NATIONAL HURRICANE CENTER TROPICAL CYCLONE REPORT

HURRICANE HUMBERTO

(AL092013)

8-19 September 2013

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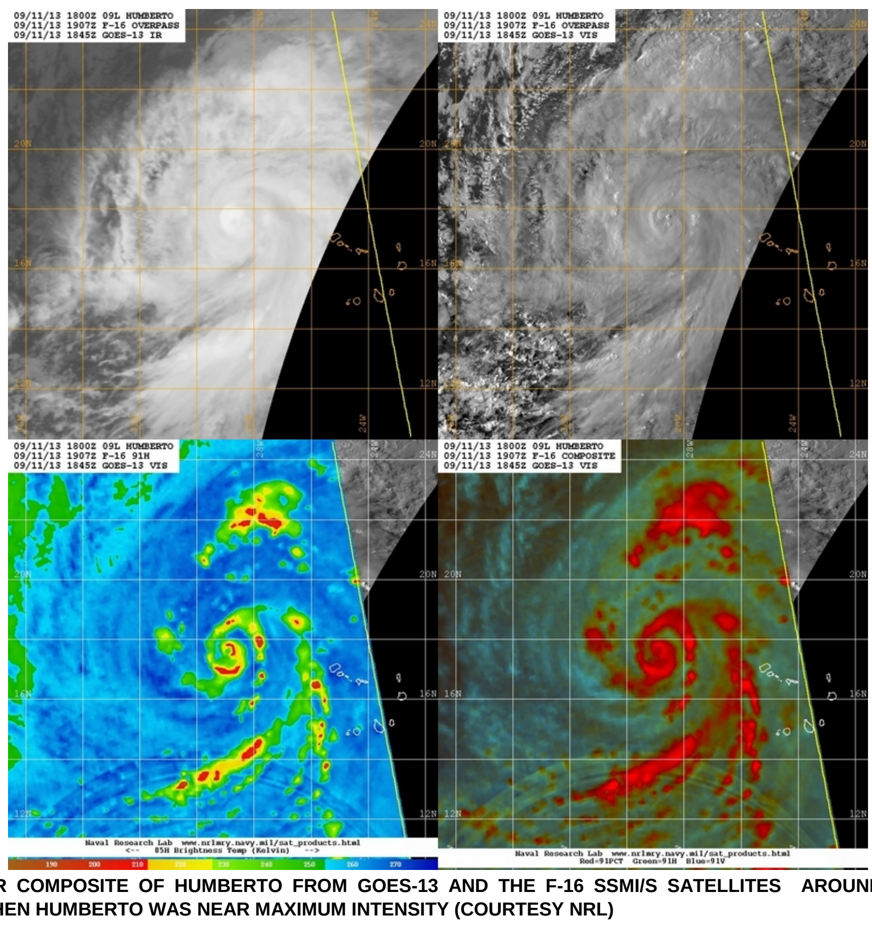

A MULTI-SENSOR COMPOSITE OF HUMBERTO FROM GOES-13 AND THE F-16 SSMI/S SATELLITES AROUND 19 UTC 11 SEPTEMBER, WHEN HUMBERTO WAS NEAR MAXIMUM INTENSITY (COURTESY NRL)

Humberto was a category 1 hurricane (on the Saffir-Simpson Hurricane Wind Scale) that produced heavy rains and gusty winds over the Cape Verde Islands early in its twelve-day lifetime over the eastern Atlantic Ocean.

Hurricane Humberto

8-19 SEPTEMBER 2013

SYNOPTIC HISTORY

Humberto's origins can be traced to a strong African easterly wave that left the coast of west Africa on 7 September. Early the next day, the system developed a closed, well-defined circulation while it was located about 100 n mi south of Dakar, Senegal. Deep convection was also present in association with the low, and by 1800 UTC the convection had developed enough bands to indicate that a tropical depression had formed about 195 n mi west-southwest of Dakar. The "best track" chart of the tropical cyclone'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].

The cyclone steadily intensified while moving westward at around 10 kt and became a tropical storm around 0600 UTC on 9 September, about 125 n mi southeast of Praia, Cape Verde Islands. Humberto continued to intensify through early on 10 September while moving through a moist atmosphere with moderate northeasterly vertical shear, and traversing 28°C sea-surface temperatures. During this time, the tropical storm continued moving generally westward to the south of a deep-layer ridge. Later that day, Humberto's intensification paused while the cyclone began a turn toward the northwest and north in response to a developing mid-level trough over the central North Atlantic. Early on 11 September, the cyclone quickly intensified and reached hurricane status around 1200 UTC, about 320 n mi west-northwest of Praia, and reached its peak intensity of 80 kt at 1800 UTC. Humberto maintained this intensity for about 12 h, during which time a small eye could be observed sporadically in visible, infrared, and microwave imagery. The intensity peak can likely be ascribed to very low vertical shear values (less than 5 kt), despite only lukewarm (about 26°C) sea surface temperatures.

Late on 12 September and on 13 September, the combination of increasing southwesterly vertical shear, cool ocean temperatures, and a drier, more stable atmosphere led to gradual weakening of Humberto. The cyclone dropped below hurricane intensity around 1200 UTC on 13 September while located about 710 n mi northwest of Praia. The hostile environmental conditions caused a cessation of the storm's deep convection and the system lost tropical cyclone status around 0000 UTC 14 September about 780 n mi northwest of Praia. While Humberto was a weakening tropical storm on 13 September and a convection-free post-tropical low on 14 September, the system was moving generally toward the west-northwest around 10 kt while being advected along in the low-level flow south of the Azores surface high.

Late on 14 September, deep convection began redeveloping in the cyclone's northeastern semicircle. By 0000 UTC 15 September the convection was organized enough to

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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.

again consider the system a tropical cyclone, though one that was experiencing strong westerly vertical shear. At the time, Humberto was located about 950 n mi southwest of Ponta Delgado, Azores. The strong vertical shear prevented any significant reintensification of the system from 15 to 17 September. Late on 16 September and early on 17 September, the storm began interacting with an approaching mid- to upper-level cyclone from the northwest, which caused Humberto to meander. The mid- to upper-level low moved above Humberto's low-level circulation on 17 September; this structure persisted and as a result, Humberto became a subtropical cyclone around 1200 UTC on 17 September. The system gradually weakened on 18 September, becoming a subtropical depression around 0600 UTC while centered about 975 n mi west-southwest of Ponta Delgado. The circulation opened into a trough by 1200 UTC 19 September and Humberto's remnants were absorbed by an approaching cold front shortly thereafter.

METEOROLOGICAL STATISTICS

Observations in Humberto (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 Tropical Rainfall Measuring Mission (TRMM), 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 Humberto. A NASA Global Hawk mission late on 16 September through early on 17 September provided some helpful dropwindsonde observations around the cyclone.

Humberto's estimated peak intensity of 80 kt from 1800 UTC 11 September (cover figure) through 0600 UTC 12 September is based upon tightly clustered subjective Dvorak, ADT, and AMSU intensity estimates.

The transition of Humberto to a subtropical storm on 17 September was evidenced by the development of asymmetric deep convection, a large (100 n mi) radius of maximum winds, and co-location of an upper-level low over the surface center, while the cyclone remained non-frontal. This classification is consistent with cyclone phase space diagrams provided by Prof. Bob Hart of Florida State University.

No ships reported sustained winds of tropical storm force in association with Humberto. No land stations reported tropical storm force winds either, although it is possible that a portion of the southernmost Cape Verde Islands experienced low-end sustained tropical storm force winds when Humberto passed south of the islands late on 9 September.

CASUALTY AND DAMAGE STATISTICS

Heavy rains and gusty winds associated with Humberto affected the southern Cape Verde Islands, causing some minor flooding and downed trees according to media reports. Fortunately, there were no casualties.

FORECAST AND WARNING CRITIQUE

The genesis of Humberto was well predicted. The disturbance that became Humberto was introduced into the experimental five-day Tropical Weather Outlook with a low (less than 30%) chance of genesis at 1800 UTC 4 September, four days before genesis. This was boosted to a medium (30 to 50%) chance at 1200 UTC 5 September, just more than three days before genesis, and increased to a high (greater than 50%) chance at 1800 UTC 6 September, two days before genesis. In the 48 h outlook, Humberto's precursor disturbance was introduced at 0000 UTC 7 September, 42 h before formation. The genesis likelihood was boosted to a medium (30 to 50%) chance 18 h later and increased to a high (greater than 50%) chance at 0200 UTC 8 September, about 16 h before genesis.

At 1500 UTC 14 September, Humberto was designated a non-tropical low and forecasts for (re)genesis of the system were included in subsequent Tropical Weather Outlooks. It was reintroduced with a medium (30 to 50%) chance at 1800 UTC 14 September, 6 h before Humberto became a tropical storm again in post-analysis.

A verification of NHC official track forecasts for Humberto is given in Table 2a. Official forecast track errors were lower than the mean official errors for the previous 5-yr period from 36 to 120 h. These low errors are somewhat notable, given that the climatology and persistence (OCD5) errors were larger than usual especially at 72 h and beyond. A homogeneous comparison of the official track errors with selected guidance models is given in Table 2b. No single model or consensus aid consistently outperformed the NHC official track predictions. The best individual models were the Geophysical Fluid Dynamics Laboratory model (GHMI) from 12 to 48 h and the Hurricane Weather Research Forecasting model (HWFI) from 72 to 120 h.

A verification of NHC official intensity forecasts for Humberto is given in Table 3a. Official forecast intensity errors were much lower than the mean official errors for the previous 5-yr period. Despite these low errors, the NHC official intensity predictions displayed a significant high bias, especially for 15-19 September (Fig. 4). A homogeneous comparison of the official intensity errors with selected guidance models is given in Table 3b. No single model consistently outperformed the NHC official intensity predictions. The Florida State Super Ensemble (FSSE) consensus technique provided intensity guidance that had lower errors than the NHC official intensity forecasts for most lead times. A significant high bias was also present for much of the model guidance (Fig. 4), but was not as substantial for FSSE.

Watches and warnings associated with Humberto are given in Table 4.

Table 1. Best track for Hurricane Humberto, 8-19 September 2013.

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
08 / 0000	13.0	17.6	1009	25	low
08 / 0600	13.0	18.4	1009	25	"
08 / 1200	13.0	19.3	1009	25	"
08 / 1800	13.0	20.3	1008	25	tropical depression
09 / 0000	13.1	21.3	1007	30	"
09 / 0600	13.3	22.4	1006	35	tropical storm
09 / 1200	13.5	23.6	1005	40	"
09 / 1800	13.7	24.6	1004	45	"
10 / 0000	13.9	25.5	1002	50	"
10 / 0600	14.1	26.5	1000	55	"
10 / 1200	14.3	27.3	1000	55	"
10 / 1800	14.7	27.9	999	55	"
11 / 0000	15.1	28.3	998	55	"
11 / 0600	15.6	28.6	994	60	"
11 / 1200	16.3	28.9	987	70	hurricane
11 / 1800	17.4	28.9	979	80	"
12 / 0000	18.6	28.9	979	80	"
12 / 0600	19.9	28.9	979	80	"
12 / 1200	21.2	28.9	980	75	"
12 / 1800	22.3	29.1	980	75	"
13 / 0000	23.2	29.5	982	70	"
13 / 0600	24.0	30.0	986	60	tropical storm
13 / 1200	24.6	30.8	988	55	“
13 / 1800	24.8	31.7	995	45	"
14 / 0000	24.8	32.6	999	40	low
14 / 0600	24.9	33.6	1003	35	"

14 / 1200	25.2	34.8	1004	35	"
14 / 1800	25.5	36.3	1005	35	"
15 / 0000	25.6	37.8	1004	35	tropical storm
15 / 0600	25.6	38.9	1004	35	"
15 / 1200	25.9	39.7	1004	35	"
15 / 1800	26.4	40.4	1004	35	"
16 / 0000	26.7	41.3	1004	35	"
16 / 0600	26.7	42.4	1004	35	"
16 / 1200	26.8	42.9	1000	40	"
16 / 1800	26.9	43.3	1000	40	"
17 / 0000	27.0	43.2	1002	35	"
17 / 0600	27.4	42.9	1002	35	"
17 / 1200	28.4	42.6	1000	40	subtropical storm
17 / 1800	29.5	42.7	1000	40	"
18 / 0000	30.5	43.2	1003	35	"
18 / 0600	31.1	43.6	1006	30	subtropical depression
18 / 1200	31.6	43.9	1006	30	"
18 / 1800	32.0	44.1	1007	30	"
19 / 0000	32.5	44.3	1007	30	"
19 / 0600	33.0	44.5	1007	30	"
19 / 1200					dissipated
11 / 1800	17.4	28.9	979	80	minimum pressure and maximum winds

Table 2a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) track forecast errors (n mi) for Humberto. 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	29.3	47.5	**61.3**	**74.9**	**91.3**	**133.3**	**165.4**
OCD5	51.1	107.0	168.7	255.1	526.3	568.3	546.6
Forecasts	29	25	23	21	17	17	17
OFCL (2008-12)	28.6	45.8	62.2	78.6	116.6	160.0	206.4
OCD5 (2008-12)	47.5	99.7	161.4	224.0	329.7	417.5	493.1

Table 2b. Homogeneous comparison of selected track forecast guidance models (in n mi) for Humberto. 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 2a due to the homogeneity requirement.

Model ID	Forecast Period (h)						
	12	24	36	48	72	96	120
OFCL	25.4	41.6	61.6	81.6	83.3	115.3	171.9
OCD5	51.9	111.6	191.5	309.7	531.0	544.7	562.8
GFSI	**24.8**	**40.1**	63.3	**76.9**	102.9	150.1	205.1
GHMI	30.4	44.0	**47.8**	**59.0**	113.6	182.7	255.6
GFNI	33.2	53.7	75.8	86.4	152.2	194.7	368.5
HWFI	32.9	59.7	96.4	120.4	92.5	125.8	**125.3**
EGRI	31.8	58.1	81.7	105.6	147.4	172.3	215.2
EMXI	28.6	45.8	**60.3**	**81.4**	125.1	177.1	209.8
CMCI	45.9	87.3	127.3	175.3	215.7	305.6	363.9
NVGI	28.3	45.0	70.2	104.6	175.6	223.2	380.9
TCON	27.3	43.3	62.5	**77.1**	84.7	**108.7**	**142.6**
TVCA	27.2	42.0	**61.0**	**76.5**	86.6	117.0	**141.5**
FSSE	26.3	**39.5**	61.7	**80.5**	92.4	145.4	184.6
AEMI	26.4	**39.0**	**58.4**	**75.2**	105.6	141.0	214.3
BAMS	36.5	56.9	80.1	121.7	120.9	135.3	178.2
BAMM	32.6	47.8	82.4	118.2	168.1	215.0	293.2
BAMD	41.0	63.1	116.9	147.3	273.4	376.6	618.9
Forecasts	21	17	15	12	11	11	9

Table 3a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) intensity forecast errors (kt) for Humberto. 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	**5.2**	**7.2**	**7.6**	**6.9**	**7.6**	**9.1**	**12.4**
OCD5	6.5	9.6	12.6	14.2	19.5	24.2	29.6
Forecasts	29	25	23	21	17	17	17
OFCL (2008-12)	6.6	10.1	12.2	14.1	15.4	15.1	16.1
OCD5 (2008-12)	7.8	11.6	14.0	15.6	17.9	18.0	17.9

Table 3b. Homogeneous comparison of selected intensity forecast guidance models (in kt) for Humberto. 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	5.9	7.5	6.6	6.1	7.7	9.6	12.5
OCD5	7.1	10.7	12.3	11.8	20.0	24.5	31.5
GFSI	7.0	9.1	10.1	11.9	20.2	22.4	27.9
EMXI	6.3	9.7	11.6	13.5	21.9	19.6	23.1
HWFI	6.0	**6.8**	6.7	7.2	13.6	13.9	17.7
GHMI	**5.5**	**7.0**	8.8	8.5	13.1	13.5	23.9
GFNI	**5.0**	**5.6**	9.3	11.6	9.5	11.1	22.3
DSHP	6.7	8.5	10.4	11.6	13.9	13.4	**12.2**
LGEM	6.5	7.6	8.9	8.6	10.5	11.2	16.3
ICON	5.9	**6.5**	6.9	**5.5**	8.1	**9.4**	15.8
IVCN	5.9	**6.5**	6.9	**5.5**	8.1	**9.4**	15.8
FSSE	6.0	**6.8**	6.8	**4.9**	**7.3**	**6.3**	**10.6**
Forecasts	22	18	16	14	13	13	14

Table 4. Tropical cyclone watches and warnings for Humberto, 8-19 September 2013.

Date/Time (UTC)	Action	Location
8/2100	Tropical Storm Warning issued	Southern Cape Verde Islands of Maio, Santiago, Fogo, and Brava
9/2100	Tropical Storm Warning discontinued	Southern Cape Verde Islands of Maio, Santiago, Fogo, and Brava

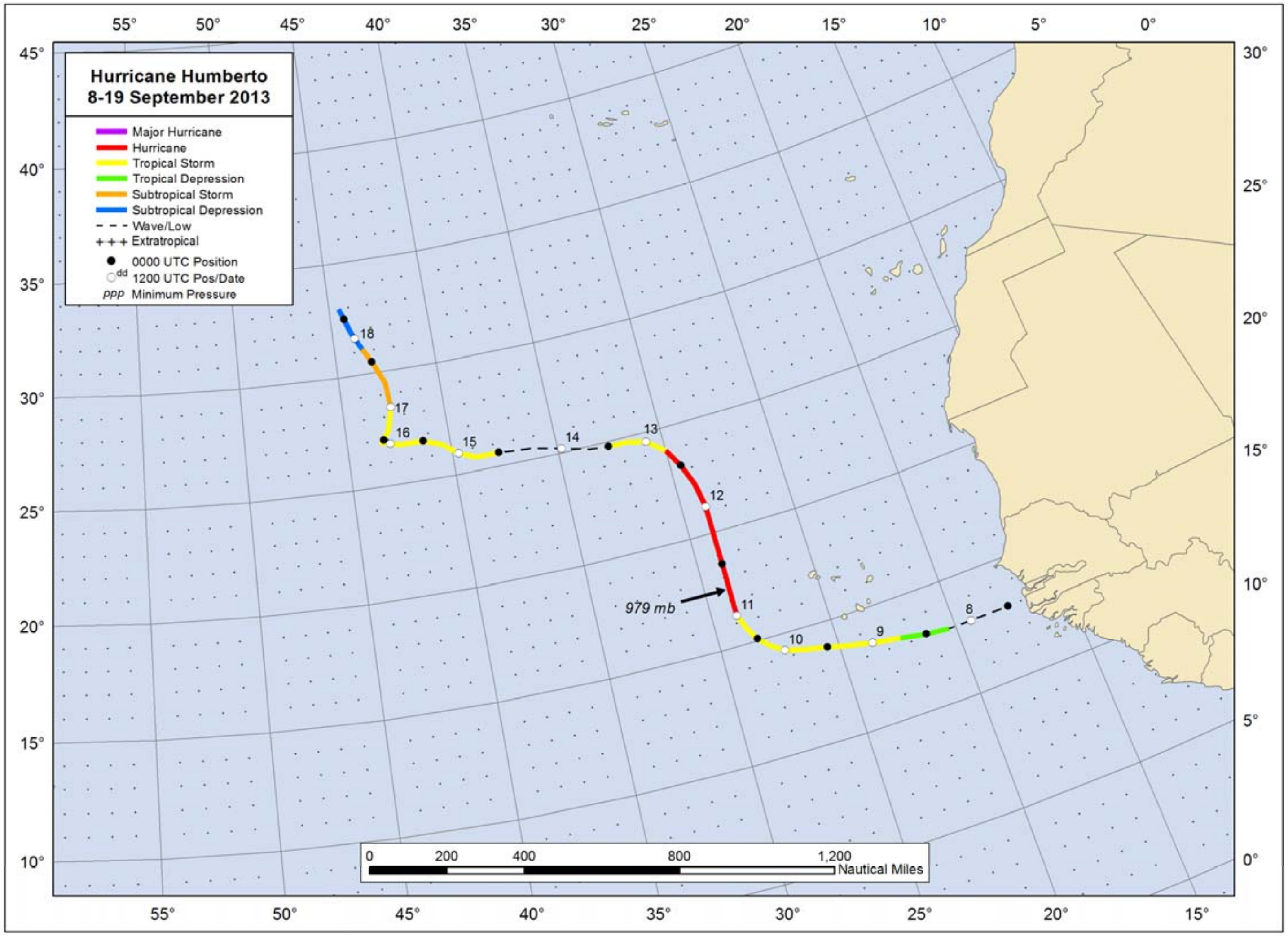

Figure 1. Best track positions for Hurricane Humberto, 8-19 September 2013.

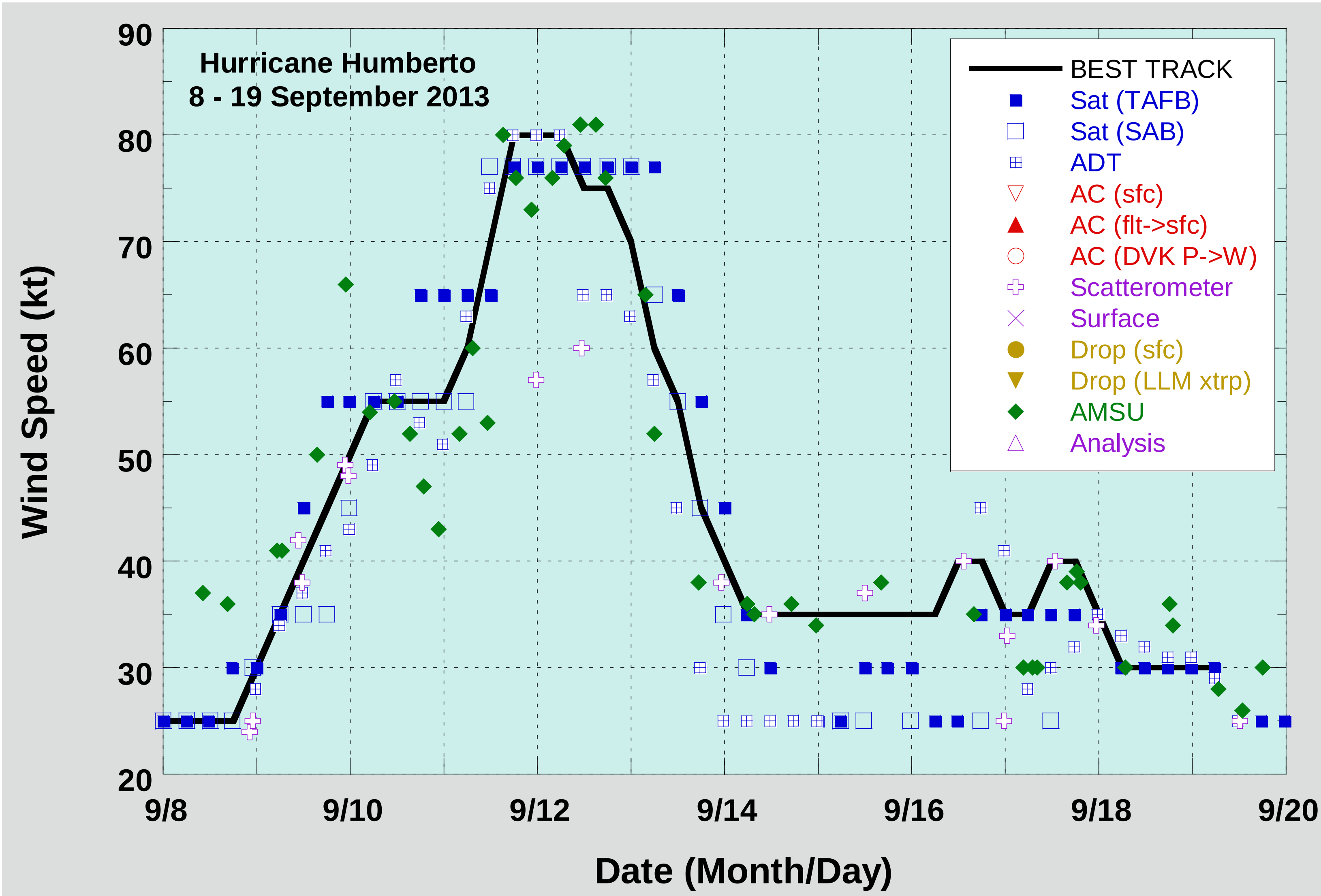

Figure 2. Selected wind observations and best track maximum sustained surface wind speed curve for Hurricane Humberto, 8-19 September 2013. Advanced Dvorak Technique estimates represent the Current Intensity at the nominal observation time. AMSU intensity estimates are from the Cooperative Institute for Meteorological Satellite Studies technique. Dashed vertical lines correspond to 0000 UTC.

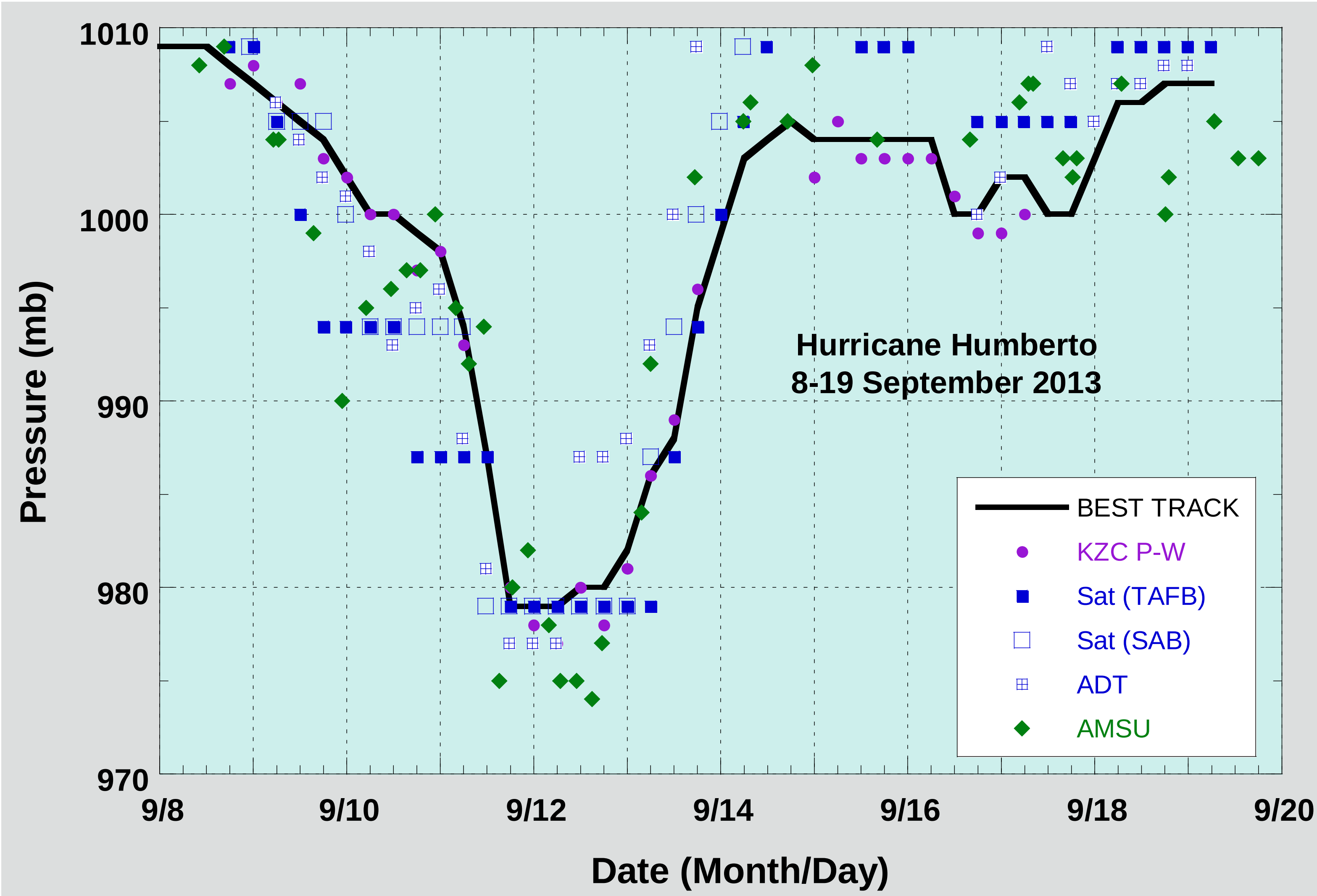

Figure 3. Selected pressure observations and best track minimum central pressure curve for Hurricane Humberto, 8-19 September 2013. Advanced Dvorak Technique estimates represent the Current Intensity at the nominal observation time. AMSU intensity estimates are from the Cooperative Institute for Meteorological 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.

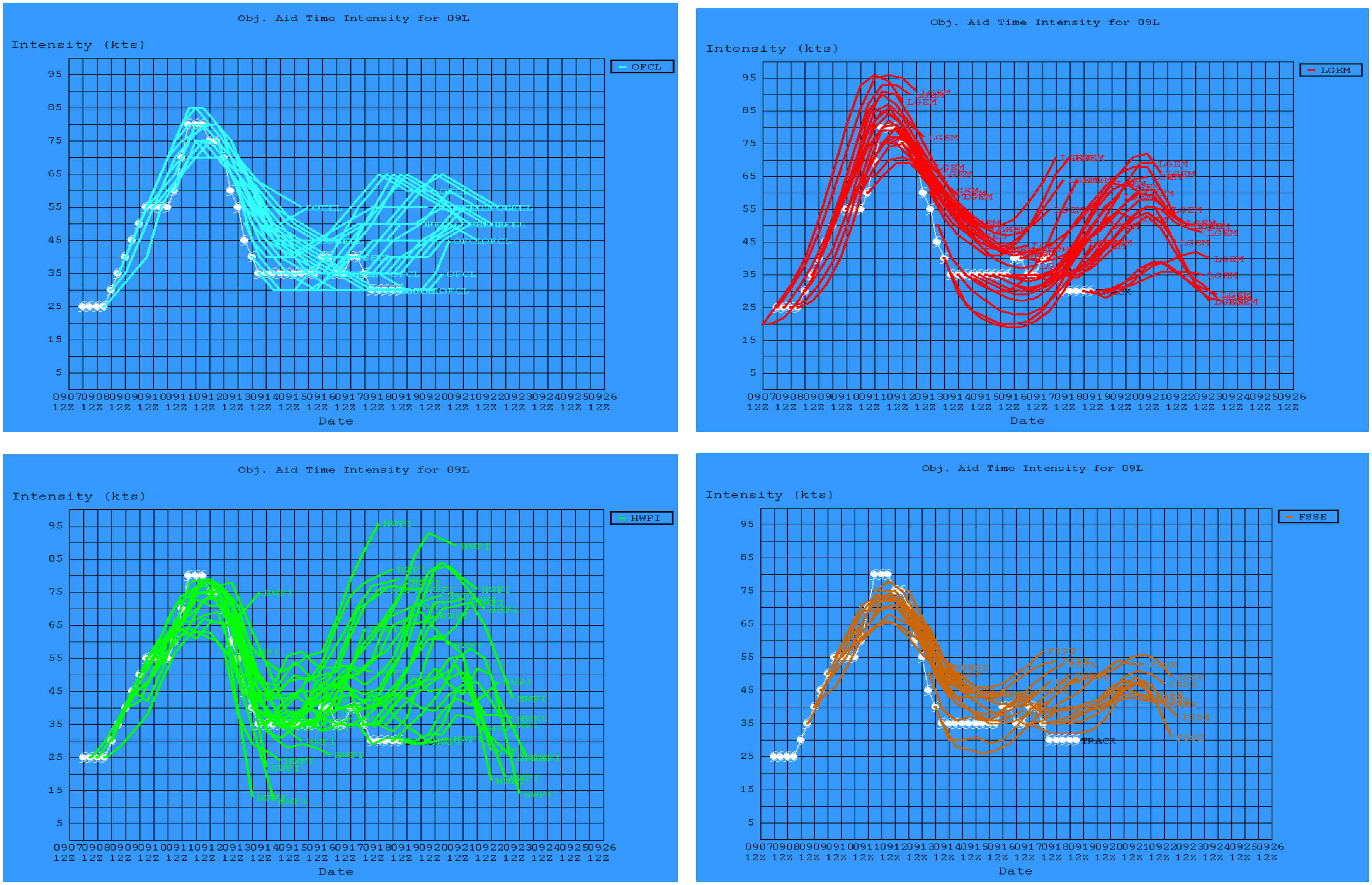

Figure 4. Intensity forecasts plots from the NHC official predictions (upper left), the Logistic Growth Equation Model (LGEM – upper right), the Hurricane Weather Research Forecast model (HWFI – bottom left), and the Florida State Super Ensemble (FSSE – bottom right).