NATIONAL HURRICANE CENTER TROPICAL CYCLONE REPORT

HURRICANE KATE

(AL122015)

8 – 11 November 2015

Lixion A. Avila
National Hurricane Center
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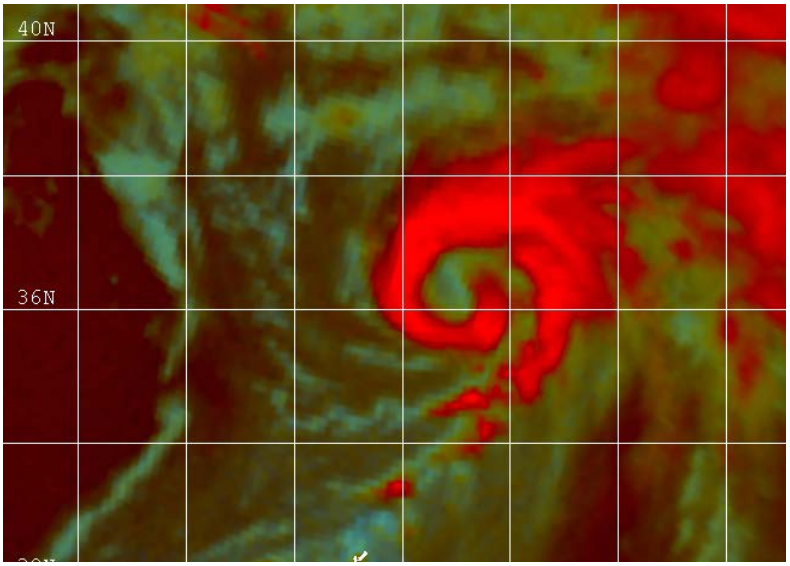

85 GHZ SSMI COLOR COMPOSITE IMAGE OF HURRICANE KATE AT 1120 UTC 11 NOVEMBER 2015. IMAGE COURTESY OF THE NAVAL RESEARCH LABORATORY.

Kate was a late-season tropical cyclone that became a category 1 hurricane (on the Saffir-Simpson Hurricane Wind Scale) while moving east-northeastward over the north Atlantic.

Hurricane KATE

8 – 11 NOVEMBER 2015

SYNOPTIC HISTORY

The development of Kate was associated with a tropical wave; such development so late in the season is rare but not unprecedented. A small area of disturbed weather associated with a poorly defined tropical wave moved across the west coast of Africa on 30 October and continued westward over the eastern Atlantic for a few days. Strong westerly wind shear prevailed over the tropical Atlantic, and the thunderstorm activity associated with the westward-moving wave remained very limited and disorganized during the next few days. The area of cloudiness and showers increased, however, when the disturbance was near the Lesser Antilles on 5 November. After that time, an area of low-level cyclonic vorticity separated from the wave and moved toward the west-northwest across the northeastern Caribbean Sea and Puerto Rico, while the wave continued westward toward Central America. Shower activity associated with the area of vorticity became concentrated northeast of Hispaniola on 7 November, but there were no signs of a circulation, and the surface pressures were relatively high. A sharp increase in organization of the convection occurred late that day, and satellite images indicated development of a surface circulation. It is estimated that a tropical depression formed at 1800 UTC 8 November just to the north of the Turks and Caicos Islands. 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 cyclone developed a well-defined upper-level outflow and some convective banding features while it moved within an area of low vertical wind shear. The depression became a tropical storm at 0600 UTC 9 November near the central Bahamas and moved toward the northwest and north, with its center passing just to the east of the northwestern Bahamas late on 9 November. However, Kate's circulation was very small and barely detectable in data from some of the nearby observing surface stations in the Bahamas. Kate moved northward around the periphery of the Azores-Bermuda subtropical ridge while it intensified. After recurving into the mid-latitudes westerly flow, Kate reached hurricane status at 0000 UTC 11 November, with its peak intensity of 75 kt occurring 12 h later. After that time, the hurricane encountered strong shear and cold waters, and transformed into an extratropical cyclone by 0000 UTC 12 November. It then continued to move eastward until 1800 UTC 13 November, when it was absorbed by a larger extratropical cyclone over the north Atlantic.

METEOROLOGICAL STATISTICS

[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.

Observations in Kate (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. Observations also include flight-level, stepped frequency microwave radiometer (SFMR), and dropwindsonde observations obtained from two flights by the 53rd Weather Reconnaissance Squadron of the U. S. Air Force Reserve Command, and three missions by the NOAA P3 aircraft. Data and imagery from NOAA polar-orbiting satellites including the Advanced Microwave Sounding Unit (AMSU), the NASA Global Precipitation Mission (GPM), 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 Hurricane Kate.

Kate was operationally upgraded to a tropical storm at 1500 UTC 9 October. However, the flight-level wind at 925 mb during the first reconnaissance mission around 1239 UTC that morning was already 50 kt with SFMR observations of 40 to 42 kt. Given the strength of these winds measured by the reconnaissance plane, and based on a post-analysis of satellite imagery, it is estimated that Kate was already a tropical storm at 0600 UTC 9 October. The 75-kt estimated peak intensity and 980-mb minimum pressure at 1200 UTC 11 November were based on a blend of satellite ADT and subjective Dvorak estimates. Microwave data also show the most organized convective banding structure of Kate was near that time (cover figure). The peak intensity occurred about 12 h after the last reconnaissance mission when the flight–level winds reached 72 kt at 700 mb. This was the strongest wind reported during the five reconnaissance missions.

Ship reports of winds of tropical storm force associated with Kate are given in Table 2.

CASUALTY AND DAMAGE STATISTICS

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

FORECAST AND WARNING CRITIQUE

The system that led to Kate's formation was introduced in the Tropical Weather Outlook (TWO) with a low chance (< 40%) of formation during the next 5 days about 102 h before genesis occurred, but the high chance (>60 %) was only introduced 6 h before genesis. The number of hours in advance of formation associated with the first NHC Tropical Weather Outlook forecast in the indicated likelihood category are included in Table 3. Global models captured well in advance the amplification of the tropical wave associated with the genesis of Kate, and also correctly forecast a change from a hostile to a favorable wind shear environment in the area near the Bahamas where the cyclone formed.

A verification of NHC official track forecasts for Hurricane Kate is given in Table 4a. Official forecast track errors were greater than the mean official errors for the previous 5-yr period. A homogeneous comparison of the official track errors with selected guidance models is given in Table 4b. Various models, including the HWFI, GFS, GFS ensemble mean (AEMI), and the multi-model consensus TVCA had lower errors than the NHC official forecast.

A verification of NHC official intensity forecasts for Hurricane Kate is given in Table 5a. Official forecast intensity errors were lower than the mean official errors for the previous 5-yr period from 12 through 36 hours. A homogeneous comparison of the official intensity errors with selected guidance models is given in Table 5b. Most of the intensity models had lower errors than the NHC official forecast at the 48-h period, and the NHC forecast had a low bias given the expectation of an unfavorable environment for strengthening. The NHC forecast, however, outperformed all guidance at 12, 24 and 36 h.

Watches and warnings associated with Hurricane Kate are given in Table 6. However, Kate's circulation was very small and tropical storm conditions were not observed within the watches and warning areas.

Table 1. Best track for Hurricane Kate, 8-11 November 2015.

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
08 / 1800	22.2	71.5	1010	30	tropical depression
09 / 0000	22.7	72.4	1010	30	"
09 / 0600	23.4	73.7	1010	35	tropical storm
09 / 1200	24.1	74.8	1008	40	"
09 / 1800	25.0	75.7	1008	45	"
10 / 0000	26.7	76.2	1006	50	"
10 / 0600	28.0	76.2	1003	55	"
10 / 1200	29.5	75.4	998	60	"
10 / 1800	31.2	74.0	993	60	"
11 / 0000	33.1	71.3	990	65	hurricane
11 / 0600	35.2	67.6	985	70	"
11 / 1200	36.2	62.5	980	75	"
11 / 1800	37.6	58.2	980	65	"
12 / 0000	38.9	55.0	980	65	extratropical
12 / 0600	40.0	52.0	980	65	"
12 / 1200	41.3	50.4	981	55	"
12 / 1800	41.9	49.9	983	55	"
13 / 0000	41.5	49.2	985	50	"
13 / 0600	40.8	47.5	985	45	"
13 / 1200	40.7	45.4	987	45	"
13 / 1800					dissipated
11 / 1200	36.2	62.5	980	75	Maximum winds and minimum pressure

Table 2. Selected ship reports with winds of at least 34 kt for Hurricane Kate, 8-11 November 2015.

Date/Time (UTC)	Ship call sign	Latitude (°N)	Longitude (°W)	Wind dir/speed (kt)	Pressure (mb)
09 / 0700	ZCEI3	22.9	72.3	100 / 43	1013.3
09 / 1400	ZCEI3	24.2	74.3	110 / 40	1015.5
09 / 1700	C6UZ7	24.7	75.2	180 / 52	1012.0
09 / 2300	TCMO2	32.2	72.5	140 / 35	1020.0
11 / 1100	TCMO2	33.0	60.4	200 / 35	1017.0
11 / 1500	DGZL	33.9	58.3	180 / 40	1015.2

Table 3. Number of hours in advance of formation associated with the first NHC Tropical Weather Outlook forecast in the indicated likelihood category. Note that the timings for the “Low” category do not include forecasts of a 0% chance of genesis.

	Hours Before Genesis	
	48-Hour Outlook	120-Hour Outlook
Low (<40%)	48	102
Medium (40%-60%)	6	48
High (>60%)	-	6

Table 4a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) track forecast errors (n mi) for Hurricane Kate. Mean errors for the previous 5-yr period 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	36.5	67.6	110.9	197.4			
OCD5	100.4	264.9	474.0	750.6			
Forecasts	10	8	6	4			
OFCL (2010-14)	28.4	45.0	60.4	77.1	113.1	157.8	210.0
OCD5 (2010-14)	48.3	101.5	161.5	222.6	329.8	412.6	483.9

Table 4b. Homogeneous comparison of selected track forecast guidance models (in n mi) for Hurricane Kate. 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 4a due to the homogeneity requirement.

Model ID	Forecast Period (h)						
	12	24	36	48	72	96	120
OFCL	39.6	72.7	128.2	244.5			
OCD5	107.3	287.8	531.6	869.9			
GFSI	**36.6**	**61.7**	**100.0**	275.5			
GHMI	40.0	**72.3**	**122.2**	**156.7**			
HWFI	**34.2**	**59.8**	**107.4**	**135.8**			
EMXI	44.2	94.7	149.3	**217.3**			
CMCI	59.2	135.3	238.6	354.2			
GFNI	54.5	104.1	199.2	**223.4**			
AEMI	**37.2**	**69.3**	**114.6**	**210.4**			
TVCA	**36.4**	**64.6**	**108.9**	**190.1**			
LBAR	67.5	161.3	259.7	419.2			
BAMD	**34.0**	87.9	171.8	332.2			
BAMM	60.2	131.6	258.7	452.5			
BAMS	88.5	173.8	294.1	453.7			
Forecasts	9	7	5	3			

Table 5a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) intensity forecast errors (kt) for Hurricane Kate. Mean errors for the previous 5-yr period 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	**5.5**	**8.8**	**11.7**	18.8			
OCD5	7.4	9.4	11.7	14.3			
Forecasts	10	8	6	4			
OFCL (2010-14)	6.2	9.4	11.5	13.3	14.6	14.6	15.8
OCD5 (2010-14)	7.3	10.8	13.3	15.3	17.7	17.8	17.6

Table 5b. Homogeneous comparison of selected intensity forecast guidance models (in kt) for Hurricane Kate. 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 5a due to the homogeneity requirement.

Model ID	Forecast Period (h)						
	12	24	36	48	72	96	120
OFCL	5.6	8.6	11.0	18.3			
OCD5	7.8	9.4	11.2	**14.0**			
GHMI	8.8	10.0	**6.8**	**3.3**			
GFNI	9.6	12.3	17.8	**4.7**			
HWFI	8.8	12.1	15.2	**12.7**			
DSHP	7.4	8.9	**10.2**	**13.3**			
LGEM	7.0	9.6	11.0	**14.7**			
IVCN	7.7	10.1	**10.0**	**9.3**			
GFSI	8.6	12.1	16.2	26.7			
EMXI	9.7	16.1	18.6	20.7			
Forecasts	9	7	5	3			

Table 6. Watch and warning summary for Hurricane Kate, 8-11 November 2015.

Date/Time (UTC)	Action	Location
9 / 0300	Tropical Storm Warning issued	SE to NW Bahamas
9 / 1200	Tropical Storm Warning modified to	Central to Northwestern Bahamas
10 / 0000	Tropical Storm Warning discontinued	All

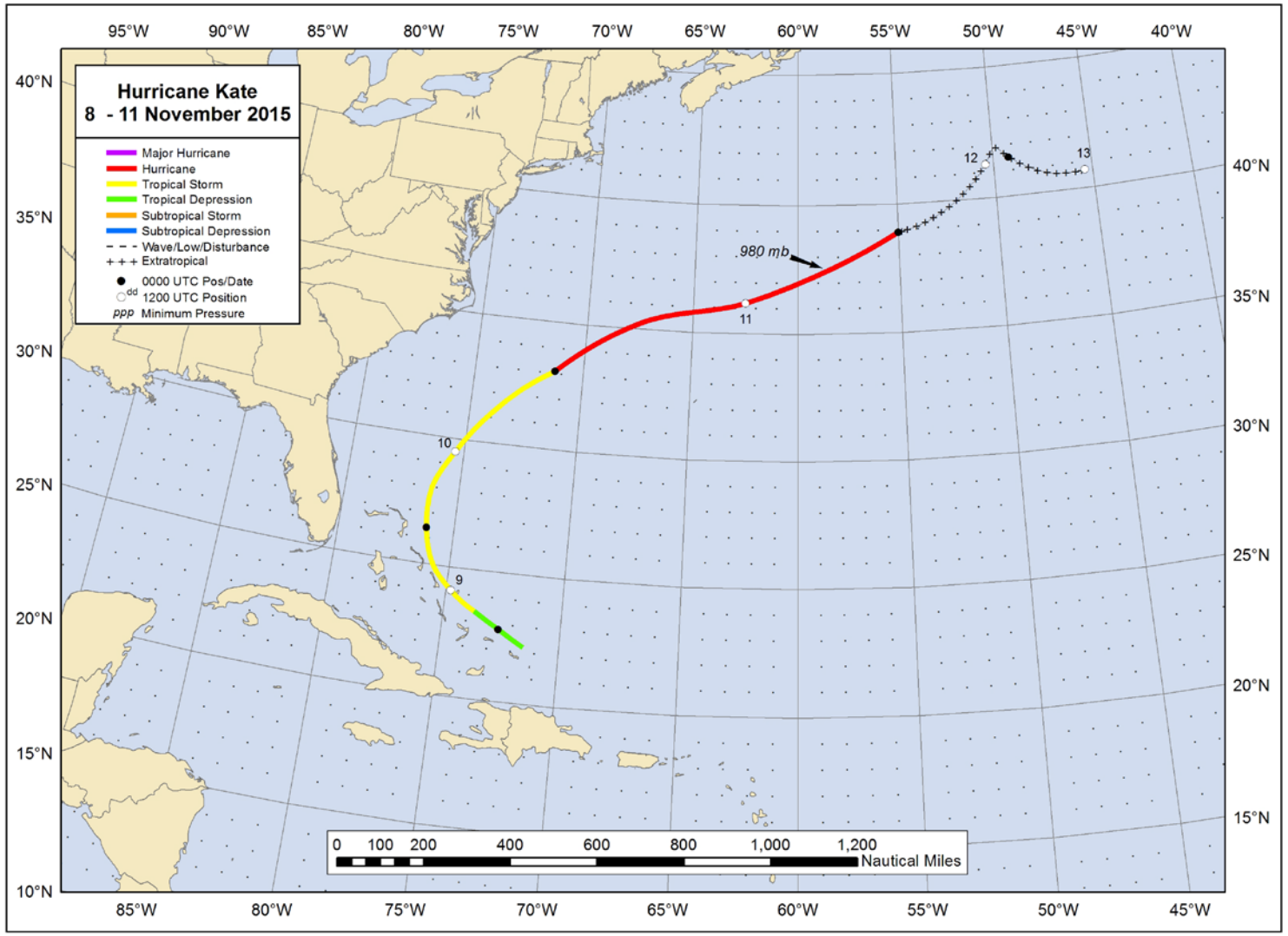

Figure 1. Best track positions for Hurricane Kate, 8-11 November 2015. Track during the extratropical stage is partially based on analyses from the NOAA Ocean Prediction Center.

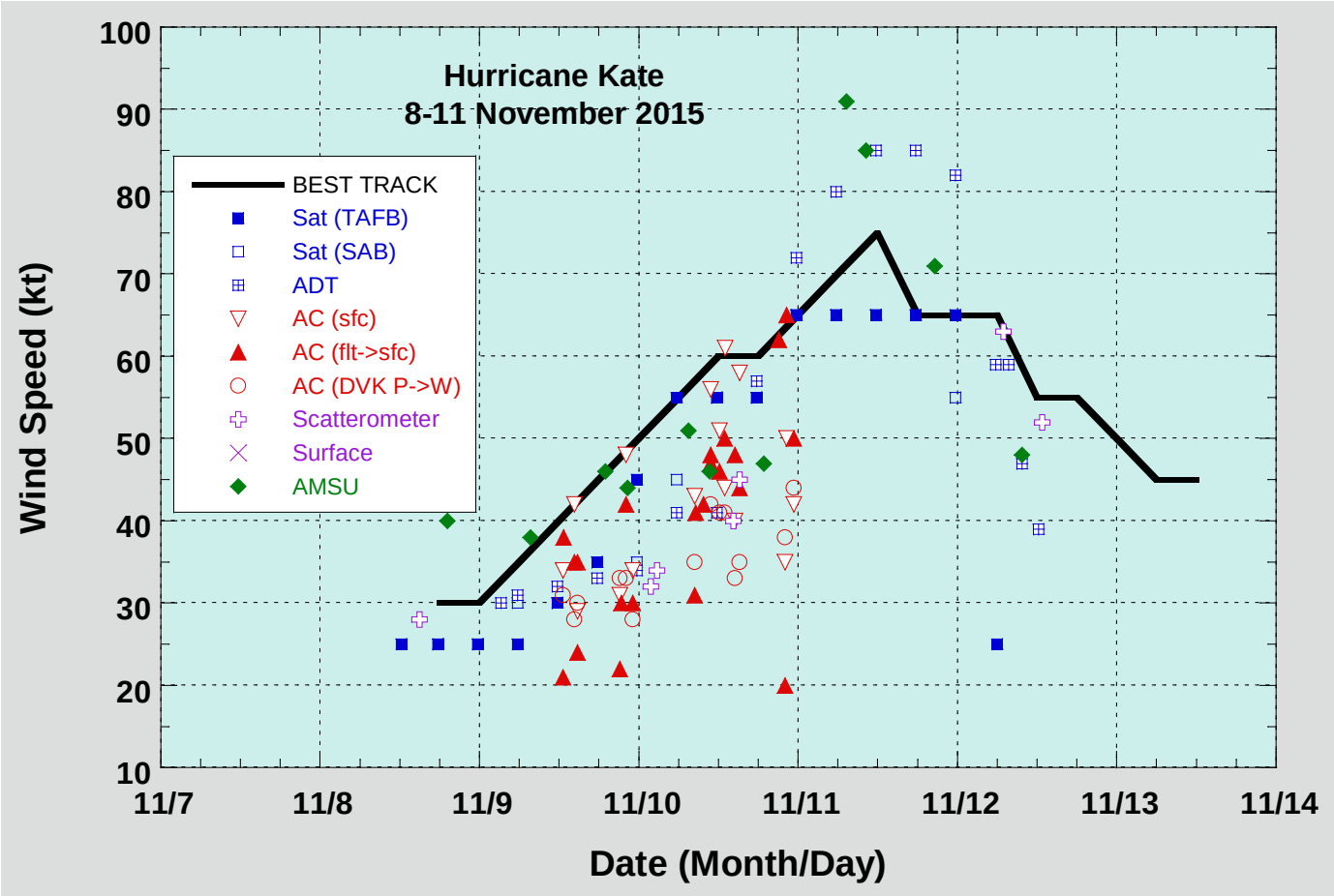

Figure 2. Selected wind observations and best track maximum sustained surface wind speed curve for Hurricane Kate, 8-11 November 2015. Aircraft observations have been adjusted for elevation using 90% and 80% adjustment factors for observations from 700 mb and 850 mb, respectively. Advanced Dvorak Technique estimates represent the Current Intensity at the nominal observation time. AMSU intensity estimates are from the Cooperative Institute for Meteorological Satellite Studies technique.

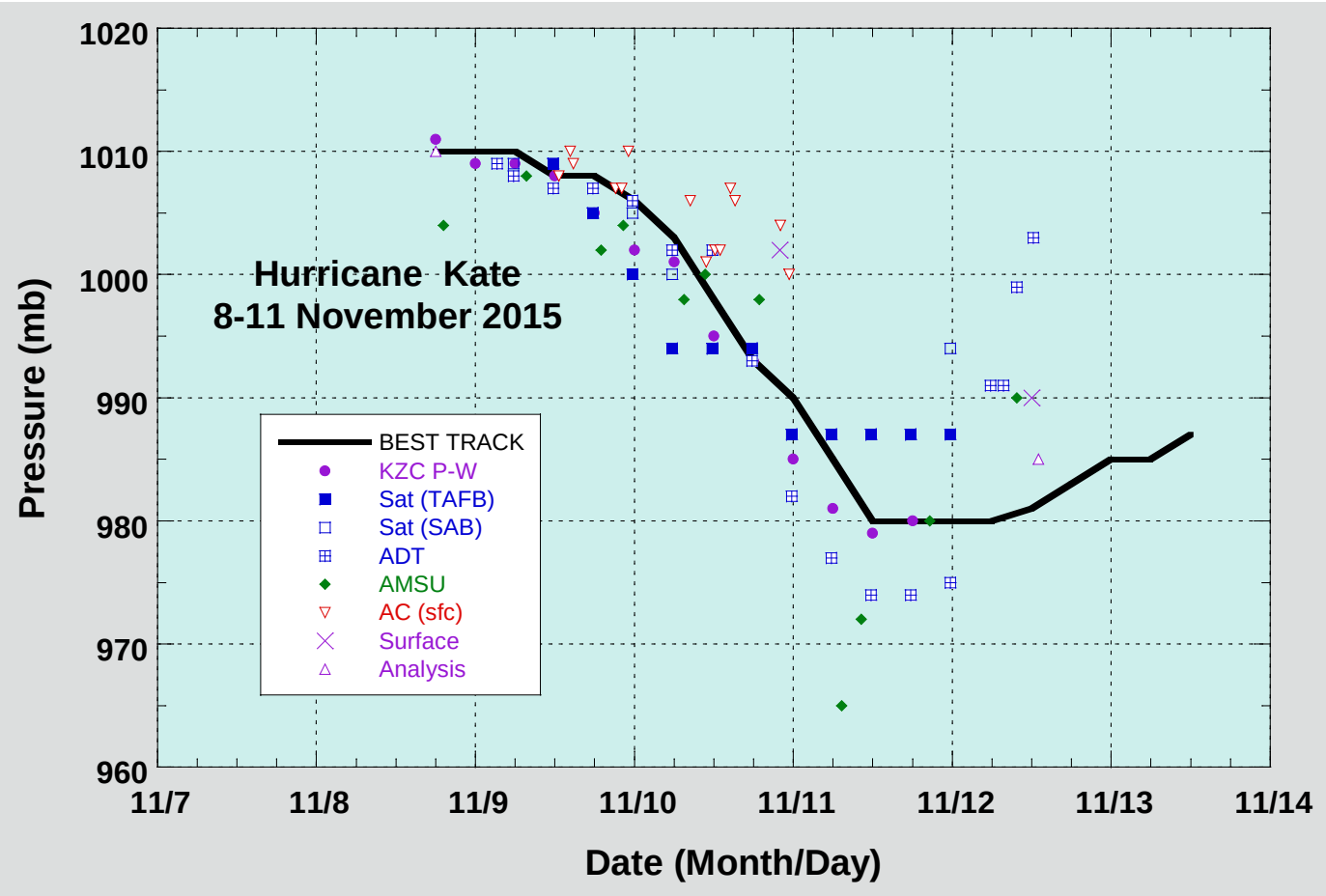

Figure 3. Selected pressure observations and best track minimum central pressure curve for Hurricane Kate, 8-11 November 2015. Advanced Dvorak Technique estimates represent the Current Intensity at the nominal observation time. AMSU intensity estimates are from the Cooperative Institute for Meteorological Satellite Studies technique. KZC P-W refers to pressure estimates derived using the Knaff-Zehr-Courtney pressure-wind relationship.