

Tropical Cyclone Report
Hurricane Fred
(AL072009)
7-12 September 2009

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Fred became the strongest hurricane on record south of 30°N and east of 35°W in the Atlantic basin. It then weakened and degenerated into a remnant low that moved west-northwestward for almost a week before dissipating.

a. Synoptic History

Fred originated from a tropical wave that moved off the west coast of Africa early on 6 September. A broad area of low pressure formed to the east of the deep convection associated with the wave around 1800 UTC that day, as the system moved westward at 15-20 knots. As the forward motion of the system slowed to less than 15 kt early the next day, convective organization near the low-level center gradually increased, and it is estimated that a tropical depression formed around 1800 UTC 7 September about 190 n mi south-southeast of the island of Brava in the Cape Verde Islands. The “best track” chart of Fred’s track 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 1¹.

By 0000 UTC 8 September a curved convective band developed south and west of the center and it is estimated that the system reached tropical storm intensity at this time, while centered about 195 n mi south-southwest of Brava. The cyclone continued moving westward to the south of a subtropical ridge over the eastern Atlantic and intensified quickly. By late on 8 September, an intermittent eye feature became apparent in infrared geostationary imagery, and it is estimated the Fred became a hurricane around 0000 UTC 9 September while centered about 360 n mi west-southwest of Brava. Subsequent microwave imagery confirmed the formation of an eye, and the hurricane intensified rapidly over the next 12 hours, reaching an estimated peak intensity of 105 kt at 1200 UTC that day. The intensity of Fred increased 55 kt in the 24-h period ending at this time, including a 35-kt increase in 12 h. While Fred intensified rapidly, the cyclone turned toward the west-northwest as it moved around the western periphery of the subtropical ridge. Fred’s intensification halted later on 9 September, when microwave imagery suggested that the hurricane may have begun an eyewall replacement cycle. The combination of the eyewall replacement and increasing southwesterly vertical wind shear ahead of a mid- to upper-level trough in the central Atlantic disrupted the inner-core circulation of the cyclone and induced weakening. Fred turned toward the north-northwest by late 10 September and then turned northeastward the next day ahead of the aforementioned trough. During this time, Fred

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 *brk* directory, while previous years’ data are located in the *archive* directory.

steadily weakened due to increasing vertical wind shear and lower sea surface temperatures. Microwave imagery suggests by late on 10 September the circulation of Fred became tilted, with the mid-level center becoming displaced to the north and northeast of the low-level circulation. Fred weakened to a tropical storm by 1800 UTC the next day as it turned toward the east and the forward motion slowed to less than 5 kt. Vertical wind shear increased further on 12 September, and by 1200 UTC that day the low-level circulation center became completely decoupled from the remaining deep convection. All of the organized deep convection dissipated later that day, and Fred degenerated to a remnant low by 1800 UTC 12 September, while centered about 495 n mi west of Santo Antao in the Cape Verde Islands.

As a remnant low Fred turned westward on 13 September as it completed an anti-cyclonic loop. The remnant low was then steered by a low-level ridge to the north and moved generally on a westward or west-northwestward heading across the Atlantic for nearly a week. During this period, deep convection developed several times; however, the convection never gained enough organization or maintained sufficient temporal continuity to result in reformation as a tropical cyclone. By 19 September, the remnant low became elongated ahead of a frontal trough situated off of the southeast coast of the United States, and the low dissipated after 1200 UTC that day, while located about 450 n mi southwest of Bermuda.

b. Meteorological Statistics

Observations in Fred (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 Dvorak intensity 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) instrument, NASA's Tropical Rainfall Measuring Mission (TRMM) and QuikSCAT satellites, EUMETSAT's ASCAT, the U.S. Navy's WindSat, and Defense Meteorological Satellite Program (DMSP) satellites, among others, were also useful in constructing the best track of Fred.

The estimated peak intensity of Fred is based on a three-hour average objective Dvorak intensity estimate of 105 kt centered on 1200 UTC 9 September. Even though the objective Dvorak estimates increased at 1800 UTC that day, the satellite presentation of Fred had become less impressive by that time (Fig. 4). As a result, the 1800 UTC best track intensity was based on subjective Dvorak estimates of 100 kt from TAFB and SAB.

Fred became only the fourth major hurricane on record in the far southeastern portion of the Atlantic basin (south of 30°N and east of 40°W) and is the only hurricane on record in the basin with an intensity greater than 100 kt when located south of 30°N and east of 35°W. However, it is important to note that prior to 1972 (when routine Dvorak classifications from polar-orbiting satellites began), it would have been difficult to assess the intensity of most tropical cyclones in this part of the Atlantic basin.

There were no ship reports of tropical-storm force winds in association with Fred.

c. Casualty and Damage Statistics

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

d. Forecast and Warning Critique

The genesis of Fred was fairly well anticipated. The tropical wave that spawned Fred entered the Atlantic from the coast of Africa early on 6 September and was first mentioned in the Tropical Weather Outlook issued at 1800 UTC that day, 24 h prior to genesis. The probabilistic genesis forecast was initially in the “medium” category (30–50% chance of formation). The forecast was raised to the “high” category (> 50% chance) at 0600 UTC 7 September, 12 h prior to formation.

A verification of NHC official track forecasts for Fred is given in Table 2a. Official forecast track errors were much lower than the mean official errors for the previous five-year period (2004-2008), especially from 24 to 96 h. However, the track errors of CLIPER5 (OCD5) were much larger than the 2004-2008 mean OCD5 errors. This suggests that Fred was a more difficult storm to forecast than average. A homogeneous comparison of the official track errors with selected guidance models is given in Table 2b. Of the dynamical models, the ECMWF model had smaller average track errors than the official NHC forecast at all forecast lead times. The GFS also performed better than the official forecast at all times except 48 and 72 h. All of the consensus models had smaller average errors than the official forecast at most lead times.

A verification of NHC official intensity forecasts for Fred is given in Table 3a. Official forecast intensity errors were a little larger than the mean official errors for the 2004-2008 period at forecast lead times of 12-48 h, and were less than the mean at 72 and 96 h. Decay-SHIFOR5 (OCD5) errors were higher than the five-year mean, especially from 24-72 h, indicating that the intensity forecasts for Fred were more difficult than average. A homogeneous comparison of the official track errors with selected guidance models is given in Table 3b. The Decay-SHIPS had smaller average errors than the NHC official forecast from 36-96 h, while the LGEM had smaller errors at 72 and 96 h. Neither the official forecast nor the various intensity aids were able to properly forecast the rapid strengthening of Fred or the rate of weakening after the cyclone reached its peak intensity (Figure 5).

Table 1. Best track for Hurricane Fred, 7-12 September 2009.

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
07 / 1800	11.8	24.0	1005	30	tropical depression
08 / 0000	11.7	25.4	1004	35	tropical storm
08 / 0600	11.7	26.8	1000	45	"
08 / 1200	11.8	28.0	994	55	"
08 / 1800	11.9	29.2	990	60	"
09 / 0000	12.4	30.3	983	70	hurricane
09 / 0600	13.0	31.3	970	90	"
09 / 1200	13.6	32.1	958	105	"
09 / 1800	14.2	32.8	960	100	"
10 / 0000	14.8	33.5	965	95	"
10 / 0600	15.4	34.2	970	90	"
10 / 1200	16.1	34.6	974	85	"
10 / 1800	16.7	34.9	975	80	"
11 / 0000	17.2	35.1	975	80	"
11 / 0600	17.5	34.8	980	75	"
11 / 1200	17.6	34.5	987	65	"
11 / 1800	17.6	34.2	994	55	tropical storm
12 / 0000	17.6	33.9	998	50	"
12 / 0600	17.6	33.6	1002	40	"
12 / 1200	17.5	33.6	1003	35	"
12 / 1800	17.5	33.8	1004	30	remnant low
13 / 0000	17.5	34.0	1006	30	"
13 / 0600	17.5	34.3	1007	30	"
13 / 1200	17.9	34.7	1007	30	"
13 / 1800	18.5	35.4	1007	30	"
14 / 0000	19.0	36.3	1007	30	"
14 / 0600	19.2	37.5	1007	30	"
14 / 1200	19.2	38.8	1007	30	"
14 / 1800	19.1	40.2	1008	25	"
15 / 0000	19.1	41.6	1008	25	"
15 / 0600	19.3	43.1	1008	25	"
15 / 1200	19.8	44.7	1008	25	"
15 / 1800	20.4	46.4	1010	25	"
16 / 0000	21.1	48.3	1010	25	"
16 / 0600	21.8	50.2	1010	25	"
16 / 1200	22.3	52.1	1010	25	"
16 / 1800	22.8	54.1	1010	25	"
17 / 0000	23.3	56.0	1010	25	"

17 / 0600	23.8	57.9	1010	25	"
17 / 1200	24.2	59.9	1011	25	"
17 / 1800	24.6	61.6	1011	25	"
18 / 0000	24.9	63.2	1012	25	"
18 / 0600	25.3	64.7	1012	25	"
18 / 1200	25.6	66.0	1012	25	"
18 / 1800	25.9	67.1	1012	25	"
19 / 0000	26.2	68.1	1012	25	"
19 / 0600	26.4	69.0	1012	25	"
19 / 1200	26.6	69.8	1012	25	"
19 / 1800					dissipation
09 / 1200	13.6	32.1	958	105	maximum wind speed and minimum pressure

Table 2a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) track forecast errors (n mi) for Hurricane Fred. Mean errors for the five-year period 2004-8 are shown for comparison. Official errors that are smaller than the five-year means are shown in boldface type.

	Forecast Period (h)						
	12	24	36	48	72	96	120
OFCL (Fred)	26.9	38.1	42.6	45.7	50.8	97.5	
OCD5 (Fred)	58.1	125.8	213.4	304.4	504.6	728.9	
Forecasts	18	16	14	12	8	4	
OFCL (2004-8)	32.1	54.9	77.1	99.0	147.0	200.3	
OCD5 (2004-8)	45.8	95.7	152.8	208.6	306.2	393.6	

Table 2b. Homogeneous comparison of selected track forecast guidance models (in n mi) for Hurricane Fred. 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	26.0	40.8	43.8	47.7	39.4	103.6	
OCD5	63.2	144.4	236.1	343.4	559.0	834.8	
GFSI	25.9	31.4	35.4	50.0	42.7	34.3	
GHMI	27.0	42.8	50.5	71.2	143.7	222.8	
HWFI	29.1	43.8	44.7	60.2	113.8	235.7	
GFNI	29.6	50.3	71.3	83.5	63.3	39.9	
NGPI	27.9	46.6	69.3	81.0	78.5	78.2	
UKMI	34.8	65.1	78.9	104.9	109.8	178.5	
EMXI	22.2	30.7	36.8	44.2	32.3	88.7	
AEMI	34.9	59.5	84.8	117.7	204.1	312.7	
FSSE	20.3	28.4	35.2	58.7	78.9	39.9	
TCON	23.8	33.9	33.5	43.3	50.4	91.0	
TCCN	23.4	34.0	38.2	45.9	33.0	86.6	
TVCN	23.7	34.8	38.6	45.7	37.4	72.1	
TVCC	23.9	35.2	42.8	49.7	28.6	46.7	
GUNA	23.1	32.9	33.5	42.4	40.4	70.9	
CGUN	23.4	34.4	39.5	47.7	32.0	83.7	
BAMD	66.8	120.3	128.9	134.4	135.8	101.2	
BAMM	48.3	82.5	104.8	111.1	106.7	146.4	
BAMS	60.2	123.1	185.9	254.2	393.5	482.7	
Forecasts	10	9	7	6	4	1	

Table 3a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) intensity forecast errors (kt) for Hurricane Fred. Mean errors for the five-year period 2004-8 are shown for comparison. Official errors that are smaller than the five-year means are shown in boldface type.

	Forecast Period (h)						
	12	24	36	48	72	96	120
OFCL (Fred)	8.1	12.8	16.1	16.3	15.6	10.0	
OCD5 (Fred)	12.1	22.4	29.1	30.7	30.0	24.8	
Forecasts	18	16	14	12	8	4	
OFCL (2004-8)	7.1	10.5	12.8	14.7	18.1	19.0	
OCD5 (2004-8)	8.5	12.3	15.3	17.7	20.8	23.1	

Table 3b. Homogeneous comparison of selected intensity forecast guidance models (in kt) for Hurricane Fred. 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	7.8	12.1	11.3	11.5	12.5	15.0	
OCD5	11.9	22.2	25.4	27.4	33.2	36.0	
HWFI	10.3	17.5	17.2	18.9	17.2	22.5	
GHMI	9.4	15.9	15.3	17.4	21.8	17.0	
GFNI	11.6	17.1	15.4	12.0	24.2	38.5	
DSHP	10.3	12.7	10.9	11.0	8.7	12.0	
LGEM	9.9	14.1	12.3	13.8	11.5	12.5	
ICON	9.8	14.2	13.5	14.4	13.7	16.5	
IVCN	10.2	14.8	13.8	14.0	15.5	20.5	
FSSE	9.6	13.0	12.7	13.8	15.7	17.0	
Forecasts	16	14	12	10	6	2	

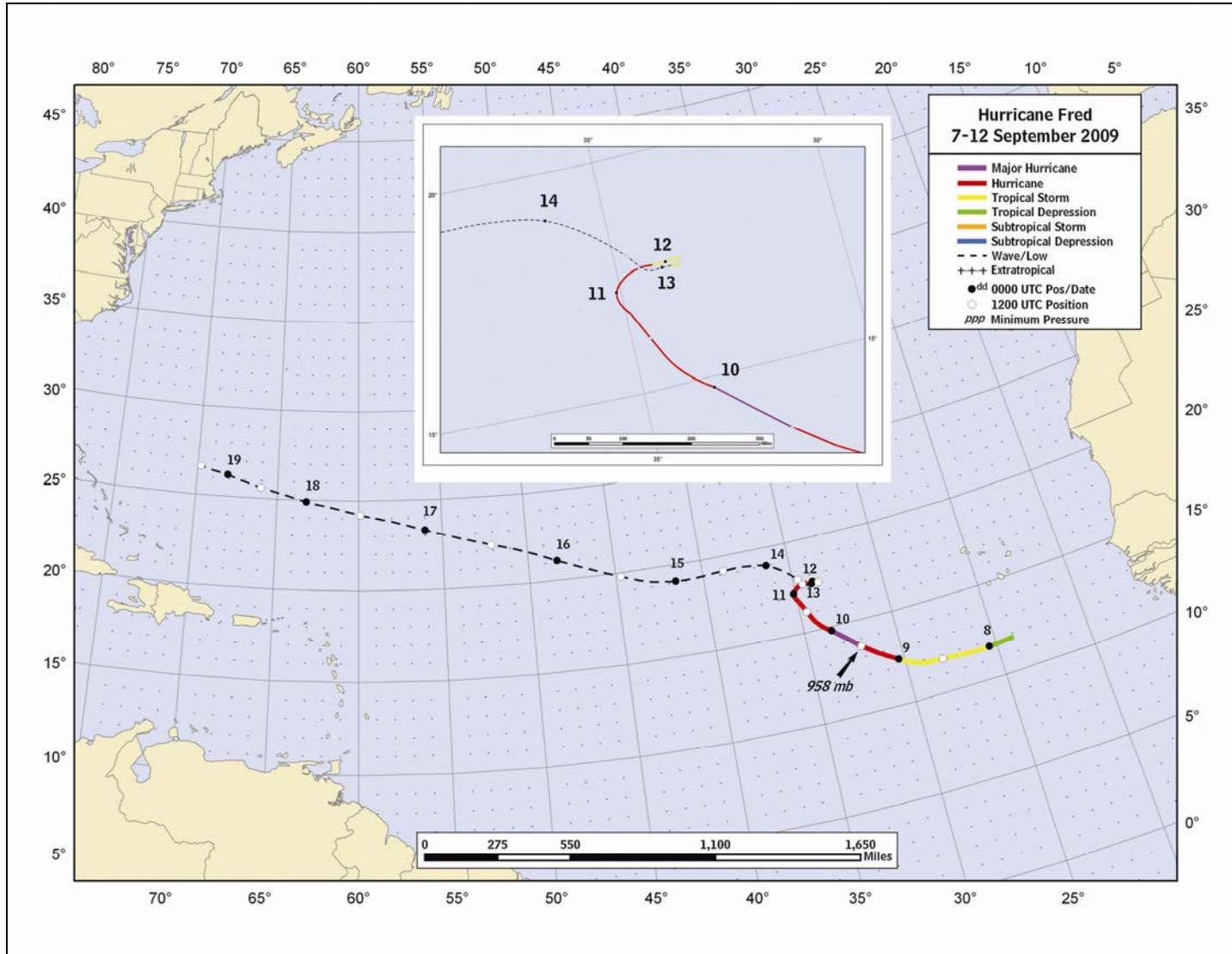


Figure 1. Best track positions for Hurricane Fred, 7-12 September 2009. Inset shows detail of looping portion of Fred's track from 10-14 September.

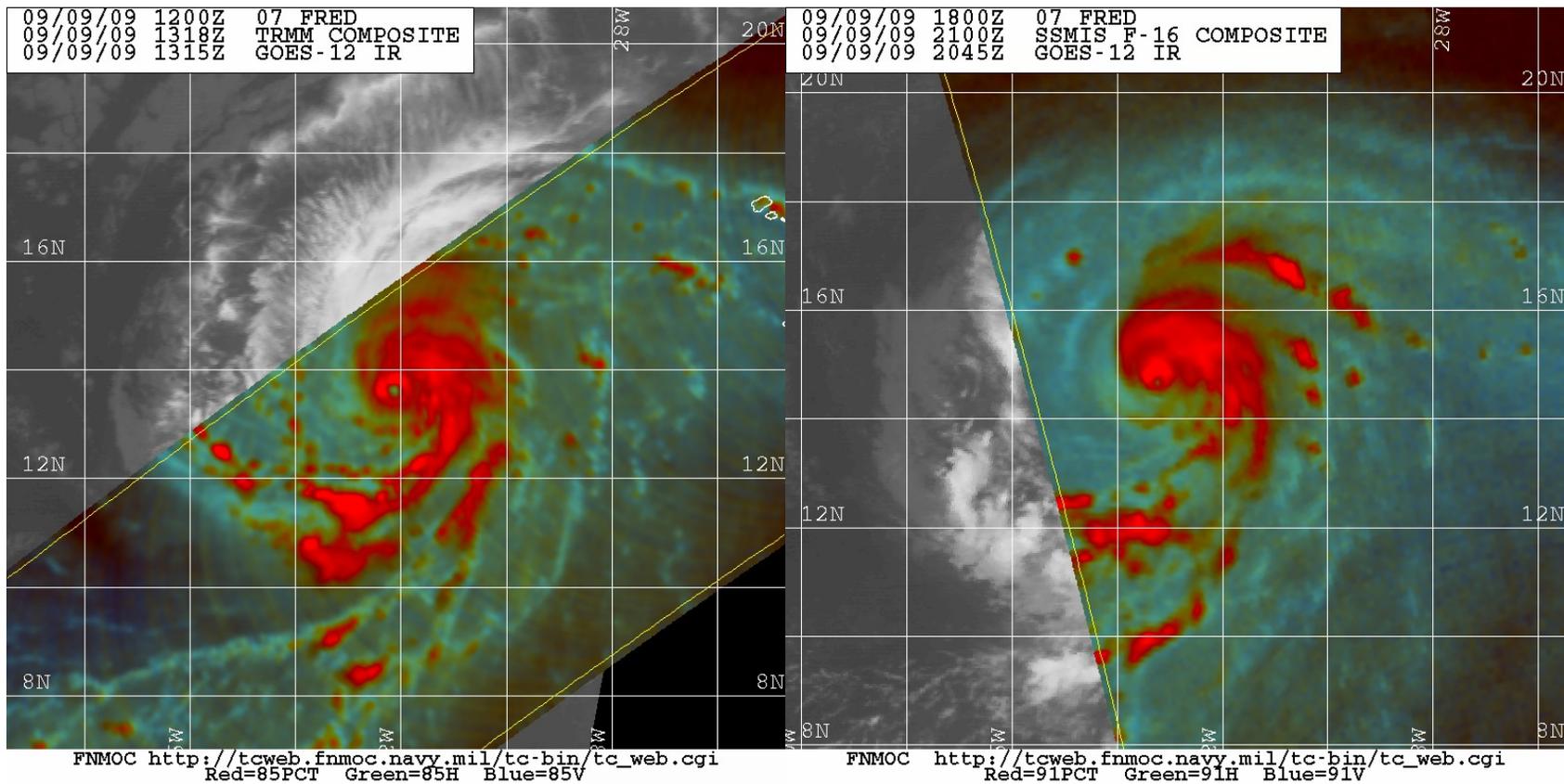


Figure 4. TRMM 85-GHz color composite image (left) at 1318 UTC 9 September near the time of Hurricane Fred's peak intensity and SSMIS 91-GHz color composite image (right) at 2100 UTC 9 September. Both images are courtesy of the U.S. Navy Fleet Numerical Meteorology and Oceanography Center (FNMOC) tropical cyclone webpage.

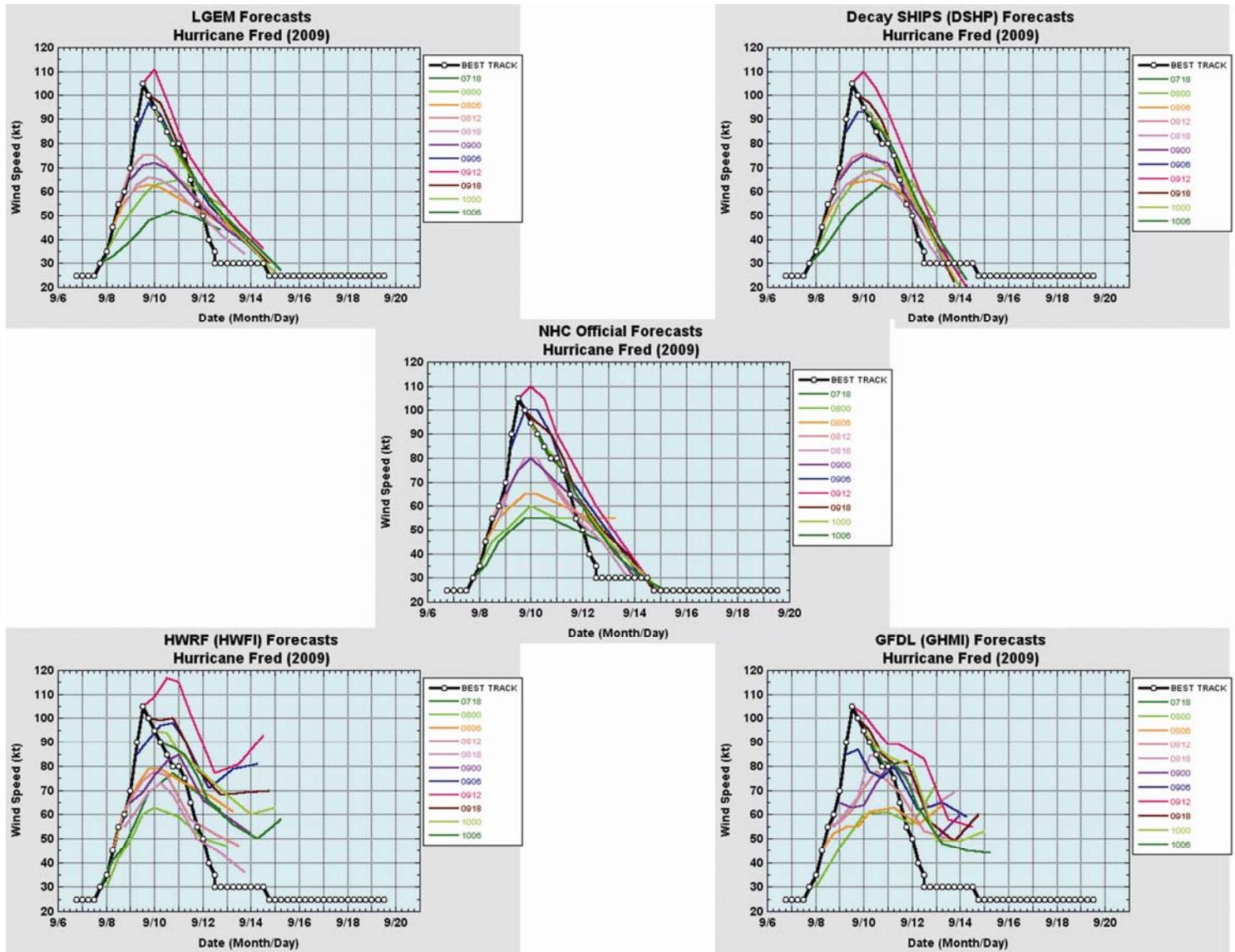


Figure 5. Selected official and model intensity forecasts (colored lines) for Hurricane Fred, 7–12 September 2009. The best track intensity is shown by the thick solid line.