NATIONAL HURRICANE CENTER TROPICAL CYCLONE REPORT

HURRICANE KARINA

(EP112014)

13 – 26 August 2014

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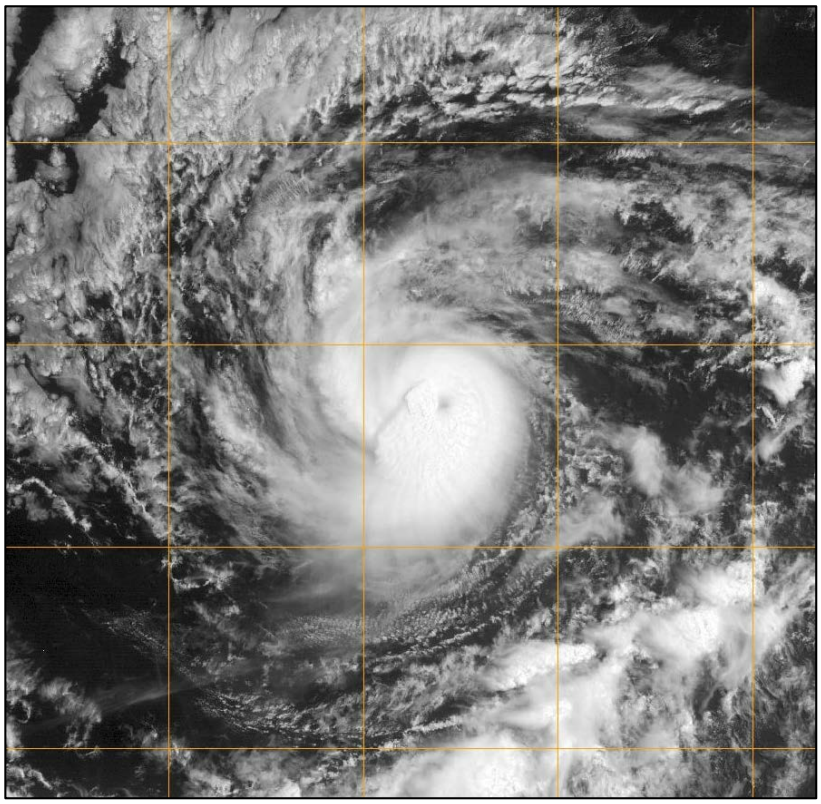

GOES-15 VISIBLE SATELLITE IMAGE OF HURRICANE KARINA AT 1900 UTC 22 AUGUST. IMAGE COURTESY OF THE NAVAY RESEARCH LABORATORY

Karina was a long-lived tropical cyclone that remained over the open waters of the eastern Pacific. Karina's nearly 14 days as a tropical cyclone makes it the seventh longest-lived tropical cyclone in the eastern Pacific since reasonably reliable records began in 1966.

Hurricane Karina

13 – 26 AUGUST 2014

SYNOPTIC HISTORY

Karina formed from a tropical wave that departed the west coast of Africa on 28 July. The wave crossed Central America on 8 August and moved over the far eastern Pacific Ocean the next day. Showers and thunderstorms associated with the wave gradually increased while the system passed south of the Gulf of Tehuantepec on 10 August, and a broad low pressure area formed the next day. The low became better defined on 12 August while it moved west-northwestward to the south of the southern coast of Mexico. Late that day, showers and thunderstorms associated with the system increased and became better organized, resulting in the formation of a tropical depression about 250 n mi southwest of Manzanillo, Mexico, at 0000 UTC 13 August. 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].

Convection associated with the depression continued to increase and become organized in a band around the western and southwestern portions of the circulation, and the system became a tropical storm by 1200 UTC 13 August. The tropical cyclone initially moved west-northwestward at about 15 kt, but turned westward later on 13 August as a mid-level ridge built westward over the subtropical eastern Pacific. Karina continued to strengthen over the next day or so while it moved over warm water and in an area of light to moderate northeasterly vertical wind shear. Satellite data indicate that the cyclone's inner-core structure improved and a banded-eye feature became evident in microwave imagery (Fig. 4) shortly after 1200 UTC 14 August. A ragged eye was briefly apparent in visible satellite imagery and Karina became a hurricane by 1800 UTC 14 August. Karina's time as a hurricane was brief, however, as increasing easterly shear caused the core to rapidly erode, and microwave data around 0000 UTC 15 August indicated that the deep convection became displaced to the west of an exposed low-level center (Fig. 4). Karina weakened to a tropical storm about that time and it continued to weaken over the next 24 h. By 0000 UTC 16 August, Karina's maximum winds had decreased to 40 kt.

During the next couple of days, easterly shear continued to affect the convective organization of the tropical cyclone and Karina remained a relatively weak tropical storm. On 17 August, Karina turned west-southwestward when the mid-level ridge to the north of the cyclone strengthened. The next day, the vertical shear over Karina decreased and the convective organization of the tropical cyclone improved, and Karina's peak winds increased to 50-kt by 0000 UTC 19 August.

[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.

Around this time, Karina turned westward and its forward motion slowed when the ridge to the north of the system weakened, and an unusually large tropical cyclone (Lowell) developed about 900 n mi to its east. Karina changed little in strength during the next couple of days. The large and strengthening Lowell caused the steering currents near Karina to further weaken, and Karina moved slowly southward, and then southeastward on 21 August. The cloud pattern of Karina improved that day and the tropical cyclone began to strengthen. Karina turned east-northeastward and then northeastward in mid-tropospheric southwesterly flow around the southern periphery of Lowell's circulation. Around 1800 UTC 22 August, an eye became apparent in visible satellite imagery (cover photo) and Karina became a hurricane for a second time. The hurricane continued to strengthen and Karina reached an estimated peak intensity of 75 kt by 0600 UTC 23 August, around the time that the tropical cyclone completed a 3-day-long cyclonic loop.

Karina turned eastward-northeastward on 23 August while Lowell passed to its northeast, and later that day increasing vertical shear and slightly lower sea surface temperatures caused weakening to commence. While moving eastward to east-southeastward, Karina weakened to a tropical storm by 0600 UTC 24 August, and became a tropical depression at 1200 UTC 25 August. The depression turned south-southeastward around the southwestern periphery of yet another large tropical cyclone (Hurricane Marie) to its east. Karina degenerated into a remnant low by 1800 UTC 26 August. The remnant low turned eastward, then northeastward around the southern portion of Marie's circulation and dissipated shortly after 0000 UTC 28 August, about 1000 n mi west-southwest 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) and the Satellite Analysis Branch (SAB). 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 Karina. Karina was well sampled by the ASCAT instrument during its long life as a tropical cyclone, and these data were useful in determining the intensity and size of Karina.

The 75-kt estimated peak intensity of Karina at 0600 and 1200 UTC 23 August is based on Dvorak intensity estimates of T4.5 or 77 kt from SAB at 0600 UTC and from TAFB at 1200 UTC 23 August. Objective Dvorak intensity estimates from the Advanced Dvorak Technique (ADT) from the Cooperative Institute for Meteorological Satellite Studies (CIMSS) also reached T4.5 by 0600 UTC 23 August.

Karina's 13.75 days as a tropical cyclone make it the seventh-longest-lived eastern North Pacific tropical cyclone since relatively reliable records began in 1966.

There were no ship reports of tropical-storm-force winds in association with Karina.

CASUALTY AND DAMAGE STATISTICS

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

FORECAST AND WARNING CRITIQUE

The development of Karina was fairly well predicted. The potential for tropical cyclone development was first mentioned in the Tropical Weather Outlook (TWO) about four days before formation occurred. The system was assessed to have a medium chance of formation (30-50%) in the 5-day forecast period 72 h before development occurred, and a high chance (>50%) of formation 48 h before genesis. The timing of genesis was not quite as well predicted, as the 48-h chance of formation remained in the low category until about 24 h before genesis, and it did not reach the high category until 6 h before development occurred. Table 2 indicates how far in advance of formation the NHC Tropical Weather Outlook forecast first reached the indicated likelihood.

A verification of the NHC official track forecasts for Karina is given in Table 3a. Official forecast track errors were below the mean official errors for the previous 5-yr period through 72 h, but higher than the long-term mean at 96 and 120 h. A homogeneous comparison of the official track errors with selected guidance models is given in Table 3b. The only individual model that exhibited lower mean track errors than the NHC forecasts (OFCL) was the ECMWF (EMXI). The FSSE and TCVE consensus models also had lower mean track errors than the official forecast at each verifying time period. The larger than average OFCL track errors at 96 and 120 h are the result of poor long-range forecasts between 19-23 August (Fig. 5). During this time, the NHC forecasts and much of the dynamical model guidance predicted that Karina would move around the eastern portion of Lowell's circulation. Instead, Karina moved eastward to the south of Lowell and then later turned northeastward around Maria's circulation before dissipating.

A verification of NHC official intensity forecasts for Karina is given in Table 4a. Official forecast intensity errors were slightly lower than the mean official errors for the previous 5-yr period at all lead times except 72 h, when it was slightly higher than the long-term mean. A homogeneous comparison of intensity errors with selected guidance models is given in Table 4b. The NHC forecasts and the intensity guidance had comparable average errors for Karina, although the model guidance generally faired a little better.

Table 1. Best track for Hurricane Karina, 13-26 August 2014.

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
12 / 1200	15.1	105.0	1008	25	low
12 / 1800	15.8	106.4	1008	25	"
13 / 0000	16.4	107.8	1007	25	tropical depression
13 / 0600	16.9	109.2	1006	30	"
13 / 1200	17.1	110.6	1005	35	tropical storm
13 / 1800	17.2	112.1	1004	40	"
14 / 0000	17.2	113.4	1001	45	"
14 / 0600	17.1	114.5	998	50	"
14 / 1200	17.0	115.6	994	60	"
14 / 1800	17.0	116.7	990	65	hurricane
15 / 0000	17.0	117.8	991	60	tropical storm
15 / 0600	17.1	118.7	994	55	"
15 / 1200	17.3	119.7	996	50	"
15 / 1800	17.5	120.6	999	45	"
16 / 0000	17.7	121.5	1002	40	"
16 / 0600	18.0	122.5	1002	40	"
16 / 1200	18.0	123.5	1002	40	"
16 / 1800	17.9	124.6	1002	40	"
17 / 0000	17.9	125.6	1002	40	"
17 / 0600	18.0	126.6	1002	40	"
17 / 1200	18.0	127.8	1002	40	"
17 / 1800	17.8	129.0	1002	40	"
18 / 0000	17.6	130.0	1003	35	"
18 / 0600	17.3	131.0	1003	35	"
18 / 1200	16.9	131.9	1002	40	"
18 / 1800	16.3	132.6	1000	45	"
19 / 0000	15.9	133.0	998	50	"
19 / 0600	15.7	133.6	998	50	"

19 / 1200	15.7	134.1	1000	45	"
19 / 1800	15.7	134.6	1002	45	"
20 / 0000	15.8	135.1	1002	45	"
20 / 0600	15.9	135.8	1002	45	"
20 / 1200	15.9	136.4	1000	50	"
20 / 1800	15.8	136.6	1000	50	"
21 / 0000	15.6	136.8	1000	50	"
21 / 0600	15.3	136.9	1000	50	"
21 / 1200	15.0	136.9	1000	50	"
21 / 1800	14.8	136.8	997	55	"
22 / 0000	14.7	136.5	997	55	"
22 / 0600	14.7	136.1	997	55	"
22 / 1200	14.9	135.7	994	60	"
22 / 1800	15.4	135.3	990	65	hurricane
23 / 0000	16.0	135.0	987	70	"
23 / 0600	16.5	134.7	983	75	"
23 / 1200	17.0	134.3	983	75	"
23 / 1800	17.3	133.8	984	70	"
24 / 0000	17.6	133.2	988	65	"
24 / 0600	17.8	132.6	991	60	tropical storm
24 / 1200	17.9	131.7	994	55	"
24 / 1800	17.8	130.7	999	45	"
25 / 0000	17.6	129.7	1001	40	"
25 / 0600	17.4	128.8	1002	35	"
25 / 1200	17.4	128.2	1002	30	tropical depression
25 / 1800	17.4	127.8	1003	30	"
26 / 0000	17.2	127.5	1003	30	"
26 / 0600	17.0	127.4	1003	30	"
26 / 1200	16.8	127.3	1004	30	"
26 / 1800	16.4	127.3	1005	25	low
27 / 0000	15.9	127.0	1005	25	"

27 / 0600	15.4	126.4	1005	25	"
27 / 1200	15.1	125.3	1006	25	"
27 / 1800	15.2	124.0	1006	25	"
28 / 0000	16.3	123.1	1006	20	"
28 / 0600					dissipated
23 / 0600	16.5	134.7	983	75	maximum winds and minimum pressure

Table 2. This table indicates how far in advance of formation the NHC Tropical Weather Outlook forecast first reached 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 (<30%)	48	96
Medium (30%-50%)	24	72
High (>50%)	6	48

Table 3a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) track forecast errors (n mi) for 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	72	96	120
OFCL	**21.9**	**31.4**	**42.4**	**51.8**	**96.4**	152.2	230.7
OCD5	38.4	81.6	137.0	204.4	352.7	518.5	687.7
Forecasts	53	51	49	47	43	39	35
OFCL (2009-13)	25.7	41.4	55.0	68.6	97.8	134.2	167.1
OCD5 (2009-13)	37.2	74.8	118.0	162.5	249.4	332.6	413.3

Table 3b. Homogeneous comparison of selected track forecast guidance models (in n mi) for 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	72	96	120
OFCL	21.0	30.4	42.3	52.4	91.7	159.7	234.7
OCD5	38.6	83.0	139.1	210.0	359.4	546.6	714.0
GFSI	**19.4**	31.6	45.3	60.4	109.3	211.8	342.4
GHMI	22.9	37.4	52.1	72.0	124.2	195.8	318.1
HWFI	**20.7**	32.6	49.4	68.9	112.8	180.9	**227.0**
EGRI	24.9	44.1	63.0	84.4	141.6	229.7	304.2
EMXI	**20.0**	**30.3**	**37.2**	**44.6**	**77.3**	**122.9**	**192.5**
CMCI	30.0	51.1	74.3	95.0	185.2	309.0	397.1
AEMI	22.0	36.2	52.2	69.6	116.0	195.4	265.5
FSSE	**16.9**	**25.7**	**37.0**	**47.3**	**81.3**	**137.1**	**192.8**
TCON	**18.4**	**29.1**	**42.1**	56.6	97.3	167.2	240.0
TVCE	**18.2**	**27.7**	**39.4**	**51.4**	**88.7**	**152.9**	**222.2**
LBAR	34.7	84.1	146.7	208.8	323.7	467.3	597.4
BAMM	34.1	68.3	108.8	150.9	205.2	289.5	348.0
BAMD	40.7	81.8	128.5	173.0	242.8	340.9	427.5
BAMS	39.5	76.5	117.8	161.8	225.0	318.3	380.7
Forecasts	49	46	45	43	37	35	29

Table 4a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) intensity forecast errors (kt) for 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	72	96	120
OFCL	**5.4**	**7.8**	**10.4**	**12.4**	15.9	**15.5**	**15.1**
OCD5	5.9	9.4	11.8	12.7	13.3	12.4	10.7
Forecasts	53	51	49	47	43	39	35
OFCL (2009-13)	6.1	10.4	13.4	14.5	15.0	16.4	16.1
OCD5 (2009-13)	7.7	12.7	16.4	18.8	20.5	20.3	20.8

Table 4b. Homogeneous comparison of selected intensity forecast guidance models (in kt) for 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	72	96	120
OFCL	5.5	7.9	10.2	13.0	16.3	15.0	14.4
OCD5	6.0	9.5	11.3	**12.5**	**13.7**	**13.1**	**10.5**
GHMI	5.6	**7.7**	**8.8**	**10.3**	**11.7**	**13.9**	**12.0**
HWFI	**4.9**	**6.8**	**9.1**	**10.5**	**14.9**	**14.4**	**12.7**
GFSI	**5.7**	**8.1**	**9.7**	**12.0**	**12.2**	**10.6**	**9.9**
EMXI	6.6	**9.4**	**10.0**	**10.6**	**10.4**	**8.9**	10.1
DSHP	5.5	8.3	**9.8**	**11.4**	**14.4**	**14.7**	16.1
LGEM	5.8	8.3	**9.9**	**12.0**	**14.9**	15.6	17.0
ICON	**4.9**	**6.9**	**7.9**	**9.8**	**12.8**	**12.9**	**12.5**
IVCN	**4.9**	**6.9**	**7.9**	**9.8**	**12.8**	**12.9**	**12.5**
FSSE	**5.1**	**6.9**	**8.8**	**11.4**	**15.2**	18.5	19.1
Forecasts	50	48	46	43	39	36	31

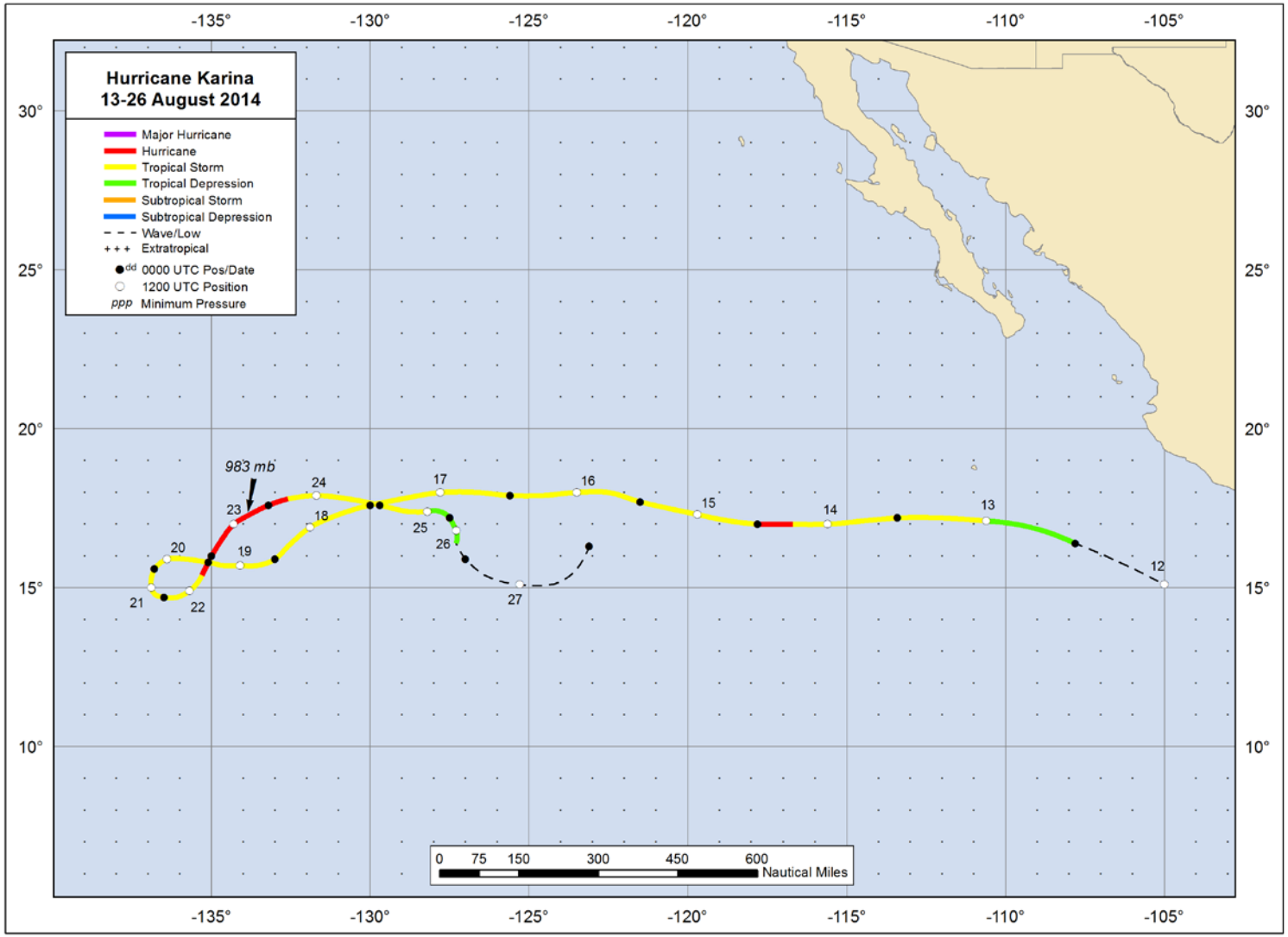

Figure 1. Best track positions for Hurricane Karina, 13-26 August 2014.

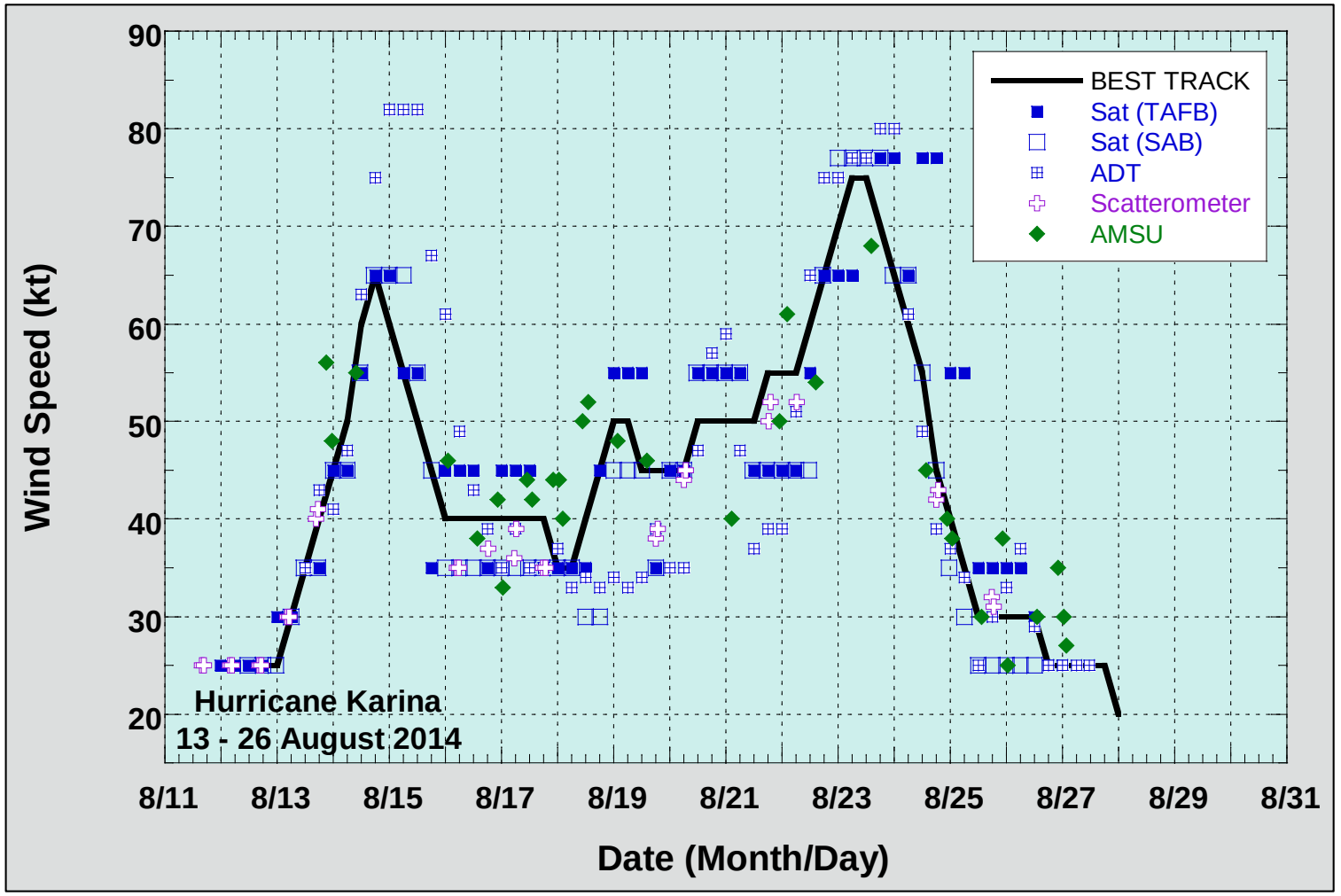

Figure 2. Selected wind observations and best track maximum sustained surface wind speed curve for Hurricane Karina, 13-26 August 2014. Advanced Dvorak Technique estimates represent the Current Intensity at the nominal observation time. AMSU intensity estimates are from the Cooperative Institute for Meteorological Satellite Studies technique. Dashed vertical lines correspond to 0000 UTC.

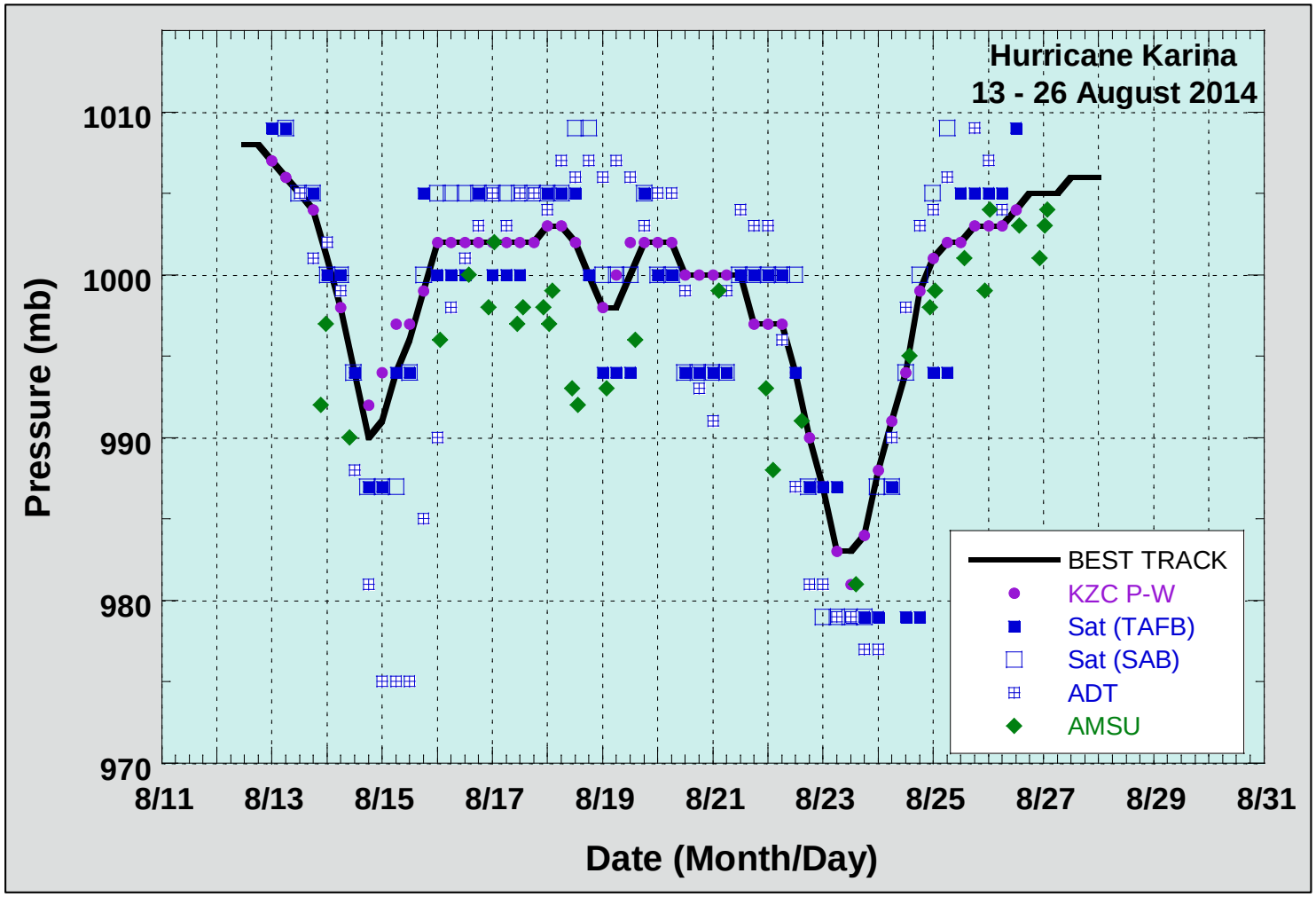

Figure 3. Selected pressure observations and best track minimum central pressure curve for Hurricane Karina, 13-26 August 2014. Advanced Dvorak Technique estimates represent the Current Intensity at the nominal observation time. AMSU intensity estimates are from the Cooperative Institute for Meteorological 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.

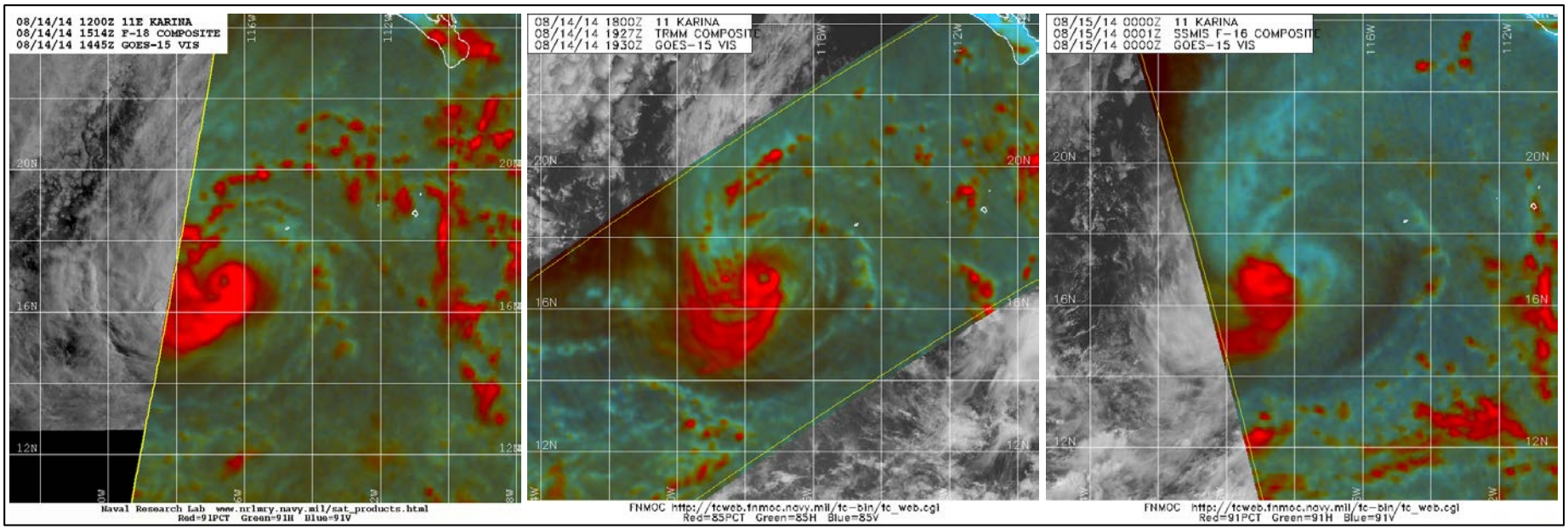

Figure 4. Composite 89-91GHz microwave images showing the evolution of Karina's inner core between 1514 UTC 14 August and 0001 UTC 15 August 2014. The eye that is apparent at 1514 UTC (left image), becomes displaced to the southwest of the low-level center at 1927 UTC (center image), and is no longer evident by 0001 UTC 15 August. Images courtesy of the Naval Research Laboratory and the Fleet Numerical and Oceanography Center.

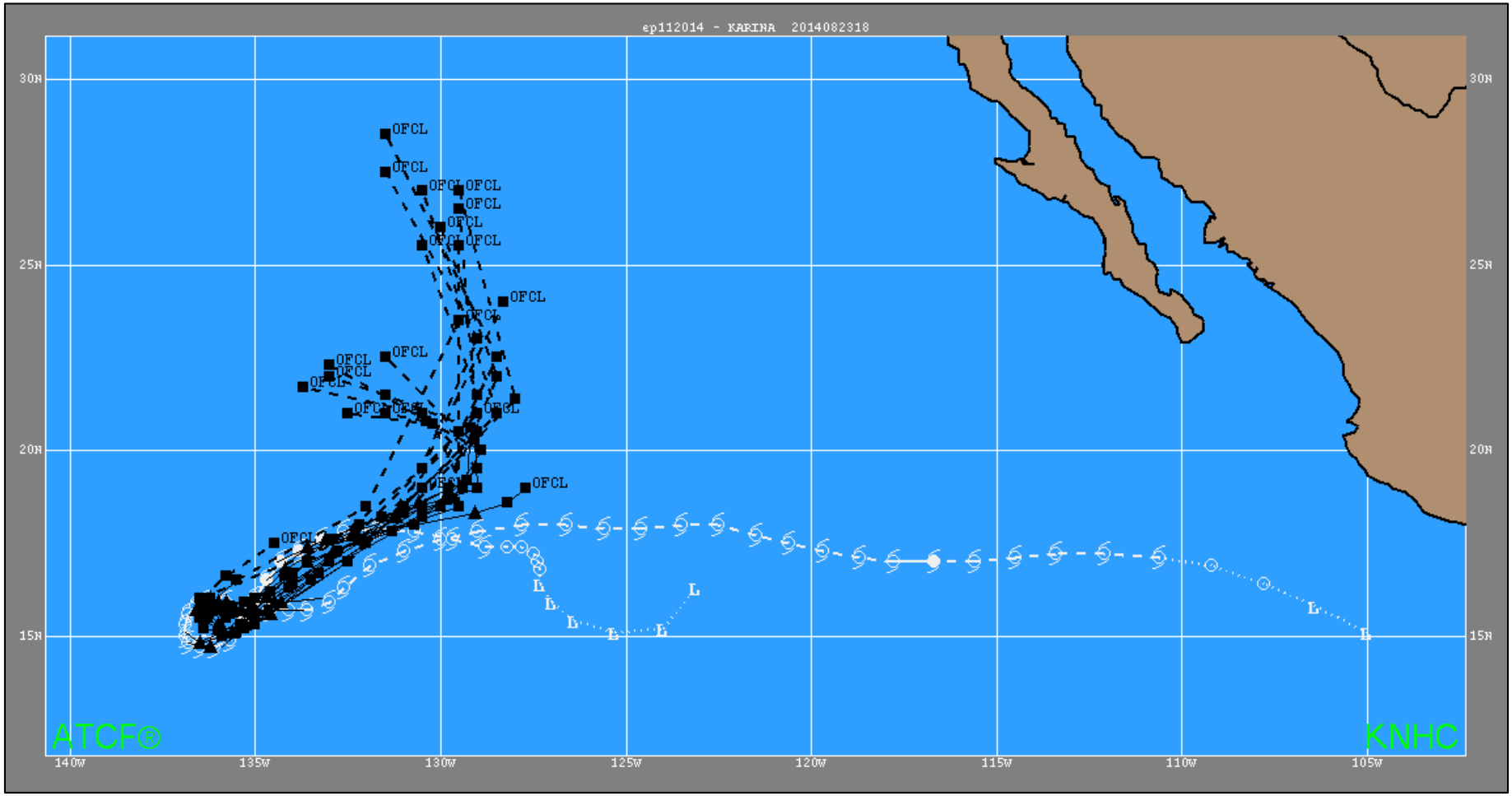

Figure 5. NHC (OFCL) track forecasts (black) for Karina between 0000 UTC 19 August and 1800 UTC 23 August. The verifying best-track of Karina is shown in white. NHC forecasts during this time exhibited a significant northward bias since much of the dynamical model guidance indicated that the tropical cyclone would turn northward around the eastern portion of weakening Hurricane Lowell.