Tropical Cyclone Report
Hurricane Kirk
(AL112012)
28 August – 2 September 2012

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Kirk was a small category 2 hurricane (on the Saffir-Simpson Hurricane Wind Scale) that spent its life over the central and northeastern Atlantic.

a. Synoptic History

Kirk originated from a tropical wave that emerged from the coast of Africa on 22 August accompanied by a broad area of low pressure. The system moved slowly westward, and the associated shower activity showed signs of organization on 24 August near the Cape Verde Islands. However, little additional development occurred during the next three days as the circulation of the low was elongated and poorly defined. The low turned northwestward late on 25 August, and this motion persisted through 27 August. On 28 August, despite the presence of west-southwesterly vertical wind shear, showers and thunderstorms became more concentrated and a better-defined circulation formed near the western edge of this convection. It is estimated that a tropical depression formed near 1800 UTC 28 August about 1120 n mi southwest of the western Azores. 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 depression initially moved westward, followed by a northwestward turn on 29 August toward a weakness in the subtropical ridge. Although the system became a tropical storm early on 29 August, continued westerly shear slowed intensification. Shear decreased early on 30 August, and Kirk quickly strengthened to a hurricane later that day. A small eye appeared in satellite imagery on 31 August when the cyclone reached an estimated peak intensity of 90 kt. Kirk weakened later that day while moving northward through a break in the subtropical ridge. On 1 September, the cyclone weakened to a tropical storm as it recurved into the westerlies. Accelerating northeastward, Kirk weakened further on 2 September due to increasing shear and decreasing sea surface temperatures. It became extratropical near 0000 UTC 3 September when it merged with a frontal system about 900 n mi north of the Azores. The extratropical low was absorbed into a large low pressure area over the northeastern Atlantic a few hours later.

[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.

b. Meteorological Statistics

Observations in Kirk (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 Kirk.

The estimated peak intensity of 90 kt is based mainly on subjective Dvorak intensity estimates from TAFB and SAB at 0600 UTC 31 August. ADT-based intensity estimates reached a peak near 0800 UTC that day, and it is possible that Kirk was a little stronger than 90 kt at that time.

There were no observations of tropical-storm-force or greater winds from Kirk. Scatterometer data indicated that Kirk was a small tropical cyclone for most of its life. Tropical-storm-force winds were confined to within 70 n mi of the center until 1 September, and these winds did not extend more than 100 n mi from the center until Kirk became embedded in the westerlies on 2 September.

c. Casualty and Damage Statistics

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

d. Forecast and Warning Critique

The genesis of Kirk was poorly forecast. While the precursor disturbance was mentioned in the Tropical Weather Outlook as early as 23 August, it was given a medium (30-50%) chance of development during the ensuing 48 hours for most of the outlooks – including those near and at the time of genesis. These poor forecasts likely resulted from: 1) the initial slow development of the disturbance, and 2) an expectation that ongoing shear would inhibit development.

A verification of NHC official track forecasts for Kirk is given in Table 2a. Official forecast track errors were lower than the mean official errors for the previous 5-yr period at 12-24 h, and significantly greater than the mean errors at 72-120 h. Examination of the individual forecasts (not shown) indicates that the first two forecasts called for a more westerly motion before recurvature than actually occurred, which caused large errors at the longer forecast times. A homogeneous comparison of the official track errors with selected guidance models is given in Table 2b. The official forecast errors were generally lower than those of the track guidance through 48 h. However, while the number of cases is small several of the dynamical and consensus models had lower average errors than the official forecasts at 72 h.

A verification of NHC official intensity forecasts for Kirk is given in Table 3a. Official forecast intensity errors were lower than the mean official errors for the previous 5-yr period at 12, 96, and 120 h. However, the official errors were much greater than the 5-yr mean errors at the other forecast times, and the forecasts generally lacked skill compared to climatology and persistence (OCD5). While the official forecasts correctly anticipated that Kirk would strengthen before recurvature and weaken afterward, the early forecasts underestimated how much Kirk would strengthen. In addition, the forecast near the time of peak intensity called for a slower weakening than actually occurred. A homogeneous comparison of the official intensity errors with selected guidance models is given in Table 3b. Several of the models had lower average errors than the official forecasts, most notably the Geophysical Fluid Dynamics Laboratory (GHMI) and Florida State Superensemble (FSSE) models at 96 and 120 h. However, all of the guidance, including those that beat the official forecasts, had average errors of 18 kt or greater at 36 and 48 hr.

There were no watches or warnings associated with Kirk.

Table 1. Best track for Hurricane Kirk, 28 August – 2 September 2012.

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
28 / 1800	23.9	43.4	1007	30	tropical depression
29 / 0000	24.0	44.5	1004	40	tropical storm
29 / 0600	24.3	45.5	1003	40	"
29 / 1200	24.6	46.3	1001	45	"
29 / 1800	25.1	47.1	999	45	"
30 / 0000	25.6	47.9	995	50	"
30 / 0600	26.1	48.6	992	55	"
30 / 1200	26.8	49.3	989	65	hurricane
30 / 1800	27.6	50.1	985	75	"
31 / 0000	28.5	50.5	981	80	"
31 / 0600	29.6	50.7	970	90	"
31 / 1200	30.6	50.9	972	90	"
31 / 1800	31.7	50.6	980	80	"
01 / 0000	33.1	50.0	988	70	"
01 / 0600	34.6	48.9	990	65	"
01 / 1200	36.5	47.3	992	60	tropical storm
01 / 1800	38.4	45.4	996	55	"
02 / 0000	40.3	43.0	998	55	"
02 / 0600	42.4	40.6	1001	50	"
02 / 1200	45.0	38.1	1002	50	"
02 / 1800	48.1	34.6	1002	45	"
03 / 0000	51.7	30.9	1002	45	extratropical
03 / 0600					absorbed by larger extratropical low
31 / 0600	29.6	50.7	970	90	maximum wind and minimum pressure

Table 2a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) track forecast errors (n mi) for Hurricane Kirk, 28 August – 2 September 2012. Mean errors for the 5-yr period 2007-11 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 (Kirk)	**22.7**	**41.3**	68.8	96.3	199.9	420.0	755.1
OCD5 (Kirk)	48.8	122.0	229.8	341.2	531.7	710.9	688.3
Forecasts	19	17	15	13	9	5	1
OFCL (2007-11)	30.4	48.4	65.9	83.1	124.4	166.5	213.4
OCD5 (2007-11)	46.9	95.2	151.7	211.6	316.8	404.3	485.2

Table 2b. Homogeneous comparison of selected track forecast guidance models (in n mi) for Hurricane Kirk, 28 August – 2 September 2012. 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	17.4	22.8	43.0	77.3	169.1		
OCD5	35.6	103.1	209.1	378.9	652.2		
GFSI	18.9	28.0	50.8	85.5	**165.7**		
GHMI	28.9	52.3	93.7	146.9	218.1		
HWFI	20.2	31.5	63.2	107.5	**163.7**		
NGXI	25.2	51.2	87.1	120.5	248.9		
EMXI	22.5	31.9	54.7	98.6	**162.8**		
CMCI	41.0	83.1	141.8	226.9	509.8		
TVCN	24.8	29.8	56.4	97.1	**154.3**		
FSSE	**17.0**	26.0	46.3	80.3	**125.4**		
AEMI	17.4	25.9	48.4	82.1	**127.8**		
LBAR	24.0	52.8	117.4	220.2	398.2		
BAMS	42.2	70.9	131.0	216.0	417.5		
BAMM	44.2	87.8	169.4	280.1	498.5		
BAMD	37.7	70.4	143.5	245.2	444.9		
Forecasts	12	8	8	8	3		

Table 3a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) intensity forecast errors (kt) for Hurricane Kirk, 28 August – 2 September 2012. Mean errors for the 5-yr period 2007-11 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 (Kirk)	**6.6**	14.1	21.0	24.2	19.4	**13.0**	**10.0**
OCD5 (Kirk)	7.1	12.8	17.7	21.9	14.4	8.8	11.0
Forecasts	19	17	15	13	9	5	1
OFCL (2007-11)	7.1	10.8	13.0	15.0	16.9	17.1	18.1
OCD5 (2007-11)	8.4	12.4	15.4	17.7	20.5	21.5	21.2

Table 3b. Homogeneous comparison of selected intensity forecast guidance models (in kt) for Hurricane Kirk, 28 August – 2 September 2012. 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	6.8	16.1	22.1	21.5	19.2	15.0	
OCD5	7.1	**14.5**	**18.9**	**20.6**	**15.0**	15.0	
HWFI	9.3	16.4	**21.8**	25.7	35.3	23.0	
GHMI	10.1	20.2	23.3	**20.6**	**10.3**	**9.5**	
DSHP	7.8	18.6	23.0	24.3	19.3	20.5	
LGEM	6.8	**15.9**	**20.2**	**19.8**	**14.7**	19.5	
ICON	8.3	17.9	22.2	21.7	19.8	18.0	
IVCN	8.3	17.9	22.2	21.7	19.8	18.0	
FSSE	7.7	**16.0**	**19.8**	**19.6**	**16.5**	**9.5**	
Forecasts	18	14	12	10	6	2	

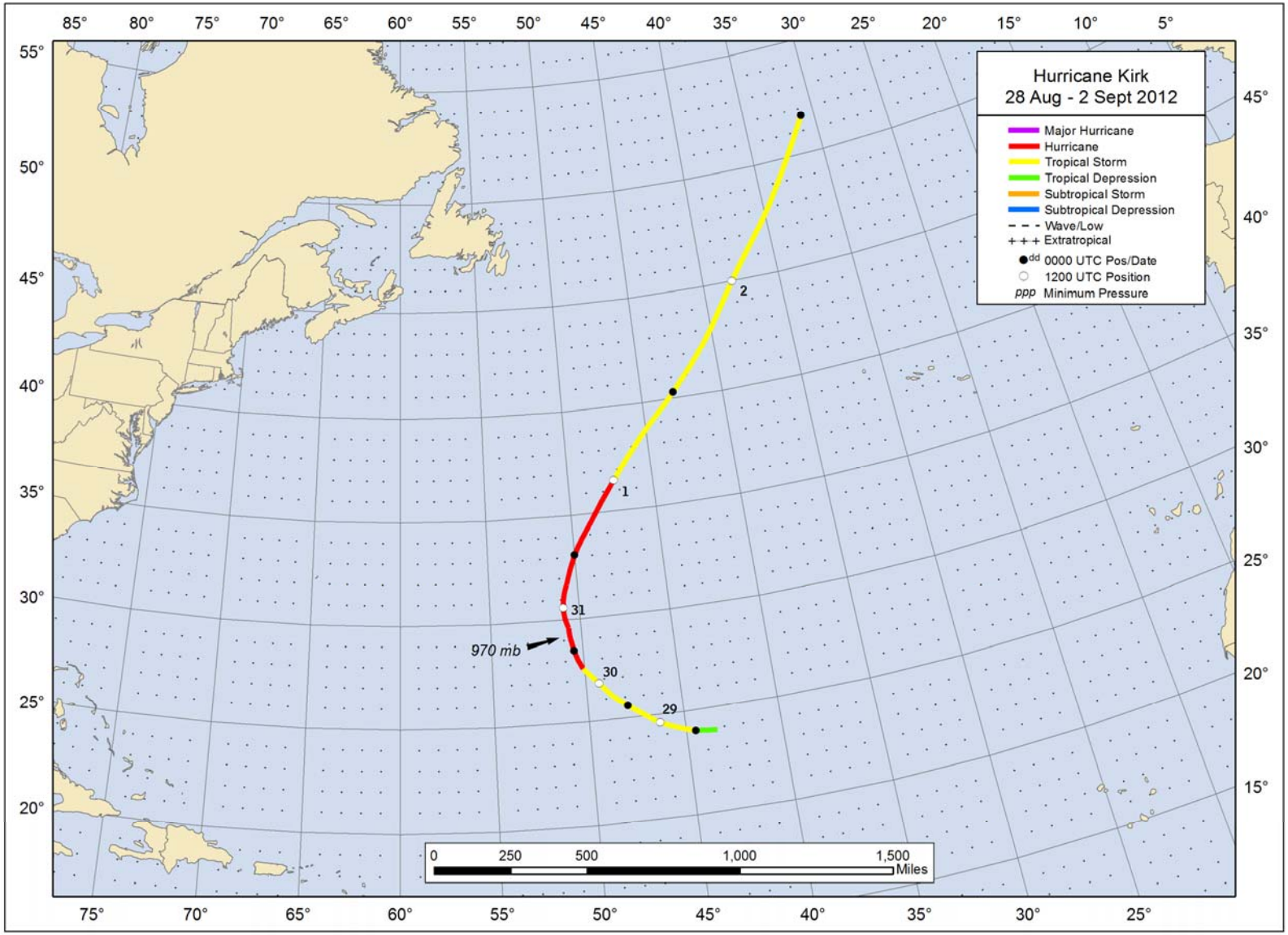

Figure 1. Best track positions for Hurricane Kirk, 28 August – 2 September 2012. Track during the extratropical stage is based on analyses from the NOAA Ocean Prediction Center.

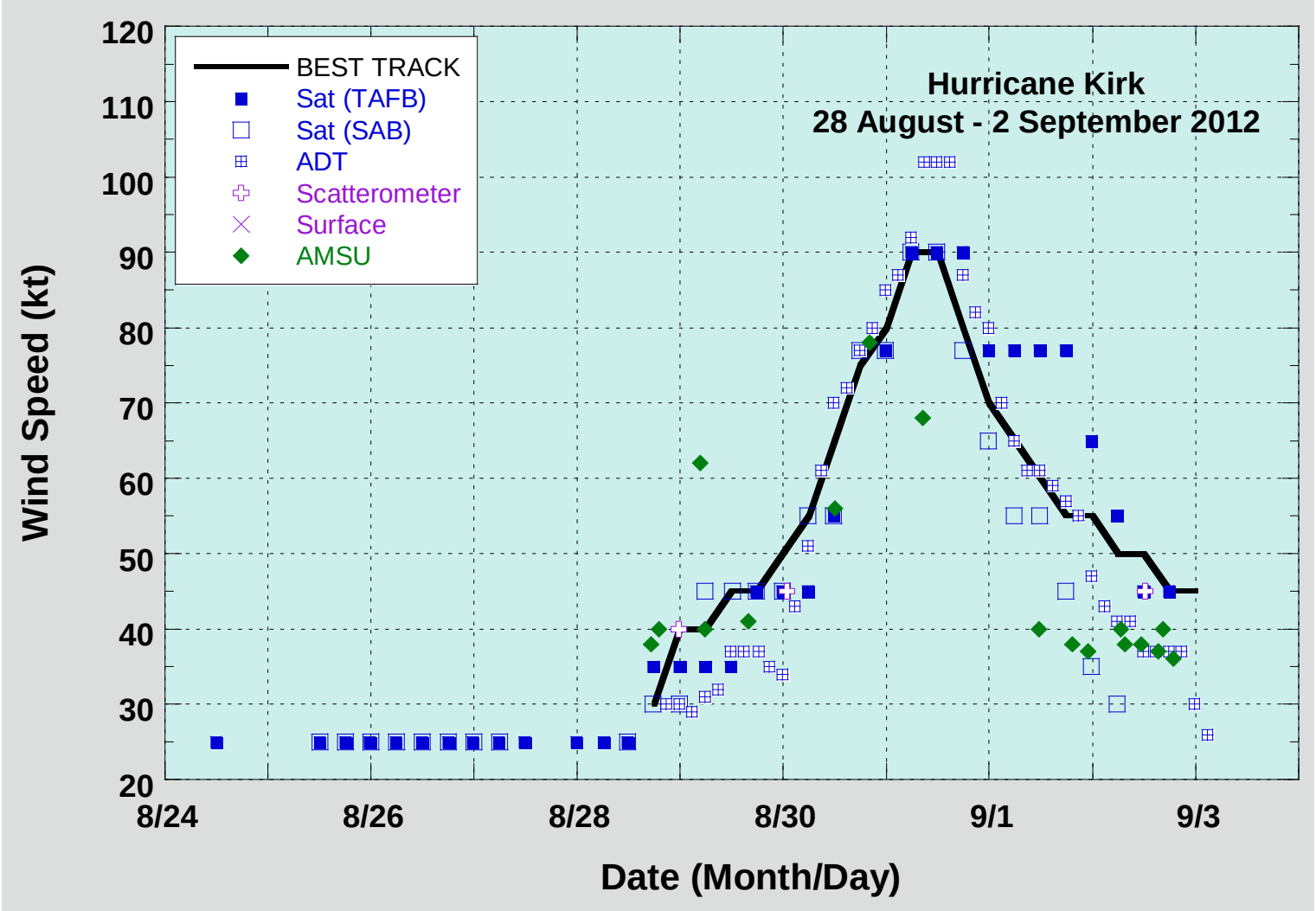

Figure 2. Selected wind observations and best track maximum sustained surface wind speed curve for Hurricane Kirk, 28 August – 2 September 2012. Advanced Dvorak Technique estimates represent CI numbers. AMSU intensity estimates are from the Cooperative Institute for Meteorological Satellite Studies technique. Estimates during the extratropical stage are based on analyses from the NOAA Ocean Prediction Center. Dashed vertical lines correspond to 0000 UTC.

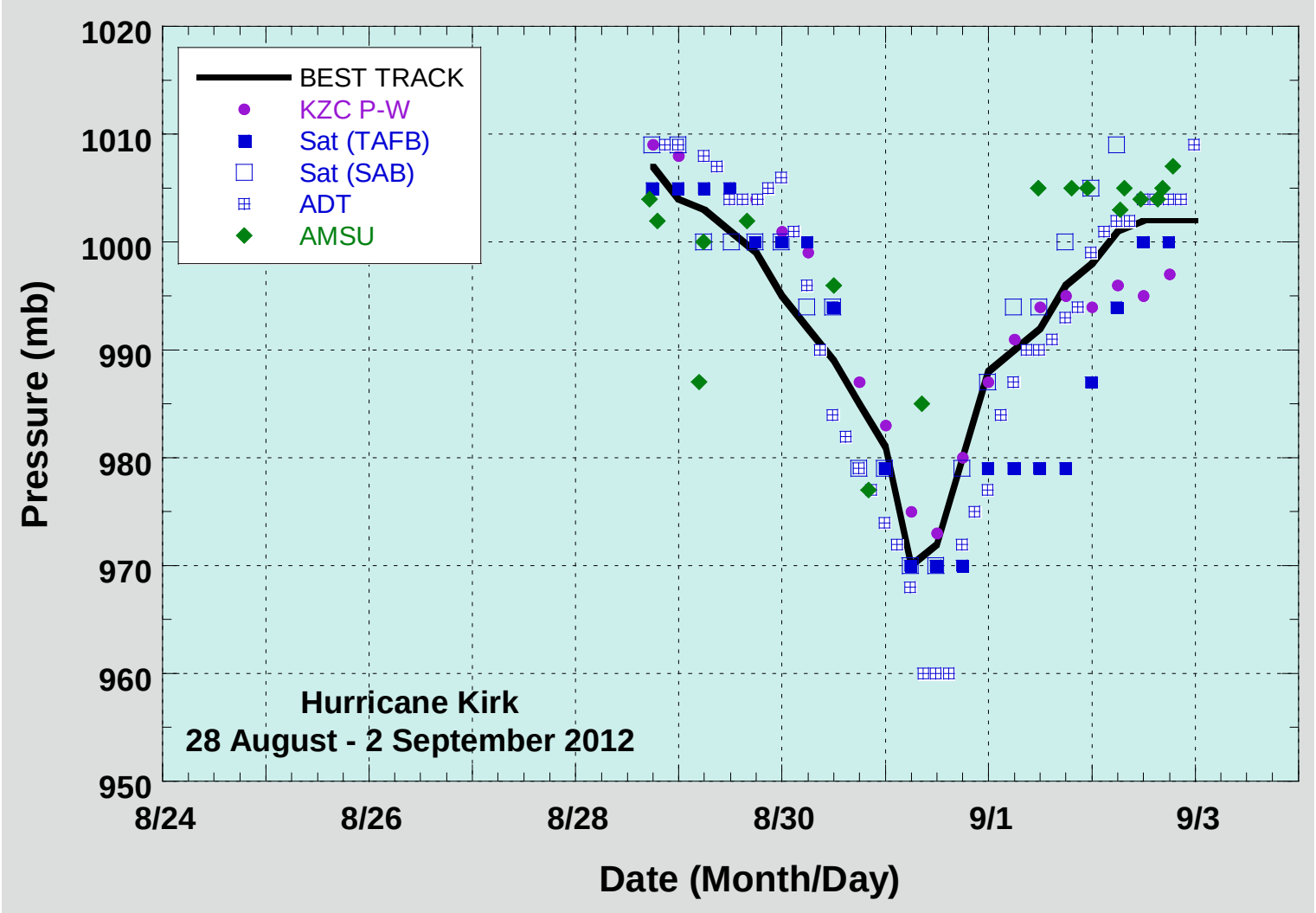

Figure 3. Selected pressure observations and best track minimum central pressure curve for Hurricane Kirk, 28 August – 2 September 2012. Advanced Dvorak Technique estimates represent CI numbers. AMSU intensity estimates are from the Cooperative Institute for Meteorological Satellite Studies technique. The KZC P-W values are obtained by applying the Knaff-Zehr-Courtney pressure-wind relationship to the best track wind data. Estimates during the extratropical stage are based on analyses from the NOAA Ocean Prediction Center. Dashed vertical lines correspond to 0000 UTC.