Tropical Cyclone Report
Hurricane Isaac
(AL092006)
27 September-02 October 2006

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Isaac was a category 1 hurricane (on the Saffir-Simpson Hurricane Scale) that developed over the central Atlantic Ocean. Even though Isaac did not make landfall, it produced tropical storm force winds over portions of southeastern Newfoundland.

a. Synoptic History

Isaac developed from a tropical wave that exited the west coast of Africa on 18 September. An area of disturbed weather associated with this wave began to show signs of organization with some curved bands and deep convection on 23 September, while located about 900 n mi west of the Cape Verde Islands. The increased organization of convection led to the initiation of Dvorak classifications at 0600 UTC that day. Convection pulsated for several days as the large disturbance moved west-northwestward under the influence of moderate to strong upper-level winds. After four days, and once the upper-level winds relaxed, the system was able to acquire sufficient organization to be designated as a tropical depression, while centered about 810 n mi east-southeast of Bermuda at 1800 UTC 27 September. 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.

The depression strengthened to a tropical storm around 0600 UTC 28 September, about 12 h after the cyclone's formation. Initially, the cyclone moved northwestward between an upper-level low to its west-southwest and a low- to mid-level ridge to its east. Deep convection sputtered throughout the day, possibly due to cool water that had been upwelled there by both Hurricane's Gordon and Helene. In addition to the cooled waters, water vapor imagery indicated that some mid- to upper-level dry air had become entrained into Isaac's core and the cyclone appeared to have some subtropical characteristics with a baroclinic-type cloud-pattern and little convection near the core on 28 September. The next day, the cyclone began to move in a more west-northwestward motion in response to mid-level ridging over the central Atlantic. Isaac appeared to be more tropical as deep convection re-developed around the center and the cloud pattern became more consolidated. Vertical shear was also lessening, and in combination with the system moving away from the area of upwelled waters, Isaac began to strengthen. The favorable atmospheric and oceanic environment resulted in Isaac intensifying to hurricane status around 1200 UTC 30 September. This strengthening episode was short-lived and Isaac reached its peak intensity of 75 kt around 0000 UTC 1 October, while centered about 285 n mi east of Bermuda.

On 1 October, Isaac began to recurve around the western periphery of a subtropical ridge with an increase in forward speed. The cyclone moved quickly to the north-northeast on 2 October ahead of a deep-layer trough approaching from the west. During this time, Isaac encountered increasing southwesterly shear and cooler sea surface temperatures. By 1200 UTC that day, it weakened to a tropical storm. While racing toward the northeast around 35 kt on 2 October, Isaac passed about 35 n mi southeast of the Avalon Peninsula of Newfoundland late in the afternoon. Although Isaac remained offshore, tropical storm force winds were felt across portions of the southern Avalon Peninsula. Isaac maintained tropical cyclone status as it passed Newfoundland since it still possessed a core of strong winds and convection near the center. Thereafter, Isaac quickly transitioned to an extratropical cyclone by 0000 UTC 3 October and merged with a larger extratropical low by 1800 UTC later that day.

b. Meteorological Statistics

Observations in Isaac (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). Microwave satellite imagery from NOAA polar-orbiting satellites, the NASA Tropical Rainfall Measuring Mission (TRMM), the NASA QuikSCAT, and Defense Meteorological Satellite Program (DMSP) satellites were also useful in tracking Isaac. Isaac was embedded in an area of high pressures throughout its lifetime, which caused the minimum pressures to be different than the Dvorak curve estimations as shown in Figure 3.

Ship reports of winds of tropical storm force associated with Isaac are given in Table 2. The most noteworthy ship observation was 45-kt from the **Elektra** (call sign SIWB) at 0600 UTC 2 October. At that time, the **Elektra** was located about 150 n mi east of the center of Isaac.

Isaac brought tropical storm conditions to portions of the southern Avalon Peninsula of Newfoundland during the afternoon and evening of 2 October; selected surface observations from land stations, data buoys, and oil platforms are given in Table 3. The strongest winds reported on land occurred from the Cape Race Newfoundland station where sustained winds reached 40 kt and gusts reached 52 kt. There was also an observation from a private weather station at Cape Pine which reported a gust of 41 kt. Since the strongest winds associated with Isaac were located in the eastern semicircle over the offshore waters, the Avalon Peninsula had relatively light winds across most of the area. Moreover, the rapid forward motion of the tropical cyclone while it was passing southeast of Newfoundland resulted in modest rainfall amounts of one inch or less across the warned area. At 1500 UTC 2 October, the Canadian moored buoy 44138 reported sustained winds of 45 kt with gusts of 56 kt at a 5 m elevation. This observation was around 60 n mi east of the center of Isaac's circulation. At 0000 UTC 3 October, after extratropical transition, three oil platforms (HP6038, VEP717, and YJUF7) reported 48-56 kt sustained winds about 110 n mi east-southeast of the circulation center. It should be noted that the anemometer heights on these oil rigs are between 60 m and 90 m.

c. Casualty and Damage Statistics

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

d. Forecast and Warning Critique

The potential development of Isaac was introduced into the Tropical Weather Outlook (TWO) on 20 September, about nine days prior to genesis. The system was described as "a tropical wave accompanied by a broad surface low pressure system". By early on 24 September, the system showed enough signs of organization that the potential of a depression forming was mentioned in the TWO. However, the low moved into an area of unfavorable upper-level winds over the next couple of days where the potential for further development lessened. By early on 26 September, the system reacquired enough organization to indicate the system had the potential, once again, to become a depression in the TWO, which was 42 hours prior to the first advisory issuance.

A verification of official and guidance model track forecasts is given in Table 4. Average official track errors for Isaac were 29, 51, 76, 115, 193, 317, and 574 n mi for the 12, 24, 36, 48, 72, 96, and 120 h forecasts, respectively. The number of forecasts ranged from 19 at 12 h to 1 at 120 h. These errors are lower than the average long-term official track errors during the 12 to 48 hour forecast periods but greater than average during the 3-day to 5-day forecast period (Table 4). The consensus models (GUNA/CONU/FSSE) performed quite well and had lower errors than the official forecasts. In particular, the FSSE had the lowest track errors of all the model guidance through 72 h. Most of the errors during the later time periods resulted from difficulties in forecasting the rapid increase in forward speed of the cyclone as it accelerated ahead of a large upper-trough. While the official track forecast errors were significantly higher than average, the sample size at these forecast times was quite small.

Average official intensity errors were 4, 6, 8, 12, 17, 13, and 5 kt for the 12, 24, 36, 48, 72, 96, and 120 h forecasts, respectively (Table 5). For comparison, the average long-term official intensity errors are 6, 10, 12, 14, 18, 20, and 22 kt, respectively. The official intensity forecasts were better than all guidance models through 48 h and better than the average long-term errors at days 3 through 5.

Watches and warnings associated with Isaac are listed in Table 6.

Acknowledgements:

Peter Bowyer and Chris Fogarty of the Canadian Hurricane Centre provided the land, Canadian moored buoy, and Canadian oil platforms observations that were used in this report.

Table 1. Best track for Hurricane Isaac, 27 September – 2 October 2006.

Date/Time (UTC)	Latitude (^{o}N)	Longitude (^{o}W)	Pressure (mb)	Wind Speed (kt)	Stage
27 / 1800	26.1	52.6	1012	30	tropical depression
28 / 0000	26.8	53.4	1012	30	"
28 / 0600	27.4	54.0	1008	35	tropical storm
28 / 1200	28.0	54.4	1006	40	"
28 / 1800	28.6	54.6	1006	40	"
29 / 0000	28.9	54.9	1006	40	"
29 / 0600	29.0	55.4	1006	40	"
29 / 1200	29.2	55.8	1003	45	"
29 / 1800	29.5	56.5	1000	50	"
30 / 0000	29.8	57.1	997	60	"
30 / 0600	30.1	57.7	995	60	"
30 / 1200	30.6	58.5	992	65	hurricane
30 / 1800	31.3	59.2	989	70	"
01 / 0000	32.0	59.8	987	75	"
01 / 0600	32.8	60.2	985	75	"
01 / 1200	33.8	60.3	986	70	"
01 / 1800	35.2	60.3	987	70	"
02 / 0000	37.2	59.6	988	65	"
02 / 0600	39.8	58.0	989	65	"
02 / 1200	42.5	56.2	990	60	tropical storm
02 / 1800	45.5	53.7	995	55	"
03 / 0000	47.6	51.0	996	55	extratropical
03 / 0600	48.6	49.0	998	45	"
03 / 1200	49.5	47.0	1000	35	"
03 / 1800					merged with extratropical low
01 / 0000	32.0	59.8	985	75	minimum pressure

Table 2. Selected ship reports with winds of at least 34 kt for Hurricane Isaac, 27 September – 2 October 2006

Date/Time (UTC)	Ship call sign	Latitude (^{o}N)	Longitude (^{o}W)	Wind dir/speed (kt)	Pressure (mb)
02 / 0600	SIWB	40.2	54.7	160 / 45	1016.6
03 / 0000	DGSE	45.0	48.2	190 / 37	1014.0
03 / 0000	WCZ654	46.5	48.2	190 / 40	1008.9

Table 3. Selected surface observations for Hurricane Isaac, 27 September – 2 October 2006.

Location	Minimum Sea Level Pressure		Maximum Surface Wind Speed			Storm surge (ft)[c]	Storm tide (ft)[d]	Total rain (in)
	Date/ time (UTC)	Press. (mb)	Date/ time (UTC)[a]	Sustained (kt)[b]	Gust (kt)			
Newfoundland								
Cape Race			02/1900	40	52			1.0
Cape Pine			02/1700		41			
Buoys								
Canadian moored buoy 44138 (44.3N 53.6W)	02 / 1600	999.9	02/1500	45	56			
Canadian moored buoy 44140 (43.8N 51.7W)			02/1700		35			
Canadian moored buoy 44251 (46.4N 53.4W)	02/1900	1001.1	02/1900		35			
Grand Banks Oil Platforms								
HP6038	03/0000	1009.2	03/0000	48				
VEP717	03/0000	1006.8	02/2100	56				
YJUF7	03/0000	1008.7	03/0000	52				

[a] Date/time is for sustained wind when both sustained and gust are listed.
[b] Except as noted, sustained wind averaging periods for C-MAN and land-based reports are 2 min; Canadian buoy averaging periods are 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).

Table 4. Preliminary track forecast evaluation (heterogeneous sample) for Hurricane Isaac, 27 September – 2 October 2006. 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.

Forecast Technique	Forecast Period (h)						
	12	24	36	48	72	96	120
CLP5	52 (19)	125 (17)	207 (15)	277 (13)	403 (9)	415 (5)	**450 (1)**
GFNI	29 (17)	**49 (13)**	83 (11)	130 (9)	228 (5)	448 (1)	
GFDI	35 (18)	61 (16)	88 (14)	**107 (12)**	**153 (8)**	**193 (4)**	
GFSI	46 (16)	78 (15)	109 (13)	143 (11)	240 (3)	**265 (1)**	
AEMI	59 (18)	94 (16)	117 (14)	121 (12)	**118 (7)**		
NGPI	29 (17)	**46 (15)**	**66 (13)**	**107 (11)**	**172 (7)**	**200 (3)**	
UKMI	46 (17)	69 (15)	**72 (13)**	125 (11)	**145 (7)**	**102 (3)**	
A98E	37 (19)	64 (17)	92 (15)	**111 (13)**	**168 (9)**	**298 (5)**	**132 (1)**
A9UK	36 (9)	67 (8)	101 (7)	145 (6)	**160 (4)**		
BAMD	35 (18)	56 (16)	88 (14)	120 (12)	**178 (8)**	**278 (5)**	**367 (1)**
BAMM	43 (18)	77 (16)	113 (14)	143 (12)	**191 (8)**	343 (5)	**118 (1)**
BAMS	65 (18)	119 (16)	165 (14)	195 (12)	198 (8)	**232 (5)**	**152 (1)**
CONU	29 (17)	**44 (15)**	**59 (13)**	**83 (11)**	**120 (7)**	**148 (3)**	
GUNA	**28 (16)**	**46 (15)**	**58 (13)**	**82 (11)**	**105 (3)**	**117 (1)**	
FSSE	**27 (16)**	**37 (14)**	**48 (12)**	**66 (10)**	**109 (6)**	**145 (2)**	
OFCL	29 (19)	51 (17)	76 (15)	115 (13)	193 (9)	317 (5)	574 (1)
NHC Official (2001-2005 mean)	37 (1930)	65 (1743)	91 (1569)	118 (1410)	171 (1138)	231 (913)	303 (742)

Table 5. Preliminary intensity forecast evaluation (heterogeneous sample) for Hurricane Isaac, 27 September – 2 October 2006. Forecast errors (kt) 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.

Forecast Technique	Forecast Period (h)						
	12	24	36	48	72	96	120
SHF5	4.7 (19)	6.9 (17)	10.3 (15)	11.8 (13)	**11.7 (9)**	**4.6 (5)**	**4.0 (1)**
GFDI	5.4 (18)	10.1 (16)	14.5 (14)	18.3 (12)	16.9 (8)	13.3 (4)	
SHIP	5.1 (19)	8.9 (17)	13.4 (15)	16.8 (13)	18.3 (9)	13.4 (5)	**2.0 (1)**
DSHP	5.1 (19)	8.9 (17)	13.4 (15)	16.8 (13)	18.3 (9)	13.4 (5)	**2.0 (1)**
FSSE	4.9 (16)	9.3 (14)	12.9 (12)	16.0 (10)	**10.8 (6)**	**6.5 (2)**	
ICON	5.5 (18)	9.6 (16)	13.2 (14)	16.8 (12)	**15.6 (8)**	**11.0 (4)**	
OFCL	3.7 (19)	5.9 (17)	7.7 (15)	11.5 (13)	16.7 (9)	13.0 (5)	5.0 (1)
NHC Official (2001-2005 mean)	6.3 (1930)	9.8 (1743)	12.1 (1569)	14.3 (1410)	18.4 (1138)	19.8 (913)	21.8 (742)

Table 6. Watch and warning summary for Hurricane Isaac, 27 September – 2 October 2006.

Date/Time (UTC)	Action	Location
01 / 0740	Tropical Storm Watch issued	Avalon Peninsula, Newfoundland
02 / 0900	Tropical Storm Watch upgraded to Tropical Storm Warning	Avalon Peninsula
02 / 0900	Tropical Storm Watch issued	Burin Peninsula and Bonavista Peninsula, Newfoundland
02 / 1800	Tropical Storm Watch discontinued	Burin Peninsula and Bonavista Peninsula
02 / 2100	Tropical Storm Warning discontinued	Avalon Peninsula

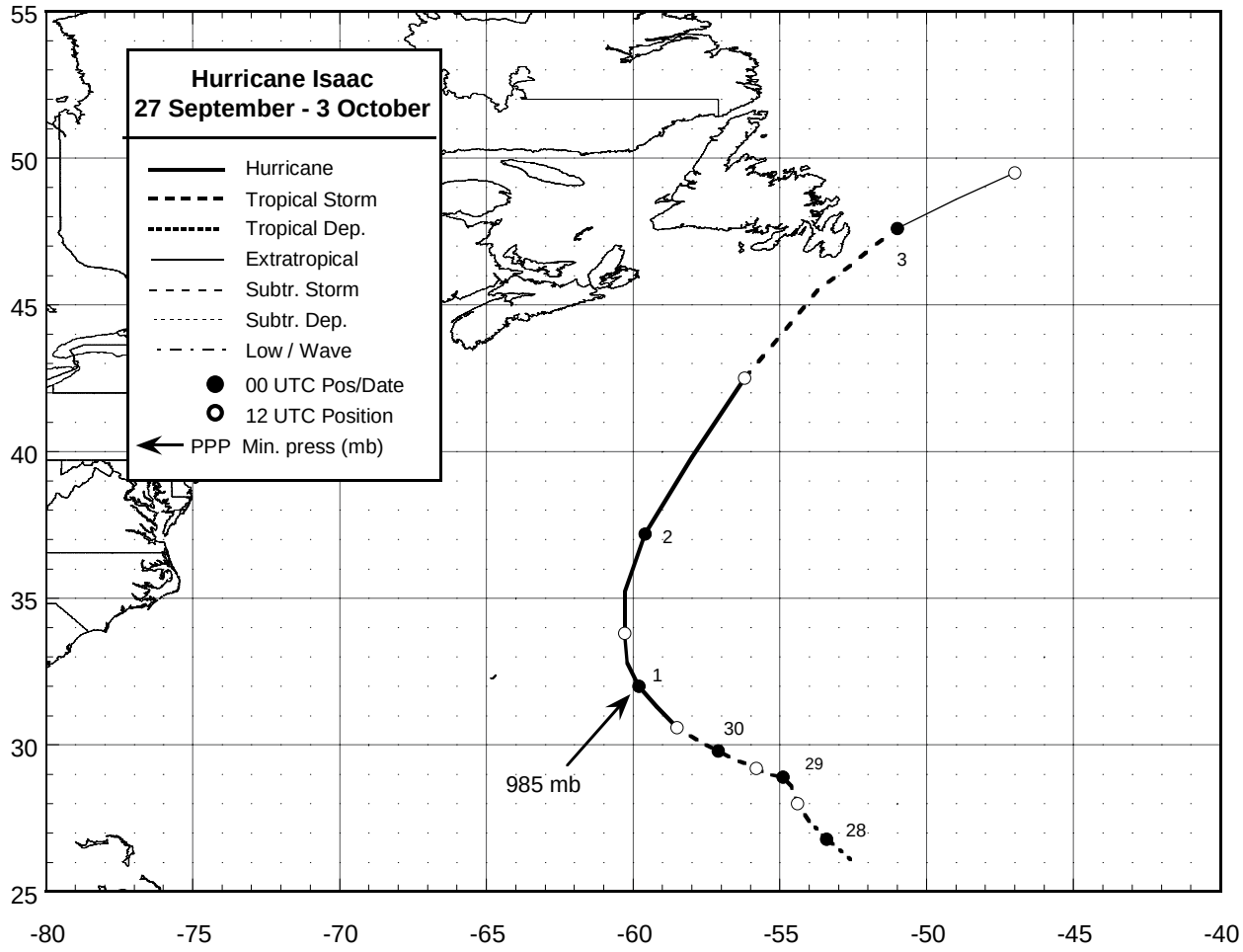

Figure 1. Best track positions for Hurricane Isaac, 27 September – 2 October 2006. Track during the extratropical stage is partly based on analyses from the NOAA Ocean Prediction Center and the Canadian Hurricane Centre.

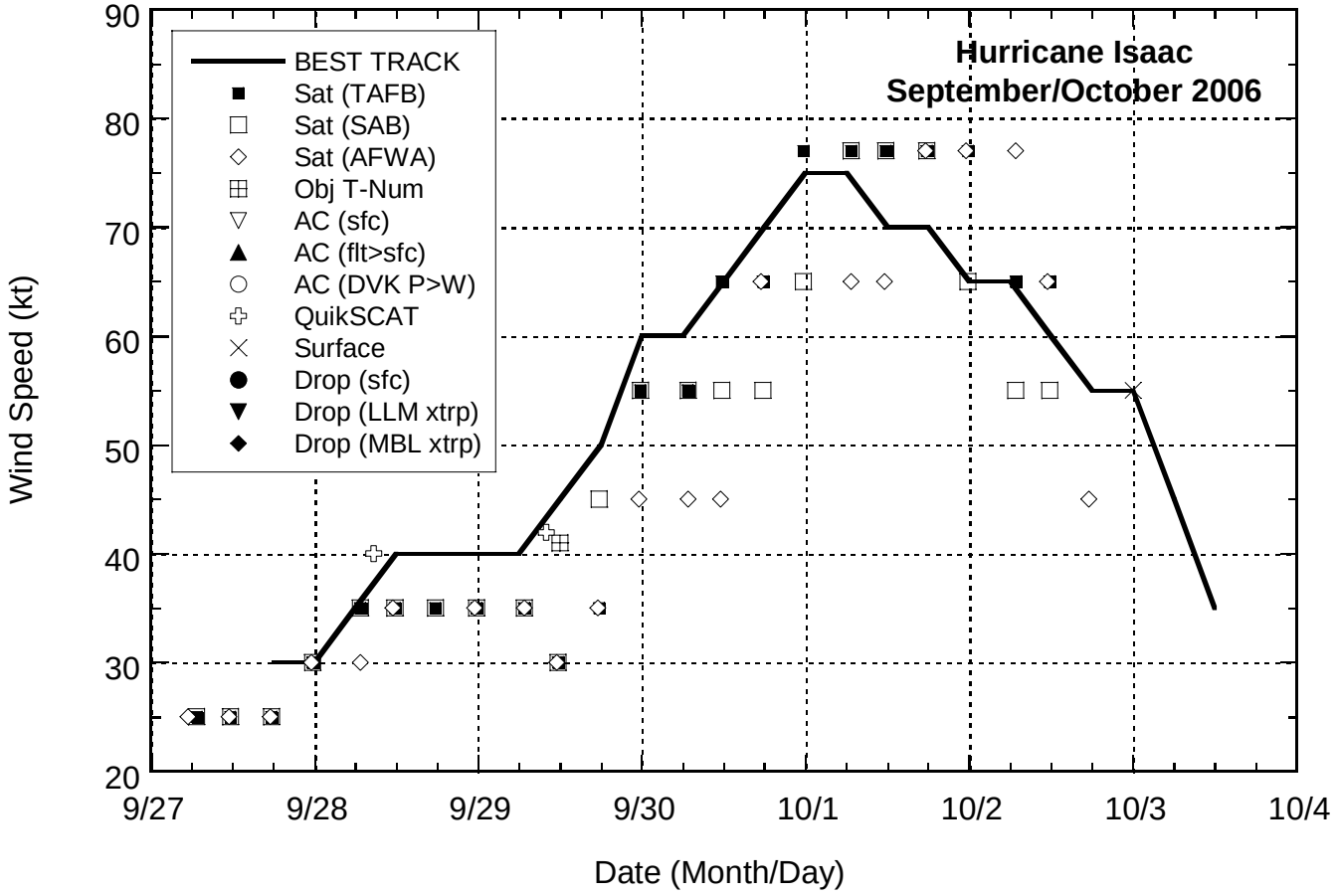

Figure 2. Selected wind observations and best track maximum sustained surface wind speed curve for Hurricane Isaac, 27 September – 2 October 2006. Objective Dvorak estimates represent linear averages over a three-hour period centered on the nominal observation time. Estimates during the extratropical stage are partly based on analyses from both the NOAA Ocean Prediction Center and Canadian Hurricane Centre.

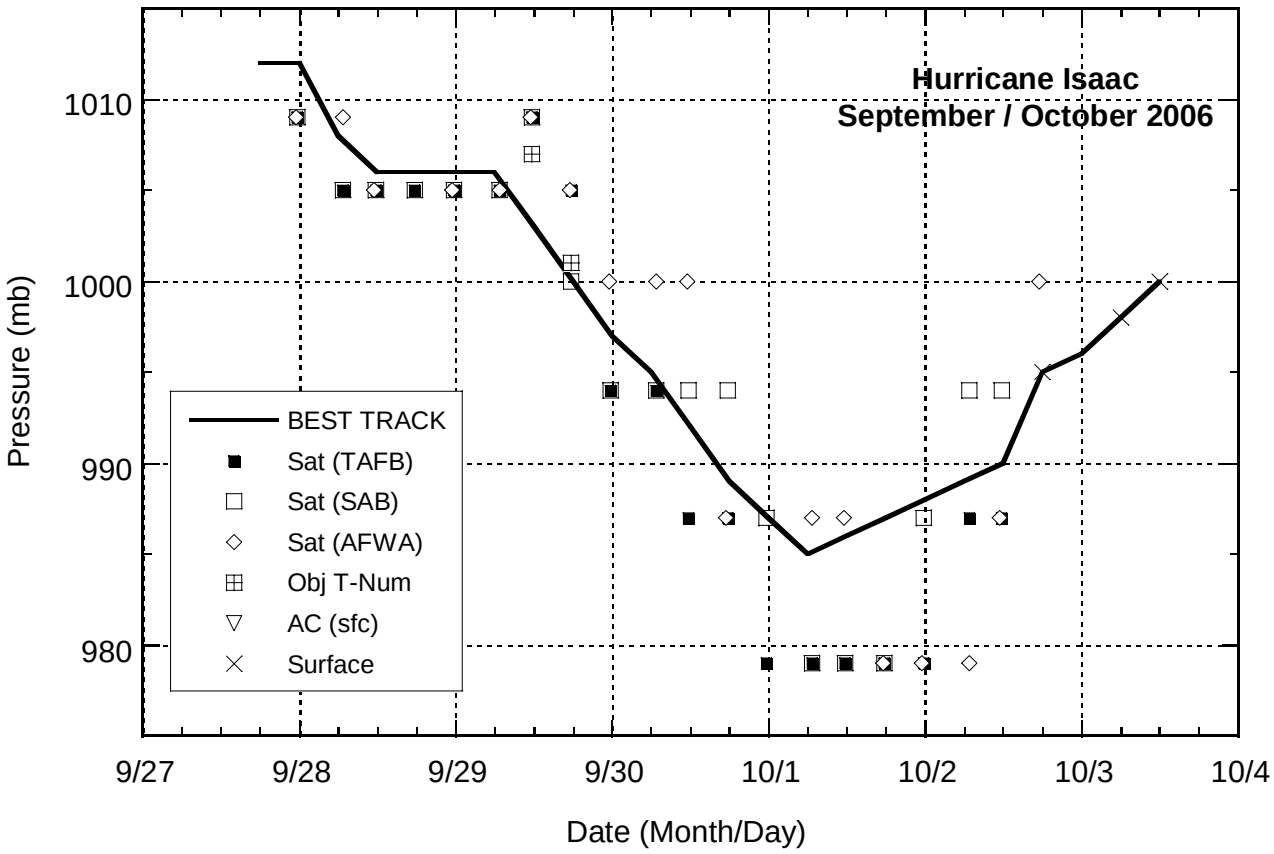

Figure 3. Selected pressure observations and best track minimum central pressure curve for Hurricane Isaac, 27 September – 2 October 2006. Objective Dvorak estimates represent linear averages over a three-hour period centered on the nominal observation time. Estimates during the extratropical stage are partly based on analyses from both the NOAA Ocean Prediction Center and Canadian Hurricane Centre.