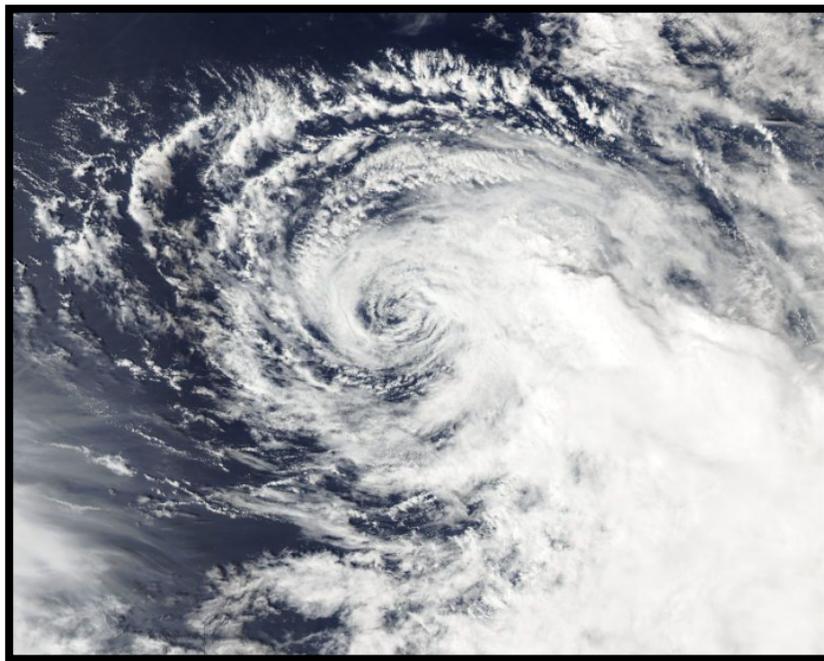# NATIONAL HURRICANE CENTER TROPICAL CYCLONE REPORT[1]

TROPICAL STORM RINA

(AL182023)

28 September–1 October 2023

Brad J. Reinhart
National Hurricane Center
22 November 2023

NASA/AQUA MODERATE RESOLUTION IMAGING SPECTRORADIOMETER (MODIS) IMAGERY OF TROPICAL STORM RINA AT 1656 UTC 29 SEPTEMBER 2023. IMAGE COURTESY NASA EOSDIS WORLDVIEW.

Rina was a sheared tropical storm that formed over the central Atlantic Ocean in close proximity to Tropical Storm Philippe.

---

[1] This is an abbreviated Tropical Cyclone Report since there were no coastal watches or warnings issued and no direct fatalities reported in association with Rina.

TROPICAL STORM RINA

28 SEPTEMBER–1 OCTOBER 2023

BEST TRACK

The "best track[2]" positions and intensities for Tropical Storm Rina are listed in Table 1. The best track chart of Rina's path is given in Fig. 1, with the wind and pressure histories along with available observations[3] shown in Figs. 2 and 3, respectively.

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

Origin

Rina appears to have developed from a tropical wave that moved off the west coast of Africa on 22–23 September.

Peak Intensity and Minimum Pressure

The peak intensity of Rina (45 kt) from 0600 UTC 29 September to 0600 UTC 30 September is supported by subjective and objective satellite estimates and scatterometer data. The subjective Dvorak classification from TAFB at 0600 UTC 29 September rose to T3.0/45 kt when deep convection developed closer to the exposed center of Rina. The objective SATCON estimates from the Cooperative Institute for Meteorological Satellite Studies (CIMSS) peaked between 40–45 kt that morning as well. Later, ASCAT-C and -B overpasses at 0007 UTC and 0054 UTC 30 September, respectively, showed believable peak wind vectors between 40–45 kt in the eastern portion of Rina's circulation.

The estimated minimum central pressure of 999 mb at 0600 UTC and 1200 UTC 29 September is consistent with the Knaff-Zehr-Courtney (KZC) pressure-wind relationship and SATCON estimates during this period.

---

[2] 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.

[3] Observations include subjective satellite-based Dvorak technique intensity estimates from the Tropical Analysis and Forecast Branch (TAFB) and the Satellite Analysis Branch (SAB), 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), 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.

CASUALTY AND DAMAGE STATISTICS

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

FORECAST AND WARNING VERIFICATION

Table 2 provides the number of hours in advance of formation with the first NHC Tropical Weather Outlook (TWO) forecast in each likelihood category. Figure 4 shows composites of 7-day TWO genesis areas for each category prior to the formation of Rina. All of the genesis areas highlighted in the 7-day graphical TWO captured the location where Rina formed.

A verification of NHC official track forecasts for Rina is given in Table 3a. Official track forecast (OFCL) errors were greater than the mean official errors for the previous 5-yr period at all forecast times. Binary interaction with nearby Tropical Storm Philippe (Fig. 5) likely contributed to the above-average track errors for Rina. The models struggled to identify which storm would become the dominant system, which caused significant model run-to-run volatility.   A homogeneous comparison of the official track errors with selected guidance models is given in Table 3b. The Canadian model (CMCI) was the best track model for Rina, while the GFS (GFSI) and both HAFS models (HFAI and HFBI) performed poorly. The OFCL track errors were lower than the simple (TVCA) and corrected (HCCA) consensus aids.

A verification of NHC official intensity forecasts for Rina is given in Table 4a. Official intensity forecast (OFCL) errors were lower than the mean official errors for the previous 5-yr period at all forecast times. A homogeneous comparison of the official intensity errors with selected guidance models is given in Table 4b.

There were no coastal watches or warnings issued for Rina.

Table 1.   Best track for Tropical Storm Rina, 28 September–1 October 2023.

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
28 / 0600	15.6	44.5	1005	35	tropical storm
28 / 1200	16.9	45.1	1004	35	"
28 / 1800	17.7	45.8	1004	35	"
29 / 0000	18.2	46.2	1002	40	"
29 / 0600	18.6	46.4	999	45	"
29 / 1200	19.1	46.7	999	45	"
29 / 1800	19.8	47.5	1000	45	"
30 / 0000	20.2	48.4	1000	45	"
30 / 0600	20.5	49.1	1000	45	"
30 / 1200	21.0	50.0	1002	40	"
30 / 1800	22.1	51.0	1004	40	"
01 / 0000	23.0	52.2	1005	35	"
01 / 0600	23.8	53.3	1005	35	"
01 / 1200	24.8	54.4	1006	35	"
01 / 1800	25.8	55.3	1007	30	low
02 / 0000	26.7	55.6	1008	30	"
02 / 0600					dissipated
29 / 0600	18.6	46.4	999	45	maximum wind and minimum pressure

Table 2.   Number of hours in advance of formation of Rina 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	**168-Hour Outlook**
Low (<40%)	90	108
Medium (40%-60%)	60	90
High (>60%)	42	78

Table 3a.   NHC official (OFCL) and climatology-persistence skill baseline (OCD5) track forecast errors (n mi) for Tropical Storm Rina, 28 September–1 October 2023. 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	29.5	53.8	90.2	154.9	219.3	253.1		
OCD5	52.1	101.7	151.1	201.5	183.6	343.7		
Forecasts	11	9	7	5	3	1		
OFCL (2018-22)	23.8	35.7	47.8	61.4	76.1	90.5	125.7	172.1
OCD5 (2018-22)	46.4	99.2	157.4	215.0	254.9	321.2	405.1	486.6

Table 3b.   Homogeneous comparison of selected track forecast guidance models (in n mi) for Tropical Storm Rina, 28 September–1 October 2023. 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	32.8	53.8	90.2	154.9	219.3	253.1		
OCD5	57.9	101.7	151.1	201.5	**183.6**	343.7		
GFSI	33.5	55.5	93.9	168.3	272.8	313.2		
HWFI	34.4	67.4	120.1	208.6	260.6	**200.9**		
HMNI	36.4	59.0	**74.6**	**135.7**	**208.2**	**205.5**		
HFAI	39.7	66.4	114.3	197.7	275.3	326.4		
HFBI	45.0	84.8	144.0	183.6	269.2	293.6		
EMXI	**31.1**	56.2	**88.2**	**111.1**	**180.2**	267.1		
NVGI	49.9	76.0	129.1	167.1	**215.6**	320.4		
CMCI	**25.5**	**31.9**	**54.2**	**109.2**	**201.7**	**171.6**		
CTCI	41.6	87.2	160.5	261.0	323.0	356.4		
TVCA	31.0	53.8	94.8	164.0	240.9	258.6		
TVCX	31.7	**53.7**	96.1	158.5	239.1	256.4		
GFEX	**29.1**	**48.8**	**85.9**	**136.6**	**218.5**	274.4		
TVDG	29.5	**50.1**	**88.6**	**152.1**	237.5	**251.3**		
HCCA	**29.0**	56.8	95.6	158.0	254.6	282.2		
FSSE	**28.2**	**51.7**	95.1	159.3	240.7	269.0		
AEMI	**29.1**	**45.7**	**83.6**	**149.9**	220.5	281.7		
TABS	48.5	76.6	102.4	156.7	283.7	341.5		
TABM	43.8	79.6	131.5	201.3	268.7	292.4		
TABD	68.2	167.8	281.7	428.0	533.7	647.8		
Forecasts	9	9	7	5	3	1		

Table 4a.   NHC official (OFCL) and climatology-persistence skill baseline (OCD5) intensity forecast errors (kt) for Tropical Storm Rina, 28 September–1 October 2023. 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	**3.2**	**2.2**	**1.4**	**5.0**	**8.3**	**10.0**		
OCD5	4.1	7.6	10.6	15.0	16.3	18.0		
Forecasts	11	9	7	5	3	1		
OFCL (2018-22)	5.1	7.6	8.9	10.1	10.7	11.5	13.3	15.5
OCD5 (2018-22)	6.8	10.7	13.9	16.5	18.3	20.2	22.9	23.4

Table 4b.   Homogeneous comparison of selected intensity forecast guidance models (in kt) for Tropical Storm Rina, 28 September–1 October 2023. 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	3.3	2.2	1.4	5.0	8.3	10.0		
OCD5	4.4	7.6	10.6	15.0	16.3	18.0		
HWFI	**2.7**	3.0	5.1	**3.4**	**3.0**	**2.0**		
HMNI	4.6	6.9	5.6	**4.4**	**3.3**	**2.0**		
HFAI	3.3	4.7	6.9	13.8	18.7	18.0		
HFBI	4.6	3.0	6.9	15.8	20.7	22.0		
DSHP	4.4	5.7	8.4	9.0	9.3	15.0		
LGEM	5.7	7.2	9.3	10.2	11.3	16.0		
ICON	4.1	4.7	4.0	**4.4**	**4.0**	**6.0**		
IVCN	**2.9**	2.8	**1.1**	**3.6**	**6.0**	**3.0**		
IVDR	**2.7**	2.2	1.9	5.0	**7.3**	**5.0**		
CTCI	4.2	3.7	3.0	7.4	**7.7**	**1.0**		
GFSI	4.8	3.8	3.0	**3.6**	**6.7**	**4.0**		
EMXI	4.0	4.8	3.6	**3.2**	**2.3**	**7.0**		
HCCA	**2.9**	2.7	2.0	6.2	**8.0**	**3.0**		
FSSE	**3.0**	**2.1**	2.3	5.4	**7.7**	**6.0**		
Forecasts	9	9	7	5	3	1		
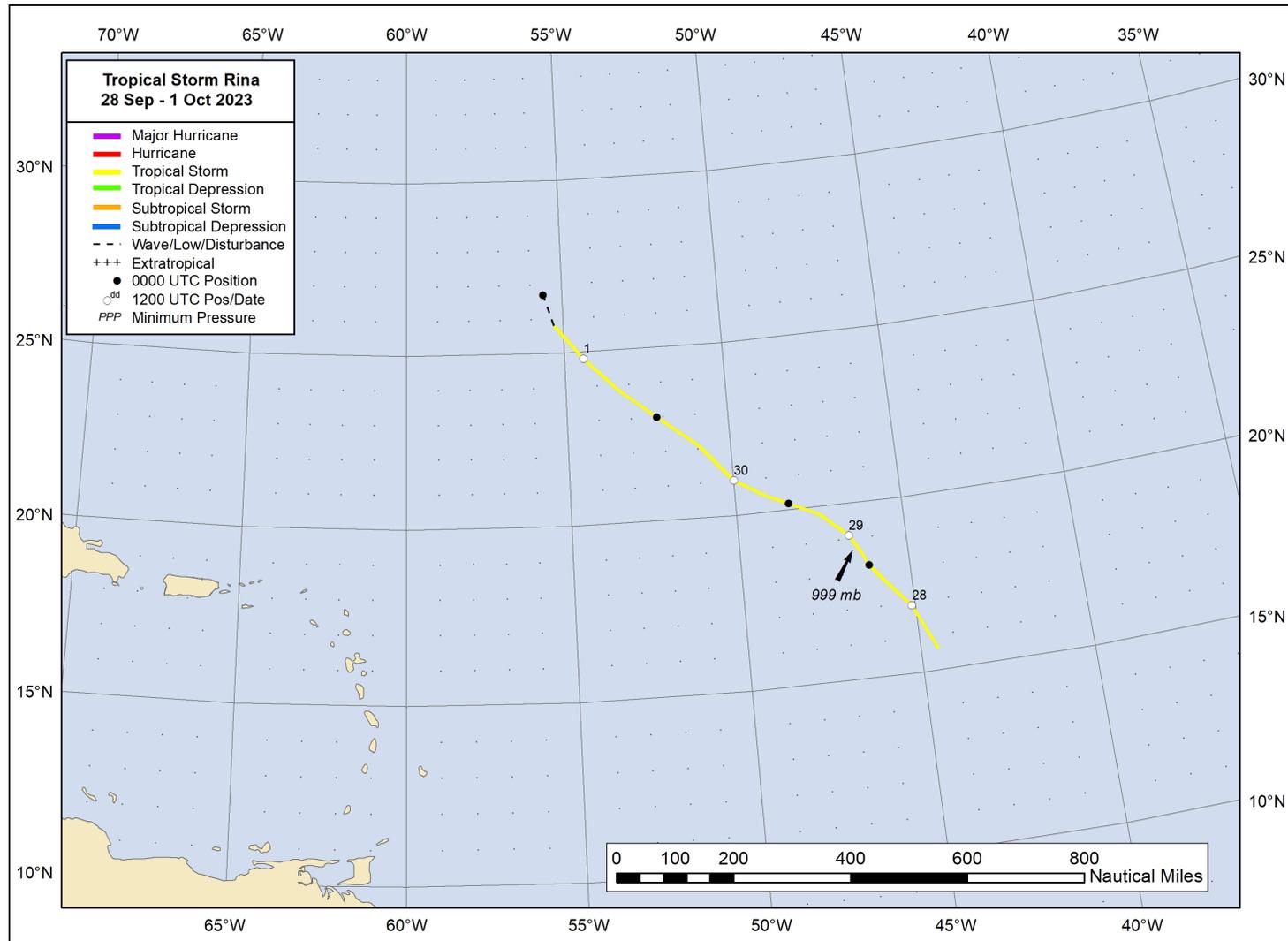
Figure 1.   Best track positions for Tropical Storm Rina, 28 September–1 October 2023.
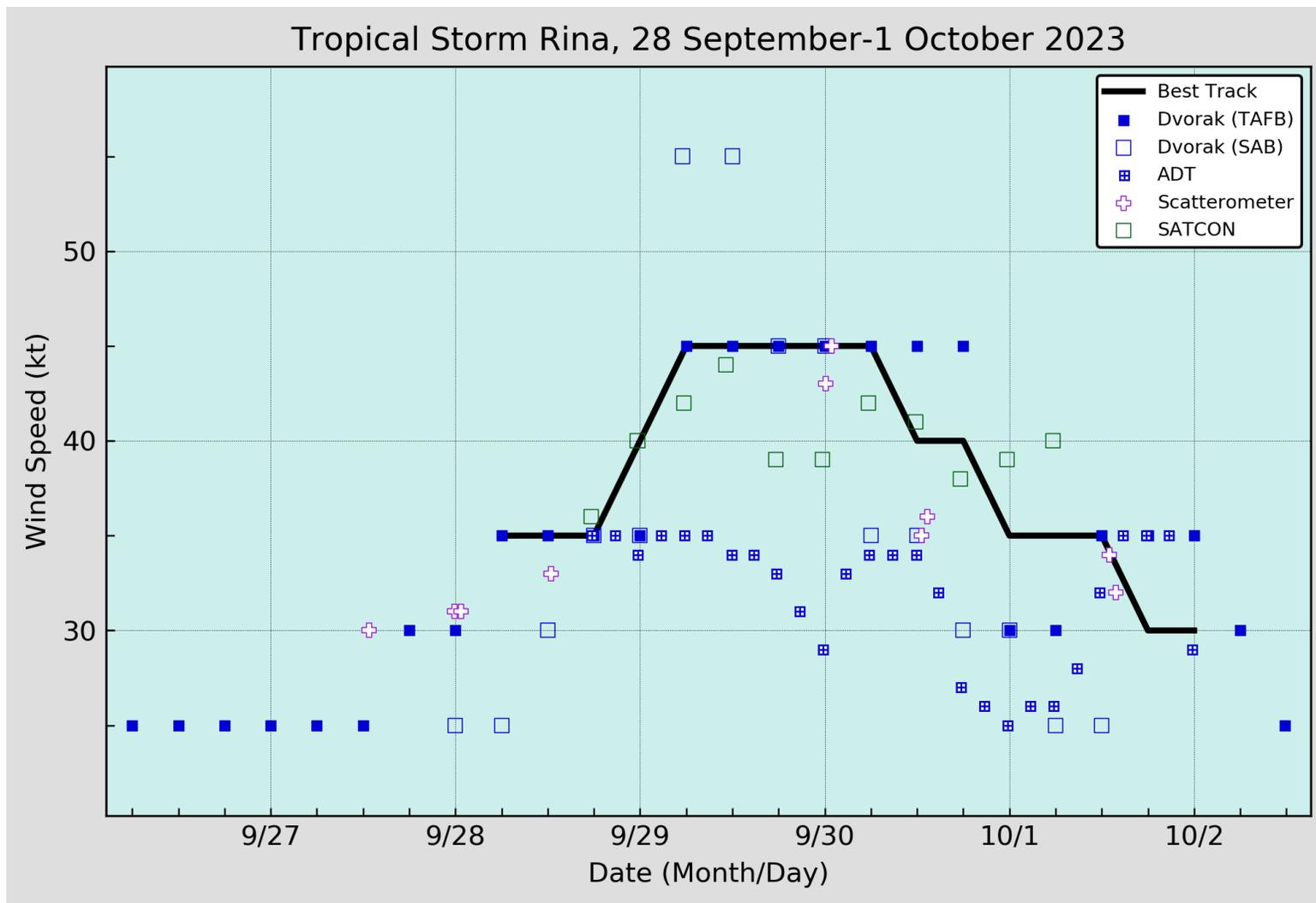
Figure 2.   Selected wind observations and best track maximum sustained surface wind speed curve for Tropical Storm Rina, 28 September–1 October 2023. Advanced Dvorak Technique estimates represent the Current Intensity at the nominal observation time. SATCON intensity estimates are from the Cooperative Institute for Meteorological Satellite Studies. Dashed vertical lines correspond to 0000 UTC.
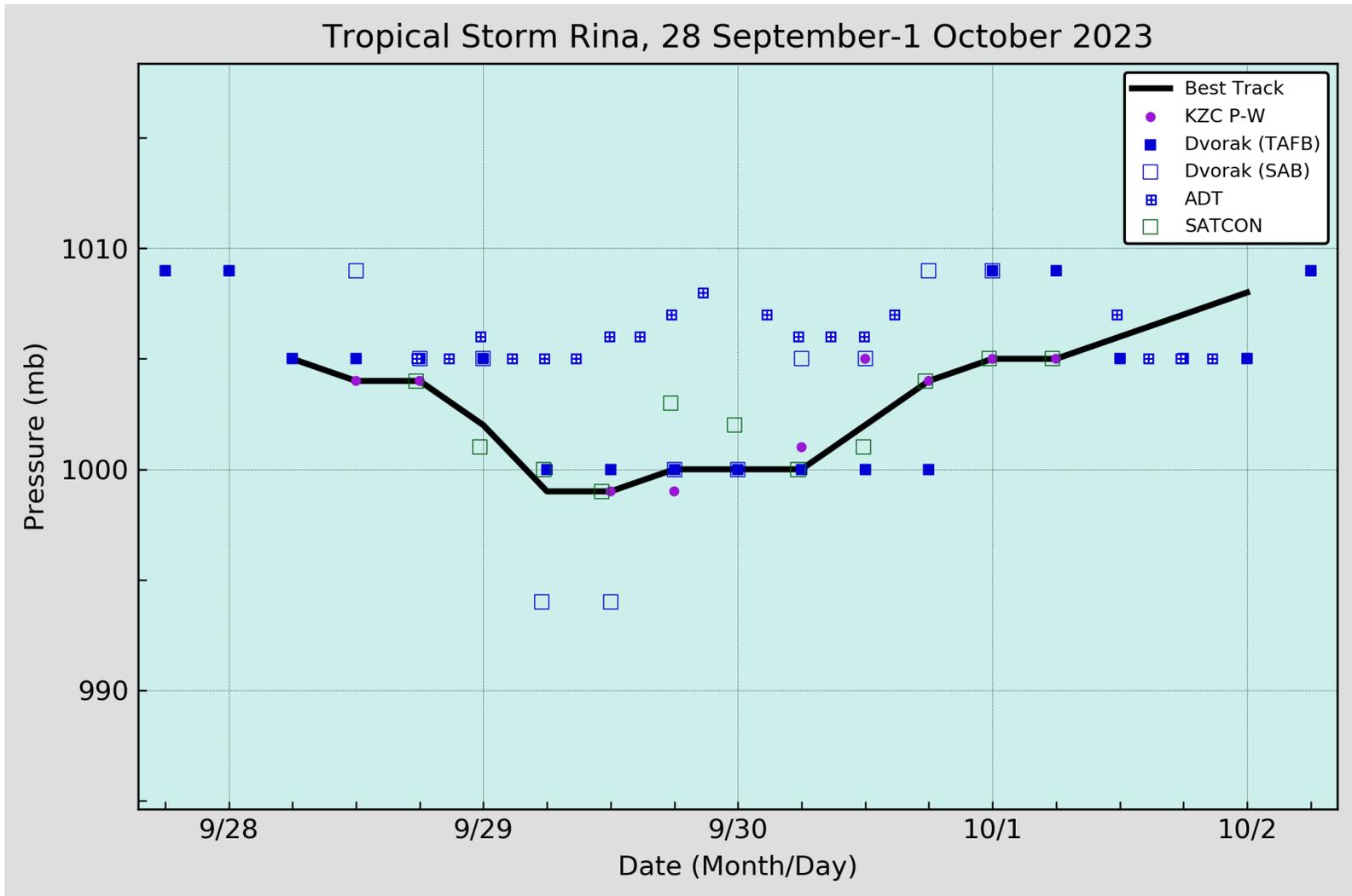
Figure 3.   Selected pressure observations and best track minimum central pressure curve for Tropical Storm Rina, 28 September–1 October 2023. Advanced Dvorak Technique estimates represent the Current Intensity at the nominal observation time. SATCON intensity estimates are from the Cooperative Institute for Meteorological Satellite Studies. KZC P-W refers to pressure estimates derived using the Knaff-Zehr-Courtney pressure-wind relationship. Dashed vertical lines correspond to 0000 UTC.

Rina 7-day Tropical Weather Outlook Areas
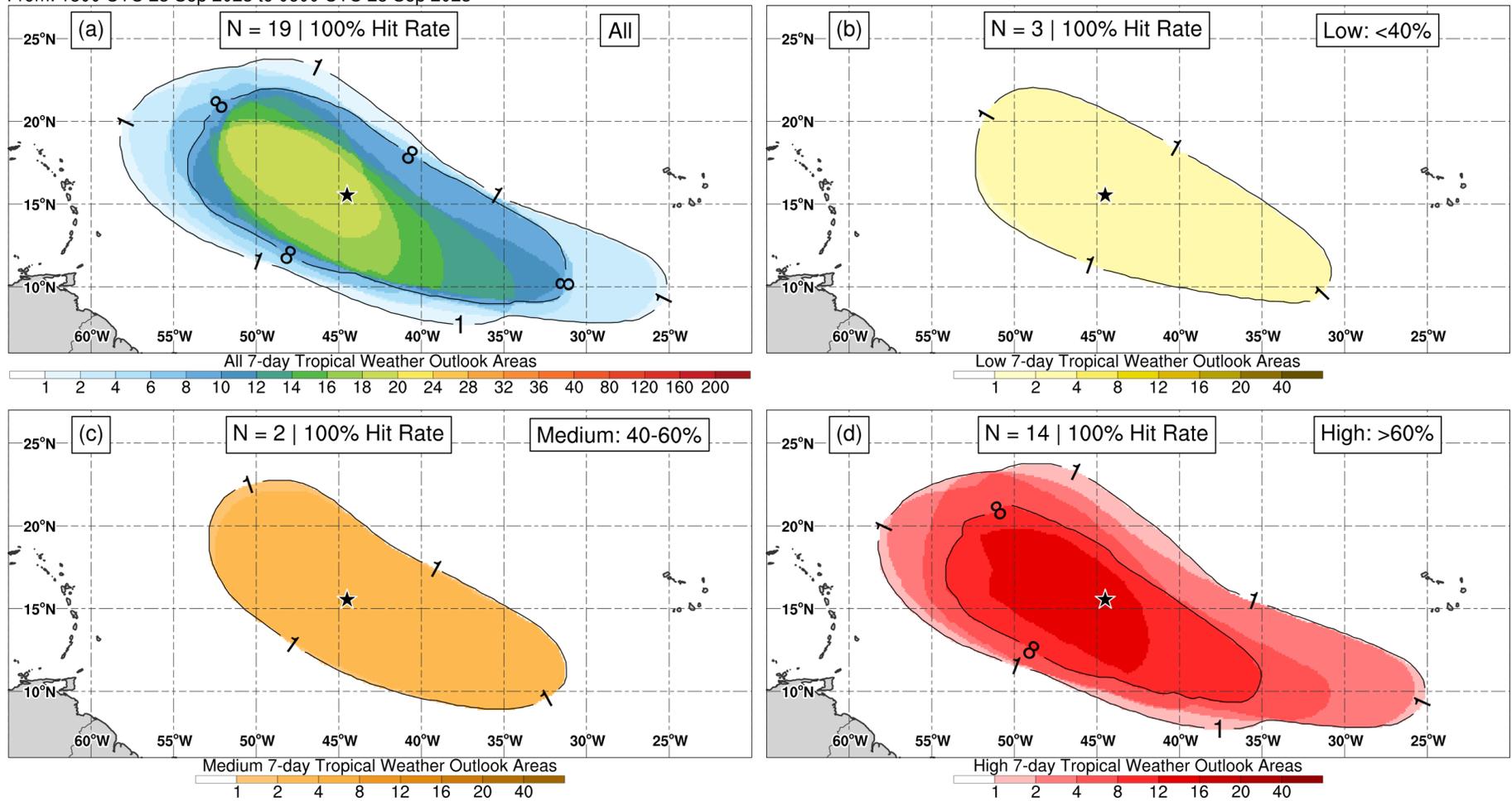From: 1800 UTC 23 Sep 2023 to 0600 UTC 28 Sep 2023

Figure 4.   Composites of 7-day tropical cyclone genesis areas depicted in NHC's Tropical Weather Outlooks prior to the formation of Rina for (a) all probabilistic genesis categories, (b) the low (<40%) category, (c) medium (40–60%) category, and (d) high (>60%) category. The location of genesis is indicated by the black star.
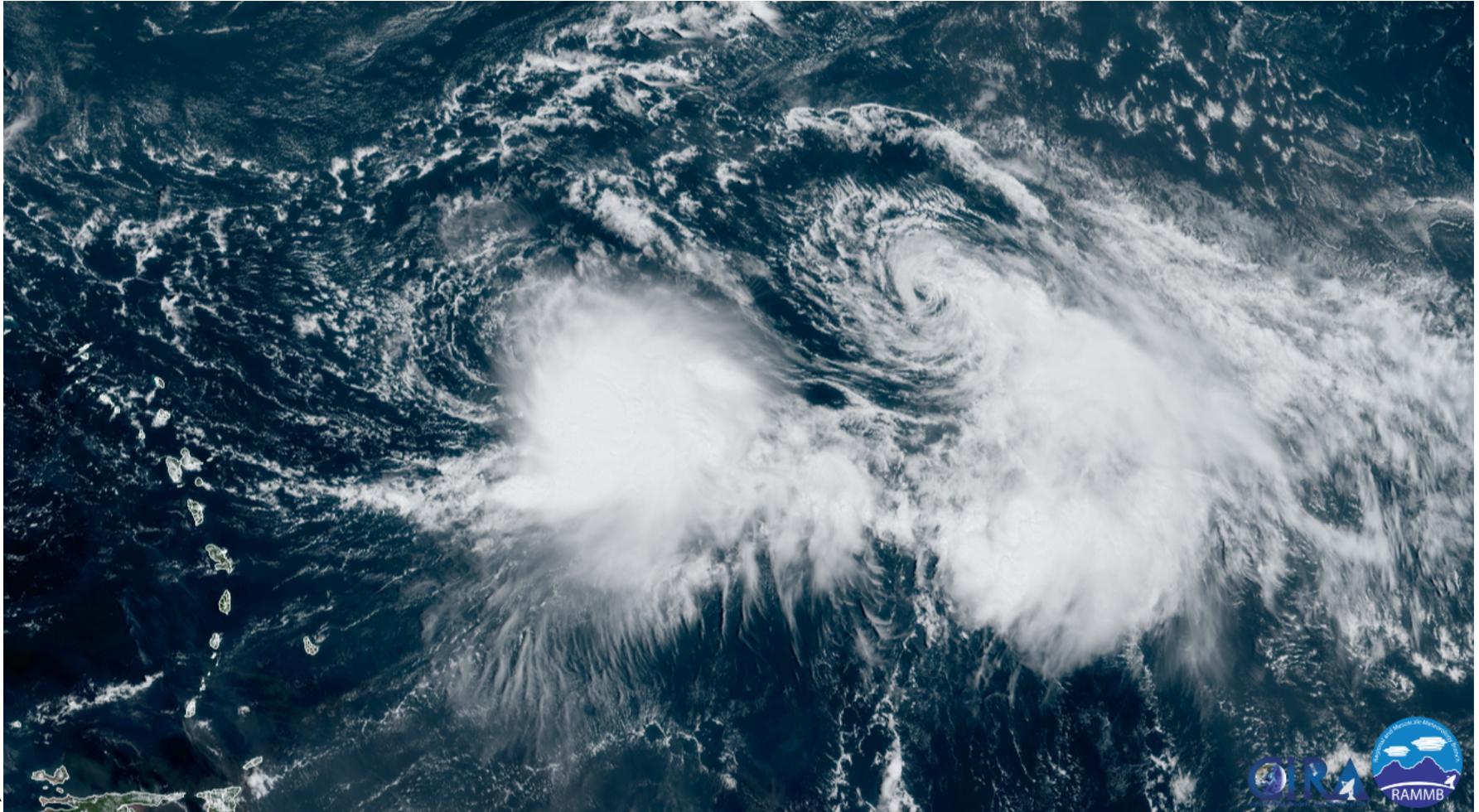
Figure 5.   GOES-16 GeoColor image showing the close proximity of Tropical Storm Philippe (left) to Tropical Storm Rina (right) at 1500 UTC 29 September 2023. Image created using the CIRA SLIDER application from RAMMB/CIRA/Colorado State University. https://rammb-slider.cira.colostate.edu/