NATIONAL HURRICANE CENTER
TROPICAL CYCLONE REPORT

TROPICAL STORM KARINA

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12–16 September 2020

Andy S. Latto
National Hurricane Center
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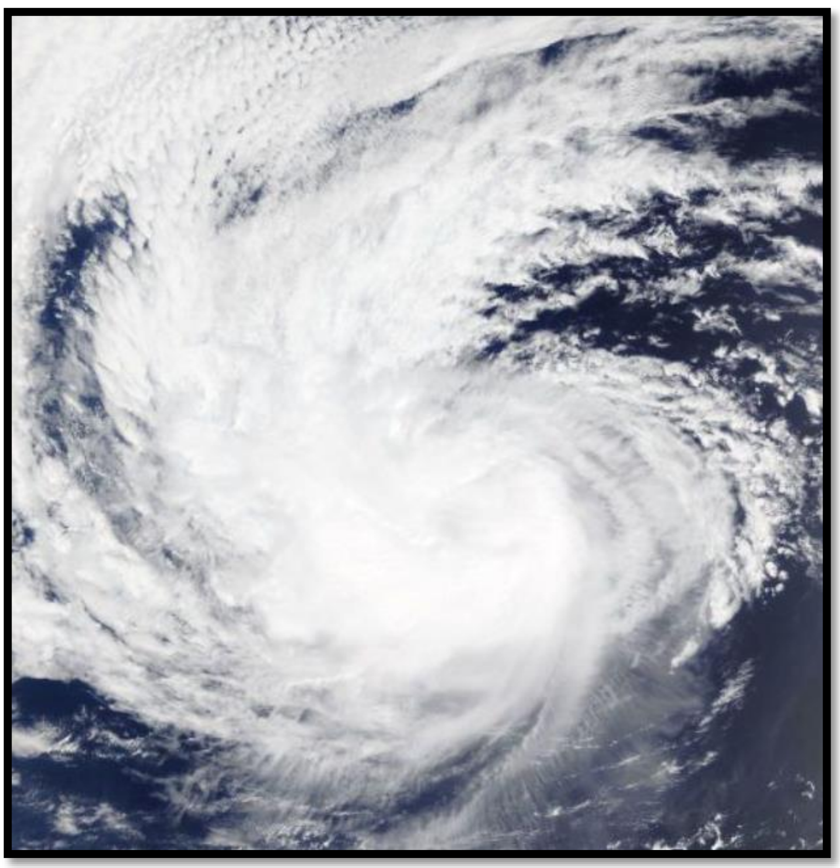

NASA MODIS/AQUA VISIBLE IMAGE OF TROPICAL STORM KARINA AT 1840 UTC 15 SEPTEMBER 2020.

Karina was a tropical storm that developed off the southwestern coast of Mexico and affected no land areas before it dissipated in the open eastern North Pacific.

Tropical Storm Karina

12–16 SEPTEMBER 2020

SYNOPTIC HISTORY

The genesis of Karina appears to be primarily associated with a large tropical wave that emerged off the west African coast on 26 August. The northern portion of this wave moved quickly across the Atlantic, while the southern portion of the wave propagated slowly westward across the tropical Atlantic, producing intermittent disorganized convection through 2 September. This southern portion of the wave began traversing the Caribbean Sea on 3 September and crossed central America on 6 September, emerging over the far eastern North Pacific by 7 September. Disorganized convection associated with the wave increased the next day while it passed to the south of southwestern Mexico, and this convection slowly increased in coverage over the next few days. During this time, the system's close proximity to the eastern Pacific monsoon trough prevented a well-defined area of low pressure from developing. By early 11 September, satellite imagery and scatterometer data indicated that a well-defined surface low pressure area had formed. However, at that time the associated convection was confined to the south of the circulation due to northeasterly shear and some dry air that had entrained into the northern portion of the system. On 12 September, the convection increased in coverage and organization near the center of the low, marking the formation of a tropical depression by 1800 UTC that day while it was located about 470 n mi south-southwest of the southern tip of the Baja California peninsula. 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].

Throughout its time as a tropical cyclone, the system was steered toward the west-northwest or northwest while located on the southwest side of a mid-level ridge. The cyclone struggled with the northeasterly vertical wind shear for the first 36 h of its existence, with the low-level center periodically becoming exposed through early 14 September. Despite this shear, scatterometer data indicated that the depression had strengthened into a tropical storm by 0600 UTC 13 September when it was located about 400 n mi southwest of the southern tip of the Baja California peninsula. The shear over Karina began to decrease on 14 September, and the deep convection re-developed near the center of the cyclone that morning and persisted throughout the remainder of that day, which resulted in strengthening. The storm reached a peak intensity of 50 kt by 0000 UTC 15 September, when it was located about 600 n mi west-southwest of the southern tip of the Baja California peninsula. Karina maintained this intensity throughout that day, as low wind shear countered a steady decrease in the underlying oceanic heat content. The storm began to weaken quickly early on 16 September as it moved over waters cooler than 26°C and into a dry and stable airmass. By 1800 UTC that day, all of the deep convection

[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.

associated with Karina had dissipated. As a result, the cyclone became a post-tropical remnant low at that time when it was located about 800 n mi west of the southern tip of the Baja California peninsula. The remnant low gradually spun down over the next couple of days while it turned toward the west within the low-level flow. By 1200 UTC 18 September, scatterometer data indicated that the low had opened into a trough about 940 n mi west of the southern tip of the Baja California peninsula.

METEOROLOGICAL STATISTICS

Observations in Karina (Figs. 2 and 3) include subjective satellite-based Dvorak technique intensity estimates from the Tropical Analysis and Forecast Branch (TAFB), the Satellite Analysis Branch (SAB), and the Central Pacific Hurricane Center (PHFO), and objective Advanced Dvorak Technique (ADT) estimates and Satellite Consensus (SATCON) 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), ASCAT, and Defense Meteorological Satellite Program (DMSP) satellites, among others, were also useful in constructing the best track of Karina.

Karina’s estimated peak intensity of 50 kt from 0000 UTC 15 September to 0000 UTC 16 September is based on blends of subjective Dvorak estimates from TAFB, SAB, and PHFO and ADT and SATCON estimates. No direct sampling of the system by scatterometer occurred during the time of the cyclone’s peak intensity. The estimated minimum pressure of 996 mb is based on the Knaff-Zehr-Courtney pressure wind relationship.

There were no observations from ships or land stations of winds of tropical storm force associated with Karina.

CASUALTY AND DAMAGE STATISTICS

There were no reports of damage or casualties associated with Tropical Storm Karina.

FORECAST AND WARNING CRITIQUE

The genesis of Karina was well forecast in the short-term, but not as well in the medium range (Table 2). The system from which Karina developed was introduced into the Tropical Weather Outlook 78 h prior to genesis with a low (<40%) chance of formation during the next 5 days. The 5-day probabilities were increased to the medium (40–60%) and high (>60%) categories 66 h and 36 h before genesis, respectively. The 2-day genesis probabilities were first introduced with a low chance of development 66 h before formation occurred. The 2-day probabilities were raised to the medium and high categories 48 h and 18 h prior to genesis, respectively. Models did not explicitly show genesis of the system until a few days prior to formation, which is the main reason that the 5-day probabilities were not introduced until 78 h before the cyclone developed.

A verification of NHC official track forecasts for Karina is given in Table 3a. Official forecast track errors were a little higher than the mean official errors for the previous 5-yr period from 12 to 24 h, less than the long-term means from 36–60 h, and near the long term mean at 72 h. A homogeneous comparison of the official track errors with selected guidance models is given in Table 3b. The NHC track errors were consistently better than most of the global models through 48 h, however the official forecast did not perform as well compared to most of the consensus and regional models during those times. The NHC forecast performed better than about half the models at 60 h, but most models had smaller errors than the NHC forecast at 72 h, albeit for a small sample size. The reason for the poorer performance of the NHC forecast later in the forecast period was a left-of-track bias (not shown) early on during the cyclone's lifecycle. The best performing models overall for track were the UKMET (EGRI) and the variable consensus TVDG.

A verification of NHC official intensity forecasts for Karina is given in Table 4a. Official forecast intensity errors were lower than the mean official errors for the previous 5-yr period at all verified forecast times. The OCD5 intensity errors were also lower than their long-term means, indicating that the intensity forecasts were less difficult than normal. A homogeneous comparison of the official intensity errors with selected guidance models is given in Table 4b. The NHC intensity forecasts were better than most models from 12–60 h. However, nearly all of models were better than the NHC forecasts at 72 h, as the left-of-track bias the NHC forecast had at that time suggested that the cyclone would remain over warmer waters longer than what actually occurred. Overall, both NHC and the models performed very well forecasting the intensity of Karina, with most of the errors less than 5 kt for the 12–60 h forecast times.

There were no coastal watches and warnings associated with Karina.

Table 1. Best track for Tropical Storm Karina, 12–16 September 2020.

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
12 / 1800	15.8	112.0	1005	30	tropical depression
13 / 0000	16.4	112.6	1005	30	"
13 / 0600	17.0	113.4	1003	35	tropical storm
13 / 1200	17.4	114.5	1001	40	"
13 / 1800	17.6	115.6	1001	40	"
14 / 0000	17.7	116.5	1001	40	"
14 / 0600	17.8	117.3	1001	40	"
14 / 1200	17.9	118.0	1001	40	"
14 / 1800	18.2	118.7	998	45	"
15 / 0000	18.7	119.3	996	50	"
15 / 0600	19.3	120.1	996	50	"
15 / 1200	20.0	120.9	996	50	"
15 / 1800	20.6	121.7	998	50	"
16 / 0000	21.3	122.5	998	50	"
16 / 0600	21.9	123.1	1002	40	"
16 / 1200	22.4	123.6	1004	35	"
16 / 1800	22.8	124.1	1006	30	low
17 / 0000	23.1	124.6	1006	30	"
17 / 0600	23.3	125.0	1006	30	"
17 / 1200	23.5	125.5	1007	30	"
17 / 1800	23.6	126.0	1008	25	"
18 / 0000	23.6	126.5	1008	25	"
18 / 0600	23.6	126.8	1008	25	"
18 / 1200					dissipated
15 / 0000	18.7	119.3	996	50	maximum wind and 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%)	66	78
Medium (40%-60%)	48	66
High (>60%)	18	36

Table 3a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) track forecast errors (n mi) for Tropical Storm Karina. 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	60	72	96	120
OFCL	31.4	38.8	**37.3**	**35.9**	**53.1**	77.5		
OCD5	43.8	79.2	120.4	127.6	108.5	103.9		
Forecasts	13	11	9	7	5	3		
OFCL (2015-19)	21.8	34.0	44.9	55.3	66.2	77.1		
OCD5 (2015-19)	34.3	69.9	108.7	146.8	181.4	216.0		

Table 3b. Homogeneous comparison of selected track forecast guidance models (in n mi) for Tropical Storm Karina. 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	60	72	96	120
OFCL	30.6	35.4	31.1	30.9	52.3	67.8		
OCD5	46.3	84.7	128.5	140.9	132.5	140.6		
GFSI	35.9	48.7	44.1	46.4	58.7	**48.3**		
HMNI	**24.0**	**33.8**	36.8	35.0	**51.3**	**39.9**		
HWFI	**24.8**	**32.4**	**26.2**	36.5	**51.9**	**53.4**		
EGRI	**23.5**	**26.0**	**21.6**	**19.9**	**32.6**	**33.6**		
EMXI	39.2	51.6	45.5	34.3	53.4	**67.4**		
CMCI	**26.5**	37.2	69.7	111.6	171.2	235.0		
NVGI	32.7	51.9	75.3	113.4	170.3	236.4		
FSSE	31.1	36.3	37.7	45.2	63.5	**66.3**		
AEMI	36.6	48.0	46.6	39.1	58.1	**62.0**		
TVCA	**29.7**	36.2	**24.7**	**26.9**	**45.9**	**51.4**		
HCCA	**29.6**	35.6	**29.7**	**27.8**	**52.1**	**56.9**		
TVDG	**29.1**	**35.2**	**25.4**	**23.5**	**41.6**	**45.8**		
GFEX	35.0	45.2	36.7	34.0	52.7	**55.2**		
TVCX	31.1	**34.9**	**27.9**	**25.2**	**44.0**	**47.7**		
TABS	46.2	92.2	123.8	122.3	95.0	**31.4**		
TABM	35.4	55.8	62.7	42.1	**41.5**	94.1		
TABD	30.8	49.0	52.0	55.0	88.1	121.3		
Forecasts	12	10	8	6	4	2		

Table 4a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) intensity forecast errors (kt) for Tropical Storm Karina. 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	60	72	96	120
OFCL	**4.2**	**4.5**	**5.0**	**4.3**	**2.0**	**11.7**		
OCD5	5.1	7.5	4.6	5.4	5.0	7.0		
Forecasts	13	11	9	7	5	3		
OFCL (2015-19)	6.0	9.9	12.1	13.5	14.5	15.4		
OCD5 (2015-19)	7.8	13.0	16.6	18.9	20.2	21.4		

Table 4b. Homogeneous comparison of selected intensity forecast guidance models (in kt) for Tropical Storm Karina. 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	60	72	96	120
OFCL	4.2	5.0	5.0	5.0	1.2	15.0		
OCD5	5.1	8.2	5.0	5.0	5.5	**9.0**		
IVDR	**4.1**	6.4	6.0	**4.8**	2.0	**11.0**		
IVCN	4.2	6.4	6.6	5.7	2.2	**9.0**		
ICON	4.5	6.3	6.9	5.8	2.5	**8.0**		
LGEM	5.1	8.5	11.1	13.2	13.0	**6.5**		
DSHP	5.1	7.1	10.0	10.8	9.5	**2.5**		
FSSE	**4.1**	6.3	5.6	5.2	4.8	15.0		
HCCA	**4.1**	5.6	5.4	6.0	4.0	**14.0**		
EMXI	6.2	9.8	13.0	13.3	12.0	**10.0**		
HWFI	5.0	7.2	7.9	5.7	6.0	20.5		
HMNI	4.9	5.3	**3.5**	5.5	4.5	16.0		
GFSI	4.7	8.1	10.9	12.8	11.5	**4.0**		
Forecasts	12	10	8	6	4	2		

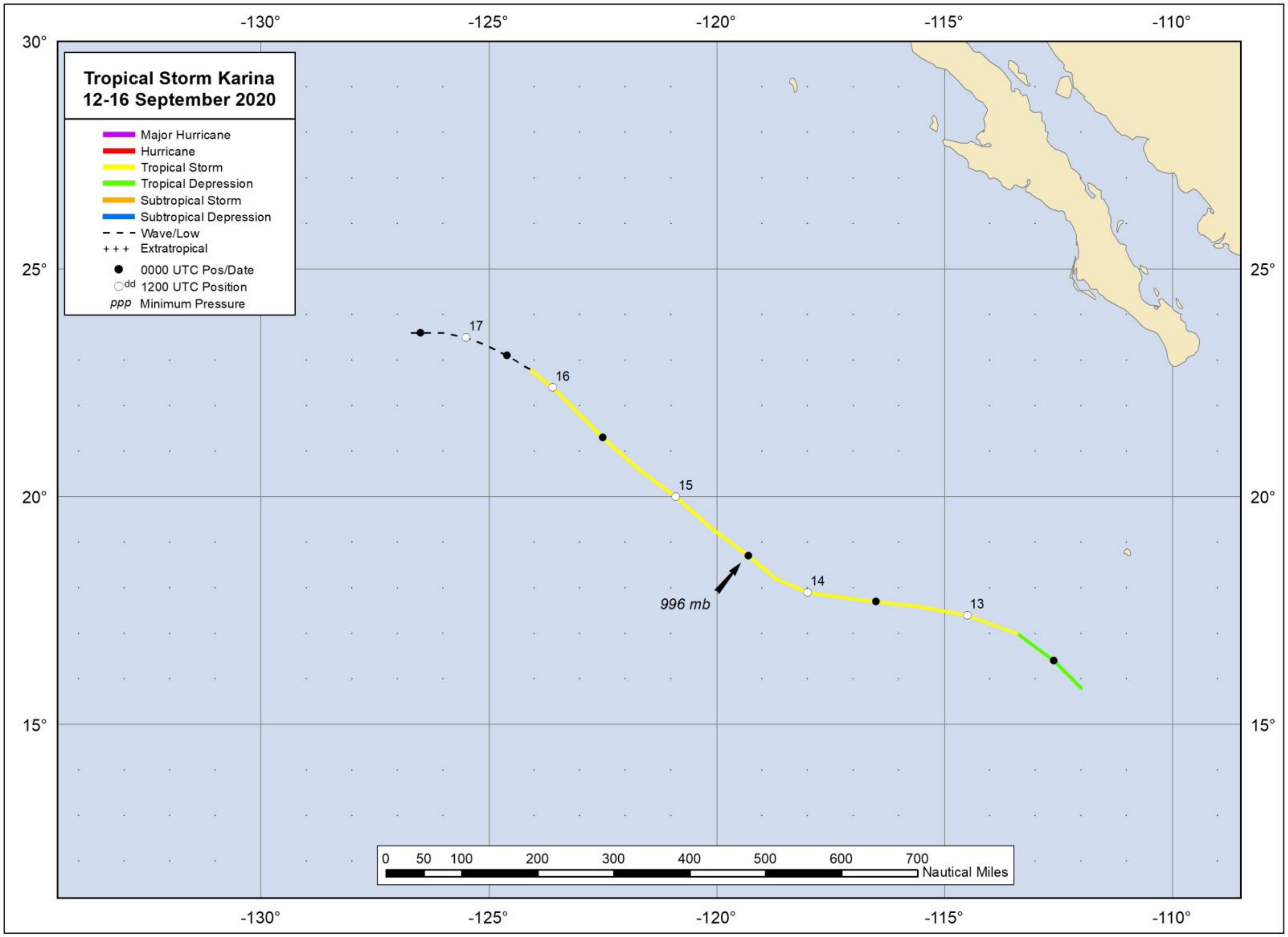

Figure 1. Best track positions for Tropical Storm Karina, 12–16 September 2020.

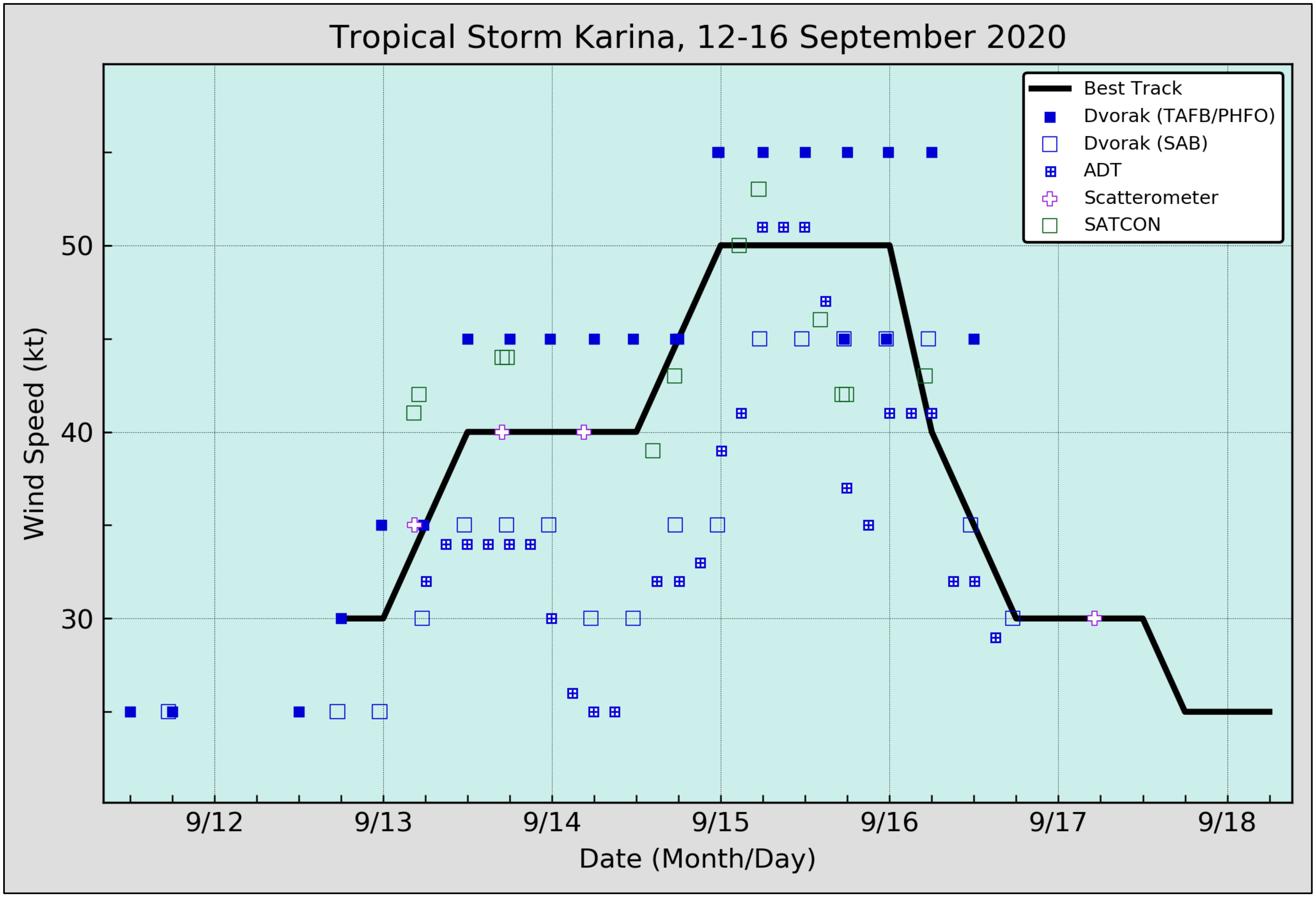

Figure 2. Selected wind observations and best track maximum sustained surface wind speed curve for Tropical Storm Karina, 12–16 September 2020. AMSU intensity estimates are from the Cooperative Institute for Meteorological Satellite Studies technique. Advanced Dvorak Technique estimates represent the Current Intensity at the nominal observation time. SATCON intensity estimates are from the Cooperative Institute for Meteorological Satellite Studies. Dashed vertical lines correspond to 0000 UTC.

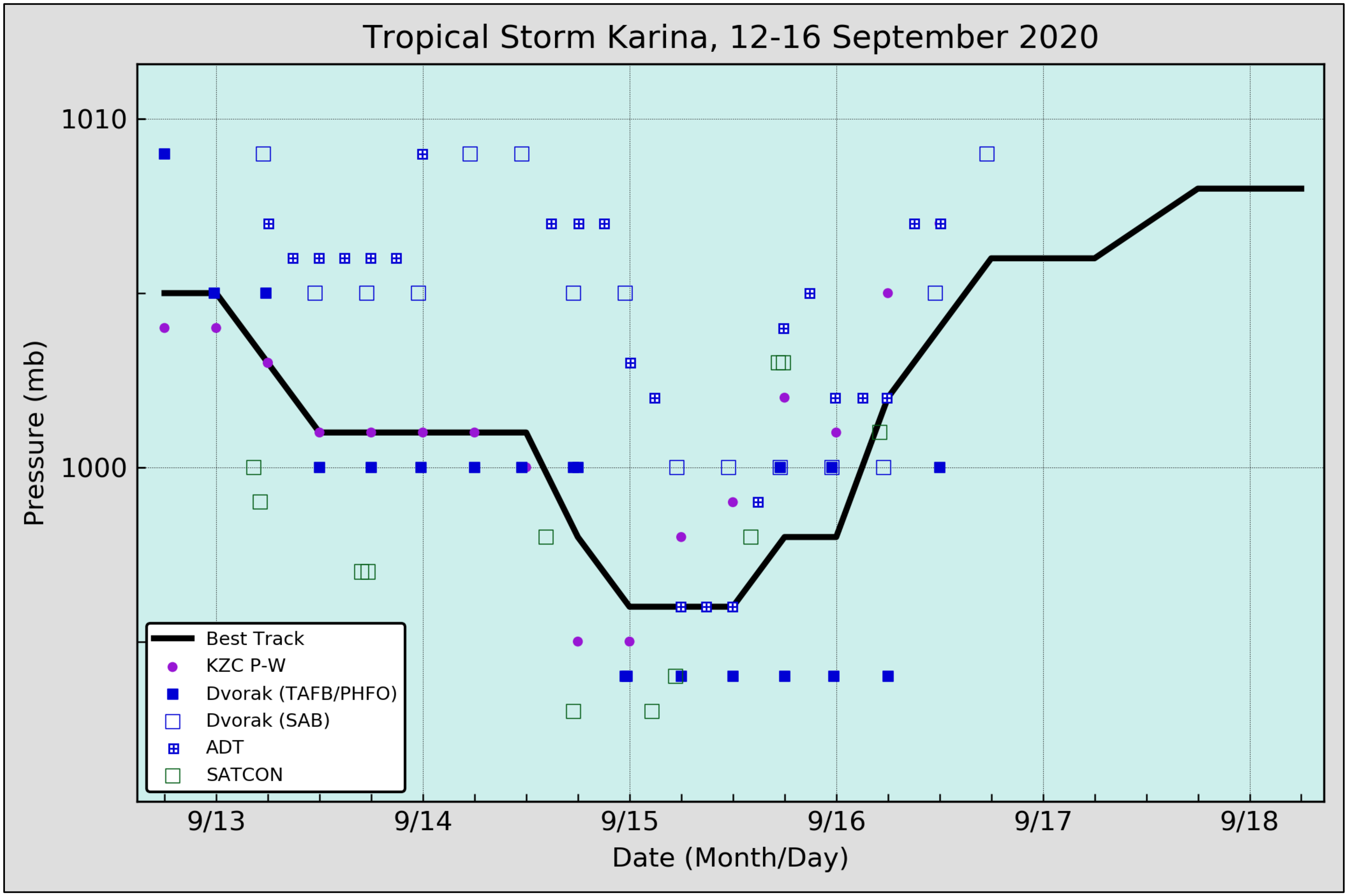

Figure 3. Selected pressure observations and best track minimum central pressure curve for Tropical Storm Karina, 12–16 September 2020. AMSU intensity estimates are from the Cooperative Institute for Meteorological Satellite Studies technique. KZC P-W refers to pressure estimates derived using the Knaff-Zehr-Courtney pressure-wind relationship. Advanced Dvorak Technique estimates represent the Current Intensity at the nominal observation time. SATCON intensity estimates are from the Cooperative Institute for Meteorological Satellite Studies. Dashed vertical lines correspond to 0000 UTC.