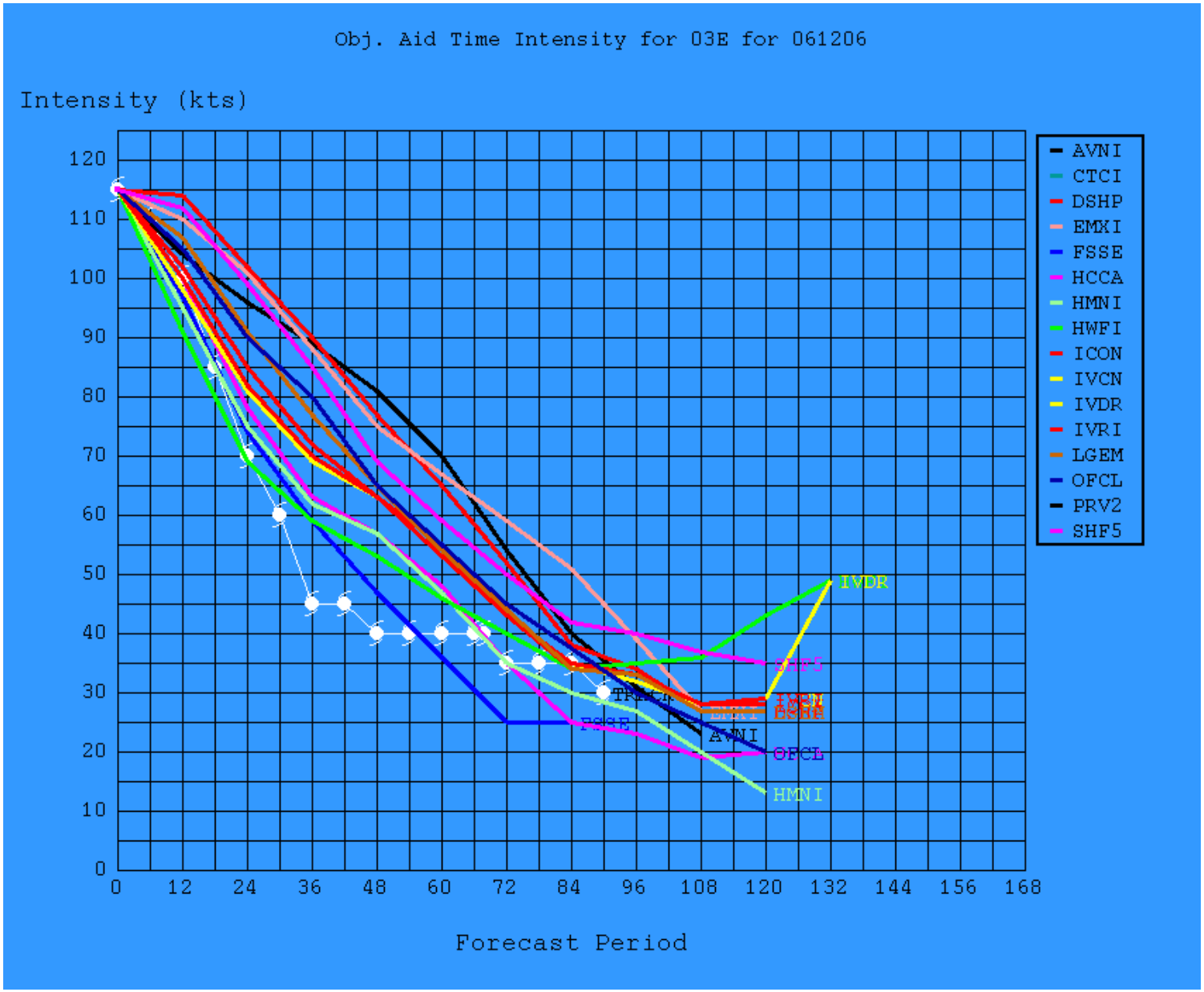


Figure 5. NHC intensity aids (kt, colored lines) for the 0600 UTC 12 June 2018 Bud forecast package (verifying intensity in white).