

Tropical Cyclone Report
Hurricane Fabian
27 August-8 September 2003

Richard J. Pasch, Eric S. Blake, and Daniel P. Brown
National Hurricane Center
19 November 2003

Fabian was a long-lived, powerful Cape Verde hurricane that struck Bermuda with category three intensity. It caused extensive damage on that island, where it was reported to be the worst hurricane since 1926.

a. Synoptic History

Fabian's genesis can be traced back to a vigorous tropical wave that emerged from western Africa on 25 August, and moved westward through the Cape Verde Islands a day later. By 27 August, the deep convection associated with the system became more consolidated in a circular area, and it is estimated that a tropical depression formed at 1800 UTC, centered about 365 n mi west of the Cape Verde Islands. Fabian's path is shown in Fig. 1, and time series of the tropical cyclone's maximum sustained wind and minimum central pressure are displayed in Figs. 2 and 3, respectively. The best track positions and intensities are listed in Table 1. With a favorable atmospheric and oceanic environment (characterized by vertical shear from 850 to 200 mb of 5-10 kt or less, sea surface temperatures near 27.5°C), the tropical cyclone strengthened fairly steadily and became a tropical storm around 1200 UTC 28 August, and a hurricane by 0000 UTC 30 August over the east-central tropical Atlantic. Fabian reached its estimated peak intensity of 125 kt at 1800 UTC 1 September when it was centered about 265 n mi east-northeast of the northern Leeward Islands. This hurricane maintained Category 3 or Category 4 intensity on the Saffir-Simpson Hurricane Scale for almost a week.

Fabian was steered on a westward to west-northwestward heading for several days by deep easterlies to the south of a subtropical ridge. The forward speed gradually slowed from 18-19 kt just after genesis to less than 10 kt by 2 September, as the tropical cyclone neared a weakness in the subtropical ridge produced by a mid-level cyclonic circulation over the southwestern North Atlantic. Then, the hurricane turned toward the northwest while continuing to decelerate over the next couple of days. A large mid-tropospheric trough nearing the east coast of the United States provided a more northward steering flow, and Fabian turned north-northwestward to northward with increasing forward speed. Fabian targeted Bermuda, and struck that island with an intensity close to 100 kt. The eastern eyewall of the hurricane moved over Bermuda around 2000 UTC on 5 September. Observers on the western end of the island reported a brief interlude of blue sky and winds decreasing to 50-60 kt at various times between 1945 and 2115 UTC, which indicates that they were in the eastern fringes of Fabian's eye. The center of Fabian did not make landfall. However, since the eyewall passed over Bermuda, the hurricane made a direct hit on that island.

After raking Bermuda, the hurricane accelerated north-northeastward and northeastward, weakening to below 100 kt after 1800 UTC 6 September. Fabian lost its tropical characteristics on 8 September while located about 700 n mi east-northeast of Cape Race, Newfoundland. It turned northward the next day and merged with another extratropical cyclone between southern Greenland and Iceland.

b. Meteorological Statistics

Observations in Fabian (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 53rd Weather Reconnaissance Squadron of the U. S. Air Force Reserve Command (AFRES) and the National Oceanic and Atmospheric Administration (NOAA).

Fabian's peak intensity is estimated to be 125 kt, based on a 700 mb flight-level wind of 140 kt measured by AFRES around 1917 UTC 1 September. A minimum central pressure of 942 mb was measured at that time. A lower central pressure of 939 mb was measured by NOAA at 2245 UTC 3 September, but maximum flight-level winds around that time only supported an intensity of 115 kt.

Surface observations in Hurricane Fabian, all from Bermuda, are listed in Table 2. A sustained (10 min average) wind speed of 105 kt and a gust to 131 kt were measured by Cable and Wireless at an elevation of 280 ft above sea level. Sustained 104 kt winds, with gusts to 127 kt, were observed at Warwick Tower at an elevation of 220 ft above ground level. Sustained winds of 102 kt with a gust to 143 kt were measured by Bermuda Harbor Radio at an elevation of 255 ft above sea level. Since these observations are unofficial and at elevations significantly higher than 10 m, it is difficult to use them to make an accurate assessment of the hurricane's strength when it hit Bermuda. They are, however, not inconsistent with category three intensity. Unfortunately, due to a loss of power, the official wind measurements from the Bermuda Airport (TXKF) anemometer ended at 1935 UTC 5 September, and the extreme sustained and gust wind speed values were estimated. Ship and drifting buoy reports of winds of tropical storm force associated with Fabian are given in Table 3.

c. Casualty and Damage Statistics

Fabian was directly responsible for eight fatalities. A man drowned in a rip current near Cape Hatteras on 4 September. Four people drowned when they, and their vehicles, were swept off of a causeway in Bermuda on 5 September. Three fishermen drowned when their vessel sank about 350 n mi southeast of St. John's, Newfoundland on 7 September.

Bermuda was hit hard by Fabian. There was extensive damage to vegetation and considerable roof damage to houses in exposed locations. Some buildings had more severe damage, due to inherent structural weakness in some cases and possibly due to tornadoes (which were not confirmed) in others. There were huge (estimated 20 to 30 ft high) battering waves on the south shore of the island, with the reported storm surge estimated near 10 ft. Significant structural damage was inflicted as a result of wave action and/or surge. Property damage estimate in Bermuda is estimated to be at least 300 million U.S. dollars.

d. Forecast and Warning Critique

In comparison to the long-term average, Fabian's track was well predicted in most cases. Average official track errors (with the number of cases in parentheses) for Fabian were 25 (46), 45 (44), 64 (42), 83 (40), 114 (36), 136 (32), and 206 (28) n mi for the 12, 24, 36, 48, 72, 96, and 120

h forecasts, respectively¹. These errors are considerably (40-50%) lower than the average official track errors for the 10-yr period 1993-2002² of 45, 81, 116, 150, 225, 282, and 374, respectively. Overall, the official forecasts were slightly slow with somewhat of a westward bias. Table 4 lists the average forecast errors for the various track prediction models and model consensus for comparison with the official forecast errors. In general the official forecasts had lower average track errors than any of the individual models. However, the GUNS and GUNA consensus had average errors that were a little lower than, or the same as, the official forecasts at hours 12 through 72.

Average official intensity errors for Fabian were 4, 7, 10, 13, 18, 20, and 21 kt for the 12, 24, 36, 48, 72, 96, and 120 h forecasts, respectively. For comparison, the average official intensity errors over the 10-yr period 1993-2002 are 6, 10, 13, 15, 19, 21, and 22 kt, respectively. Thus the intensity forecasts for Fabian were about the same as the recent historical averages.

Table 5 lists the watches and warnings, all for Bermuda, associated with Hurricane Fabian. A hurricane watch was issued 35 h before Fabian's closest approach, and a hurricane warning was issued 29 h before Fabian's closest approach.

Acknowledgements

We thank Roger Williams, director of the Bermuda Meteorological Service, for providing meteorological observations and the information on Fabian's impact on Bermuda.

¹ All forecast verifications in this report include the depression stage of the cyclone. National Hurricane Center verifications presented in these reports prior to 2003 did not include the depression stage.

² Errors given for the 96 and 120 h periods are averages over the two-year period 2001-2.

Table 1. Best track for Hurricane Fabian, 27 August-8 September 2003.

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
27 / 1800	14.6	30.7	1009	25	tropical depression
28 / 0000	14.7	32.3	1008	30	"
28 / 0600	14.9	34.2	1008	30	"
28 / 1200	15.0	36.2	1006	35	tropical storm
28 / 1800	15.1	38.2	1004	40	"
29 / 0000	15.2	40.1	1000	45	"
29 / 0600	15.4	41.8	997	50	"
29 / 1200	15.5	43.1	997	50	"
29 / 1800	15.8	44.3	990	60	"
30 / 0000	16.3	45.6	987	65	hurricane
30 / 0600	16.7	46.9	984	70	"
30 / 1200	17.0	48.0	973	85	"
30 / 1800	17.3	49.2	960	100	"
31 / 0000	17.6	50.3	952	110	"
31 / 0600	17.8	51.4	952	110	"
31 / 1200	18.0	52.5	952	110	"
31 / 1800	18.2	53.5	948	115	"
01 / 0000	18.3	54.3	945	120	"
01 / 0600	18.5	55.3	949	120	"
01 / 1200	18.7	56.3	949	120	"
01 / 1800	19.0	57.3	944	125	"
02 / 0000	19.3	58.3	943	125	"
02 / 0600	19.6	59.2	945	120	"
02 / 1200	20.1	59.9	945	120	"
02 / 1800	20.5	60.7	946	120	"
03 / 0000	20.9	61.3	945	115	"
03 / 0600	21.3	61.8	945	110	"

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
03 / 1200	21.9	62.3	945	110	"
03 / 1800	22.5	62.8	944	110	"
04 / 0000	23.2	63.0	939	115	"
04 / 0600	23.8	63.3	944	105	"
04 / 1200	24.8	63.8	944	105	"
04 / 1800	25.8	64.3	941	110	"
05 / 0000	27.1	64.6	940	115	"
05 / 0600	28.6	65.1	946	105	"
05 / 1200	30.1	65.3	951	105	"
05 / 1800	31.8	65.3	950	105	"
06 / 0000	33.4	64.7	953	100	"
06 / 0600	34.9	64.0	956	100	"
06 / 1200	36.0	62.4	957	100	"
06 / 1800	36.9	60.4	958	100	"
07 / 0000	37.9	58.2	962	90	"
07 / 0600	39.1	55.7	965	85	"
07 / 1200	40.6	53.4	967	80	"
07 / 1800	42.3	50.7	972	75	"
08 / 0000	44.3	47.9	975	70	"
08 / 0600	46.3	44.7	977	70	"
08 / 1200	48.7	40.8	980	65	"
08 / 1800	51.7	36.0	980	65	extratropical
09 / 0000	54.0	32.0	980	60	"
09 / 0600	56.0	29.0	982	50	"
09 / 1200	58.0	27.0	982	50	"
09 / 1800	60.0	27.0	990	40	"
10 / 0000					absorbed
01 / 1800	19.0	57.3	944	125	maximum intensity

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
04 / 0000	23.2	63.0	939	115	minimum pressure
05 / 2000	32.3	65.1	952	100	closest approach (12 n mi west) to Bermuda

Table 2. Selected surface observations for Hurricane Fabian, 5 September 2003.

Location	Minimum Sea Level Pressure		Maximum Surface Wind Speed			Storm surge (ft) ^c	Storm tide (ft) ^d	Total rain (in)
	Time (UTC)	Press. (mb)	Time (UTC) ^a	Sustained (kt) ^b	Gust (kt)			
Bermuda								
Bermuda Airport (TXKF)	2030	964.0	2055	105 ^e	130 ^e			1.82 ^f
TXKF anemometer site ^g			1927	72	102			
Cable and Wireless ^h			1940	105	131			
Bermuda Harbour Radio ⁱ	2050	961.0	1855	102	143			
Weatherbird (research vessel) ^j	2048	961.0	1855	67	95			
Pitt's Bay (Hamilton) ^k	2000	960.0						
Cambridge Beaches Hotel ^l	2100	953.0						
Southampton ^m	2000	954.5						
Warwick Tower ⁿ			1900	98	120			
Warwick Tower ^o			1900	104	127			

^a Time is for sustained wind.

^b Averaging period is 10 min.

^c Storm surge is water height above normal astronomical tide level.

^d Storm tide is water height above National Geodetic Vertical Datum (1929 mean sea level).

^e TXKF maximum winds estimated at weather service building 130 ft asl.

^f Rain data unreliable but total rainfall amounts were unlikely to exceed 3 in. Most observations reported only light rain and low visibility due to sea spray.

^g Airfield anemometer 40 ft asl; power failed at mast base due to storm surge at 1935 UTC.

^h Instrument height 280 ft asl.

ⁱ Instrument height 255 ft asl; mast fell down shortly after peak gust at 1935 UTC. Pressure from barograph trace.

^j Wind instrument not well exposed.

^k Voluntary observer (barograph).

^l West end of Bermuda; pressure from barograph (time not calibrated).

^m Voluntary observer; Davis Instruments.

ⁿ Instrument height 157 ft agl.

^o Instrument height 220 ft agl.

Table 3. Available ship and drifting buoy reports with winds of at least 34 kt for Hurricane Fabian, 2003.

Date/Time (UTC)	Ship call sign or buoy ID	Latitude (°N)	Longitude (°W)	Wind dir/speed (kt)	Pressure (mb)
03 / 1800	ELRU8	20.6	59.4	180 / 35	1014.5
05 / 0000	ELZU6	29.0	61.7	150 / 37	1014.0
05 / 0900	ELZU6	30.9	63.0	140 / 41	1010.0
05 / 2200	ELZU6	34.3	66.1	040 / 43	1003.0
07 / 1200	3FKD9	38.4	51.1	180 / 45	1007.3
07 / 2000	44551	43.5	45.7	150 / 39	1006.1
07 / 2100	44551	43.5	45.7	150 / 39	1003.2
08 / 0300	VEP717	46.7	48.7	010 / 35	993.8
08 / 0300	3FPK7	46.7	48.0	320 / 36	990.7
08 / 0300	HP6038	46.4	48.4	040 / 40	990.9
08 / 0600	ELVX4	43.0	40.8	200 / 35	1011.0
08 / 0600	VEP717	46.7	48.7	350 / 40	995.2
08 / 0600	3FPK7	46.7	48.0	340 / 37	992.7
08 / 0600	HP6038	46.4	48.4	310 / 41	993.6
08 / 0700	62711	47.3	45.8	320 / 70	985.7
08 / 0800	62711	47.3	45.8	350 / 45	985.5
08 / 0900	HP6038	46.4	48.4	290 / 36	1001.9

Table 4. Preliminary forecast evaluation (heterogeneous sample) for Hurricane Fabian, 27 August-8 September 2003. Forecast errors (n mi) are followed by the number of forecasts in parentheses. Errors smaller than the NHC official forecast are shown in bold-face type. Verification includes the depression stage, but does not include the extratropical stage, if any.

Forecast Technique	Forecast Period (h)						
	12	24	36	48	72	96	120
CLP5	34 (46)	78 (44)	114 (42)	155 (40)	253 (36)	351 (32)	413 (28)
GFNI	27 (38)	52 (37)	73 (35)	90 (33)	147 (30)		
GFDI	26 (43)	49 (42)	71 (40)	96 (37)	159 (33)	197 (29)	261 (25)
GFDL	28 (45)	50 (43)	71 (41)	92 (38)	154 (34)	201 (30)	240 (26)
LBAR	31 (45)	68 (43)	99 (41)	132 (39)	219 (35)	315 (31)	422 (27)
AVNI	27 (44)	51 (42)	77 (40)	114 (38)	181 (34)	191 (30)	275 (24)
AVNO	32 (45)	55 (43)	77 (41)	109 (39)	177 (35)	207 (31)	250 (25)
AEMI	26 (24)	51 (22)	74 (21)	100 (20)	177 (18)	277 (13)	469 (11)
BAMD	31 (46)	62 (44)	88 (42)	112 (40)	193 (36)	260 (32)	356 (28)
BAMM	37 (46)	73 (44)	106 (42)	140 (40)	219 (36)	286 (32)	358 (28)
BAMS	50 (45)	99 (43)	143 (41)	181 (39)	259 (35)	315 (31)	380 (27)
NGPI	24 (42)	46 (40)	73 (38)	98 (36)	156 (32)	220 (28)	274 (24)
NGPS	27 (43)	42 (41)	66 (39)	93 (37)	149 (33)	216 (29)	268 (25)
UKMI	29 (44)	53 (42)	69 (40)	80 (38)	103 (34)	190 (30)	248 (26)
UKM	29 (23)	52 (22)	77 (21)	89 (20)	100 (18)	171 (16)	229 (14)
A98E	32 (46)	61 (44)	102 (42)	144 (40)	248 (36)	327 (32)	403 (28)
A9UK	28 (23)	57 (22)	83 (21)	109 (20)	176 (18)		
GUNS	19 (41)	37 (40)	55 (38)	75 (35)	109 (31)	159 (27)	216 (23)
GUNA	19 (41)	37 (40)	56 (38)	77 (35)	114 (31)	144 (27)	211 (21)
OFCL	25 (46)	45 (44)	64 (42)	83 (40)	114 (36)	136 (32)	206 (28)
NHC Official (1993-2002 mean)	45 (2985)	81 (2726)	116 (2481)	150 (2230)	225 (1819)	282 (265)	374 (216)

Table 5. Watch and warning summary for Hurricane Fabian, September 2003.

Date/Time (UTC)	Action	Location
04/0900	Hurricane Watch	Bermuda
04/1500	Hurricane Warning	Bermuda
06/0300	Hurricane Warning Discontinued	Bermuda

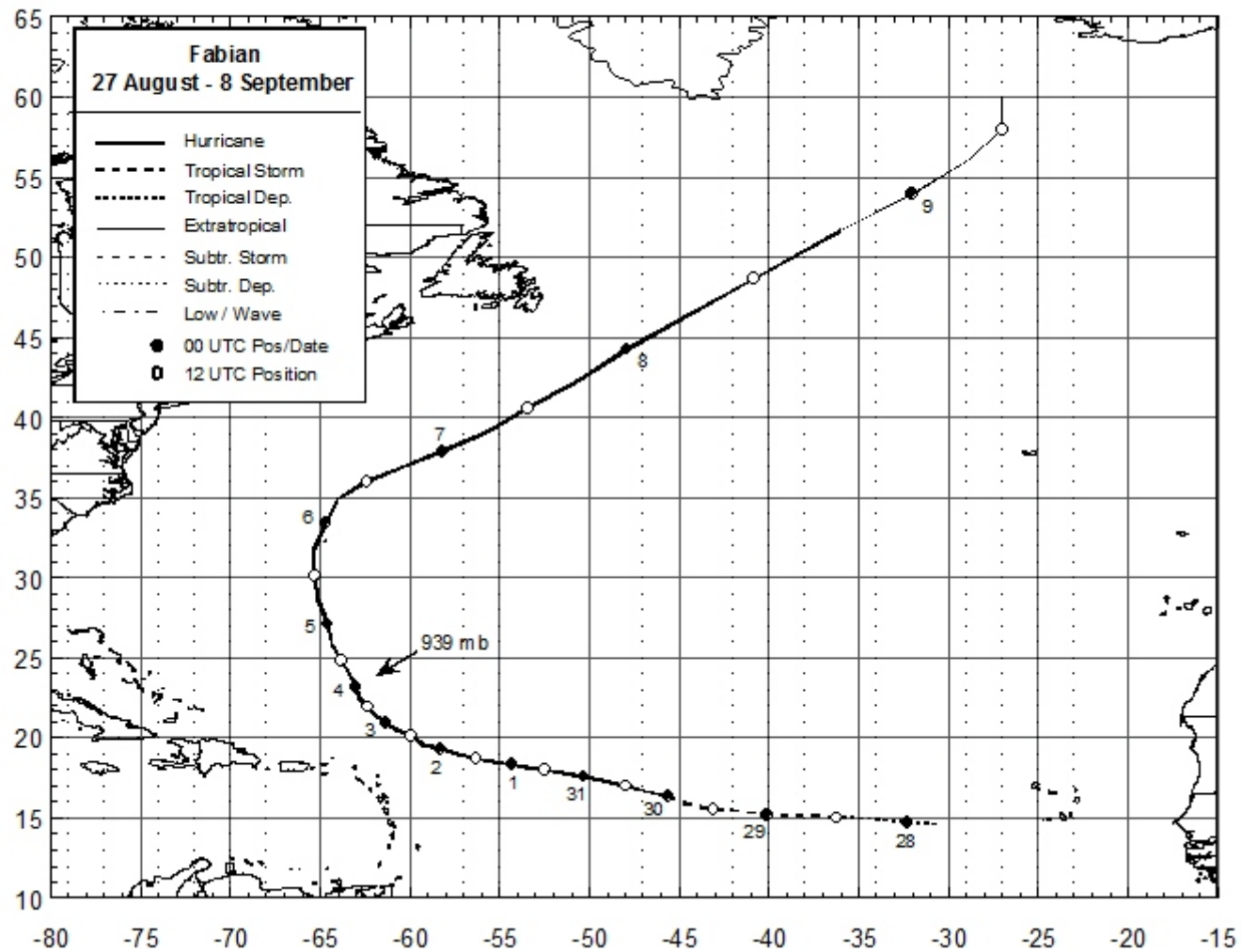


Figure 1. Best track positions for Hurricane Fabian, August/September 2003. Track during the extratropical stage is based on analyses from the NOAA Ocean Prediction Center.

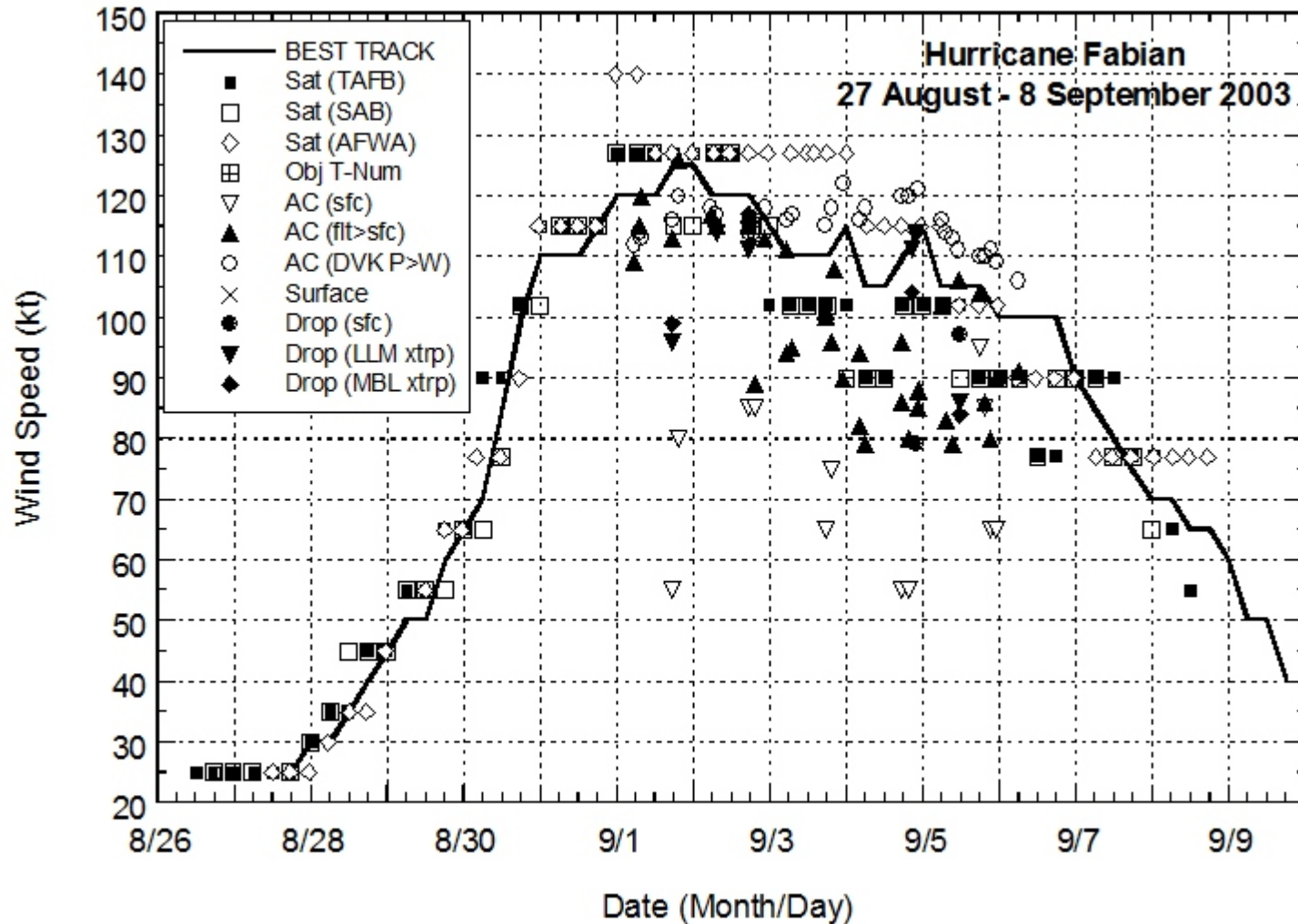


Figure 2. Selected wind observations and best track maximum sustained surface wind speed curve for Hurricane Fabian, August/September 2003. Aircraft observations have been adjusted for elevation using 90%, 80%, and 80% reduction factors for observations from 700 mb, 850 mb, and 1500 ft, respectively. 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). Estimates during the extratropical stage are based on analyses from the NOAA Ocean Prediction Center.

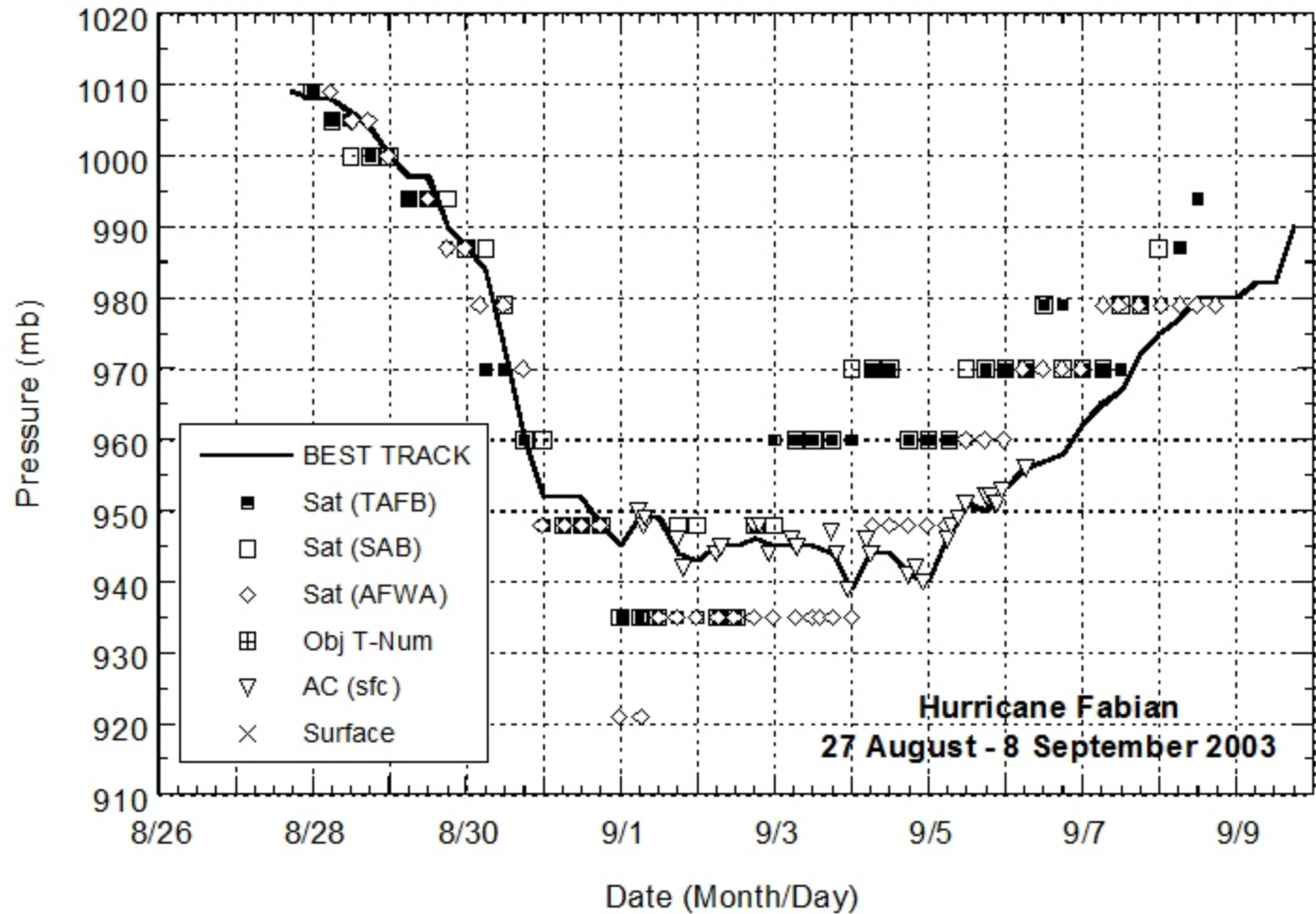


Figure 3. Selected pressure observations and best track minimum central pressure curve for Hurricane Fabian, August/September 2003. Objective Dvorak estimates represent linear averages over a three-hour period centered on the nominal observation time. Estimates during the extratropical stage are based on analyses from the NOAA Ocean Prediction Center.