NATIONAL HURRICANE CENTER TROPICAL CYCLONE REPORT

HURRICANE RICK

(EP172021)

22 – 25 October 2021

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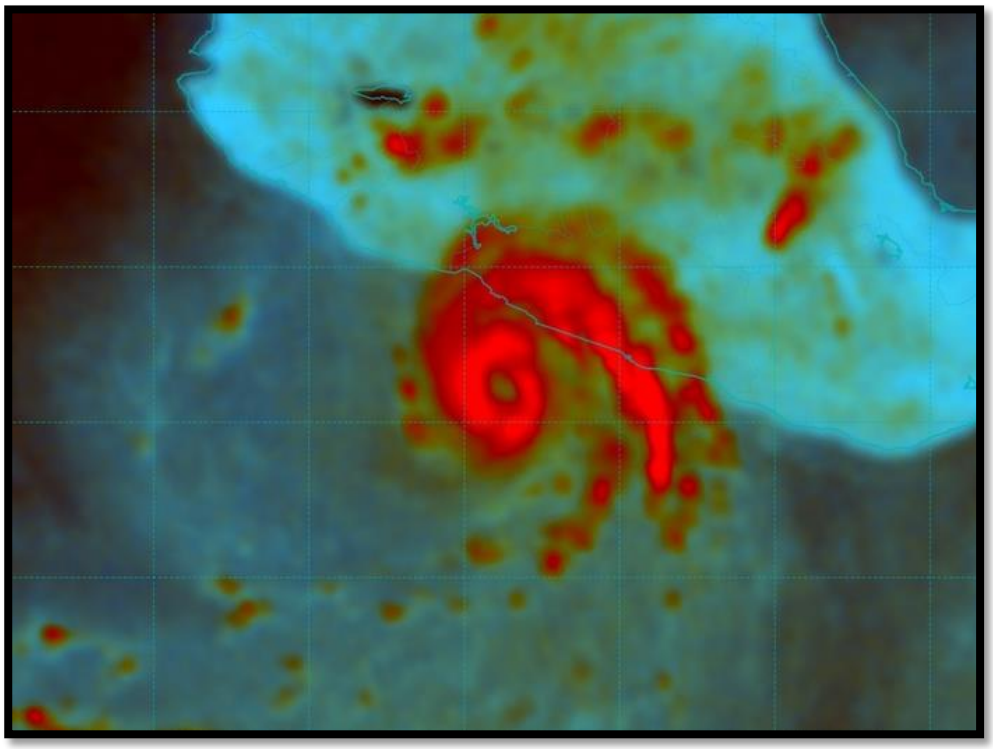
National Hurricane Center
24 January 2022



89-GHZ SSMIS SATELLITE IMAGE OF HURRICANE RICK AT 2308 UTC 24 OCTOBER 2021, SEVERAL HOURS BEFORE IT REACHED ITS PEAK INTENSITY AND MADE LANDFALL JUST EAST OF LAZARO CARDENAS, MEXICO (IMAGE COURTESY OF THE NAVAL RESEARCH LABORATORY)

Rick was a category 2 hurricane (on the Saffir-Simpson Hurricane Wind Scale) that made landfall just east of Lázaro Cárdenas, Mexico. Rick caused wind and flooding damage in western Guerrero and southern Michoacán states, and inland flooding took the life of one person in the state of Morelos.

Hurricane Rick

22 – 25 OCTOBER 2021

SYNOPTIC HISTORY

Rick's origins are not entirely clear. The first distinct signs of an incipient disturbance occurred on 16 October with an increase in showers and thunderstorms over Colombia, Panama, and the adjacent waters of the southwestern Caribbean Sea and far eastern Pacific Ocean. The increase in convection could have been associated with a low-latitude tropical wave that appeared to move off the west coast of Africa on 8 October and reach northern South America on 14 October. The disturbance moved west of Central America by 19 October, but it did not begin producing organized deep convection until late on 21 October. The system then developed a well-defined center of circulation the next day, and it is estimated that a tropical depression formed by 1200 UTC 22 October about 245 n mi south of Acapulco, Mexico. The depression strengthened into a tropical storm 6 h later. The "best track" chart of Rick'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].

Warm ocean waters of 29 to 30°C and an environment of low deep-layer shear and strong upper-level divergence resulted in Rick rapidly intensifying by 50 kt during the 30-h period from 1200 UTC 22 October to 1800 UTC 23 October. Rick became a hurricane shortly after 0600 UTC 23 October while located about 200 n mi south of Zihuatanejo, Mexico, when the development of a pinhole eye was noted in microwave imagery (Fig. 4a). Rick continued to strengthen and reached a relative peak intensity of 80 kt by 1800 UTC that day, and the hurricane maintained those winds through 0600 UTC 24 October while crawling northward through a break in the subtropical ridge. For unknown reasons, an erosion of Rick's eastern eyewall occurred soon thereafter (Fig. 4b), followed by a complete loss of the microwave eye feature (Fig. 4c), and Rick weakened slightly to 75 kt by 1200 UTC 24 October.

The weakening phase was short lived, however, with the re-formation of a larger microwave eye occurring later in the afternoon of 24 October (Fig. 4d). Moving a little faster toward the north-northwest and approaching the coast of Mexico, Rick went through another period of intensification and reached a peak intensity of 90 kt by 0600 UTC 25 October while centered about 30 n mi southwest of Zihuatanejo. Rick maintained that intensity up until landfall in the municipality of La Unión de Isidoro Montes de Oca in the state of Guerrero around 1100 UTC that morning. The rugged terrain of the Sierra Madre Occidentals caused Rick to weaken rapidly after landfall, and it became a tropical storm later that morning over the state of Michoacán. The circulation dissipated before 0000 UTC 26 October while continuing north-northwestward over the state of Jalisco.

[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.

METEOROLOGICAL STATISTICS

Observations in Rick (Figs. 2 and 3) include subjective satellite-based Dvorak technique intensity estimates from the Tropical Analysis and Forecast Branch (TAFB) and Satellite Analysis Branch (SAB), and objective Advanced Dvorak Technique (ADT) estimates and Satellite Consensus (SATCON) 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 from three flights of the 53rd Weather Reconnaissance Squadron of the U.S. Air Force Reserve Command. 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 Rick.

There were no ship reports of winds of tropical storm force associated with Rick. Selected surface observations from land stations are given in Table 2.

Winds and Pressure

Rick's first relative peak in intensity is estimated to be 80 kt from 1800 UTC 23 October to 0600 UTC 24 October based on SFMR surface wind measurements of around 80 kt from the first and second Air Force Reserve Hurricane Hunter flights, as well as objective ADT and SATCON satellite intensity estimates of 77 to 82 kt during that period. Rick's absolute peak intensity of 90 kt from 0600 UTC 25 October through landfall along the coast of Mexico at 1100 UTC is based on SFMR surface wind measurements of 89 kt and a flight-level-to-surface wind adjustment of 86 kt from the third Air Force Reserve reconnaissance flight. Objective satellite intensity estimates were not that high during the same period, but ADT values did steadily increase to as high as 85 kt just before landfall.

Rick likely produced sustained hurricane- or tropical-storm-force winds across western portions of Guerrero and southern portions of Michoacán states in Mexico. However, available observations in the affected areas were limited, and the highest wind report received was a sustained wind of 37 kt with a gust to 52 kt at Puerto Vicente on the coast of Guerrero. A gust of 51 kt was also reported at Zihuatanejo.

Rick's estimated minimum central pressure of 977 mb from 0600 UTC 25 October through landfall at 1100 UTC is based on data from a dropsonde which was released at 0517 UTC and reported a surface pressure of 978 mb with 8-kt winds. There were no pressure observations in the immediate area where Rick's center made landfall, and the lowest pressure reported on land was about 992 mb in Petacalco, just west of the landfall location.

Rainfall and Flooding

Over the period from 23 to 25 October, Rick produced at least 4 inches (100 mm) of rain over coastal sections of the states of Guerrero and far southern Michoacán in Mexico, including in the Sierra Madre Occidentals (Fig. 5). The highest rainfall totals reported were 11.06 inches (281.0 mm) at both Petacalco and Coyuquilla, Guerrero; 8.63 inches (219.2 mm) at Zihuatanejo, Guerrero; and 8.39 inches (213.0 mm) at Melchor Ocampo, Lázaro Cárdenas, Michoacán. The heavy rains caused flash flooding as well as the overflow of four rivers and streams in Zihuatanejo and Tecpan de Galeana.

CASUALTY AND DAMAGE STATISTICS

Rick is directly responsible for the death of one person due to heavy rainfall associated with the hurricane's outer rainbands: a 35-year-old man was swept away by flash flooding in Tepoztlán in the state of Morelos, well inland from the coast.[2]

According to the insurance company AON, Rick caused tens of millions of USD in economic losses in Mexico, but a more exact number is not available.[3] Media reports indicate that Rick caused the evacuation of 402 people and damaged 1,277 houses across 11 states and 700 municipalities. Nearly 184,000 homes, particularly in the states of Michoacán and Guerrero, lost power from the storm.[4] Floodwaters stranded cars in Acapulco and Zihuatanejo, and flooding of the Petatlán River cut off the Acapulco-Zihuatanejo federal highway.[5] Storm chaser Josh Morgerman from iCyclone reported that many large trees were downed and some damage to buildings occurred in the zone between Ixtapa and Lázaro Cárdenas. Heavy rainfall and flooding from Rick's outer rainbands also caused damage well inland in the state of Morelos, including in the cities of Cuernavaca and Tepoztlán.

FORECAST AND WARNING CRITIQUE

The possibility of Rick's genesis was identified several days in advance, but the ultimate timing of genesis was not well predicted. Table 3 provides the number of hours in advance of formation with the first NHC Tropical Weather Outlook (TWO) forecast in each likelihood category. A low (<40%) chance of genesis during the next 5 days was first indicated in the TWO 108 h before Rick formed, and chances were raised to the medium (40–60%) category 90 h before

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[2] Bacaz, Verónica. Huracán 'Rick' dejan un muerto en Tepoztlán y daños por inundaciones. *El Financiero*. 24 October 2021. https://www.elfinanciero.com.mx/estados/2021/10/24/huracan-rick-dejan-un-muerto-en-tepoztlan-y-danos-por-inundaciones/

[3] Global Catastrophe Recap October 2021 (PDF) (Report). Aon. 11 November 2021. http://thoughtleadership.aon.com/Documents/20211011-analytics-if-october-global-recap.pdf

[4] Natural Hazards Monitoring. ReliefWeb. 26 October 2021. https://reliefweb.int/report/guatemala/natural-hazards-monitoring-26-october-2021

[5] No casualties reported after Hurricane Rick makes landfall in Guerrero. *Mexico News Daily*. 25 October 2021. https://mexiconewsdaily.com/news/hurricane-rick-makes-landfall-in-guerrero/

formation and to the high (>60%) category 60 h before formation. For the 2-day forecast period, the precursor disturbance was given a low chance of genesis 60 h before formation, but the chances were only raised to the medium and high categories 24 and 12 h, respectively, before genesis. NHC accurately forecast the location of Rick's formation, which was contained within all tropical cyclone genesis areas depicted in the Graphical Tropical Weather Outlook (Fig. 6).

A verification of NHC official track forecasts for Rick is given in Table 4a. Official track forecast errors were similar to or lower than the mean official errors for the previous 5-year period at all verifying times between 12 and 72 h. However, climatology-persistence (OCD5) errors were higher than their respective 5-year means at all forecast times, suggesting that Rick's track should have been more difficult to forecast than usual.

A homogeneous comparison of the official track errors with selected guidance models is given in Table 4b and Fig. 7. Due to the homogeneity requirement, the UKMET model (EGRI) was not included in the verification. The official track forecasts (Fig. 8a) were competitive with the best-performing deterministic and consensus models, and the GFS model (GFSI; Fig. 8b) and the Florida State Superensemble (FSSE; Fig. 8c) had some of the lowest errors, particularly at 36 and 48 h. These models were also accurate in predicting Rick's landfall location in the Lázaro Cárdenas area. The accuracy of the NHC official track forecasts likely suffered a bit from the poor performance of the ECMWF model (EMXI), which had some of the largest errors and projected a landfall farther north in the Manzanillo area during the first few forecasts (Fig. 8d).

A verification of NHC official intensity forecasts for Rick is given in Table 5a. Official intensity errors were higher than the mean official errors for the previous 5-year period from 12 to 36 h but were lower from 48 to 72 h. An inspection of the official intensity forecasts (not shown) indicates that NHC's forecasts were too low during Rick's rapid intensification phase at forecast times valid from 1800 UTC 22 October through 1800 UTC 23 October. Then, NHC's forecasts were too high during Rick's unexpected weakening phase at forecast times valid from 0000 UTC 24 October through 0600 UTC 25 October and explicitly showed the storm reaching major hurricane intensity (which did not occur).

A homogeneous comparison of the official intensity errors with selected guidance models is given in Table 5b and Fig. 9. Even with Rick's rapid intensification phase and the unexpected weakening on 24 October, NHC's intensity forecasts had respectable errors compared to the available model guidance. The SHIPS and LGEM models had lower errors than the official forecasts during the times valid from 12 to 48 h.

Coastal watches and warnings issued by the government of Mexico in association with Rick are given in Table 6.

ACKNOWLEDGMENTS

Data in Table 2 were provided by CONAGUA, the national meteorological service of Mexico.

Table 1. Best track for Hurricane Rick, 22–25 October 2021.

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
22 / 1200	12.7	100.3	1007	30	tropical depression
22 / 1800	12.9	100.8	1005	35	tropical storm
23 / 0000	13.2	101.1	1001	45	"
23 / 0600	13.7	101.2	995	60	"
23 / 1200	14.4	101.4	983	75	hurricane
23 / 1800	14.9	101.8	979	80	"
24 / 0000	15.1	101.8	978	80	"
24 / 0600	15.4	101.6	980	80	"
24 / 1200	15.7	101.5	980	75	"
24 / 1800	16.0	101.4	980	75	"
25 / 0000	16.5	101.5	979	80	"
25 / 0600	17.2	101.8	977	90	"
25 / 1100	17.9	102.0	977	90	"
25 / 1200	18.1	102.1	980	85	"
25 / 1800	19.0	102.5	997	50	tropical storm
26 / 0000					dissipated
25 / 0600	17.2	101.8	977	90	maximum winds and minimum pressure
25 / 1100	17.9	102.0	977	90	landfall at La Unión de Isidoro Montes de Oca, Guerrero, Mexico

Table 2. Selected surface observations for Hurricane Rick, 22–25 October 2021.

Location	Minimum Sea Level Pressure		Maximum Surface Wind Speed			Total rain (in)
	Date/ time (UTC)	Press. (mb)	Date/ time (UTC)[a]	Sustained (kt)	Gust (kt)	
Mexico						
Guerrero						
Puerto Vicente (17.27N 101.06W)			25/0530	37	52	
Zihuatanejo (17.65N 101.55W)	25/0700	1002.9	25/0720		51	8.63
Petacalco (17.98N 102.12W)	25/1210	991.7	25/1010		43	11.06
Acapulco (16.82N 99.91W)	24/1015	994.8	25/0245		36	6.30
Ixtapa (iCyclone) (17.66N 101.60W)	25/0724	1001.5				
Coyuquilla						11.06
Kilómetro 21						7.80
Observatorio de Acapulco						6.97
San Jerónimo						6.27
Copala						5.54
Michoacán						
Lázaro Cárdenas (17.94N 102.18W)	25/1200	994.4	25/1315	30	42	8.39
Lázaro Cárdenas (iCyclone) (17.96N 102.20W)	25/1108	995.7				
Infiernillo						5.04

[a] Date/time is for sustained wind when both sustained and gust are listed.

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%)	60	108
Medium (40%-60%)	24	90
High (>60%)	12	60

Table 4a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) track forecast errors (n mi) for Hurricane Rick, 22–25 October 2021. 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	22.9	**30.0**	**41.2**	**51.2**	68.9	77.6		
OCD5	44.4	85.9	134.3	180.3	279.7	433.4		
Forecasts	12	10	8	6	4	2		
OFCL (2016-20)	21.3	33.1	44.0	54.6	65.3	76.0	95.9	116.6
OCD5 (2016-20)	33.1	69.4	107.8	147.0	183.4	219.7	280.2	342.0

Table 4b. Homogeneous comparison of selected track forecast guidance models (in n mi) for Hurricane Rick, 22–25 October 2021. 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	23.7	28.7	41.1	46.8	60.6	61.9		
OCD5	41.0	76.5	118.6	148.6	233.1	403.6		
GFSI	25.1	30.4	**34.1**	**30.4**	**28.7**	149.4		
EMXI	25.7	41.7	59.6	84.4	112.1	123.4		
CMCI	24.1	30.9	**32.7**	47.6	**58.1**	62.4		
NVGI	26.0	44.4	62.0	90.8	96.8	85.3		
HWFI	24.0	**21.4**	**31.5**	**38.8**	**53.2**	**54.5**		
HMNI	**19.8**	32.7	**36.0**	53.0	64.5	**36.1**		
CTCI	**17.5**	35.8	59.9	73.0	88.0	66.0		
HCCA	**17.5**	**24.6**	41.3	51.0	81.6	99.3		
FSSE	**18.1**	**20.3**	**30.2**	**30.8**	**39.8**	**41.3**		
AEMI	24.0	36.5	46.9	**41.9**	82.0	103.7		
GFEX	**19.6**	**27.3**	**39.3**	**40.9**	**45.6**	100.1		
TVCE	**17.3**	**27.1**	43.4	52.5	66.0	**53.7**		
TVCX	**17.8**	**28.5**	43.1	52.1	69.9	70.2		
TVDG	**17.5**	**25.5**	**40.2**	49.0	**59.4**	69.0		
TABD	27.1	36.3	49.9	72.4	111.0	229.1		
TABM	27.5	42.0	65.3	87.1	149.7	270.5		
TABS	28.9	51.1	66.3	90.4	145.2	226.6		
Forecasts	10	9	7	5	3	1		

Table 5a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) intensity forecast errors (kt) for Hurricane Rick, 22–25 October 2021. 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	9.6	14.5	11.9	**6.7**	**12.5**	**12.5**		
OCD5	9.6	15.5	14.2	12.0	23.2	20.0		
Forecasts	12	10	8	6	4	2		
OFCL (2016-20)	5.6	9.0	10.9	12.6	14.0	15.3	16.0	16.7
OCD5 (2016-20)	7.2	12.0	15.3	17.6	19.0	20.4	21.2	20.8

Table 5b. Homogeneous comparison of selected intensity forecast guidance models (in kt) for Hurricane Rick, 22–25 October 2021. 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	60	72	96	120
OFCL	10.5	13.3	11.4	8.0	16.7	15.0		
OCD5	**9.6**	14.0	12.7	11.6	24.0	15.0		
HWFI	14.9	21.8	14.1	15.2	**6.0**	**0.0**		
HMNI	13.3	18.0	14.6	**6.2**	19.0	26.0		
CTCI	13.1	17.9	**11.3**	10.8	22.7	**12.0**		
DSHP	**7.7**	**10.1**	**9.0**	**3.2**	17.7	**6.0**		
LGEM	**8.7**	**11.9**	**9.6**	**5.2**	19.7	**13.0**		
ICON	10.7	14.4	**10.7**	**3.6**	**12.7**	**1.0**		
IVCN	11.1	15.0	**10.3**	**3.8**	**14.7**	**3.0**		
IVDR	12.2	16.3	11.7	**4.6**	**16.3**	**10.0**		
HCCA	11.2	16.1	15.4	11.2	**11.0**	**3.0**		
FSSE	12.5	16.7	**11.1**	**6.2**	**16.3**	17.0		
GFSI	13.2	19.8	18.3	29.2	53.7	33.0		
EMXI	15.4	16.7	23.1	25.8	30.3	**6.0**		
Forecasts	10	9	7	5	3	1		

Table 6. Watch and warning summary along the Pacific coast of Mexico for Hurricane Rick, 22–25 October 2021.

Date/Time (UTC)	Action	Location
22 / 2100	Hurricane Watch issued	Zihuatanejo to Punta San Telmo
22 / 2100	Tropical Storm Watch issued	East of Zihuatanejo to Tecpan de Galeana
22 / 2100	Tropical Storm Watch issued	West of Punta San Telmo to Manzanillo
23 / 0900	Hurricane Watch extended	Punta San Telmo to Tecpan de Galeana
23 / 0900	Tropical Storm Watch extended	Tecpan de Galeana to Acapulco
23 / 1500	Hurricane Watch changed to Hurricane Warning	Tecpan de Galeana to Punta San Telmo
23 / 1500	Tropical Storm Watch changed to Tropical Storm Warning	Acapulco to Tecpan de Galeana
23 / 1500	Tropical Storm Watch changed to Tropical Storm Warning	Punta San Telmo to Manzanillo
25 / 1800	Hurricane Warning discontinued	All
25 / 1800	Tropical Storm Warning discontinued	All

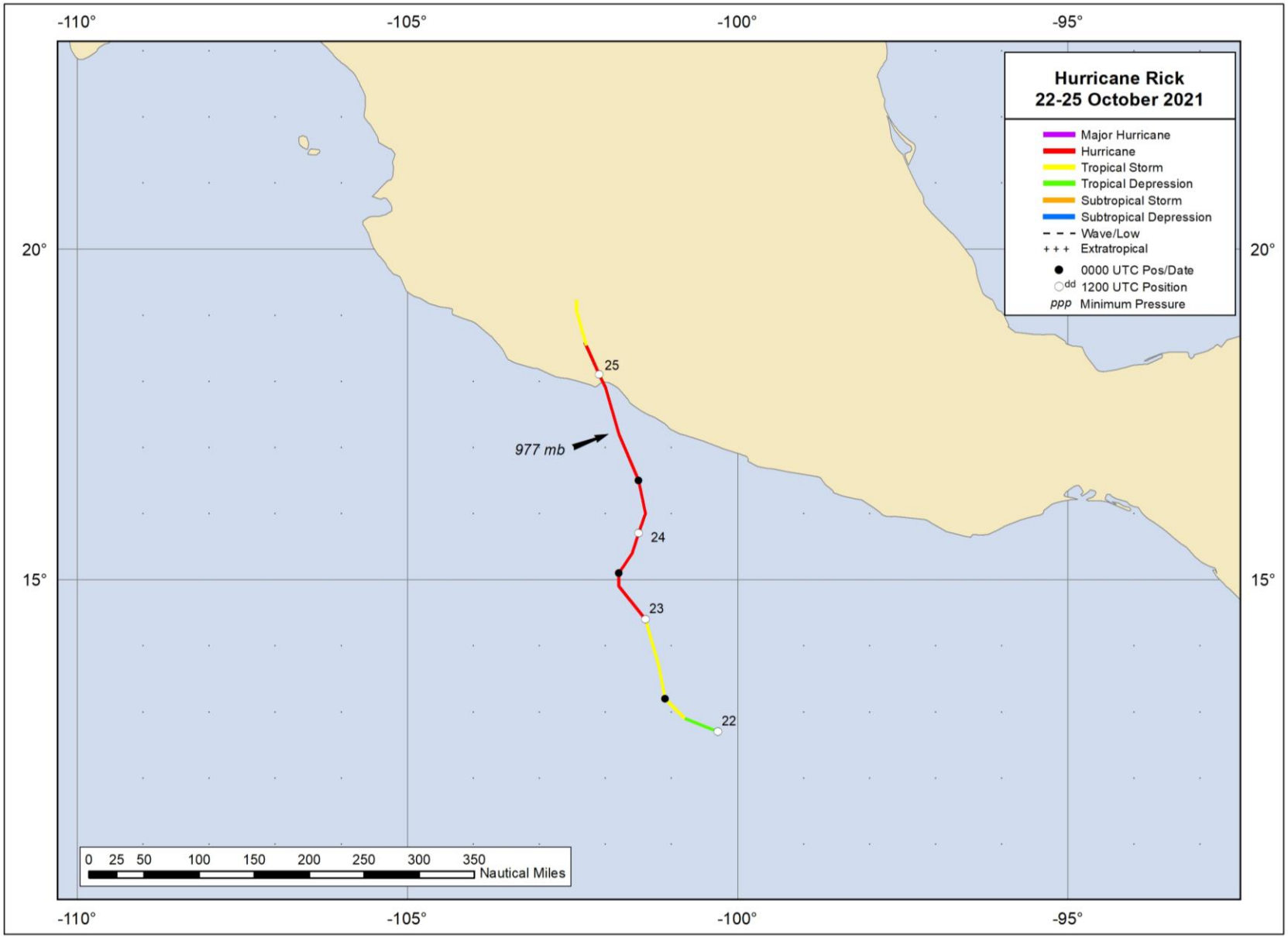

Figure 1. Best track positions for Hurricane Rick, 22–25 October 2021.

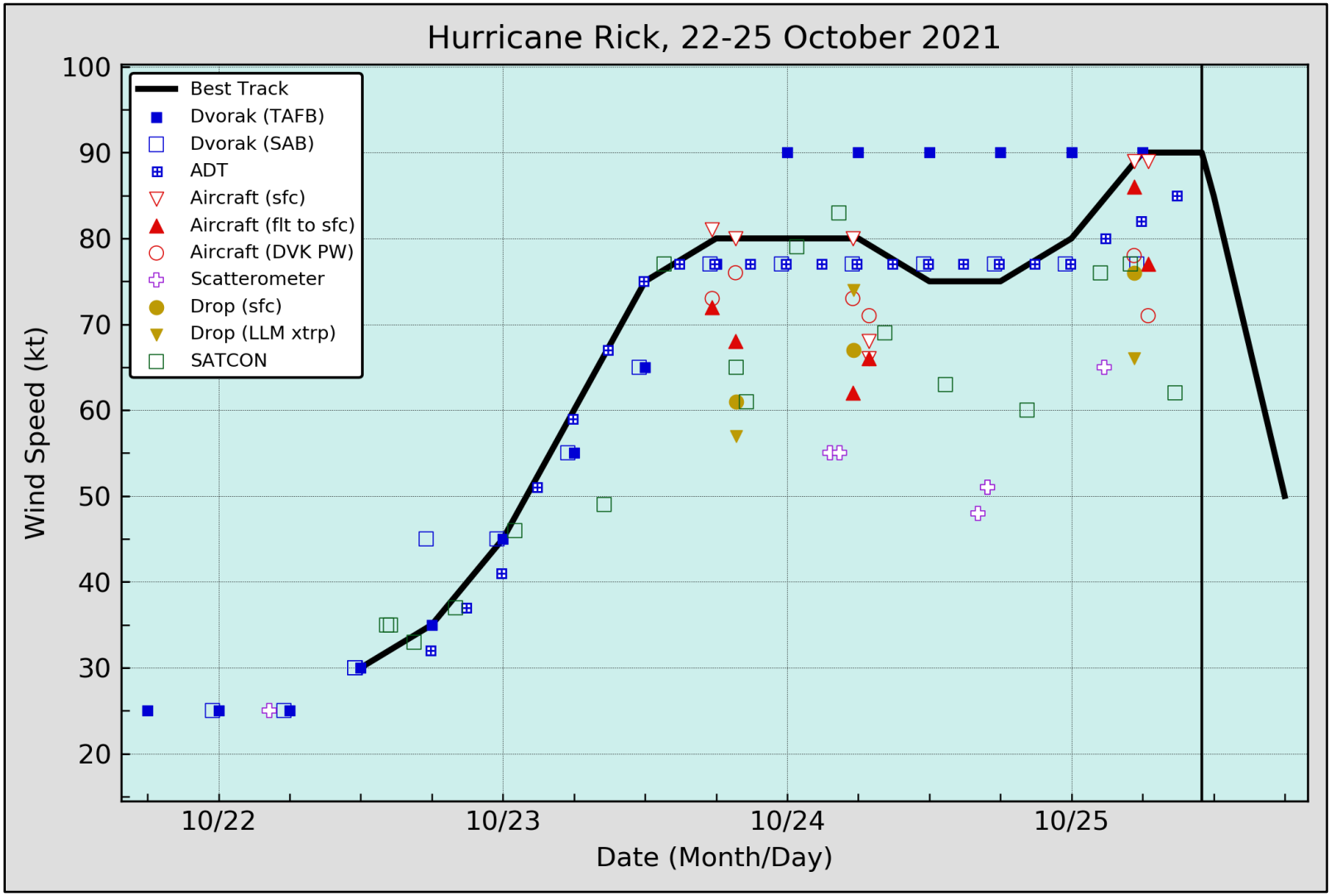

Figure 2. Selected wind observations and best track maximum sustained surface wind speed curve for Hurricane Rick, 22–25 October 2021. Aircraft observations have been adjusted for elevation using a 90% adjustment factor for observations from 700 mb. Advanced Dvorak Technique estimates represent the Current 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, and solid vertical lines correspond to landfalls.

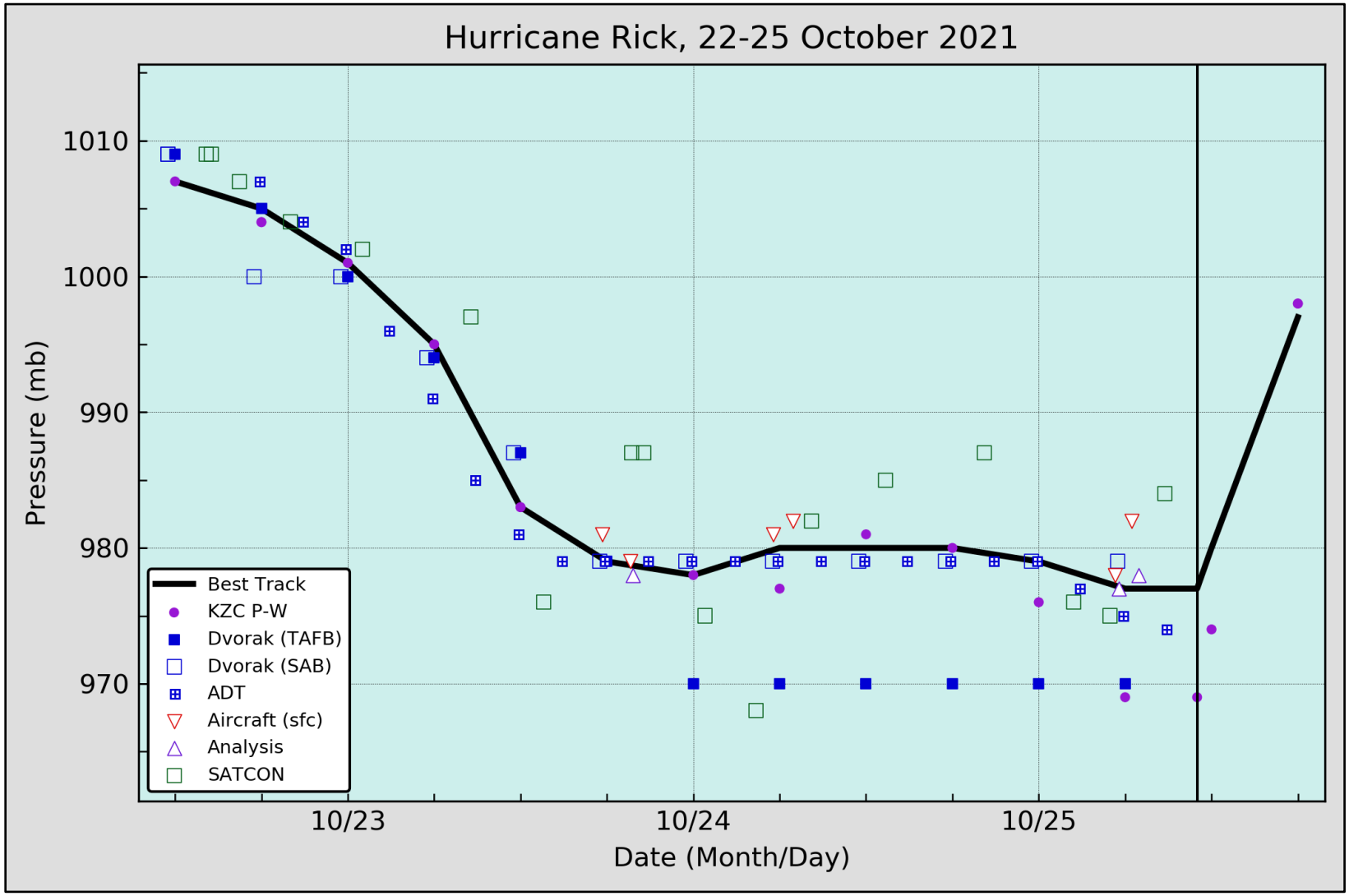

Figure 3. Selected pressure observations and best track minimum central pressure curve for Hurricane Rick, 22–25 October 2021. Advanced Dvorak Technique estimates represent the Current Intensity at the nominal observation time. SATCON intensity estimates are from the Cooperative Institute for Meteorological 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, and solid vertical lines correspond to landfalls.

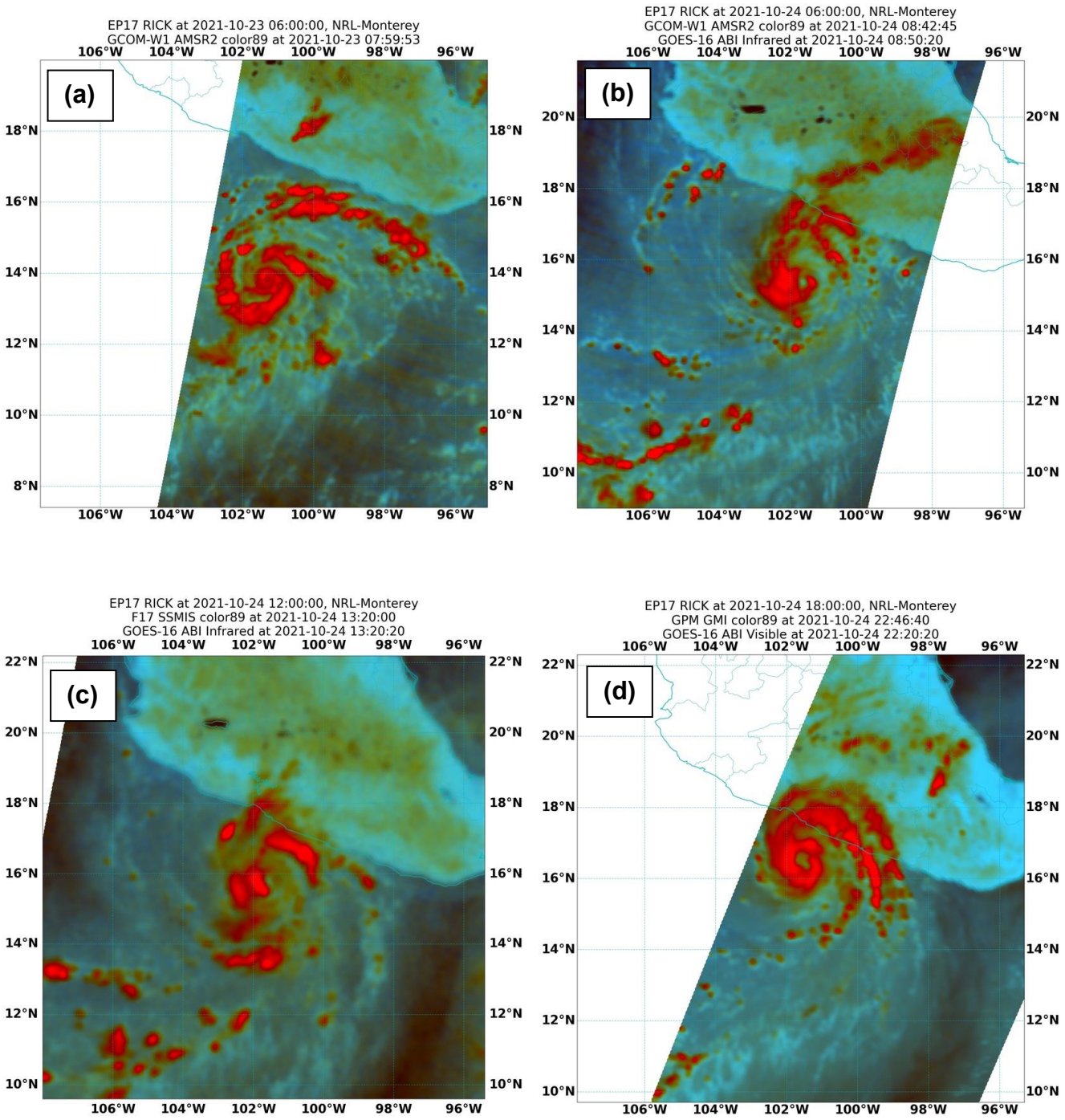

Figure 4. Structural evolution of Hurricane Rick in 89-GHz microwave images showing (a) the formation of a pinhole microwave eye at 0759 UTC 23 October (AMSR2), (b) a break in the northeastern eyewall at 0842 UTC 24 October (AMSR2), (c) a lack of an eye at 1320 UTC 24 October (SSMIS), and (d) the re-formation of a larger eye at 2246 UTC 24 October (GMI). Images courtesy of the Naval Research Laboratory.

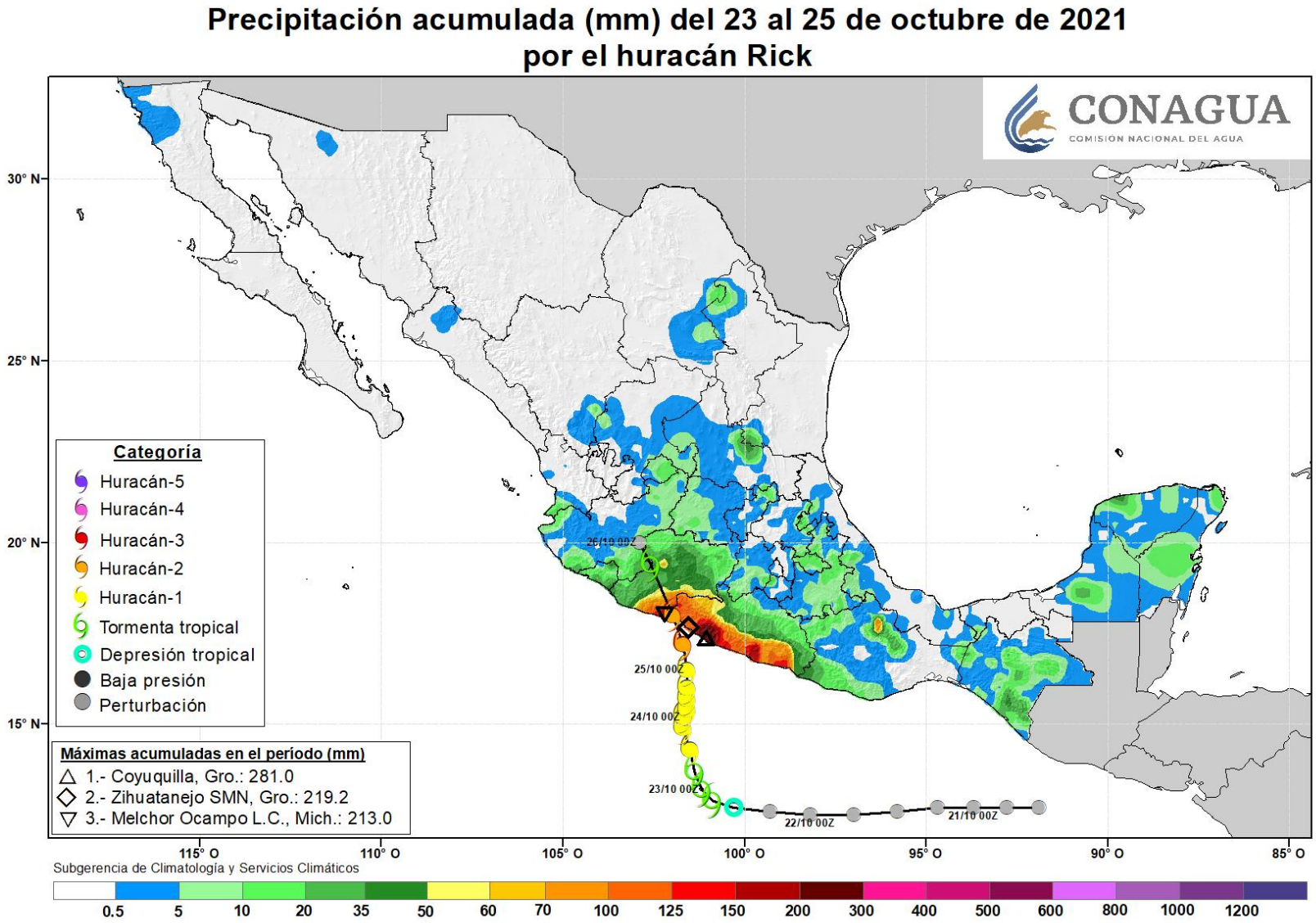

Figure 5. Rainfall accumulations (mm) in Mexico from 23 to 25 October 2021, including the effects of Hurricane Rick. Rick's track is based on operational location and intensity estimates. Image courtesy of CONAGUA, the National Meteorological Service of Mexico.

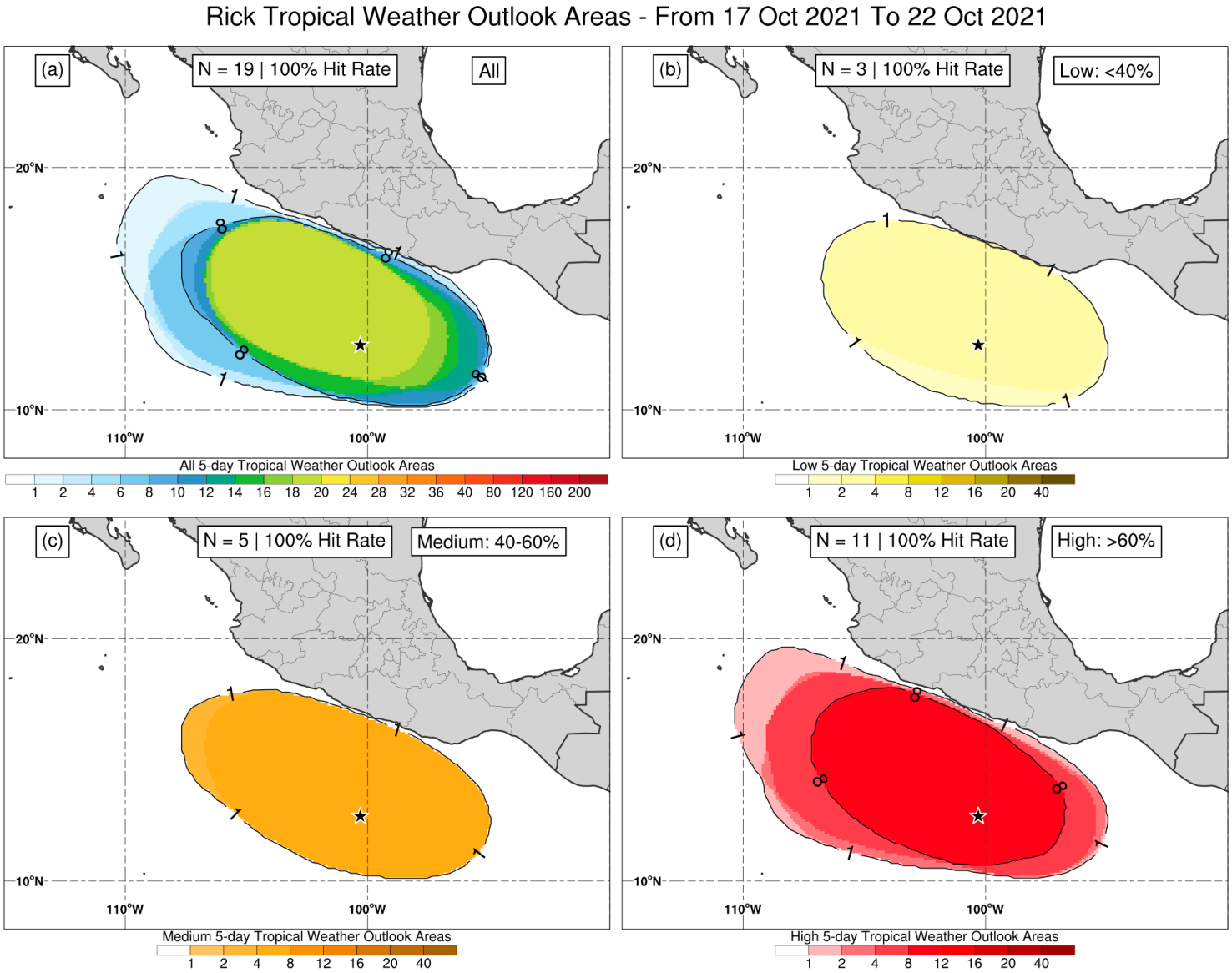

Figure 6. Composites of 5-day tropical cyclone genesis areas depicted in NHC's Tropical Weather Outlooks prior to the formation of Hurricane Rick for (a) all probabilistic genesis categories, (b) the low (<40%) category, (c) medium (40–60%) category, and (d) high (>60%) category. Rick's location of genesis is indicated by the black star.

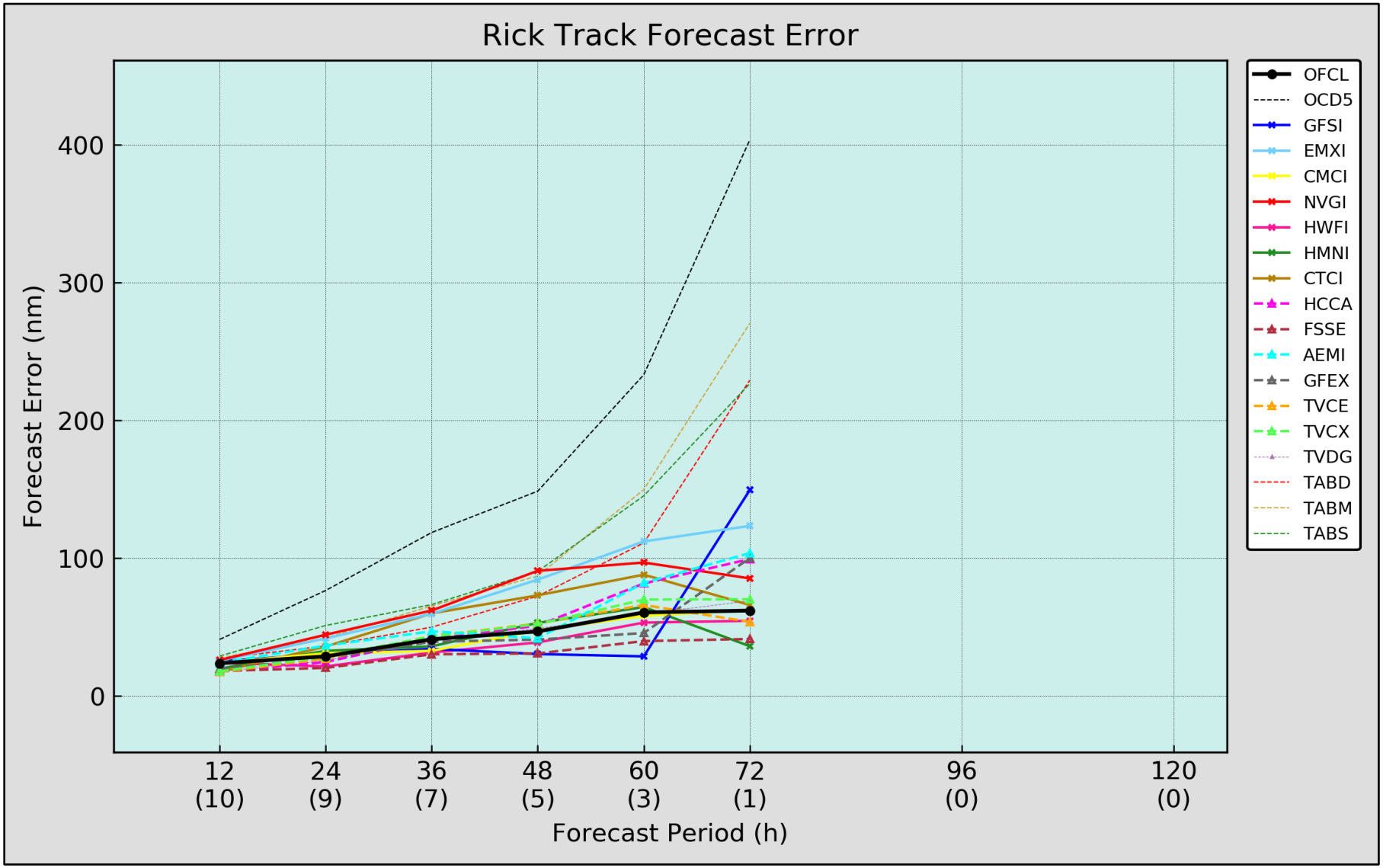

Figure 7. Homogeneous comparison of selected track forecast guidance model errors (in n mi) for Hurricane Rick, 22–25 October 2021. Official NHC track errors are denoted by the thick black line.

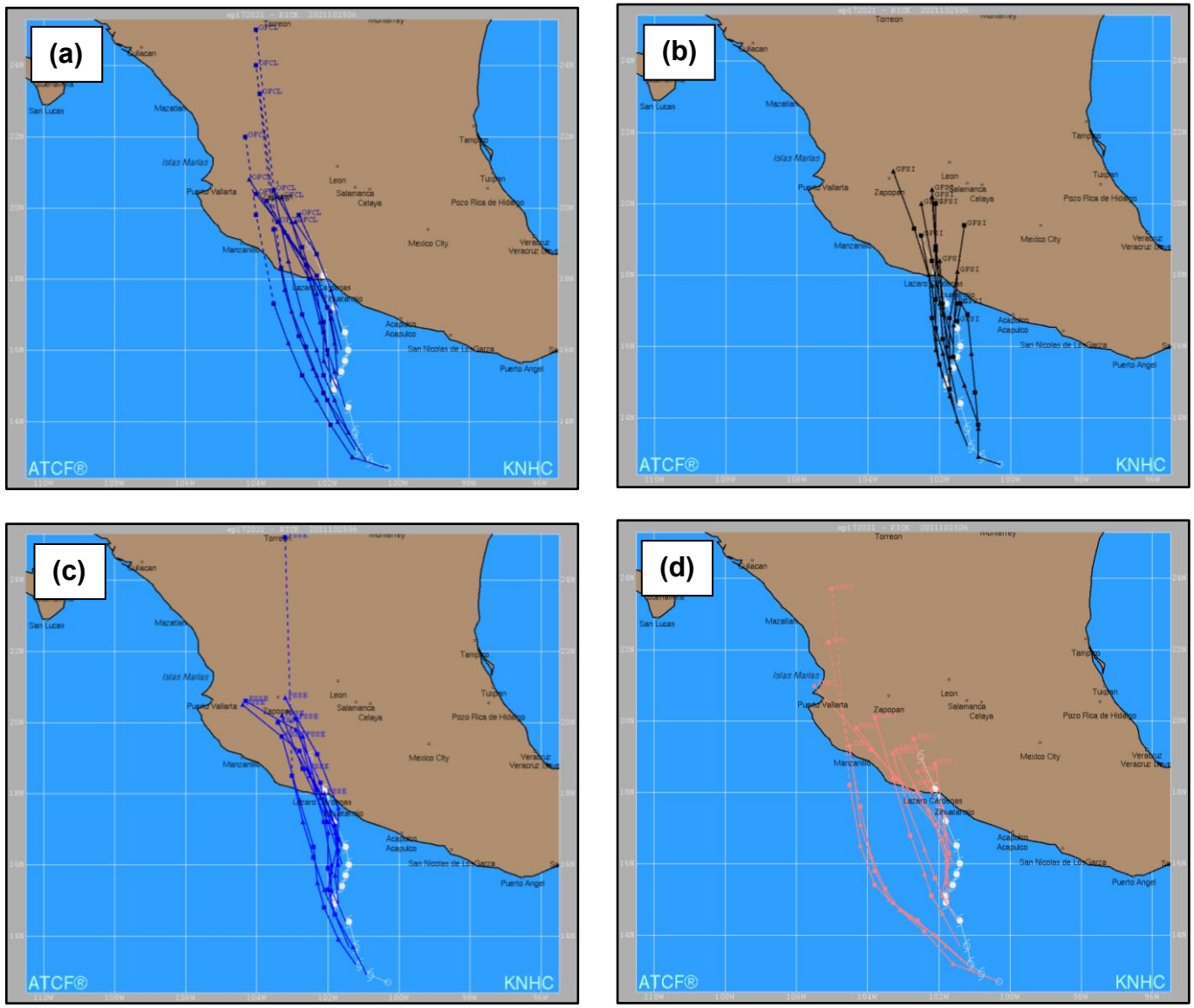

Figure 8. (a) NHC official track forecasts [dark blue] for Hurricane Rick, compared with model solutions from the (b) GFS [black], (c) Florida State Superensemble [blue], and (d) ECMWF [pink]. The NHC best track is denoted by the white line and symbols in each figure.

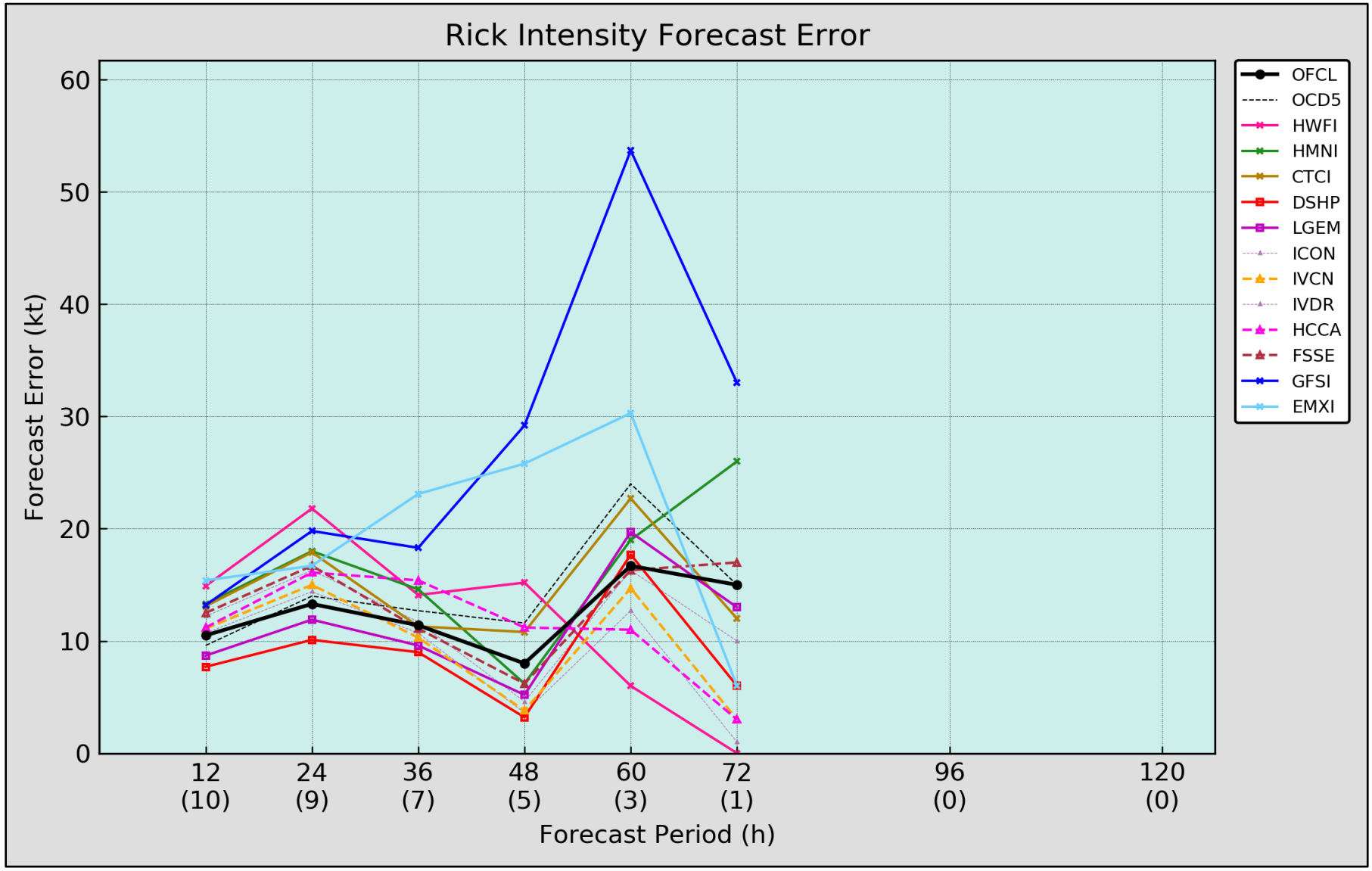

Figure 9. Homogeneous comparison of selected intensity forecast guidance model errors (in kt) for Hurricane Rick, 22–25 October 2021. Official NHC intensity errors are denoted by the thick black line.