

Tropical Cyclone Report  
Hurricane Humberto  
21-27 September 2001

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Humberto was a category 2 hurricane (on the Saffir-Simpson Hurricane Scale) that passed about 120 n mi to the west of Bermuda.

a. Synoptic History

Humberto had its origin in a trough of low pressure that extended southwestward from the circulation of Hurricane Gabrielle. On 18 September, a westward-moving upper-level low passed over the surface trough about 600 n mi south-southeast of Bermuda and enhanced deep convection there. A weak low formed in this area the following day and began to drift westward. The system gradually became better organized, and Dvorak classifications were initiated early on 20 September. The system became Tropical Depression Ten near 1200 UTC 21 September, when deep convection developed near the center of a broad cyclonic circulation defined by low-cloud vectors in the satellite imagery, about 425 n mi south of Bermuda.

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. Moving to the northwest at about 8 kt, the depression’s surface circulation remained weak and disorganized on 21 September despite a rapidly improving and impressive appearance in satellite imagery. Surface development appeared to catch up to the satellite signature the next day, however, and the depression is estimated to have reached tropical storm strength by 1200 UTC 22 September, about 275 n mi south-southwest of Bermuda. Moving around the periphery of the subtropical ridge, Humberto turned to the north-northwest and gradually strengthened, becoming a hurricane at 1200 UTC 23 September, about 150 n mi west-southwest of Bermuda. Humberto then turned to the north-northeast and reached its first peak in intensity, 85 kt and 983 mb, shortly thereafter at 0000 UTC 24 September.

Strong upper-level westerlies began to shear the system, and within 12 h the estimated maximum surface winds in Humberto had fallen to 70 kt. However, once Humberto passed north of the subtropical ridge, it turned to the northeast and accelerated within a more vertically uniform steering current and the weakening trend slowed. With a large mid- to upper-level cutoff low over the Midwestern states, downstream ridging caused Humberto to slow on 25 September. An eye was then apparent intermittently on satellite images. Humberto moved underneath the downstream ridge and turned briefly northward early the next day. At this point the eye became much better defined and Humberto quickly strengthened over water temperatures no higher than 25-26°C, reaching its peak intensity of 90 kt and 970 mb at 1200 UTC 26 September, about 175 n mi south-southeast of Sable Island.

The ridging that had been sheltering Humberto quickly collapsed and upper-level westerly flow again impinged on the cyclone. Humberto turned northeastward again and began to accelerate over colder waters, weakening rapidly. Moving eastward at 28 kt, Humberto weakened to a tropical storm at 1200 UTC 27 September about 350 n mi southeast of Cape Race Newfoundland. As Humberto was beginning to lose its tropical characteristics, its cloud pattern becoming distorted and separated from the low-level wind center, the cyclone dissipated when its weakening circulation degenerated into an open trough shortly after 1800 UTC 27 September.

b. Meteorological Statistics

Observations in Humberto (Figs. 2 and 3) include satellite-based Dvorak technique intensity estimates from the Tropical Analysis and Forecast Branch (TAFB), the Satellite Analysis Branch (SAB) and the U. S. Air Force Weather Agency (AFWA), as well as flight-level and dropwindsonde observations from flights of the 53<sup>rd</sup> Weather Reconnaissance Squadron of the U. S. Air Force Reserve Command, and NOAA/Hurricane Research Division flights of the WP-3D aircraft flown by the NOAA Aircraft Operations Center.

The first reconnaissance mission in the depression near 1800 UTC 21 September was not able to formally close off the center; however, the data did suggest that a small circulation was present. Subsequent reconnaissance missions indicated that Humberto's circulation remained small. When the reconnaissance aircraft entered then-Tropical Depression Ten near 1800 UTC 22 September, they found a peak flight-level (1500 ft) wind of 57 kt (estimated surface-equivalent of 46 kt), and visually estimated the surface winds to be 55-60 kt (Fig. 2). It is therefore assumed that Humberto had reached tropical storm strength by 1200 UTC that day. The first peak intensity of 85 kt at 0000 UTC 24 September is based in part on a dropwindsonde spot surface report of 87 kt. While surface winds derived from dropsonde layer averages are lower, suggesting that this surface value may not have been representative, the surface report is consistent with data from the Stepped Frequency Microwave Radiometer (SFMR) on board the NOAA WP-3D research aircraft (Fig. 4). Humberto's peak intensity of 90 kt on 26 September is based on Dvorak satellite classifications from TAFB and SAB.

Ship reports of winds of tropical storm force associated with Humberto are given in Table 2. Bermuda experienced a maximum sustained wind of 24 kt, with gusts to 37 kt, when Humberto passed 120 n mi to the west of the island. Bermuda also reported a storm total rainfall of 1.69 inches.

c. Casualty and Damage Statistics

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

d. Forecast and Warning Critique

Average official track errors (with the number of cases in parentheses) for Humberto were 41 (20), 76 (18), 121 (16), 125 (14), and 176 (10) n mi for the 12, 24, 36, 48, and 72 h forecasts,

respectively. These errors are comparable to the previous 10-year averages for 12-36 h, and less than the 10-year averages at 48 and 72 h (Table 4). A number of models outperformed the official forecast out to 36 hours, including the barotropic models and the Aviation (AVNI). However, none of the guidance models outperformed the official forecast for 72 h.

As was the case for track, the longer-range intensity forecasts were better than the shorter-range forecasts, relative to the long-term means. Average official intensity errors were 9, 14, 15, 14, and 13 kt for the 12, 24, 36, 48, and 72 h forecasts, respectively. For comparison, the average official intensity errors over the 10-yr period 1991-2000 are 7, 11, 14, 16, and 20 kt, respectively. For the most part the intensity of Humberto was under-forecast, with biases of 10-15 kt from 24-72 h. The SHIPS guidance had similar mean errors but smaller biases than the official forecast, while the GFDI and AVNI also had significant under-forecast biases. Figure 5 shows selected official intensity forecasts for Humberto. The first intensification period was modestly under-forecast, but the second intensification was missed entirely, even after it was underway.

There were no watches or warnings associated with Humberto.

Table 1. Best track for Hurricane Humberto, 21-27 Sept. 2001.

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
21 / 1200	25.1	64.2	1012	25	tropical depression
21 / 1800	25.8	65.0	1012	25	"
22 / 0000	26.5	65.5	1010	25	"
22 / 0600	27.2	65.9	1010	30	"
22 / 1200	27.9	66.3	1007	40	tropical storm
22 / 1800	28.6	66.7	998	50	"
23 / 0000	29.3	67.0	995	55	"
23 / 0600	30.1	67.3	994	55	"
23 / 1200	31.0	67.5	990	65	hurricane
23 / 1800	31.9	67.4	986	80	"
24 / 0000	32.8	67.1	983	85	"
24 / 0600	33.8	66.8	989	75	"
24 / 1200	35.0	66.3	990	70	"
24 / 1800	35.9	65.4	991	70	"
25 / 0000	36.8	64.3	992	65	"
25 / 0600	37.7	63.4	992	65	"
25 / 1200	38.5	62.4	992	65	"
25 / 1800	39.2	61.6	990	65	"
26 / 0000	39.6	60.7	990	65	"
26 / 0600	40.4	60.3	980	75	"
26 / 1200	41.0	59.2	970	90	"
26 / 1800	41.8	57.5	977	80	"
27 / 0000	42.2	54.6	987	70	"
27 / 0600	42.4	51.3	991	65	"
27 / 1200	42.2	47.5	994	60	tropical storm

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
27 / 1800	41.5	44.5	996	45	"
28 / 0000					dissipated
26 / 1200	41.0	59.2	970	90	minimum pressure

Table 2. Selected ship reports with winds of at least 34 kt for Hurricane Humberto, 21-27 Sept. 2001.

Date/Time (UTC)	Ship call sign	Latitude (°N)	Longitude (°W)	Wind dir/speed (kt)	Pressure (mb)
23/1800	WPGJ	30.5	70.0	040/37	1016.0
27/1200	UCTI	43.1	51.1	360/37	1007.9

Table 3. Preliminary track forecast evaluation (heterogeneous sample) for Hurricane Humberto, 21-27 Sept. 2001. Forecast errors for tropical storm and hurricane stages (n mi) are followed by the number of forecasts in parentheses. Errors smaller than the NHC official forecast are shown in bold-face type.

Forecast Technique	Forecast Period (h)				
	12	24	36	48	72
CLIP	51 (19)	111 (17)	131 (15)	143 (14)	193 (10)
GFDI	48 (20)	88 (18)	<b>112</b> (16)	135 (14)	203 (10)
LBAR	<b>26</b> (19)	<b>65</b> (17)	<b>99</b> (15)	154 (14)	179 (10)
AVNI	42 (20)	<b>73</b> (18)	<b>105</b> (16)	133 (14)	220 (10)
BAMD	<b>26</b> (19)	<b>45</b> (17)	<b>75</b> (15)	<b>105</b> (14)	227 (10)
BAMM	<b>34</b> (19)	<b>66</b> (17)	<b>104</b> (15)	132 (14)	192 (10)
BAMS	52 (19)	101 (17)	144 (15)	187 (14)	255 (10)
NGPI	49 (19)	102 (17)	162 (15)	262 (13)	489 (9)
UKMI	53 (19)	96 (17)	<b>91</b> (15)	<b>103</b> (13)	267 (5)
GUNS	46 (19)	83 (17)	<b>93</b> (15)	126 (13)	201 (5)
NHC Official	41 (20)	76 (18)	121 (16)	125 (14)	176 (10)
NHC Official (1991-2000 mean)	44 (2049)	82 (1835)	118 (1646)	151 (1475)	226 (1187)

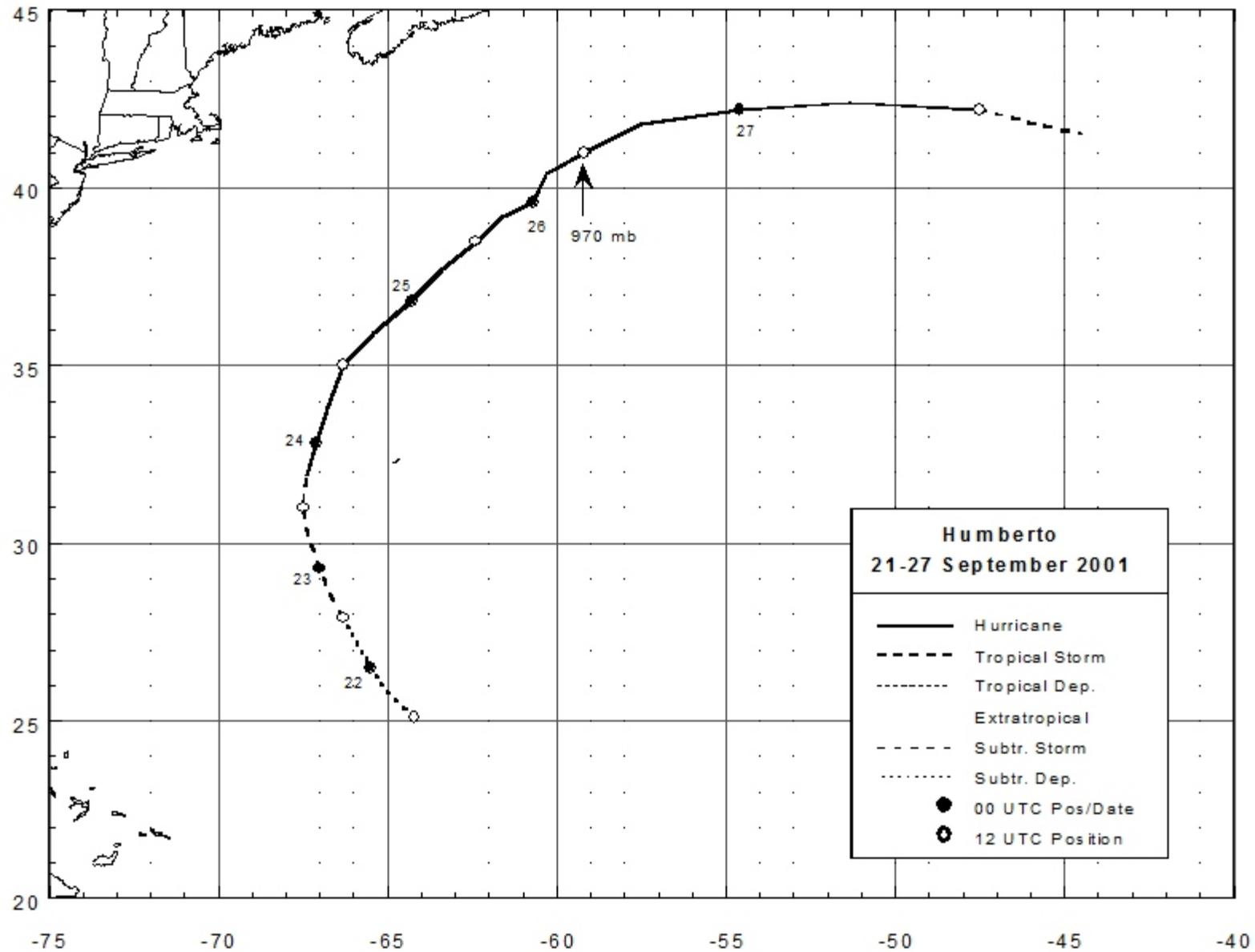


Figure 1. Best track positions for Hurricane Humberto, 21-27 Sept. 2001.

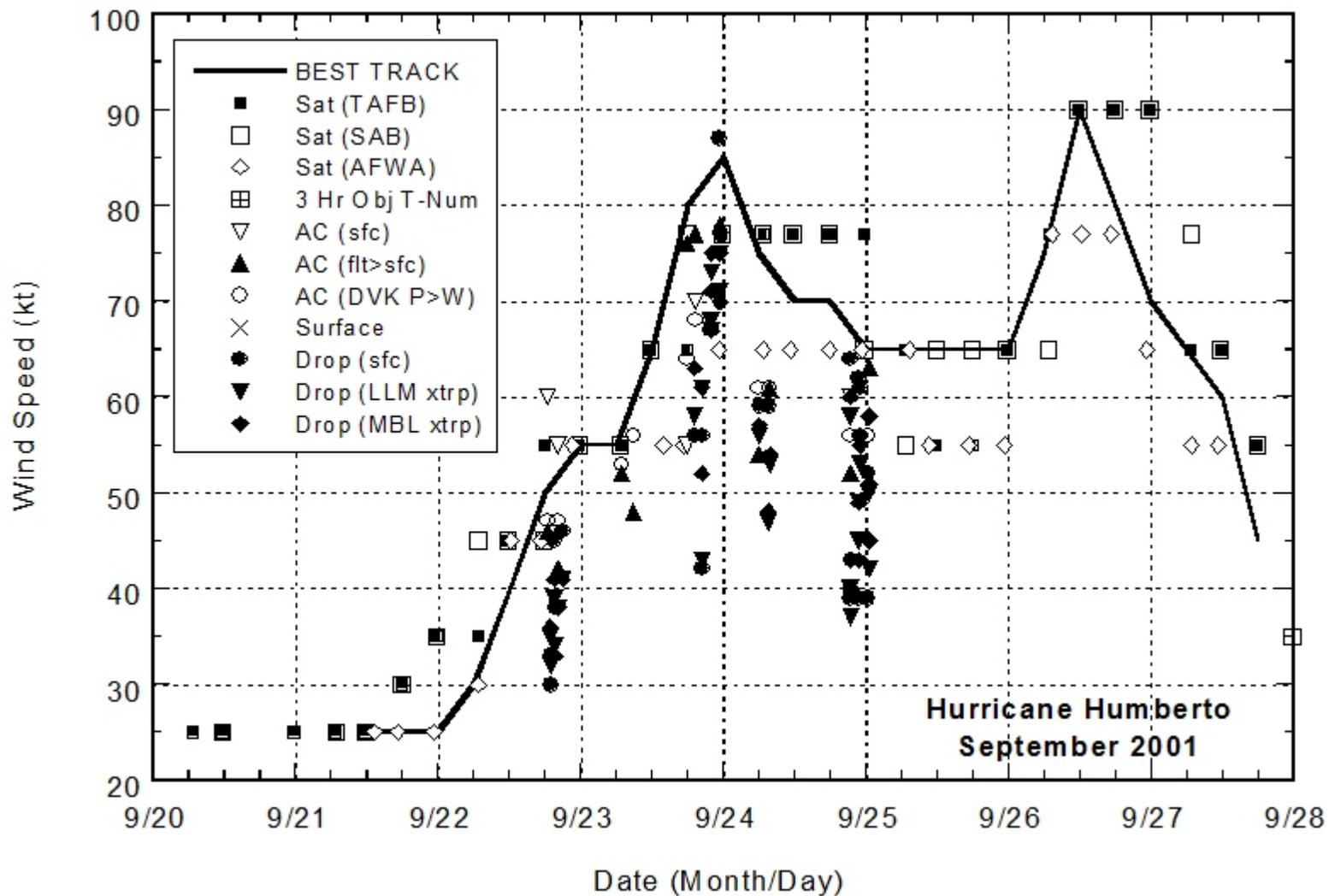


Figure 2. Best track maximum sustained surface wind speed curve for Hurricane Humberto, 21-27 Sept. 2001, and the observations on which the best track curve is based. Aircraft observations have been adjusted for elevation using 90%, 80%, and 80% reduction factors for observations from 700 mb, 850 mb, and 1500 ft, respectively. Dropwindsonde observations include actual 10 m winds (sfc), as well as surface estimates derived from the mean wind over the lowest 150 m of the wind sounding (LLM), and from the sounding boundary layer mean (MBL).

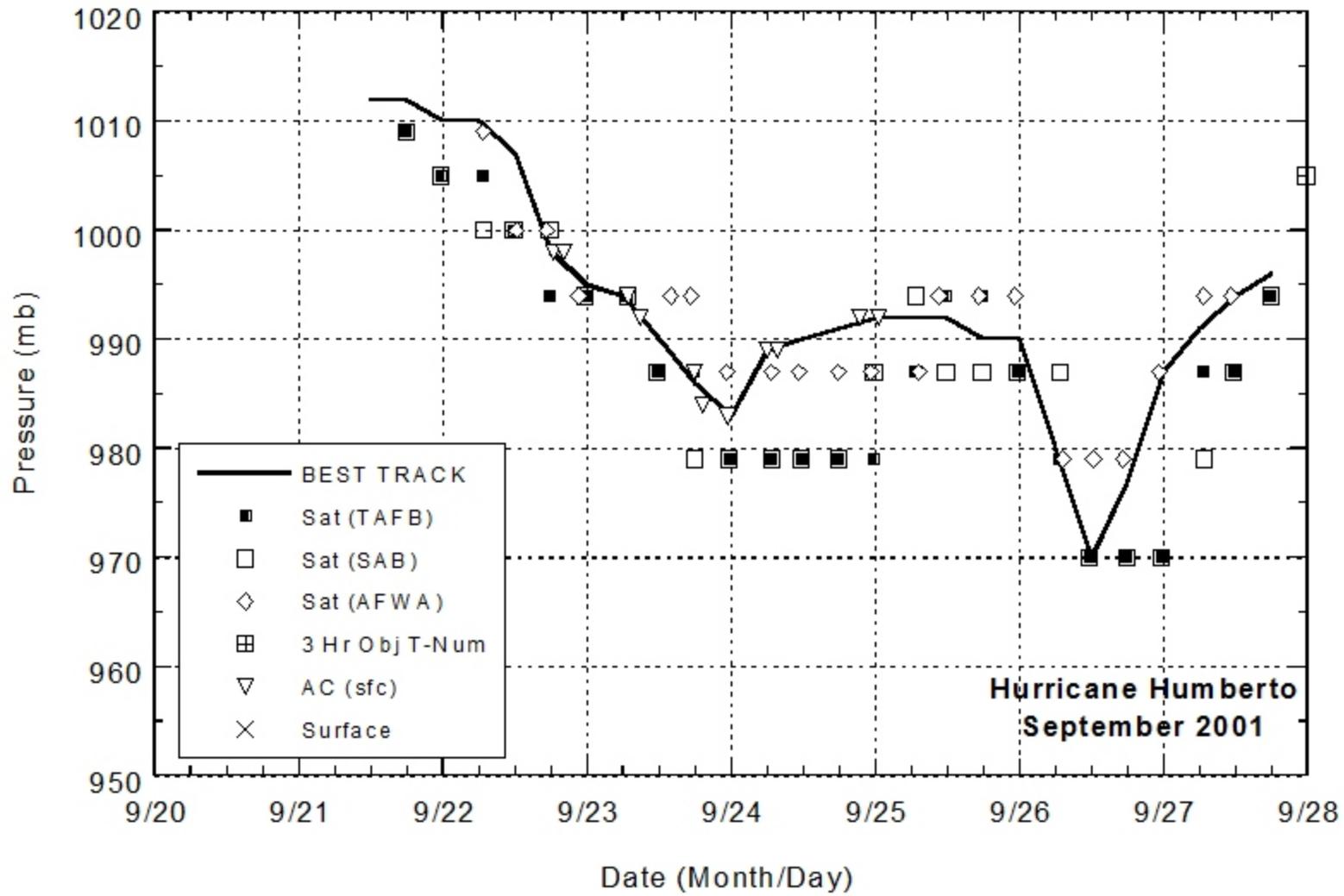


Figure 3. Best track minimum central pressure curve for Hurricane Humberto, 21-27 Sept. 2001, and the observations on which the best track curve is based.

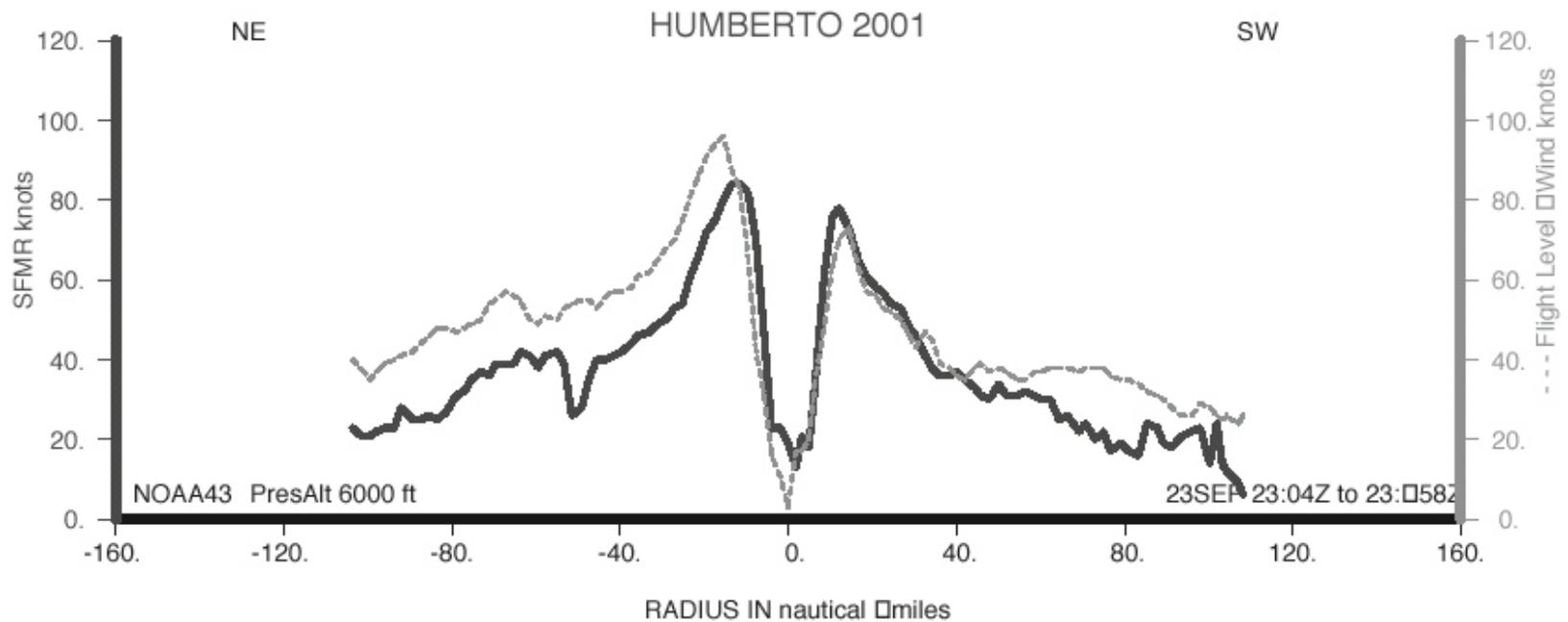


Figure 4. Horizontal wind profiles of flight-level (grey line) and SFMR-derived surface wind (heavy black line) during a northeast to southwest traverse across the core of Hurricane Humberto from 2304-2358 UTC 23 September 2001. Flight level of the NOAA WP-3D aircraft was 850 mb. Diagram courtesy of Dr. Peter Black, NOAA/Hurricane Research Division.

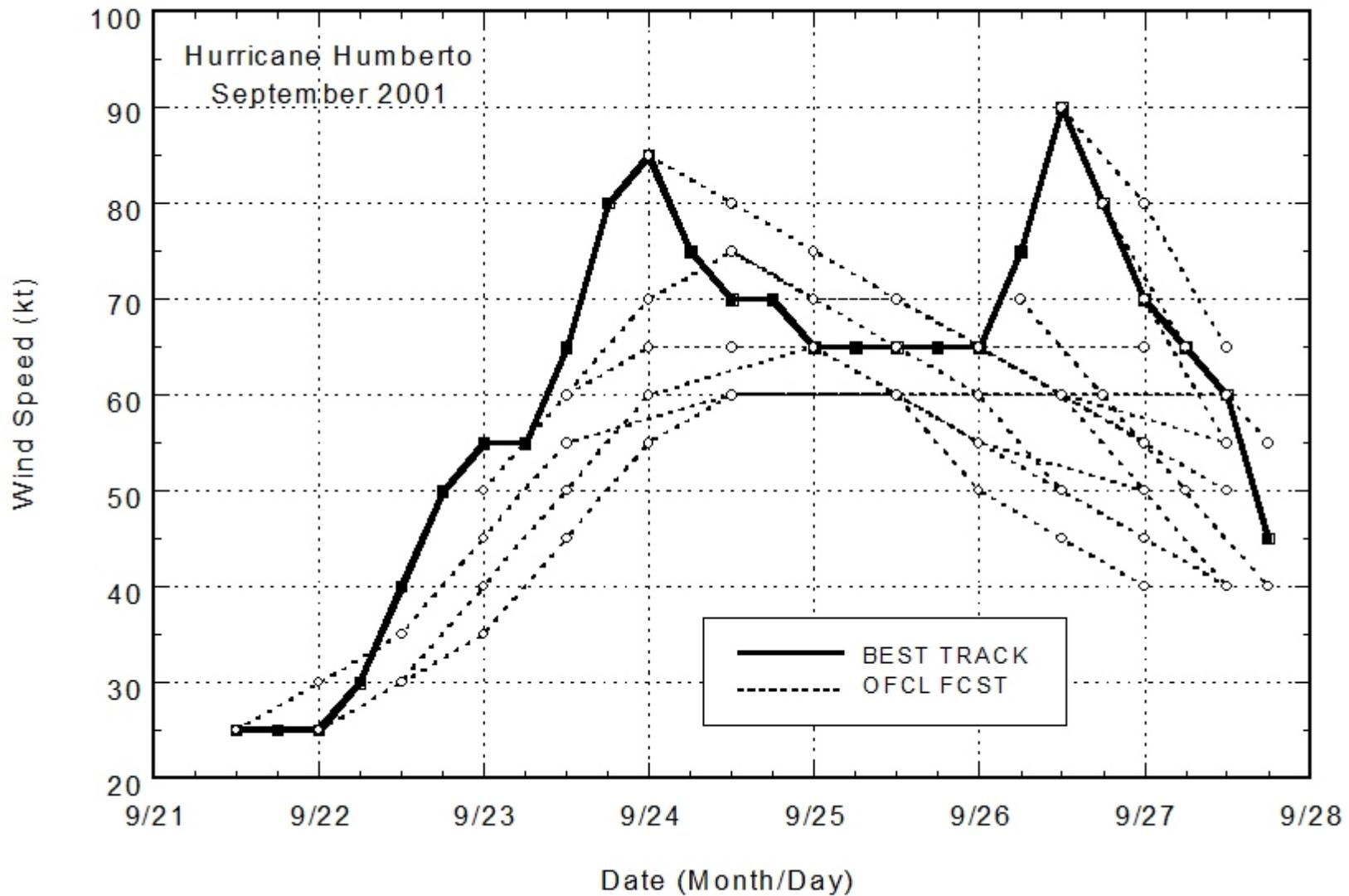


Figure 5. Selected official intensity forecasts (dashed lines) for Hurricane Humberto, 21-27 Sept. 2001. The best track intensity is given by the thick solid line.