NATIONAL HURRICANE CENTER
TROPICAL CYCLONE REPORT

TROPICAL STORM IVETTE

(EP102016)

3-8 August 2016

John L. Beven II, Christopher W. Landsea
National Hurricane Center
Jon Jelsema
Central Pacific Hurricane Center
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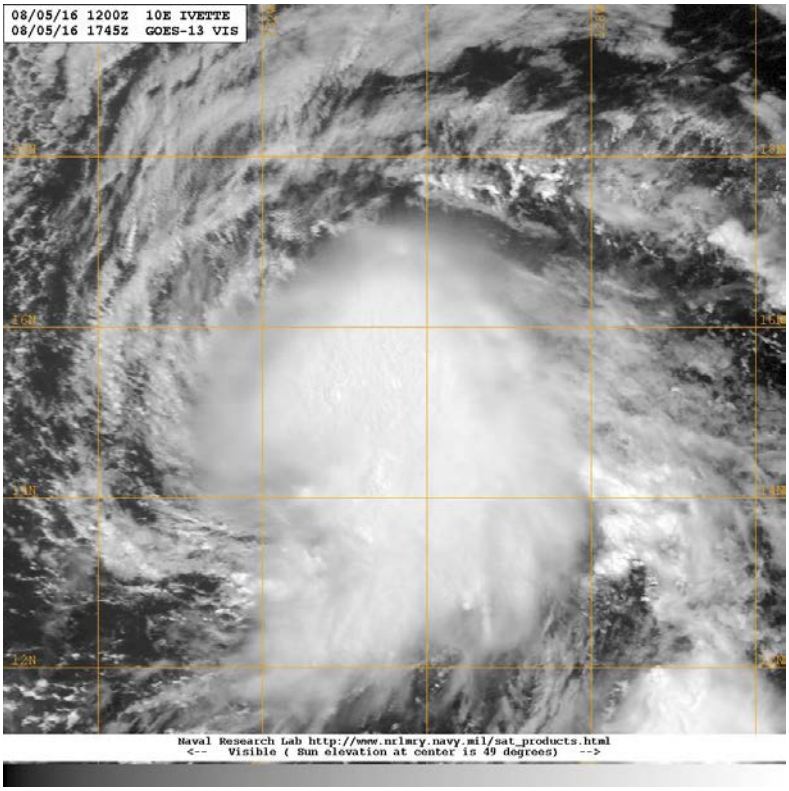

VISIBLE SATELLITE IMAGE FROM 1745 UTC 5 AUGUST OF TROPICAL STORM IVETTE NEAR THE TIME OF PEAK INTENSITY. IMAGE COURTESY OF THE NAVAL RESEARCH LABORATORY.

Ivette was a small tropical storm that remained over the eastern and central North Pacific without affecting land.

[1] Original report date 21 November 2016. Updated 18 January 2017 to include analyses from CPHC.

Tropical Storm Ivette

3-8 AUGUST 2016

SYNOPTIC HISTORY

A tropical wave exited the coast of western Africa on 21 July and moved across the Atlantic Ocean and the Caribbean Sea with little associated convection. The wave reached the eastern North Pacific on 28 July and deep convection slowly began increasing in association with the wave over the next few days. Around 1 August, an eastward-moving convectively coupled Kelvin wave approached the tropical wave, causing the shower and thunderstorm activity to further increase, and a broad area of low pressure formed a couple of hundred miles south of the southern tip of Baja California Sur, Mexico. While the convective structure was sufficiently organized on 2 August for the low to be considered a tropical cyclone, scatterometer observations indicated that the system had not yet developed a closed circulation, possibly because the system's forward speed of 18 kt made obtaining an earth-relative closed circulation difficult. Around 0000 UTC 3 August, the system developed a well-defined center of circulation and it became a tropical depression while located about 650 n mi southwest of the southern tip of Baja California Sur, and 6 h later the system intensified into a tropical storm. The "best track" chart of Ivette'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[2].

For the next five days, Ivette was steered westward to west-northwestward by a large subtropical ridge to its north at a gradually decreasing forward speed. Though warm waters and moist, unstable atmospheric conditions were conducive for intensification, moderate northerly vertical shear limited Ivette to a very slow intensification through late on 5 August. The tropical storm reached its estimated peak intensity of 50 kt around 1800 UTC 5 August, while located about 1,280 n mi west-southwest of the southern tip of Baja California Sur. On 6 and 7 August, the combination of increasing southwesterly vertical shear and a drier, more stable atmosphere caused a gradual weakening. By 0600 UTC 8 August, as Ivette reached the central Pacific basin, the system diminished to a tropical depression while located about 860 n mi east of Hilo, Hawaii.

Ivette was entering an increasingly hostile environment while moving into the central Pacific basin, with strong southwesterly vertical wind shear and very dry air aloft inhibiting any chance for re-strengthening of the system. As a result, Ivette held on to tropical characteristics for just a short time after crossing into the central Pacific, and weakened into a post-tropical remnant low by 1800 UTC 8 August. The remnant low continued to move to the west-southwest over the next several days before dissipating around 375 miles south of Hilo, Hawaii by 0600 UTC 11 August.

[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.

METEOROLOGICAL STATISTICS

Observations in Ivette (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 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 Ivette.

The estimated 50-kt peak intensity of Ivette at 1800 UTC 5 August (front cover figure) is based on a blend of subjective and objective Dvorak classifications.

Ivette remained very small throughout its entire life cycle, its tropical-storm-force winds extending at most 120 n mi in diameter.

No ships observed tropical-storm-force winds in association with Ivette.

CASUALTY AND DAMAGE STATISTICS

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

FORECAST AND WARNING CRITIQUE

The genesis of Ivette was reasonably well forecast. Table 2 provides the number of hours in advance of formation associated with the first NHC Tropical Weather Outlook (TWO) forecast in each likelihood category. The system that became Ivette was first included in the five-day TWO 102 h in advance of genesis, while its initial inclusion into the two-day TWO was 42 h before formation. The High category was indicated in the five-day TWO 42 h before genesis, but only reached High in the two-day TWO 12 h before formation.

A verification of NHC official track forecasts for Ivette is given in Table 3a. Official forecast track (OFCL) errors were lower than the mean official errors for the previous 5-yr period at all time periods. The climatology-persistence model (OCD5) displayed lower errors that its previous 5-yr history, suggesting that Ivette's movement was easier to predict than usual due to its relatively straight-moving, climatological track. A homogeneous comparison of the official track errors with selected guidance models is given in Table 3b. Out through three days, official track forecasts outperformed all of the individual track models and nearly all of the consensus techniques. NHC official forecasts were bested slightly by the Florida State Superensemble model (FSSE) at 72 h

and by the ensemble mean of the Global Forecast System (AEMI) at 36 h. Beyond three days, the number of forecasts is too low for a meaningful comparison.

A verification of NHC official intensity forecasts for Ivette is given in Table 4a. Official forecast intensity errors were smaller than the mean official errors for the previous 5-yr period for the 12 to 36 h forecasts and larger at 48 h and beyond. The worse-than-usual official intensity forecasts at 48 to 120 h occurred despite the climatology and persistence model (OCD5) having smaller errors than usual. A homogeneous comparison of the official intensity errors with selected guidance models is given in Table 4b. Unlike the official track predictions, the official intensity forecasts were bested by nearly all models at all forecast periods. Early in the lifecycle of Ivette, the official intensity forecasts tended to be closest to the highest available guidance, in part because of the low bias that most guidance had previously shown in the eastern North Pacific during 2016. Figure 4 shows the intensity predictions provided by the guidance that makes up the variable consensus technique (IVCN), as well as for the official forecasts. Readily apparent is the substantial high bias that existed for OFCL and all of the standard models, as they all called for Ivette to reach hurricane intensity for at least three forecast cycles. Of the individual models, the Logistic Growth Equation model (LGEM) displayed the smallest high bias, while the Hurricane Weather Research Forecast model (HWFI) had the largest high bias. It is possible that the small size of Ivette made it more susceptible to the moderate amount of vertical shear that occurred (DeMaria 1996).

Due to the very short period that Ivette was a tropical cyclone in the central Pacific basin, track and intensity verifications are not available for forecasts issued by the CPHC.

There were no coastal watches and warnings issued in association with Ivette.

Reference

DeMaria, M., 1996: The effect of vertical shear on tropical cyclone intensity change. *J. Atmos. Sci.*, **53**, 2076-2088.

Table 1. Best track for Tropical Storm Ivette, 3-8 August 2016.

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
3 / 0000	13.8	116.7	1007	30	tropical depression
3 / 0600	14.0	118.3	1006	35	tropical storm
3 / 1200	14.2	119.8	1005	40	"
3 / 1800	14.4	121.4	1004	40	"
4 / 0000	14.6	122.8	1004	40	"
4 / 0600	14.7	124.1	1004	40	"
4 / 1200	14.8	125.5	1003	40	"
4 / 1800	14.8	126.7	1002	45	"
5 / 0000	14.8	128.0	1002	45	"
5 / 0600	14.9	129.2	1002	45	"
5 / 1200	15.1	130.3	1001	45	"
5 / 1800	15.3	131.2	1000	50	"
6 / 0000	15.4	132.1	1000	50	"
6 / 0600	15.6	133.1	1002	45	"
6 / 1200	15.8	134.0	1003	45	"
6 / 1800	16.1	134.9	1003	45	"
7 / 0000	16.4	135.9	1004	40	"
7 / 0600	16.7	136.8	1005	40	"
7 / 1200	17.0	137.7	1006	35	"
7 / 1800	17.2	138.5	1006	35	"
8 / 0000	17.2	139.4	1006	35	"
8 / 0600	17.1	140.1	1007	30	tropical depression
8 / 1200	17.1	140.7	1009	30	"
8 / 1800	17.1	141.3	1010	25	low
9 / 0000	17.1	142.2	1010	25	"
9 / 0600	17.0	143.2	1010	25	"
9 / 1200	16.9	144.4	1010	25	"
9 / 1800	16.7	145.6	1010	25	"
10 / 0000	16.4	146.8	1010	25	"
10 / 0600	16.0	148.3	1011	25	"

10 / 1200	15.6	150.0	1011	25	“
10 / 1800	15.2	151.7	1011	25	“
11 / 0000	14.8	153.4	1011	25	“
11 / 0600					dissipated
5 / 1800	15.3	131.2	1000	50	maximum winds and 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%)	42	102
Medium (40%-60%)	30	60
High (>60%)	12	42

Table 3a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) track forecast errors (n mi) for Tropical Storm Ivette, 3-8 August 2016. 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	**16**	**26**	**34**	**43**	**65**	**89**	**137**
OCD5	24	42	56	74	115	141	194
Forecasts	21	19	17	15	11	7	3
OFCL (2011-15)	23.4	36.4	47.2	59.4	89.0	123.6	159.5
OCD5 (2011-15)	36.6	74.2	116.5	159.7	245.6	331.1	427.4

Table 3b. Homogeneous comparison of selected track forecast guidance models (in n mi) for Tropical Storm Ivette, 3-8 August 2016. 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	17	26	32	37	57	78	121
OCD5	24	43	56	72	110	139	196
GFSI	22	34	41	48	81	91	199
GHMI	23	36	49	57	76	109	262
HWFI	26	39	50	52	67	106	**120**
EGRI	21	32	42	50	68	**75**	187
EMXI	21	34	42	45	63	97	**120**
NVGI	29	48	60	70	84	81	146
GFNI	19	41	66	92	149	229	270
CMCI	21	30	38	54	88	149	386
CTCI	26	39	51	64	84	96	149
TCON	20	28	37	39	61	**74**	126
TVCE	19	29	36	41	58	**70**	127
FSSE	18	27	33	38	**56**	**65**	128
AEMI	20	26	**29**	37	61	**76**	144
BAMS	36	61	79	94	126	198	233
BAMM	27	46	67	86	122	157	254
BAMD	46	81	110	139	228	310	478
Forecasts	18	16	14	12	9	5	1

Table 4a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) intensity forecast errors (kt) for Tropical Storm Ivette, 3-8 August 2016. 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	**3.8**	**6.3**	**11.2**	16.3	25.9	32.9	35.0
OCD5	4.5	4.9	7.8	8.9	14.6	16.4	17.3
Forecasts	21	19	17	15	11	7	3
OFCL (2011-15)	5.9	9.8	12.5	14.0	15.5	16.3	14.9
OCD5 (2011-15)	7.7	12.8	16.4	18.8	21.1	20.9	19.7

Table 4b. Homogeneous comparison of selected intensity forecast guidance models (in kt) for Tropical Storm Ivette, 3-8 August 2016. 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	3.6	5.9	10.7	16.7	24.4	31.0	35.0
OCD5	4.3	**4.7**	**7.4**	**9.2**	**17.0**	**19.2**	**19.0**
HWFI	4.2	6.7	**7.9**	**12.7**	**22.8**	**29.6**	**10.0**
GHMI	**2.9**	**4.8**	**10.1**	**12.5**	**20.0**	**22.4**	**30.0**
DSHP	**3.1**	**4.8**	**8.7**	**12.1**	**19.3**	**25.6**	**28.0**
LGEM	**3.2**	**3.1**	**5.6**	**5.3**	**9.8**	**14.6**	**18.0**
CTCI	5.3	8.2	**10.3**	**12.7**	**17.4**	**18.2**	**6.0**
ICON	**3.1**	**4.4**	**6.6**	**10.2**	**18.2**	**23.4**	**22.0**
IVCN	**3.3**	**5.1**	**7.4**	**10.7**	**18.0**	**22.4**	**19.0**
GFNI	**3.5**	5.9	**10.6**	**13.7**	**20.3**	**30.8**	35.0
GFSI	**3.5**	7.0	11.1	**15.7**	**24.3**	31.6	**30.0**
EMXI	**2.8**	**5.4**	**7.5**	**11.5**	**17.0**	**17.8**	**30.0**
FSSE	3.9	9.4	14.4	19.6	27.0	**30.2**	**26.0**
Forecasts	18	16	14	12	9	5	1

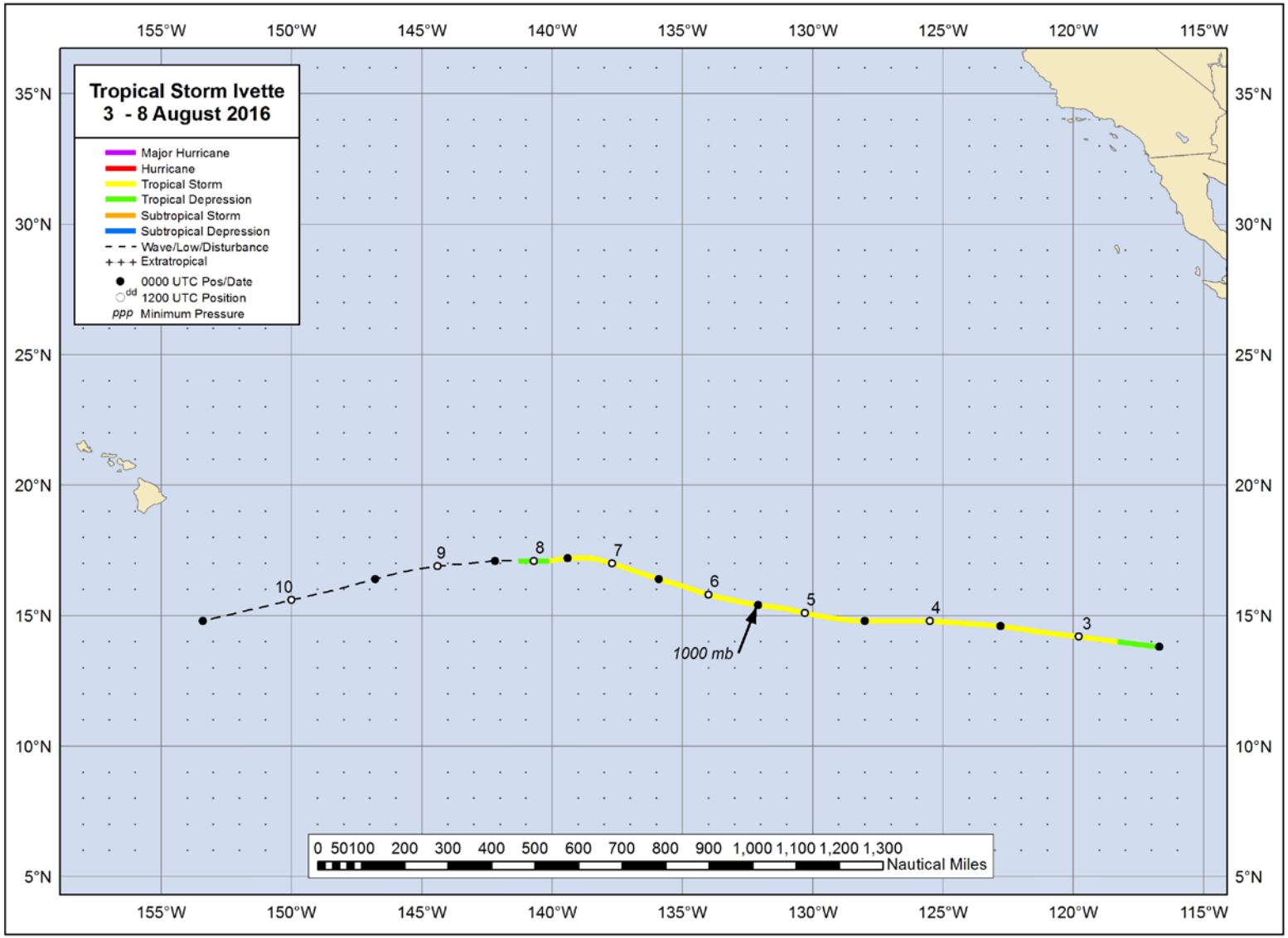

Figure 1. Best track positions for Tropical Storm Ivette, 3-8 August 2016.

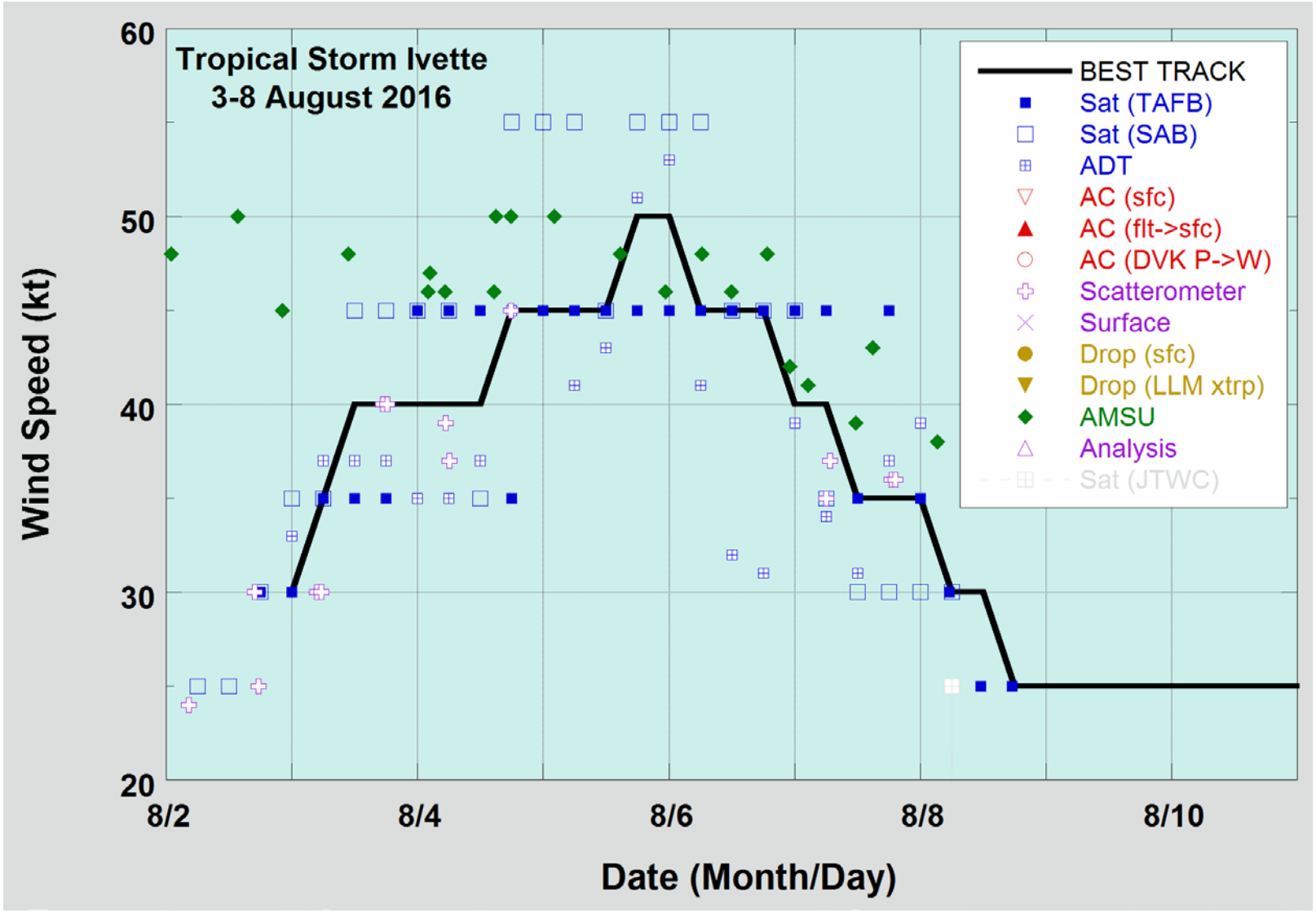

Figure 2. Selected wind observations and best track maximum sustained surface wind speed curve for Tropical Storm Ivette, 3-8 August 2016. Advanced Dvorak Technique estimates represent the Current Intensity at the nominal observation time. AMSU intensity estimates are from the Cooperative Institute for Meteorological Satellite Studies technique. Dashed vertical lines correspond to 0000 UTC.

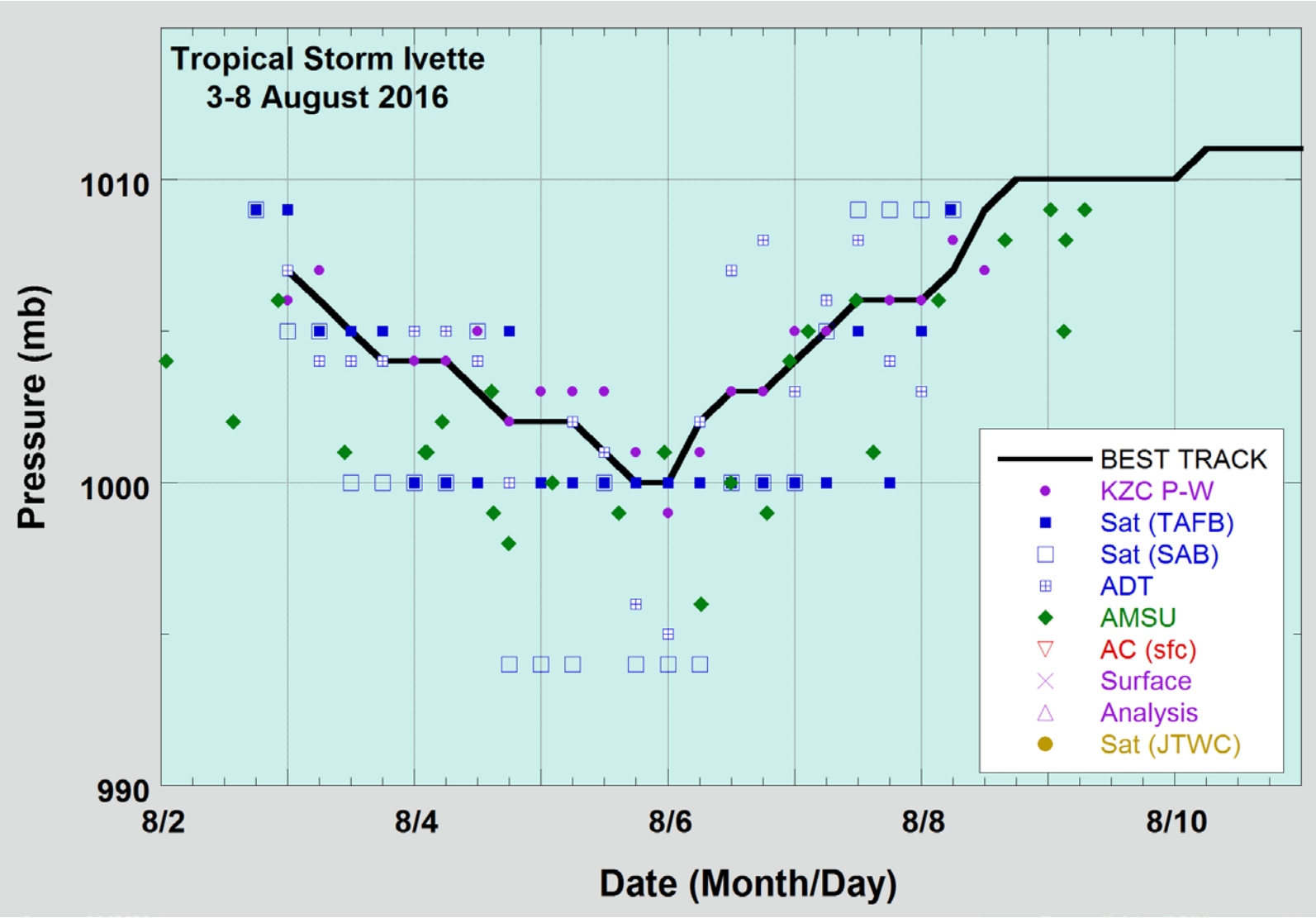

Figure 3. Selected pressure observations and best track minimum central pressure curve for Tropical Storm Ivette, 3-8 August 2016. Advanced Dvorak Technique estimates represent the Current Intensity at the nominal observation time. AMSU intensity estimates are from the Cooperative Institute for Meteorological Satellite Studies technique. KZC P-W refers to pressure estimates derived using the Knaff-Zehr-Courtney pressure-wind relationship. Dashed vertical lines correspond to 0000 UTC.

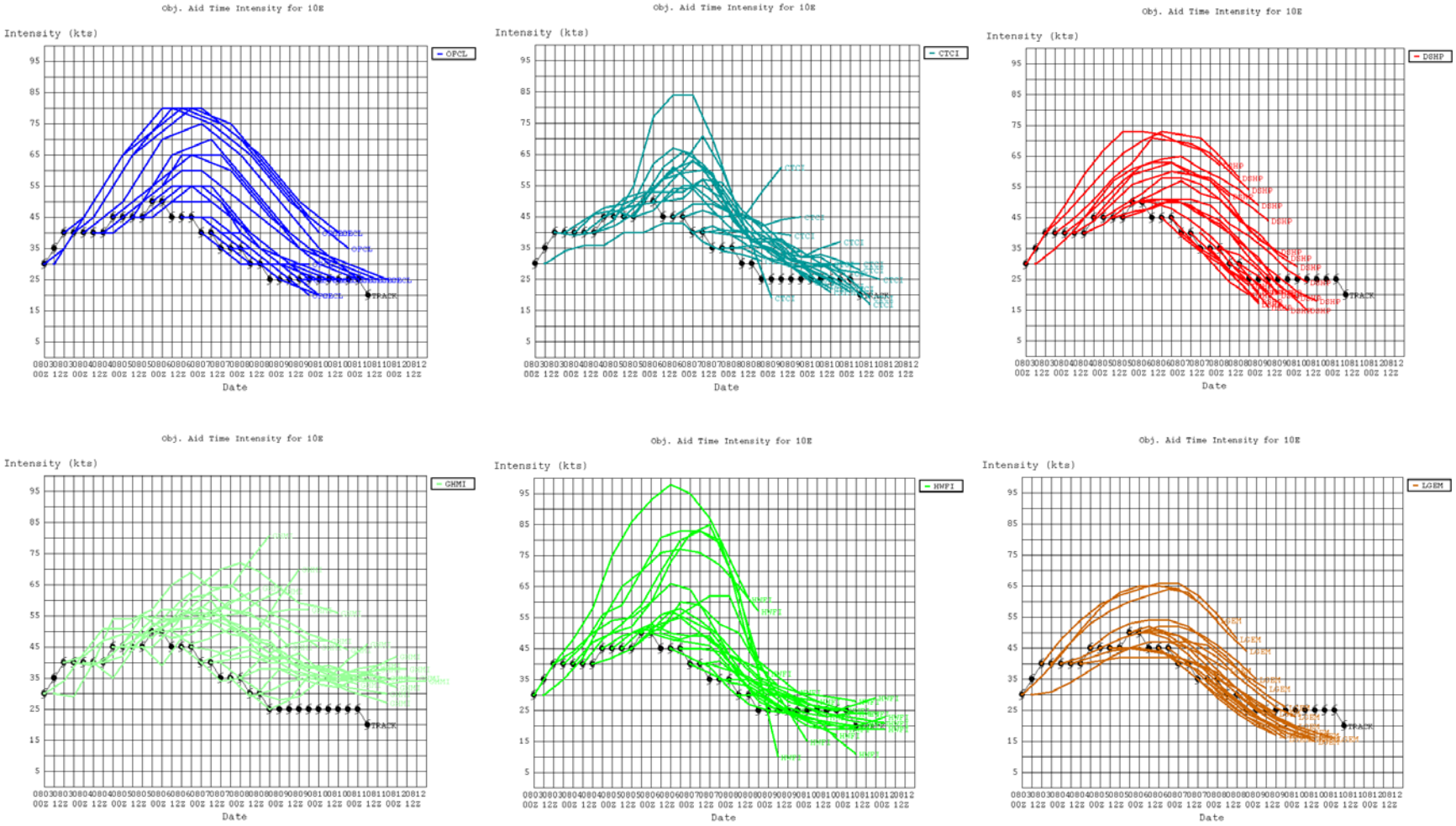

Figure 4. Intensity forecasts for Ivette from (top left – dark blue) the NHC Official Forecast (OFCL), (top center – green blue) the Navy Coupled Atmosphere Ocean model (CTCI), (top right – red) the Decay Statistical Hurricane Intensity Prediction model (DSHP), (bottom left – yellow green) the Geophysical Fluid Dynamics Model (GHMI), (bottom center – bright green) the Hurricane Weather Research model (HWFI), and (bottom right – orange) the Logistic Growth Equation model (LGEM).