NATIONAL HURRICANE CENTER TROPICAL CYCLONE REPORT

HURRICANE JULIA

(AL132022, EP182022)

7–10 October 2022

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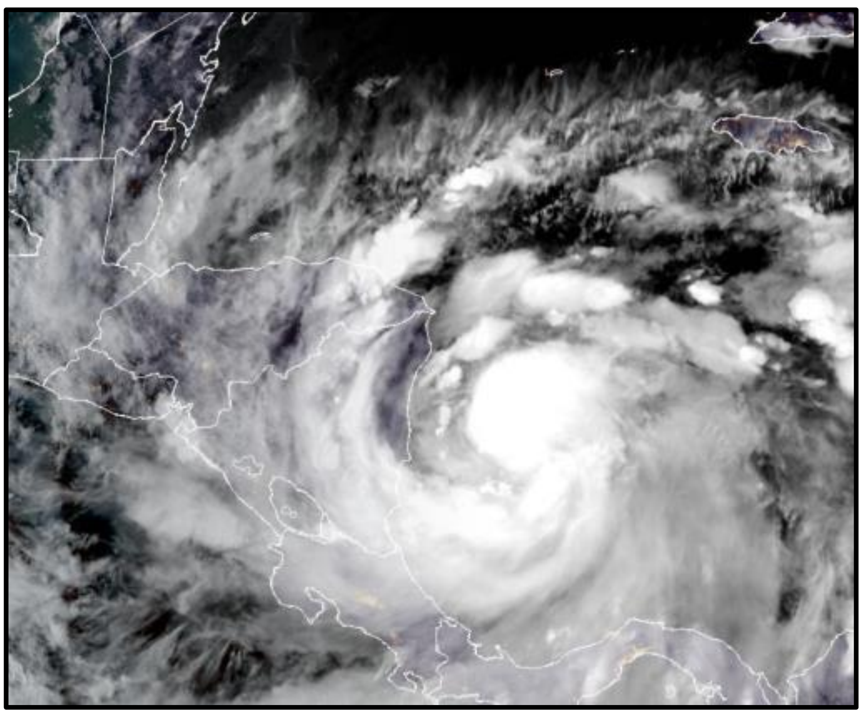
National Hurricane Center
15 March 2023[1]



GOES-16 GEOCOLOR IMAGE OF HURRICANE JULIA JUST PRIOR TO LANDFALL IN NICARAGUA AT 0530 UTC 9 OCTOBER 2022. IMAGE COURTESY OF NOAA.

Julia was a category one hurricane (on the Saffir-Simpson Hurricane Wind Scale) that made landfall in Nicaragua and affected many countries in South America, Central America, and Mexico. A total of 35 direct flood-related fatalities occurred due to the tropical cyclone.

[1] Original report dated 2 March 2023. This version amends the direct fatality count based on updated information from the Venezuela meteorological service, removing deaths from Venezuela as not being directly related to Julia.

Hurricane Julia

7–10 OCTOBER 2022

SYNOPTIC HISTORY

Julia originated from a tropical wave that departed the west coast of Africa on 26 September. The wave was quite weak and produced limited shower activity while it moved across the tropical eastern Atlantic during the next few days. By 1 October, however, showers and thunderstorms increased along the wave axis when it reached 40°W longitude. Although the convective activity became more concentrated when the wave reached the southern Windward Islands and the northeastern portions of Venezuela on 4 and 5 October, there were no indications of a low-level center at that time. The wave continued westward at low latitudes, bringing heavy rain to portions of northern Venezuela, the ABC Islands, and northern Colombia during the next couple of days. Satellite images, surface observations, and radar data from Curacao indicated that the wave developed a well-defined center and maintained sufficiently organized deep convection to be classified as a tropical depression by 0000 UTC 7 October, when it was located over the extreme southern Caribbean Sea between Curacao and the northern coast of Venezuela. 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[2].

After genesis, the depression moved westward to west-northwestward steered by a low- to mid-level ridge to its north, bringing the system across Aruba and northern Venezuela early on 7 October. Meanwhile, satellite images showed banding features becoming better established around the center, and the system strengthened into Tropical Storm Julia by 1200 UTC that day shortly after it passed by the northern tip of Colombia. Around that time, the forward speed of the cyclone increased, and it turned due westward on the south side of the building ridge. In conducive environmental conditions of relatively low vertical wind shear, high mid-level humidity, and very warm waters, Julia steadily strengthened over the southwestern Caribbean Sea. The storm developed well-organized curved bands around a central dense overcast feature on 8 October, and it reached hurricane intensity by 0000 UTC 9 October when it was located about 70 n mi east of the Caribbean coast of Nicaragua (cover image). Julia strengthened further until it made landfall as a 75-kt hurricane around 0715 UTC that day near Laguna de Perlas, Nicaragua, just north of Bluefields.

After Julia made landfall, steady weakening occurred due to land interaction. However, the weakening rate was tempered due to the system's relatively fast forward motion and because the terrain of southern and central Nicaragua is not as rugged as areas farther north in Central America. Julia weakened back to a tropical storm shortly after 1200 UTC 9 October, when it was

[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.

over the central part of Nicaragua, and it moved off the Pacific coast of the country by 0000 UTC 10 October. Although Julia survived its passage across Nicaragua, the structure of the storm was very degraded, and the intensity decreased to about 35 kt by the time it exited the country.

By early 10 October, Julia turned west-northwestward and moved very near the coast of El Salvador. Julia is estimated to have maintained its strength until the storm made its final landfall near Acajutla, El Salvador, not far from the border with Guatemala around 1100 UTC that day. The storm dissipated shortly after moving inland, however, its remnants partially contributed to the formation of Tropical Storm Karl over the Gulf of Mexico about a day later.

METEOROLOGICAL STATISTICS

Observations in Julia (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), 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 seven flights of the 53rd Weather Reconnaissance Squadron of the U.S. Air Force Reserve Command and two flights from the NOAA Aircraft Operations Center. Data and imagery from radars from the southern Caribbean region and Central America, 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 Julia.

There was one ship that reported tropical-storm-force winds in Julia. Ship *Kapellen* (call sign ONJG) measured 42-kt winds at 0000 UTC 9 October when the hurricane was located over the southwestern Caribbean Sea. Selected surface observations from land stations and data buoys are given in Table 2.

Winds and Pressure

Julia's 75-kt peak intensity at 0600 UTC 9 October and the landfall time of 0715 that day in Nicaragua is based on a blend of satellite intensity estimates from TAFB, SAB, and the ADT, and a surface observation of 70 kt measured in Bluefields, Nicaragua, around the time of landfall. The last Air Force Hurricane Hunter mission departed Julia roughly 6 h prior to landfall, and that data supported an intensity of 65-70 kt at that time. However, the satellite appearance of Julia improved notably after that mission, therefore, the landfall intensity is estimated to have been higher. The minimum pressure of 982 mb is largely based on the Knaff-Zehr-Courtney pressure-wind relationship.

Storm Surge[3]

Julia is estimated to have raised water levels along the Caribbean coast of Nicaragua by as much as 4 to 6 ft above normal tide levels near and to the north of the landfall location near Laguna de Perlas. Unfortunately, there are no data available to confirm the water levels during the hurricane, but video footage showed significant coastal flooding along Nicaragua's Caribbean coast. Water level rises were negligible in Guatemala, El Salvador, and southeastern Mexico as Julia was much weaker when it was near those countries.

Rainfall and Flooding

By far, the most life-threatening hazard associated with Julia was the large swath of heavy rains and associated flash flooding. Figure 4 shows an accumulated rainfall map for the Central American region. A large swath of 4-8 inches (100-200 mm) of rain occurred across the majority of that area. However, the worst flooding occurred along the storm's track over central Nicaragua and El Salvador, where 8-12 inches (200-300 mm) of rain fell. Similar rains also occurred across the northeastern portion of Nicaragua and much farther south in portions of Costa Rica and Panama, where landslides were reported.

Although no rainfall observations are available at the time of this writing, it is believed that rainfall amounts up to 10 inches (250 mm) likely occurred in northern portions of Venezuela and Colombia, where significant flooding was reported. Lighter rains, generally 3-5 inches (75-125 mm) occurred in Honduras, Belize, Guatemala, and southeastern Mexico.

CASUALTY AND DAMAGE STATISTICS

Julia was responsible for 35 direct deaths[4] across portions of Central America, and all of the fatalities appear to be related to flash flooding and associated mudslides. The fatality breakdown consists of 14 in Guatemala, 10 in El Salvador, 5 in Nicaragua, 4 in Honduras, and 2 in Panama. In addition, there were 54 indirect flood fatalities in Venezuela.

Central America and Mexico

Julia moved east to west across the central portions of Nicaragua and caused significant wind, surge, and rain-induced flood damage in portions of the country. The latest estimate of damage from the Nicaraguan government is 400 million U.S. dollars, and flash flooding was reported as the biggest impact (Fig. 5). Five fatalities due to the flooding were reported in that country, and more than 1 million people lost power during the hurricane. Four fatalities due to

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[3] Storm surge is defined as the abnormal rise of water generated by a storm, over and above the predicted astronomical tide, and is expressed in terms of height above normal tide levels. Because storm surge represents the deviation from normal water levels, it is not referenced to a vertical datum.

[4] Deaths occurring as a direct result of the forces of the tropical cyclone are referred to as "direct" deaths. These would include those persons who drowned in storm surge, rough seas, rip currents, and freshwater floods. Direct deaths also include casualties resulting from lightning and wind-related events (e.g., collapsing structures). Deaths occurring from such factors as heart attacks, house fires, electrocutions from downed power lines, vehicle accidents on wet roads, etc., are considered indirect" deaths.

Julia's floods were reported in Honduras. In addition, the heavy rains caused several communities to become isolated for days with roads being impassable during that time. Although no damage estimate is currently available in Honduras, significant harm was reported to the banana, corn, and African palm crops across the country.

In Guatemala, significant flooding was also reported and resulted in 14 fatalities. Nine of them were in the Huehuetenango province in flood waters and five in Alta Verapaz in a landslide. Similar damage was reported in El Salvador, where 10 people drowned in the floods from Julia. Of the 10 fatalities, five of them were soldiers that were on rescue missions. No monetary damage estimate is currently available from Guatemala or El Salvador.

Although Julia tracked well north of Panama and Costa Rica, heavy rains on the system's south side resulted in two fatalities in Panama, just south of the border with Costa Rica. In both countries, the flooding rains resulted in significant crop damage. Two landslides were reported in Panama and thousands of homes were damaged in each country.

Significant flooding was also reported in extreme southeastern Mexico in Chiapas and Oaxaca states.

South America

Although no deaths were reported in Colombia, hundreds of homes were destroyed by Julia, and thousands were damaged from heavy rainfall and flooding. In Venezuela, 54 people lost their lives in flooding and landslides in the town of Las Tejerias. However, these fatalities occurred a couple of days after Julia's passage and were not directly associated with the tropical cyclone. Satellite images indicate that an of showers and thunderstorms, primarily associated with the Intertropical Convergence Zone, developed late on 8 October and caused the significant flooding that led to the fatalities. There are currently no monetary damage figures available in either Venezuela or Colombia.

FORECAST AND WARNING CRITIQUE

The genesis of Julia was fairly well anticipated. The system was introduced in the Tropical Weather Outlook with a low chance (<40%) of development over the next 2 and 5 days 108 h before formation (Table 3). The system was assessed a 5-day medium (40-60%) chance of formation 96 h before development, but it was briefly lowered below that threshold after that time. The 5-day probabilities reached the high category (>60%) 42 h before tropical cyclone formation took place. The 2-day probability of development reached the medium category on a Special Tropical Weather Outlook 56 h prior to genesis, and it reached the high category 24 h prior to development. NHC accurately forecast the location of Julia's formation, which was contained within all tropical cyclone genesis areas depicted in the Graphical Tropical Weather Outlook (Fig. 6).

Since NHC's verification requires the system to be classified as a tropical cyclone at both the forecast's initial time and the projection's valid time, the first two official forecasts are not included in the verification statistics. The first two forecasts were issued before the system was a tropical depression in order to invoke a Tropical Storm Warning for portions of Colombia. It is also worth noting that although Julia spent time in both the Atlantic and eastern North Pacific basins, the mean errors are being compared to the long-term Atlantic averages since the majority of the forecasts were made in that basin. Official track forecast errors for Julia were a little lower than the mean official errors for the previous 5-year period at 12 and 24 h, but higher than the means from 36 to 72 h (Table 4a). The climatology and persistence (OCD5) model errors were significantly larger than their 5-year averages from 48 to 72 h, suggesting that the track of Julia was more difficult than average to predict for those lead times. An examination of the official forecasts indicates that a northward bias existed in many of the forecasts around and after the landfall time in Central America (Fig. 7).

A homogeneous comparison of the official track errors with selected guidance models is given in Table 4b and illustrated in Figure 8. The best-performing deterministic model was the UKMET (EGRI), and it was the only one that outperformed the NHC official forecasts from 36 to 72 h. The corrected consensus models (HCCA and FSSE) also performed well and had lower errors than the official forecasts at most time periods.

A verification of NHC official intensity forecasts for Julia is given in Table 5a. Official intensity errors were excellent and well below the mean official errors for the previous 5-year period at all forecast times. Climatology-persistence (OCD5) errors were significantly higher than their respective 5-year means at all forecast times, which is likely linked to the poor track forecasts from that model.

A homogeneous comparison of the official intensity errors with selected guidance models is given in Table 5b and illustrated in Figure 9. The NHC intensity forecasts had equal or lower errors than all of the models at 12 h, 24 h, and 72 h and near the low end of the guidance at the other forecast times. In general, the intensity models all had relatively low errors.

Watches and warnings associated with Julia and its incipient disturbance (Potential Tropical Cyclone Thirteen) are given in Table 6. Advisories on Potential Tropical Cyclone Thirteen were initiated at 1500 UTC 6 October to issue tropical storm warnings for portions of Colombia. Subsequent tropical storm and hurricane warnings were issued in other portions of South and Central America.

ACKNOWLEDGEMENTS

Figure 4 was provided by Jose Galvez and Gabriela Chinchilla of the International Desk of the Weather Prediction Center. Philippe Papin of the National Hurricane Center provided Figure 6.

Table 1. Best track for Hurricane Julia, 7–10 October 2022.

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
06 / 1200	11.4	66.5	1006	30	disturbance
06 / 1800	11.6	67.8	1005	30	"
07 / 0000	11.9	69.2	1004	30	tropical depression
07 / 0300	12.0	69.8	1004	30	“
07 / 0600	12.1	70.6	1004	30	"
07 / 0830	12.2	71.2	1004	30	“
07 / 1200	12.5	72.1	1002	35	tropical storm
07 / 1800	12.8	73.8	1002	40	"
08 / 0000	12.8	75.5	999	45	"
08 / 0600	12.7	77.2	999	50	"
08 / 1200	12.7	78.9	994	55	"
08 / 1800	12.6	80.5	993	60	"
09 / 0000	12.5	82.0	989	65	hurricane
09 / 0600	12.4	83.3	982	75	"
09 / 0715	12.4	83.6	982	75	“
09 / 1200	12.3	84.7	985	65	"
09 / 1800	12.3	86.2	988	45	tropical storm
10 / 0000	12.6	87.6	993	40	"
10 / 0600	13.1	88.8	998	35	"
10 / 1100	13.6	89.7	1001	35	“
10 / 1200	13.7	89.9	1002	30	tropical depression
10 / 1800					dissipated
09 / 0600	12.4	83.3	982	75	Maximum wind and minimum pressure

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
07 / 0300	12.0	69.8	1004	30	Landfall near Adicora, Venezuela
07 / 0830	12.2	71.2	1004	30	Landfall near Punta Espada, Colombia
09 / 0715	12.4	83.6	982	75	Landfall near Laguna de Perlas, Nicaragua
10 / 1100	13.6	89.7	1001	35	Landfall near Acajutla, El Salvador

Table 2. Selected surface observations for Hurricane Julia, 7–10 October 2022.

Location	Minimum Sea Level Pressure		Maximum Surface Wind Speed			Total rain (in)
	Date/ time (UTC)	Press. (mb)	Date/ time (UTC)[a]	Sustained (kt)[b]	Gust (kt)	
Bluefields, Nicaragua (MNBL) *(11.99N 83.77W)*			09/0600	70		
Rivas, Nicaragua (MNRS) *(11.25N 86.17W)*			10/1500	20		
Managua, Nicaragua (MNMG) *(12.15N 84.41W)*			10/1400	21		
San Salvador, El Salvador (MSSS) *(13.42N 89.08W)*						5.26
Santa Ana, El Salvador (MSSA) *(13.59N 89.34W)*						3.56
San Miguel, El Salvador (MSSM) *(13.27N 88.07W)*						7.39
La Union, El Salvador (MSLU) *(13.33N 87.88W)*						9.46
Acajutla, El Salvador (MSAC) *(13.34N 89.50W)*						3.56
San Salvador, El Salvador (MSLP) *(13.26N 89.03W)*						3.38
Volcán Conchagua ANP, El Salvador						12.38
Los Naranjos, El Salvador						11.67
Santiago de María, El Salvador						10.08
Berlin Met, El Salvador						12.74
Volcán San Miguel 2, El Salvador						11.17

[a] Date/time is for sustained wind when both sustained and gust are listed.
[b] Except as noted, sustained wind averaging periods for C-MAN and land-based reports are 2 min; buoy averaging periods are 8 min.
[i] Incomplete record

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%)	108	108
Medium (40%-60%)	56	96
High (>60%)	24	42

Table 4a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) track forecast errors (n mi) for Hurricane Julia, 7–10 October 2022. 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	**12.9**	**28.5**	52.9	76.5	104.2	127.1		
OCD5	37.7	93.5	167.4	270.5	429.7	557.9		
Forecasts	13	11	9	7	5	3		
OFCL (2017-21)	23.6	35.5	47.6	61.4	78.2	91.3	125.6	172.1
OCD5 (2017-21)	45.5	98.3	156.7	213.7	252.4	316.9	403.6	484.6

Table 4b. Homogeneous comparison of selected track forecast guidance models (in n mi) for Hurricane Julia, 7–10 October 2022. 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	11.1	26.0	49.5	71.7	92.5	94.6		
OCD5	34.3	81.6	140.5	229.8	381.3	452.3		
GFSI	14.6	28.7	**42.9**	**69.4**	99.7	133.3		
HMNI	14.2	34.3	60.0	86.9	97.8	105.9		
HWFI	16.7	42.6	71.0	111.2	119.1	148.3		
EGRI	20.1	33.2	**40.8**	**59.3**	**34.1**	**88.1**		
EMXI	11.2	30.4	51.5	77.7	111.2	110.9		
CMCI	22.1	53.1	87.8	124.2	146.8	138.8		
NVGI	30.8	71.7	86.8	125.0	190.5	213.8		
CTCI	20.1	41.5	75.5	118.9	148.4	151.9		
AEMI	15.2	39.6	65.6	96.4	115.1	151.7		
HCCA	**8.1**	**23.0**	**39.9**	**53.1**	**65.7**	**55.4**		
FSSE	11.4	**24.2**	**42.4**	**59.6**	**79.9**	**68.4**		
TVCA	11.1	29.9	50.1	75.3	**89.7**	**83.8**		
TVCE	**11.0**	28.6	50.4	75.0	93.1	**83.8**		
Forecasts	9	9	7	5	3	1		

Table 5a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) intensity forecast errors (kt) for Hurricane Julia, 7–10 October 2022. 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	**3.5**	**4.1**	**2.8**	**2.9**	**6.0**	**3.3**		
OCD5	4.6	12.0	16.2	33.4	28.8	37.7		
Forecasts	13	11	9	7	5	3		
OFCL (2017-21)	5.4	8.0	9.5	10.9	11.0	12.1	13.1	14.7
OCD5 (2017-21)	7.0	11.1	14.5	17.1	18.0	20.2	21.9	22.1

Table 5b. Homogeneous comparison of selected intensity forecast guidance models (in kt) for Hurricane Julia, 7–10 October 2022. 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	4.4	4.4	3.6	4.0	3.3	0.0		
OCD5	5.3	11.6	12.9	33.2	39.7	47.0		
HWFI	8.7	12.1	10.1	4.2	4.0	3.0		
HMNI	8.3	10.3	8.1	**2.2**	4.0	0.0		
CTCI	8.2	11.7	9.4	6.2	5.0	4.0		
DSHP	5.8	5.4	5.4	5.8	**1.7**	2.0		
LGEM	6.1	6.9	5.6	**3.2**	**1.7**	1.0		
IVCN	6.6	8.1	5.0	**2.8**	**2.3**	1.0		
HCCA	5.8	5.9	4.7	**3.2**	**3.0**	1.0		
FSSE	6.2	5.9	5.7	6.8	5.7	4.0		
Forecasts	9	9	7	5	3	1		

Table 6. Watch and warning summary for Hurricane Julia, 7–10 October 2022.

Date/Time (UTC)	Action	Location
06 / 1500	Tropical Storm Warning issued	Colombia from border with Venezuela to Riohacha
06 / 1800	Hurricane Watch issued	San Andres, Providencia, Santa Catalina Islands
07 / 1500	Hurricane Watch changed to Hurricane Warning	San Andres, Providencia, Santa Catalina Islands
07 / 1500	Hurricane Watch issued	Nicaragua from Bluefields to border with Honduras
07 / 1500	Tropical Storm Watch issued	Honduras from border with Nicaragua to Punta Patuca
07 / 1800	Tropical Storm Watch changed to Tropical Storm Warning	Colombia from border with Venezuela to Riohacha
07 / 2100	Hurricane Warning issued	Laguna de Perlas to Puerto Cabezas, Nicaragua
07 / 2100	Tropical Storm Warning issued	Puerto Cabezas to Bluefields, Nicaragua
08 / 0900	Hurricane Warning modified	Nicaragua from Bluefields to Puerto Cabezas
08 / 0900	Tropical Storm Warning modified	Nicaragua from Bluefields to the border with Costa Rica
08 / 1500	Tropical Storm Warning issued	Pacific coasts of Nicaragua and Honduras, including the Gulf of Fonseca
08 / 1500	Tropical Storm Watch issued	Pacific coast of El Salvador
08 / 2100	Tropical Storm Watch changed to Tropical Storm Warning	Pacific coast of El Salvador
09 / 0900	Hurricane Warning changed to Tropical Storm Warning	San Andres, Providencia, Santa Catalina Islands
09 / 0900	Tropical Storm Watch issued	Pacific coast of Guatemala
09 / 1200	Tropical Storm Warning discontinued	San Andres, Providencia, Santa Catalina Islands
09 / 1500	Hurricane Warning discontinued	Caribbean coast of Nicaragua

Date/Time (UTC)	Action	Location
09 / 1500	Tropical Storm Warning discontinued	Caribbean coasts of Nicaragua and Honduras
10 / 0300	Tropical Storm Warning discontinued	Pacific coast of Nicaragua south of Puerto Sandino
10 / 0900	Tropical Storm Warning discontinued	Remainder of Nicaragua
10 / 1500	Tropical Storm Warning discontinued	All

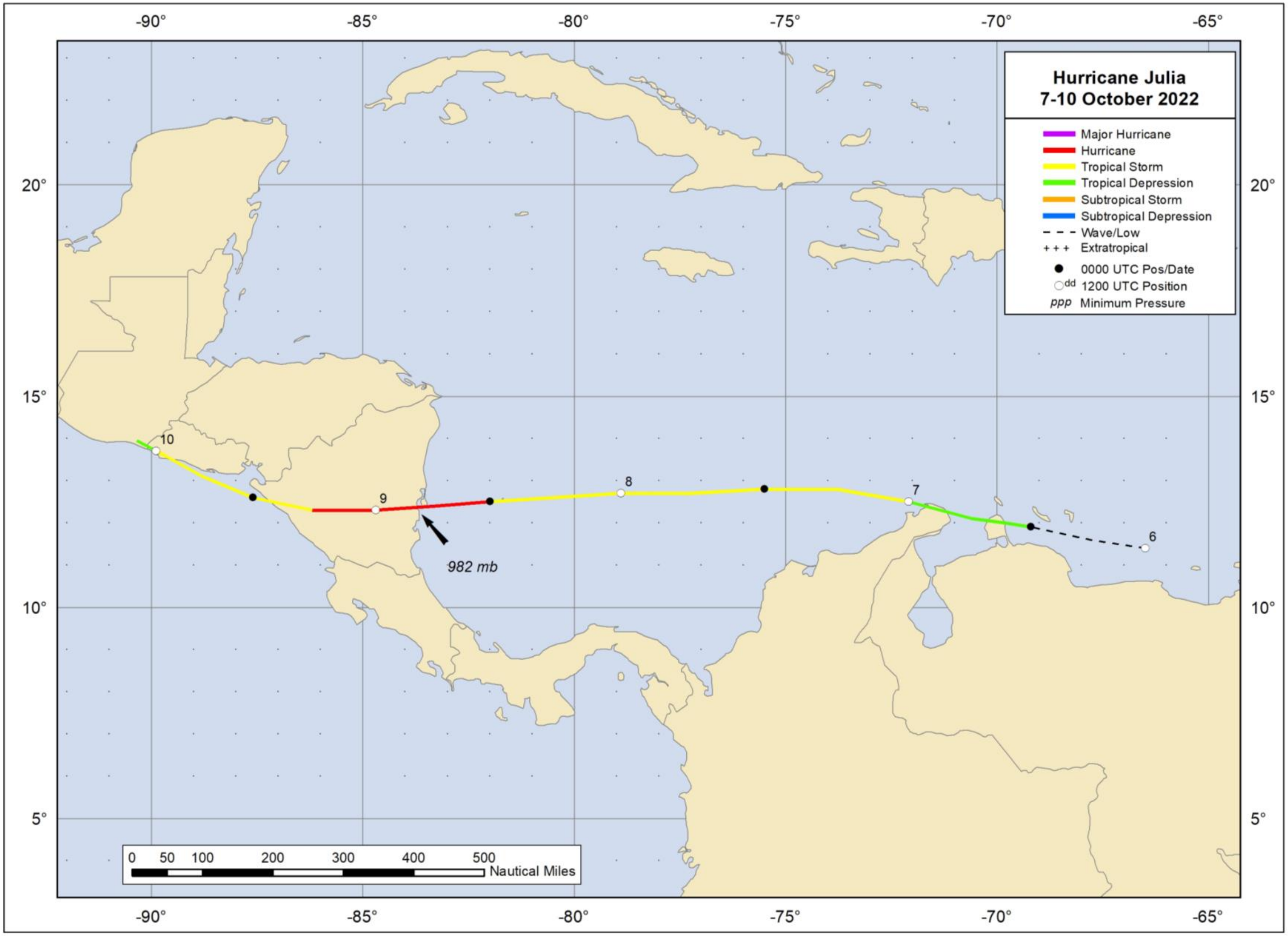

Figure 1. Best track positions for Hurricane Julia, 7–10 October 2022.

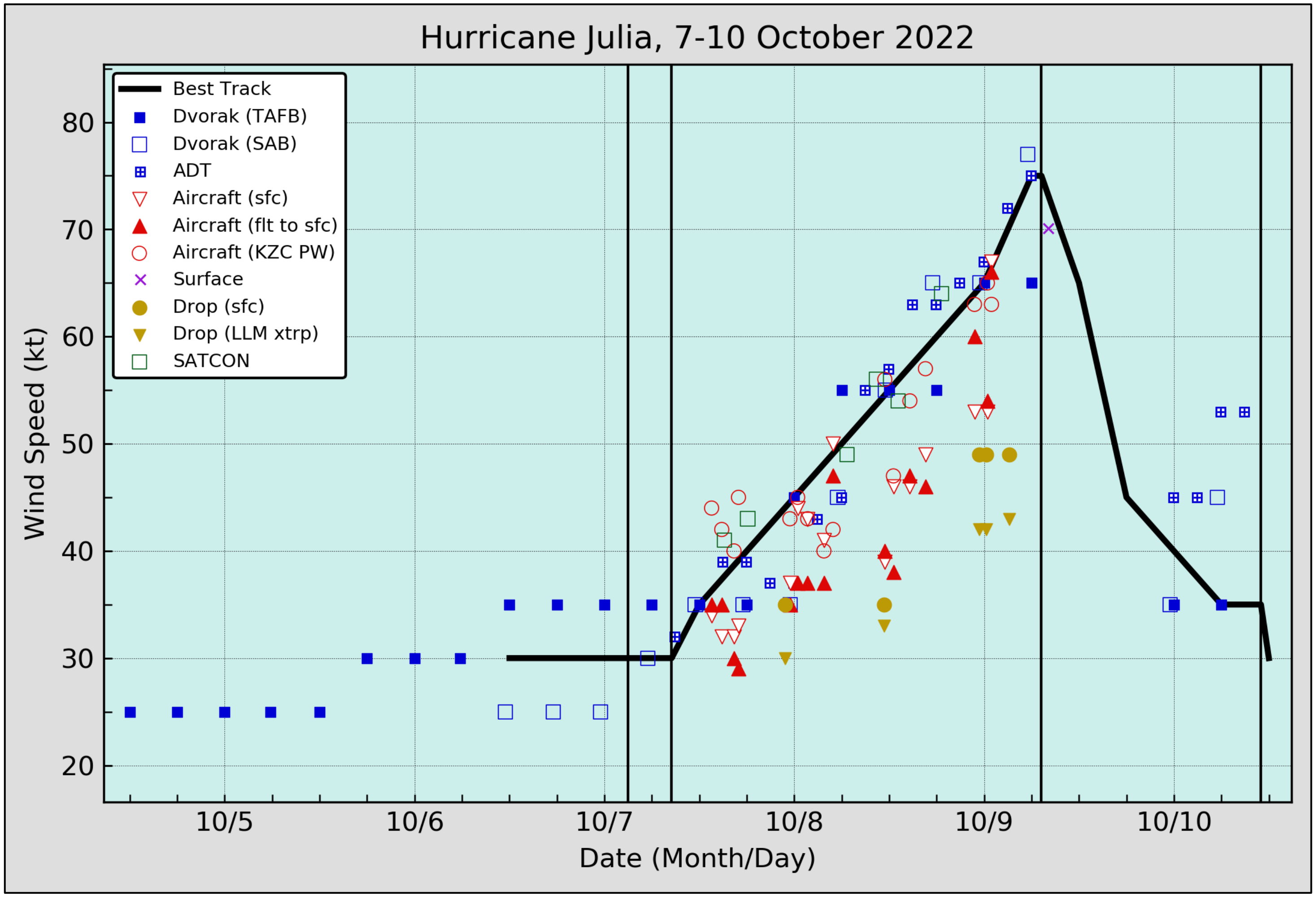

Figure 2. Selected wind observations and best track maximum sustained surface wind speed curve for Hurricane Julia, 7–10 October 2022. Aircraft observations have been adjusted for elevation using 90%, 80%, and 80% adjustment factors for observations from 700 mb, 850 mb, and 1500 ft, respectively. Dropwindsonde observations include actual 10 m winds (sfc), as well as surface estimates derived from the mean wind over the lowest 150 m of the wind sounding (LLM). 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.

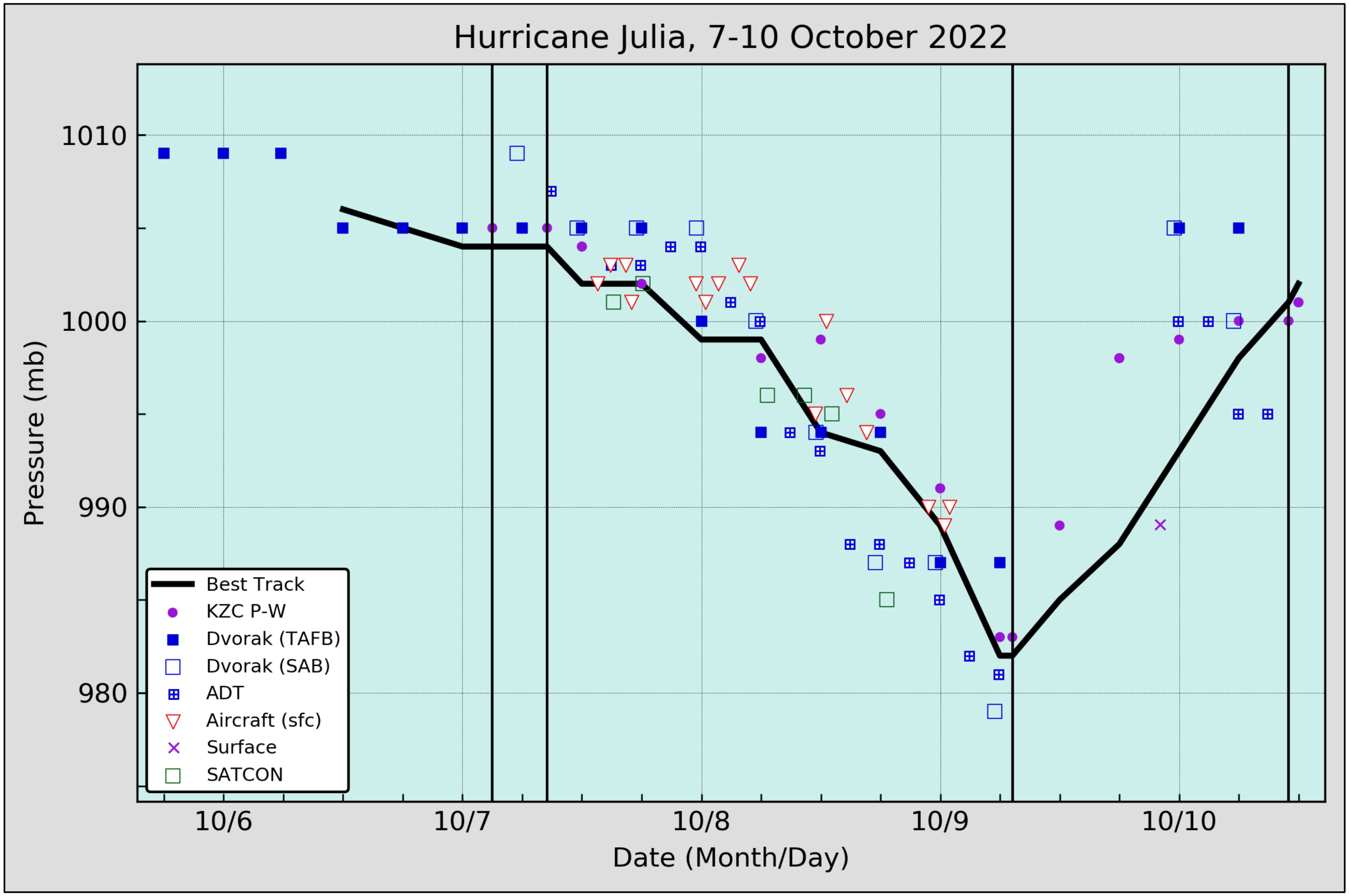

Figure 3. Selected pressure observations and best track minimum central pressure curve for Hurricane Julia, 7–10 October 2022. Advanced Dvorak Technique estimates represent the Current Intensity at the nominal observation time. SATCON intensity estimates are from the Cooperative Institute for Meteorological 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.

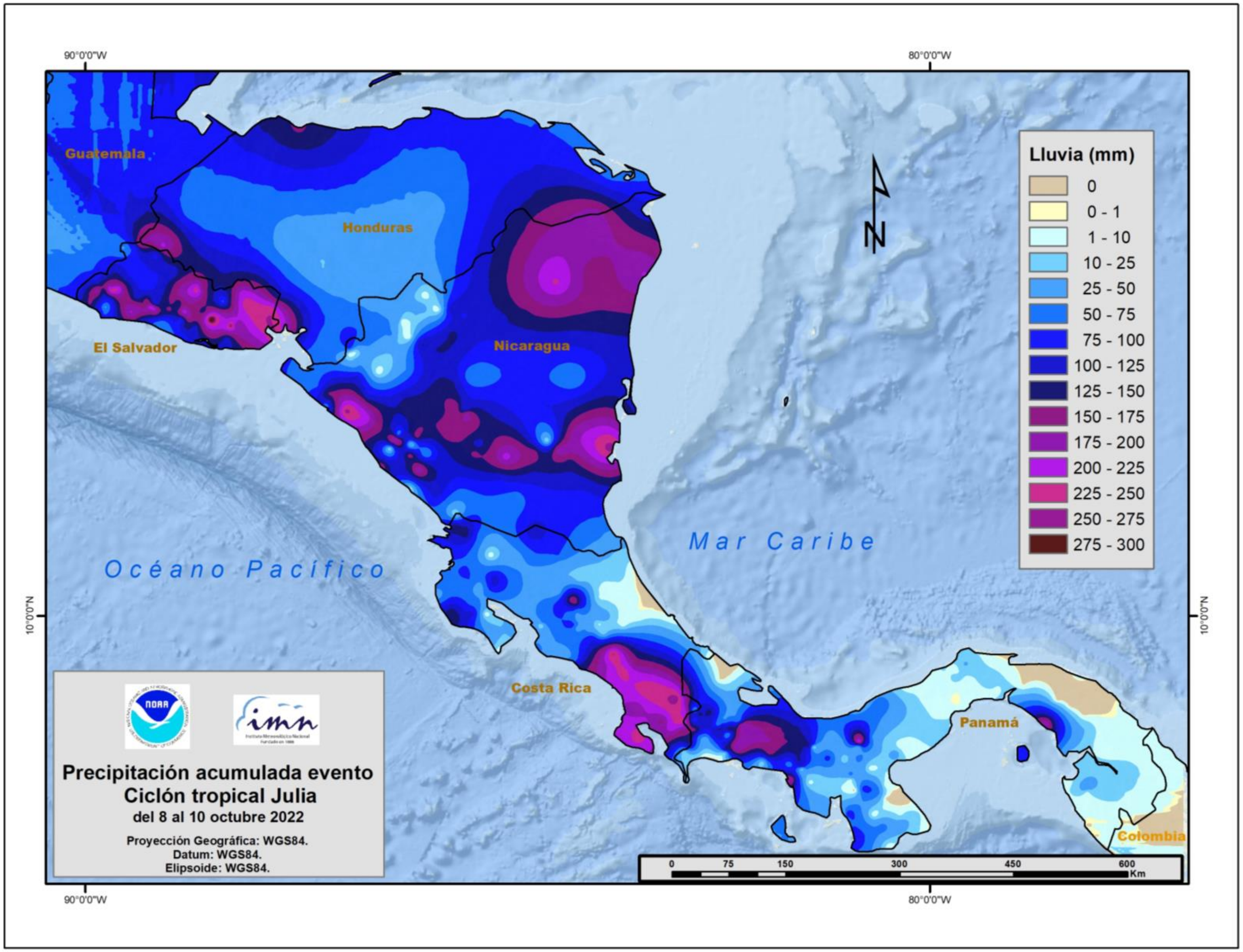

Figure 4. Total rainfall (mm) produced by Hurricane Julia across Central America. Courtesy of the Weather Prediction Center's International Desk.

Figure 5. Flooding near Bluefields, Nicaragua, on 9 October after the core of Julia passed to the west of the region. Image courtesy of the Associated Press.

Julia 5-day Tropical Weather Outlook Areas
From: 1200 UTC 2 Oct 2022 to 0000 UTC 7 Oct 2022

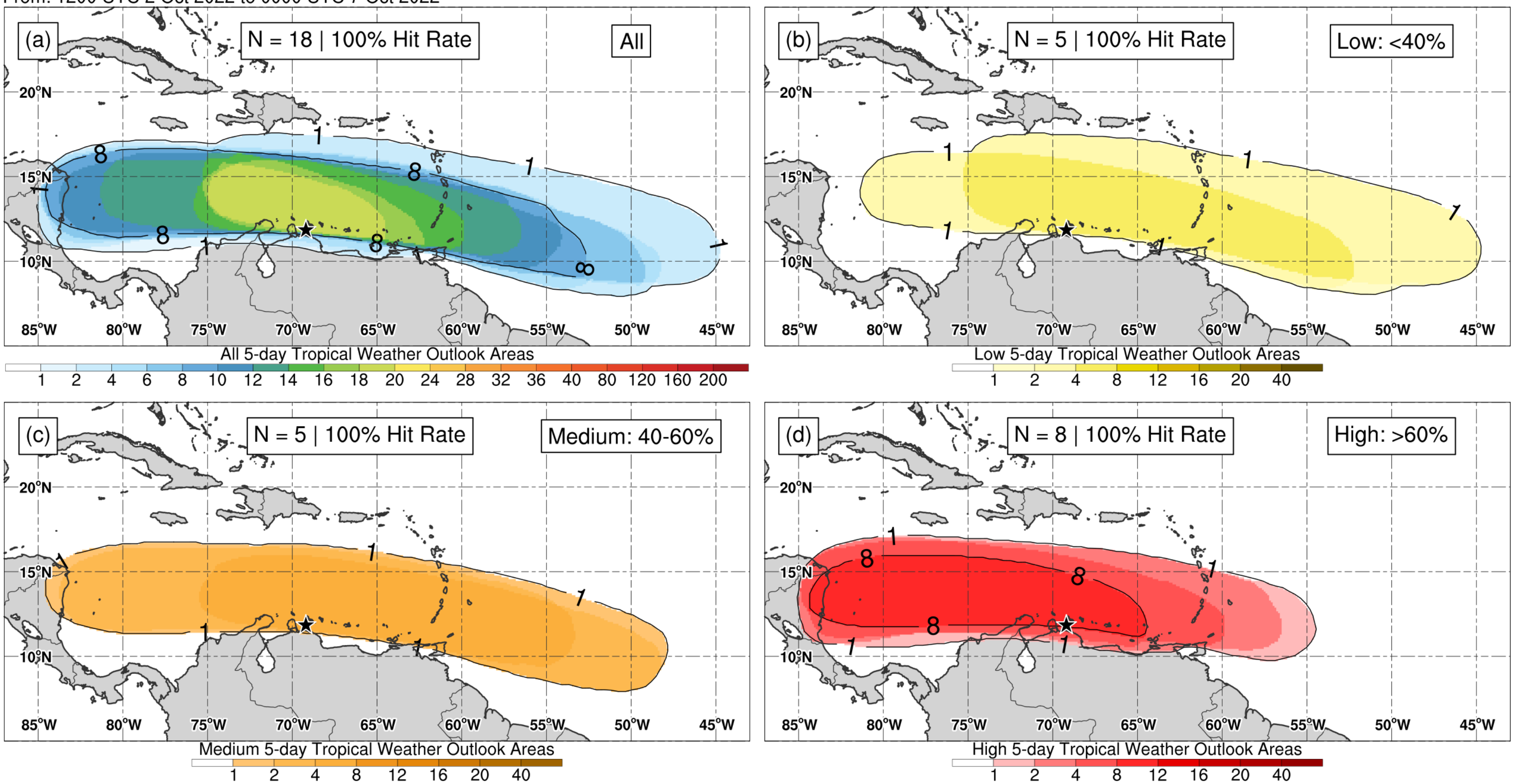

Figure 6. Composites of 5-day tropical cyclone genesis areas depicted in NHC's Tropical Weather Outlooks prior to the formation of Hurricane Julia for (a) all probabilistic genesis categories, (b) the low (<40%) category, (c) medium (40-60%) category, and (d) high (>60%) category. Julia's location of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

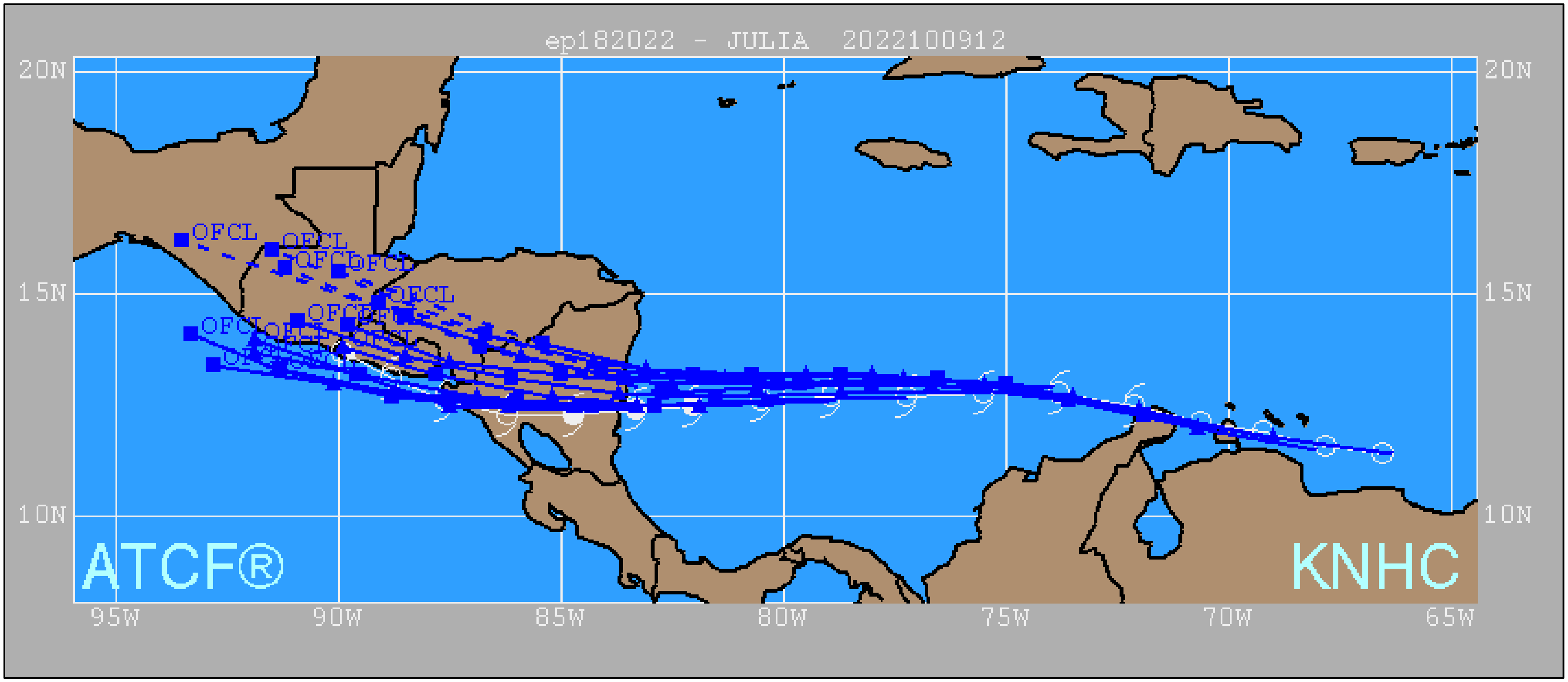

Figure 7. Official NHC track forecasts for Hurricane Julia from 1200 UTC 6 October to 1200 UTC 10 October 2022.

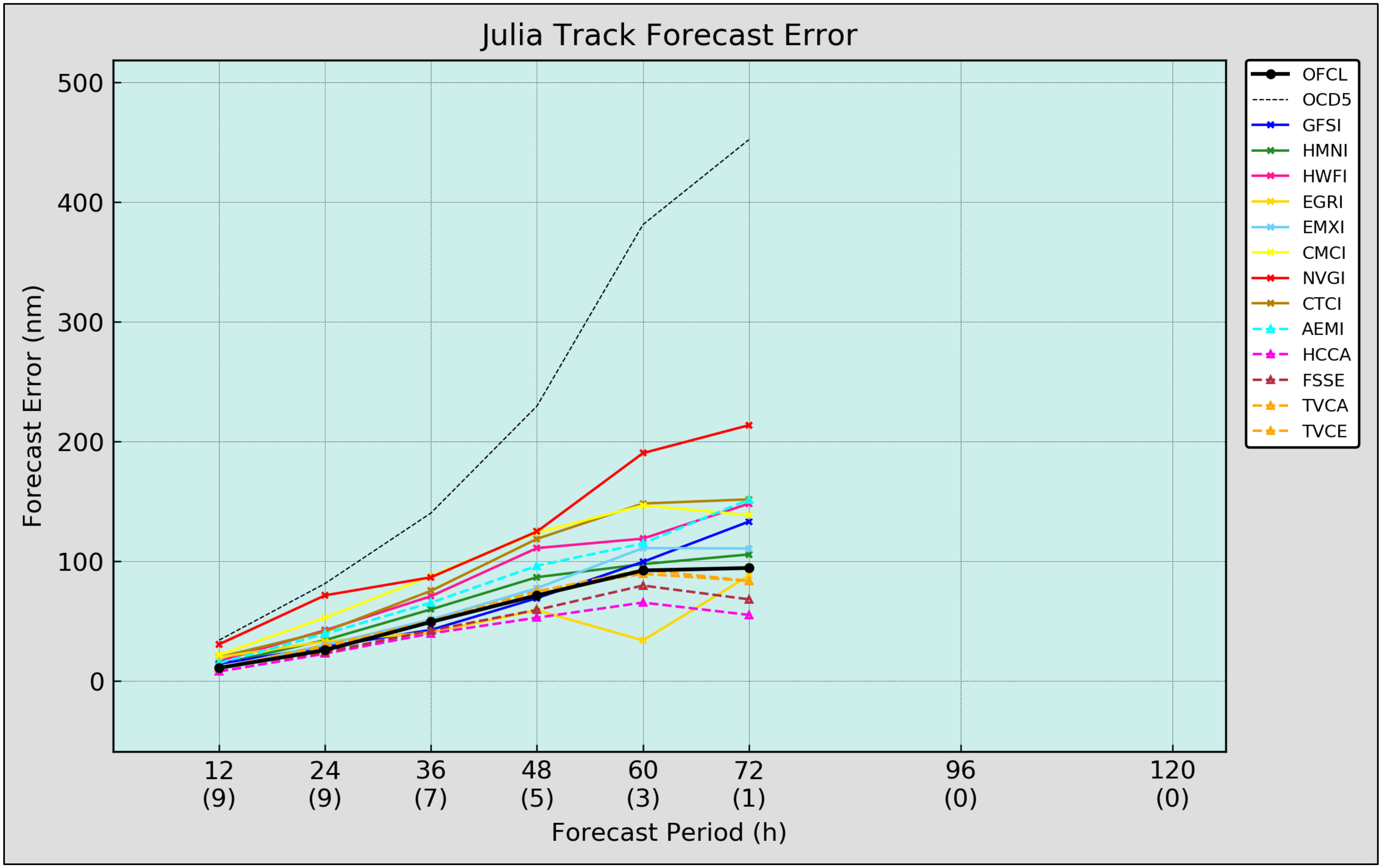

Figure 8. Official track and selected model errors (n mi) for Hurricane Julia, 7–10 October 2022.

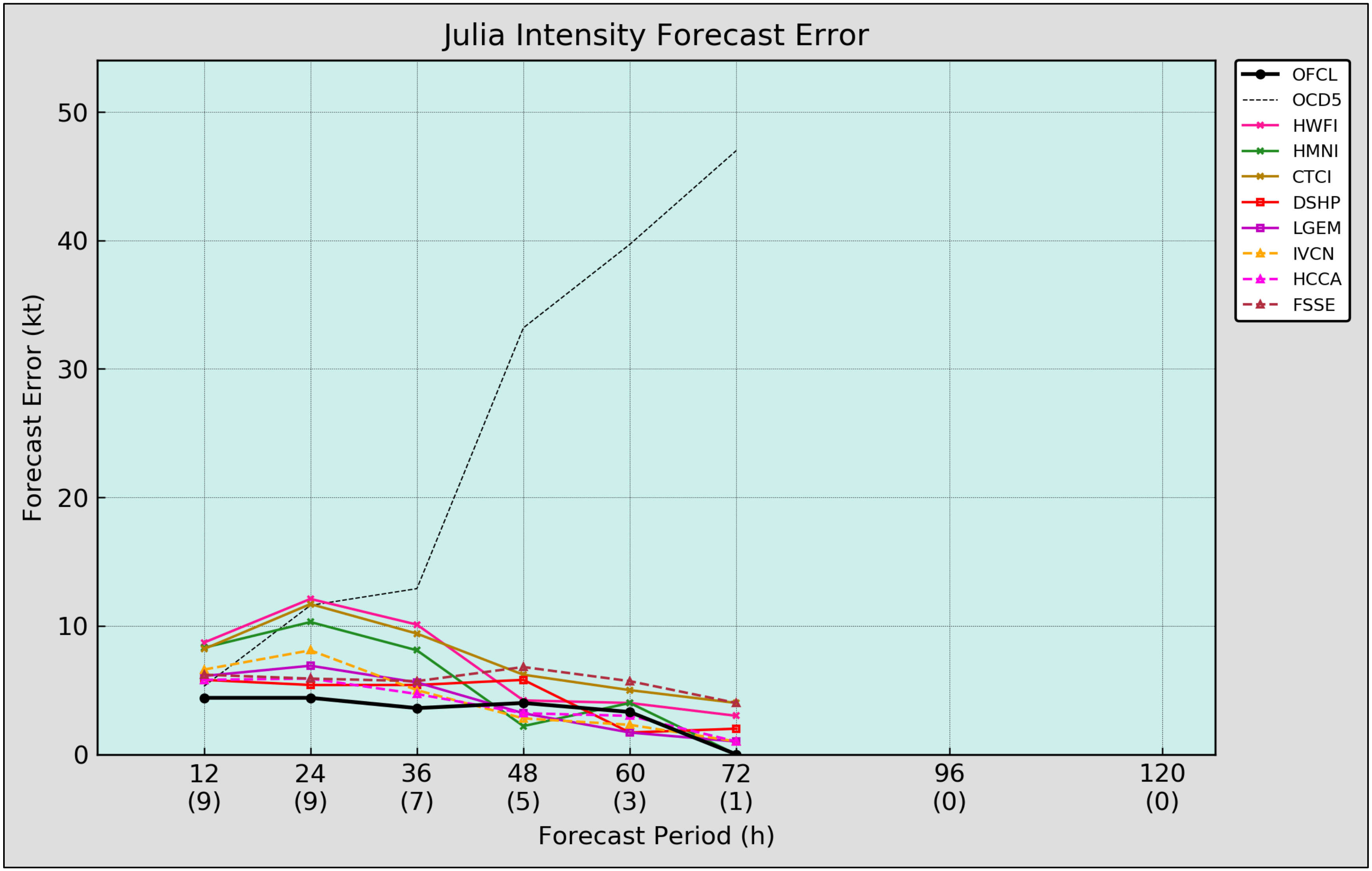

Figure 9. Official intensity and selected model errors (kt) for Hurricane Julia, 7–10 October 2022.