NATIONAL HURRICANE CENTER
TROPICAL CYCLONE REPORT

TROPICAL STORM RINA

(AL192017)

5 – 9 November 2017

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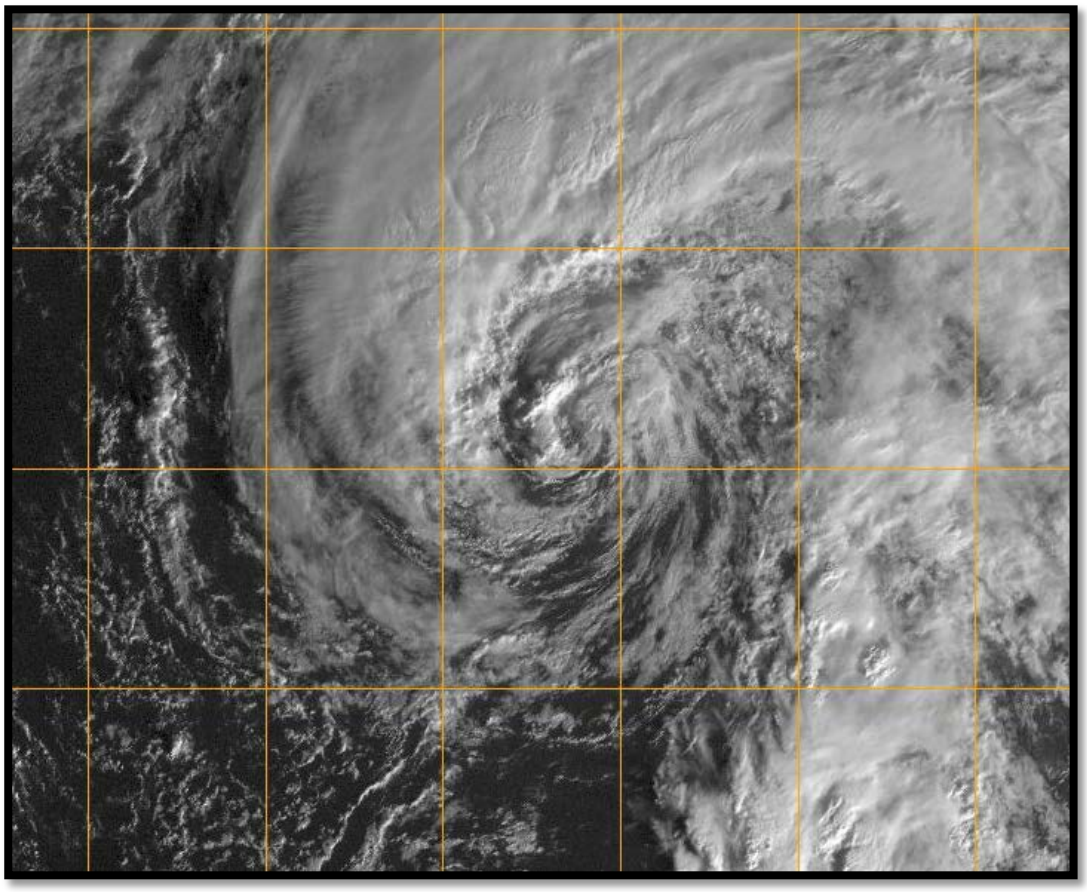

GOES-EAST VISIBLE SATELLITE IMAGE OF TROPICAL STORM RINA SHORTLY AFTER ITS PEAK INTENSITY AT 1115 UTC 8 NOVEMBER. IMAGE COURTSEY OF THE U.S. NAVAL RESEARCH LAB.

Rina was a relatively short-lived late-season tropical storm that moved northward over the central Atlantic Ocean and did not affect land.

Tropical Storm Rina

5 – 9 NOVEMBER 2017

SYNOPTIC HISTORY

Rina developed from a combination of tropical and non-tropical features. A low-latitude tropical wave, accompanied by a limited amount of deep convection, moved off the west coast of Africa early on 26 October. This wave continued to produce disorganized showers and thunderstorms while moving westward within the Intertropical Convergence Zone during the next few days. Meanwhile, a large mid- to upper-level trough became well established over the central Atlantic Ocean by 31 October, which caused the northern portion of the wave to fracture and move northwestward. The southerly flow on the east side of the trough advected a significant amount of tropical moisture northward into the subtropics, and a weak and elongated low pressure system formed in association with the fractured portion of the tropical wave about 600 n mi east-northeast of the northern Leeward Islands late on 3 November. Visible satellite images indicate that the low developed a well-defined center around 1200 UTC the following day, and deep convection became sufficiently organized to classify the system as a tropical depression by 1800 UTC 5 November when it was located about 700 n mi east-southeast 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[1].

The depression changed little in structure after genesis with the cloud pattern consisting of a partially exposed low-level center to the west of the main area of deep convection in response to westerly shear. While maintaining its intensity, the cyclone moved slowly eastward for the next 6 to 12 h, possibly as a result of its convective asymmetry, before turning northward on the west side of a mid-level ridge. Although the system was moving over sea surface temperatures below 26°C, cool temperatures aloft caused deep convection to increase late on 6 November, and it is estimated that the depression became a tropical storm around 0000 UTC 7 November when Rina was located about 780 n mi east of Bermuda. Rina continued to slowly strengthen while moving generally northward, still on the western periphery of a mid-level high pressure system, and it reached its peak intensity of 50 kt by 0600 UTC 8 November when it was situated about 650 n mi south-southeast of Cape Race, Newfoundland, in Canada. Around this time, Rina developed some subtropical characteristics with an expanding wind field and a comma-cloud appearance in satellite images (cover image).

Shortly after Rina reached its peak intensity, deep convection decreased and became even more separated from the low-level center due to strong shear, cool waters, and dry air. While weakening, Rina began accelerating northward in the strong mid-latitude flow between a

[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.

ridge to its east and a trough to the west. Almost all of the deep convection near the center of the system dissipated by 0600 UTC 9 November, and it estimated that Rina became a post-tropical cyclone at that time when it was located about 300 n mi southeast of Cape Race, Newfoundland. The post-tropical cyclone merged with a complex extratropical low pressure area over the northern Atlantic about 12 h later.

METEOROLOGICAL STATISTICS

Observations in Rina (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 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 Rina.

The estimated maximum intensity of 50 kt at 0600 UTC 8 November is based on a blend of a 3.5/55 kt SAB Dvorak satellite classification and a 3.0/45-50 kt subtropical Herbert-Poteat classification from TAFB.

The estimated minimum pressure of 991 mb at 0000 UTC 9 November occurred after Rina reached its peak intensity while it was moving into a region of lower pressure over the north Atlantic.

There were no reports of winds of tropical storm force associated with Rina.

CASUALTY AND DAMAGE STATISTICS

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

FORECAST AND WARNING CRITIQUE

The genesis of Rina was poorly forecast. The low pressure system from which Rina developed was included in the 5-day Tropical Weather Outlook only 48 h and 6 h prior to genesis in the low (< 40%) and medium (40–60%) categories, respectively (Table 2). For the 48-h genesis forecasts, the disturbance was given a low chance of development 42 h before Rina formed, but the disturbance did not reach the medium or high categories before development occurred. The primary reason for the poor forecasts was that it was unclear if the system that became Rina

would have enough time to obtain tropical characteristics before it moved into a region of cold waters and high vertical wind shear.

A verification of NHC official track forecasts for Rina is given in Table 3a. Official forecast track errors were notably (1.5 to 2 times) greater than the mean official errors for the previous 5-yr period for the verifying forecasts from 12 to 48 h. The climatology and persistence model (OCD5) also had significantly higher track errors than its 5-yr mean, indicating that Rina was a difficult system to predict. A homogeneous comparison of the official track errors with selected guidance models is given in Table 3b. The best performing models were the NOAA HFIP Corrected Consensus Approach (HCCA), the Track Variable Consensus models (TVCA/TVCX) and the European Centre for Medium-Range Weather Forecasts model (EMXI). All of these models beat the official forecast at all verifying times. Most of the models and the official forecast had a fast and right-of-track bias.

A verification of NHC official intensity forecasts for Rina is given in Table 4a. Unlike the track forecasts, the official forecast intensity errors were much lower than the mean official errors for the previous 5-yr period as these forecasts correctly predicted that Rina would not become a hurricane. A homogeneous comparison of the official intensity errors with selected guidance models is given in Table 4b. No model consistently beat the NHC forecast.

There were no coastal watches or warnings associated with Rina.

Table 1. Best track for Tropical Storm Rina, 5–9 November 2017.

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
04 / 1200	25.5	52.3	1013	25	low
04 / 1800	26.5	52.1	1013	25	"
05 / 0000	27.5	52.0	1013	25	"
05 / 0600	28.4	52.0	1013	25	"
05 / 1200	29.0	51.9	1013	25	"
05 / 1800	29.2	51.7	1012	30	tropical depression
06 / 0000	29.1	51.2	1011	30	"
06 / 0600	29.0	50.7	1010	30	"
06 / 1200	29.1	50.4	1010	30	"
06 / 1800	29.4	50.2	1009	30	"
07 / 0000	30.0	50.0	1008	35	tropical storm
07 / 0600	30.8	49.9	1006	40	"
07 / 1200	31.8	49.5	1004	40	"
07 / 1800	33.0	49.1	1002	40	"
08 / 0000	34.6	48.7	999	45	"
08 / 0600	36.4	48.7	996	50	"
08 / 1200	38.3	48.8	994	45	"
08 / 1800	40.1	49.0	992	45	"

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
09 / 0000	41.8	48.8	991	45	"
09 / 0600	43.6	48.0	993	40	low
09 / 1200	45.5	47.0	995	40	"
09 / 1800					dissipated
08 / 0600	36.4	48.7	996	50	maximum winds
09 / 0000	41.8	48.8	991	45	minimum pressure

Table 2. 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%)	42	48
Medium (40%-60%)	-	6
High (>60%)	-	-

Table 3a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) track forecast errors (n mi) for Tropical Storm Rina, 5-9 November 2017. 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	39.2	64.9	95.1	159.4			
OCD5	58.3	154.6	270.4	408.5			
Forecasts	10	8	6	4			
OFCL (2012-16)	24.9	39.6	54.0	71.3	105.8	155.4	208.9
OCD5 (2012-16)	47.3	103.9	167.8	230.3	343.1	442.6	531.0

Table 3b. Homogeneous comparison of selected track forecast guidance models (in n mi) for Tropical Storm Rina, 5-9 November 2017. Errors smaller than the NHC official forecast are shown in boldface type.

Model ID	Forecast Period (h)						
	12	24	36	48	72	96	120
OFCL	39.2	64.9	95.1	159.4			
OCD5	58.3	154.6	270.4	408.5			
GFSI	42.3	82.3	136.1	222.6			
HMNI	42.5	74.2	**91.8**	**158.8**			
HWFI	41.3	67.7	**84.5**	**120.7**			
EMXI	**34.0**	**61.7**	**77.2**	**82.0**			
CMCI	57.2	92.1	**81.4**	**84.8**			
CTCI	**38.1**	67.1	**80.4**	**79.7**			
AEMI	**38.9**	70.2	107.8	192.2			
HCCA	**34.0**	**61.5**	**81.3**	**123.6**			
TVCX	**35.6**	**63.2**	**75.9**	**98.0**			
TVCA	**36.7**	**63.9**	**80.5**	**108.6**			
GFEX	**36.4**	66.2	**90.0**	**135.2**			
TABS	**33.8**	77.4	119.7	184.4			
TABM	39.2	89.0	156.2	263.9			
TABD	45.0	104.3	185.3	291.9			
Forecasts	10	8	6	4			

Table 4a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) intensity forecast errors (kt) for Tropical Storm Rina, 5-9 November 2017. 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	**3.5**	**1.9**	**1.7**	**3.8**			
OCD5	5.0	4.5	5.0	4.5			
Forecasts	10	8	6	4			
OFCL (2012-16)	5.5	8.2	10.5	12.0	13.4	14.0	14.5
OCD5 (2012-16)	7.1	10.5	13.0	15.1	17.4	18.2	20.6

Table 4b. Homogeneous comparison of selected intensity forecast guidance models (in kt) for Tropical Storm Rina, 5-9 November 2017. 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	3.3	2.1	1.0	3.3			
OCD5	5.0	5.0	5.6	4.3			
HMNI	**3.0**	4.1	3.6	**1.7**			
HWFI	3.3	4.0	4.2	3.3			
DSHP	4.4	4.1	8.4	16.0			
LGEM	5.0	3.1	4.0	3.3			
HCCA	3.9	2.7	3.0	4.7			
IVCN	3.9	2.1	2.6	**3.0**			
GFSI	3.6	**1.6**	2.8	3.7			
EMXI	**3.2**	3.3	3.4	**2.3**			
Forecasts	9	7	5	3			

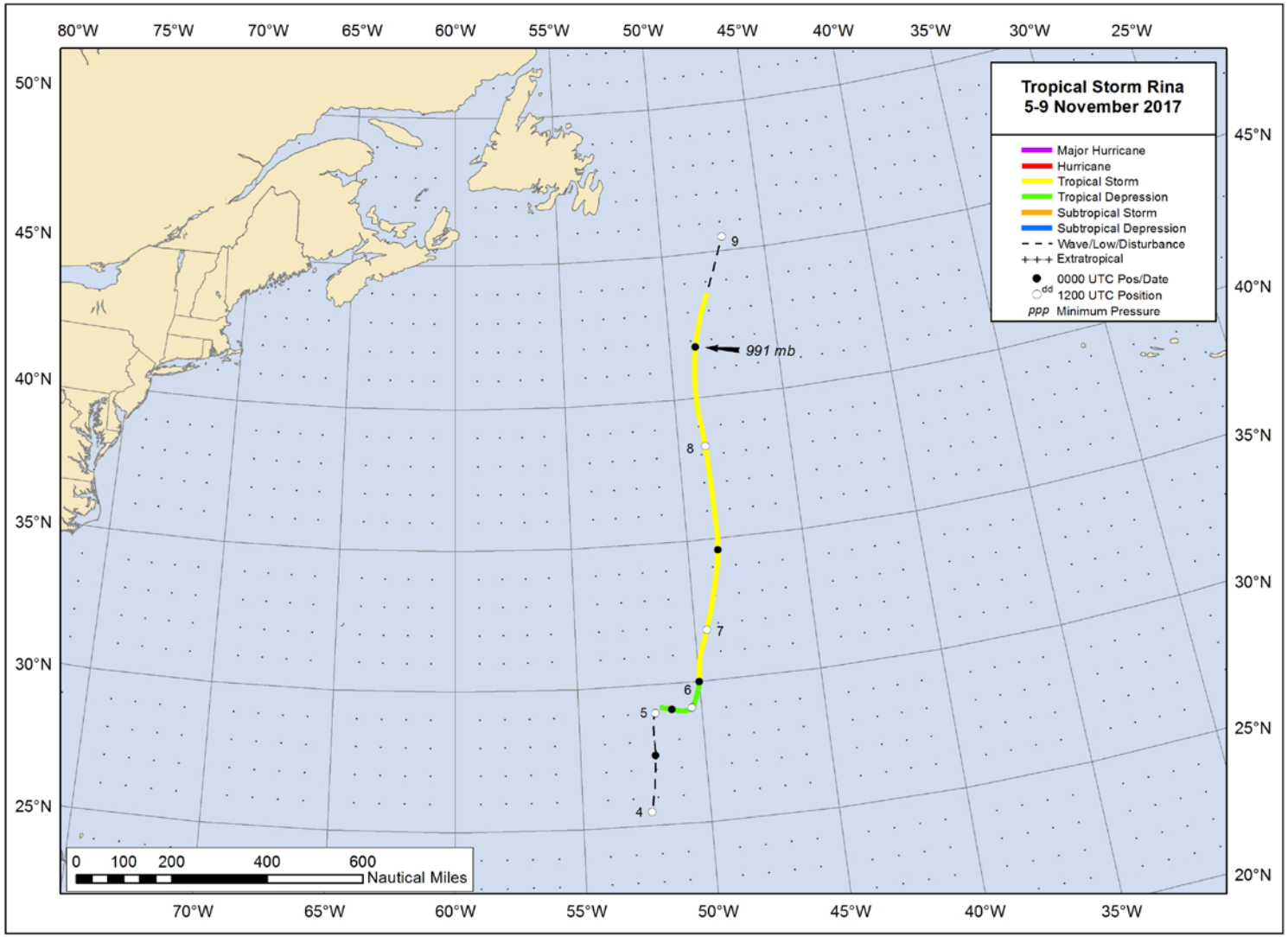

Figure 1. Best track positions for Tropical Storm Rina, 5–9 November 2017.

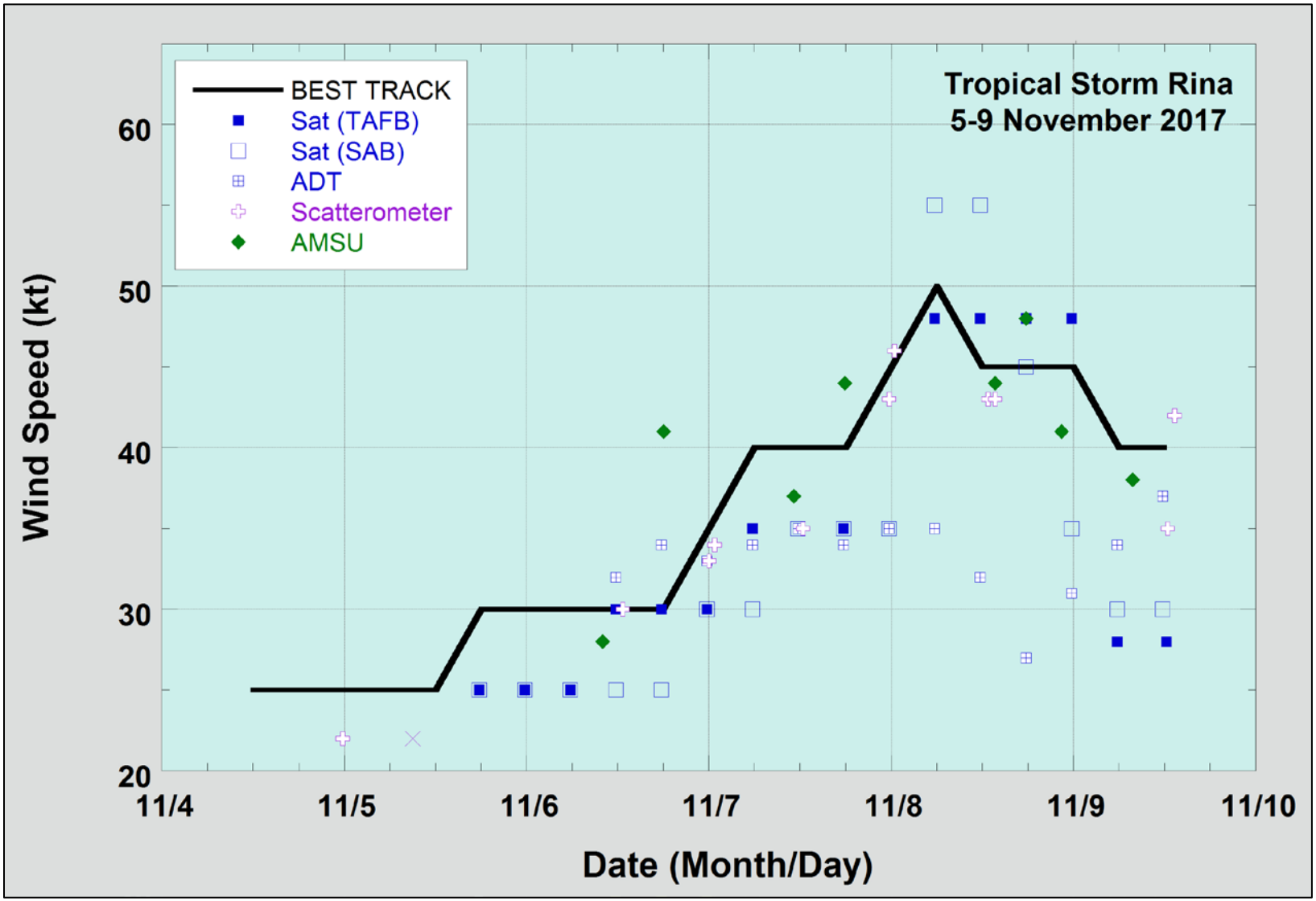

Figure 2. Selected wind observations and best track maximum sustained surface wind speed curve for Tropical Storm Rina, 5–9 November 2017. Advanced Dvorak Technique estimates represent the Current Intensity at the nominal observation time. AMSU intensity estimates are from the Cooperative Institute for Meteorological Satellite Studies technique. Dashed vertical lines correspond to 0000 UTC.

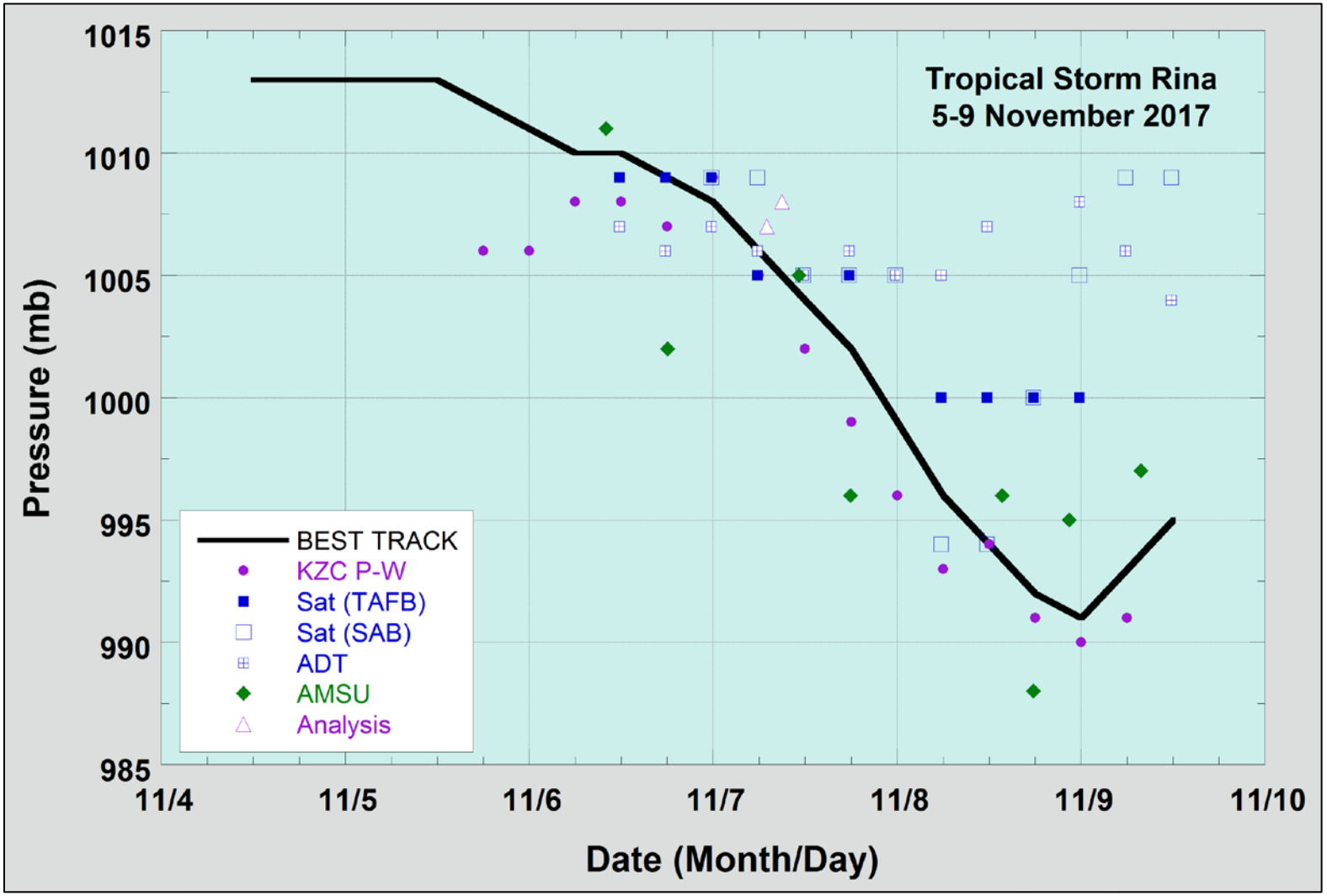

Figure 3. Selected pressure observations and best track minimum central pressure curve for Tropical Storm Rina, 5–9 November 2017. Advanced Dvorak Technique estimates represent the Current Intensity at the nominal observation time. AMSU intensity estimates are from the Cooperative Institute for Meteorological Satellite Studies technique. KZC P-W refers to pressure estimates derived using the Knaff-Zehr-Courtney pressure-wind relationship. Dashed vertical lines correspond to 0000 UTC.