NATIONAL HURRICANE CENTER TROPICAL CYCLONE REPORT

HURRICANE JOHN

(EP102024)

22–27 September 2024

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National Hurricane Center
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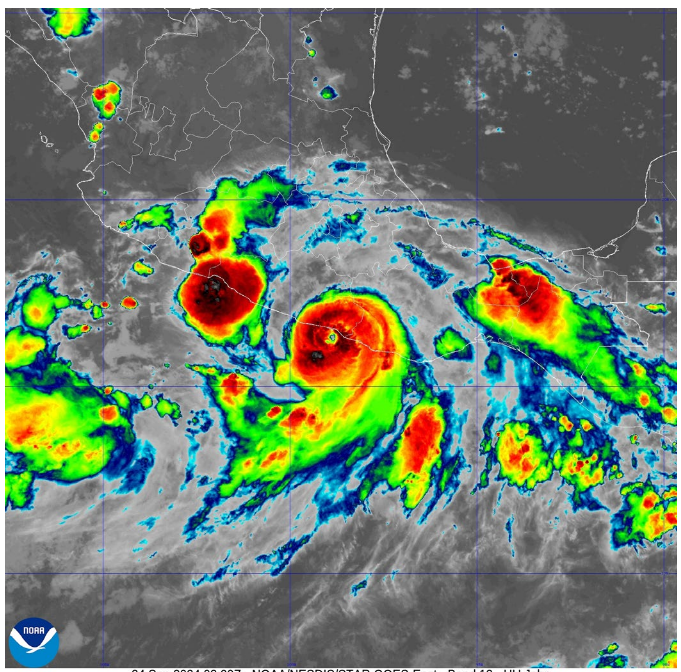

GOES-16 INFRARED IMAGE OF HURRICANE JOHN AT 0200 UTC 24 SEPTEMBER 2024. IMAGE COURTESY OF NOAA/NESDIS/STAR.

John made landfall as a category 3 hurricane (on the Saffir/Simpson Hurricane Wind Scale) in the state of Guerrero, Mexico. After degenerating into a broad area of low pressure after landfall, John moved back offshore and redeveloped into a hurricane. It then weakened and made a second landfall as a tropical storm in the state of Michocán, Mexico. John produced huge amounts of rain and extensive flooding over southern Mexico, and was responsible for 29 deaths.

Hurricane John

22–27 SEPTEMBER 2024

SYNOPTIC HISTORY

John appears to have had its origins from a westward-moving tropical wave that crossed Central America around 16 September. Deep convection associated with the disturbance became more concentrated to the south of the Gulf of Tehuantepec on 19 September. The cloud pattern gradually became better organized while the system moved little over the next couple of days. A well-defined low-level circulation became apparent on 22 September, and it is estimated that a tropical depression formed around 1200 UTC that day while centered about 210 n mi south-southeast of Acapulco, Mexico. The "best track" chart of John'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].

The cyclone moved little during the first day of its existence while strengthening into a tropical storm around 0000 UTC 23 September. Later on that date, John moved generally northward on the eastern side of a broad trough of low pressure in an environment of low vertical wind shear and very warm ocean waters, and intensified rapidly. It became a hurricane before 1800 UTC on the 23rd, and a 100-kt major hurricane by 0000 UTC on the 24th. While turning toward the left, John made landfall in the eastern part of the state of Guerrero near Marquelia, Mexico around 0315 UTC 24 September with an estimated intensity of 105 kt. John weakened rapidly after landfall while continuing to turn toward the left, moving west-northwestward and then west-southwestward to southwestward over southern Guerrero. The system became a tropical storm by 1200 UTC 24 September and then degenerated into a broad area of disturbed weather near the coast of Guerrero around 1800 UTC that day.

John's mid-level circulation appeared to remain intact while the system moved back over the waters of the eastern Pacific on 25 September. Deep convective banding re-developed within the system, and it became sufficiently well-organized to support John's redevelopment into a tropical storm at 1200 UTC 25 September, while centered about 70 n mi south of Zihuatanejo, Mexico. John moved rather slowly but generally northwestward or west-northwestward into 26 September and with favorable atmospheric and oceanic conditions, it re-strengthened into a hurricane by 1200 UTC that day. John's intensification trend was halted and then reversed, likely due to the close proximity of land. On 27 September, the cyclone moved northward to northwestward toward the coast, to the southwest of a mid-level ridge. Gradual weakening on 27 September resulted in John's intensity being reduced to a tropical storm, and the cyclone made landfall in the state of Michoacán near Playa Zapote de Tizupan, Mexico around 1600 UTC 27

[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.

September with an intensity of about 50 kt. After landfall, John quickly dissipated over southwestern Mexico.

METEOROLOGICAL STATISTICS

Observations in John (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 one flight of the 53rd Weather Reconnaissance Squadron of the U.S. Air Force Reserve Command (AFRES). 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, and the Time-Resolved Observations of Precipitation structure and storm Intensity with a Constellation of Smallsats (TROPICS) satellites, among others, were also useful in constructing the best track of John. The one reconnaissance mission of the AFRES into John occurred late on 25 September before the system restrengthened into a hurricane.

Ship reports of winds of tropical storm force associated with John are given in Table 2.

Winds and Pressure

The peak intensity of John, 105 kt is based primarily on Dvorak data T-numbers of 5.5 from both TAFB and SAB at 0000 UTC 24 September, and the presumption of some slight additional strengthening up to landfall. John's minimum pressures are based primarily on the Knaff-Zehr-Courtney pressure-wind relationship.

There were no observations available near the hurricane landfall location, which was a sparsely settled area of the coastline. Las Vigas, just inland over eastern Guerrero along the path of John at an elevation of 41 m, recorded a sustained wind of 39 kt with a gust to 69 kt at 0520 UTC 24 September and a minimum pressure of 986.4 mb at 0510 UTC 24 September.

Rainfall and Flooding

John dumped enormous amounts of rain near its path along the coast of Mexico. A storm total rainfall of 1442 mm, or about 56.8 inches, was recorded at Acapulco with most of the rain, 44.6 inches, falling during the 24-26 September period. The rains produced widespread flooding and landslides. Figure 4 is a map of John's storm total rainfall in Mexico. The heaviest rains occurred in the Mexican states of Guerrero, Oaxaca, and Michoacán.

CASUALTY AND DAMAGE STATISTICS

According to media reports, John caused 29 deaths in Mexico, including 23 in the state of Guerrero, most of which were presumably direct[2]. Near the path of the hurricane, roofs were blown off of structures, and fallen trees blocked highways. Considerable damage was caused by flooding and landslides over portions of southern Mexico (Fig. 5). According to the global reinsurance brokerage Gallagher Re, the total damage estimate for John is 2.45 billion U.S. dollars.

FORECAST AND WARNING CRITIQUE

Neither the first nor the second geneses of John were well anticipated (Tables 3a and 3b), mainly because the global model guidance was not very aggressive in showing the system's development. The disturbance that led to the first formation of John was introduced into the Tropical Weather Outlook (TWO) just 18 h prior to genesis, with a low (less than 40%) chance of formation in 2 and 7 days, and the formation probability was never set to high (greater than 60%) prior to John's first development. The remnants of John were introduced into the TWO with a medium chance of formation in 2 and 7 days only 18 h prior to its second genesis, and the 2- and 7-day formation chances were raised to high only 6 hours before redevelopment. Both of John's genesis locations were well forecast (Figs. 6a and 6b), although the lead times were quite short.

A verification of NHC official track forecasts for John is given in Table 4a. Official track forecast errors were considerably larger than the mean official errors for the previous 5-yr period. A homogeneous comparison of the official track errors with selected guidance models is given in Table 4b. In general, the ECMWF and consensus track model guidance had lower mean errors than the NHC forecasts. Several of the official forecasts had an east of track bias particularly in the case of John's first landfall (Fig. 7).

A verification of NHC official intensity forecasts for John is given in Table 5a. Official intensity forecast errors were substantially higher than the mean official errors for the previous 5-yr period. A homogeneous comparison of the official intensity errors with selected guidance models is given in Table 5b. All of the prediction aids listed in this table had lower mean intensity errors than the NHC forecasts at the 24- through 72-h forecast intervals. The timing of John's rapid intensification on 23 September was not well anticipated in the official forecasts (Fig. 8) until just before landfall. In fact, the first 3 advisories, issued 30, 24, and 18 h before landfall early on 24 September did not indicate that John would become a hurricane.

Watches and warnings associated with John are given in Table 6. In general, the warnings for the coast of Mexico were issued with less than desirable lead times for this storm. A Hurricane

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[2] 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.

Warning was issued just 12 to 15 hours prior to the arrival of tropical-storm-force winds in the location of John's first landfall. It is notable, however, that a Hurricane Watch was issued at 0900 UTC 23 September, only 3 hours earlier than the time of issuance of the Hurricane Warning, but the official forecast at that time did not explicitly predict John to become a hurricane.

ACKNOWLEDGEMENTS

Fabián Vázquez Romaña of CONAGUA provided observations from Mexico. Philippe Papin of NHC produced Figs. 5a and 5b. Lisa Bucci of NHC provided Figs.7 and 8.

Table 1. Best track for Hurricane John, 22–27 September 2024.

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
22 / 1200	13.8	98.6	1005	25	tropical depression
22 / 1800	13.9	98.6	1004	30	"
23 / 0000	14.0	98.6	1002	35	tropical storm
23 / 0600	14.2	98.5	1000	40	"
23 / 1200	14.6	98.4	992	60	"
23 / 1800	15.2	98.4	977	80	hurricane
24 / 0000	15.9	98.6	960	100	"
24 / 0315	16.6	98.9	956	105	"
24 / 0600	16.9	99.3	973	85	"
24 / 1200	17.5	100.3	999	45	tropical storm
24 / 1800	17.4	100.7	1003	30	disturbance
25 / 0000	17.1	101.0	1001	30	"
25 / 0600	16.8	101.3	1000	30	low
25 / 1200	16.4	101.5	1000	35	tropical storm
25 / 1800	16.7	101.7	996	45	"
26 / 0000	16.9	102.0	984	55	"
26 / 0600	17.0	102.3	982	60	"
26 / 1200	17.1	102.5	979	65	hurricane
26 / 1800	17.3	102.7	979	65	"
27 / 0000	17.5	102.9	984	60	tropical storm
27 / 0600	17.8	102.9	988	55	"
27 / 1200	18.0	102.9	993	50	"

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
27 / 1600	18.2	103.1	993	50	"
27 / 1800	18.3	103.2	1000	35	"
28 / 0000					dissipated
24 / 0315	16.6	98.9	956	105	maximum winds, minimum pressure, and landfall near Marquelia, Guerrero, Mexico
27 / 1600	18.2	103.1	993	50	landfall near Playa Zapote de Tizupan, Michoacán, Mexico

Table 2. Selected ship reports with winds of at least 34 kt for Hurricane John, 22–27 September 2024.

Date/Time (UTC)	Ship call sign	Latitude (°N)	Longitude (°W)	Wind dir/ speed (kt)	Pressure (mb)
23 / 1900	5LDS2	13.3	97.4	240 / 40	1004.1
24 / 0200	9HJC9	14.0	101.1	280 / 40	1005.0
24 / 0400	8PRGBJ	17.4	102.4	070 / 38	1005.9
24 / 0900	9HJC9	12.2	99.6	230 / 37	1005.0
24 / 1000	9HJC9	12.0	99.4	230 / 36	1005.0
25 / 0400	MLBD9	15.1	101.1	230 / 35	1003.0
25 / 1100	7JDE	16.8	101.1	080 / 45	998.7
25 / 1700	9V7979	16.5	101.0	200 / 38	995.9
25 / 1800	C6WW7	15.6	100.7	210 / 46	1001.0
25 / 1900	7JDE	15.9	99.0	200 / 38	1005.7
27 / 0400	C6EI4	16.8	103.8	350 / 36	1001.0
27 / 0700	C6EI4	16.8	103.8	350 / 36	1001.0
27 / 1800	GKHEAB	12.9	102.7	250 / 35	1009.2
28 / 0000	GKHEAB	13.4	104.4	270 / 35	1006.2

Table 3a. Number of hours in advance of the first formation of John 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%)	18	18
Medium (40%-60%)	0	12
High (>60%)	-	-

Table 3b. Number of hours in advance of the redevelopment of John 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%)	-	-
Medium (40%-60%)	18	18
High (>60%)	6	6

Table 4a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) track forecast errors (n mi) for Hurricane John, 22–27 September 2024. Mean errors for the previous 5-yr period are shown for comparison.

	Forecast Period (h)							
	12	24	36	48	60	72	96	120
OFCL	35.8	69.6	92.0	118.0	195.8	268.7	561.8	
OCD5	39.5	85.3	137.0	182.4	244.8	210.4	90.0	
Forecasts	14	11	8	5	3	4	1	
OFCL (2019-23)	22.6	34.4	46.0	57.6	69.6	83.5	112.4	137.2
OCD5 (2019-23)	38.2	75.5	117.0	160.0	203.5	247.6	329.5	404.4

Table 4b. Homogeneous comparison of selected track forecast guidance models (in n mi) for Hurricane John, 22–27 September 2024. 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	29.8	68.2	90.3	123.1	110.4	206.4		
OCD5	34.6	86.0	142.2	207.1	337.8	264.7		
GFSI	**21.1**	**56.7**	120.0	142.0	185.4	358.6		
EMXI	31.9	**64.6**	**74.2**	125.4	**109.9**	**128.3**		
HWFI	36.2	82.4	125.6	133.6	150.5	305.2		
HMNI	**24.3**	72.0	109.6	126.5	152.8	258.5		
HFAI	**27.1**	**54.5**	116.9	**51.7**	**50.3**	266.0		
HFBI	**23.6**	**53.5**	110.1	**35.0**	**52.5**	277.1		
HCCA	**26.9**	**60.5**	**85.5**	**115.5**	124.5	222.4		
AEMI	**27.0**	74.5	139.9	215.4	289.5	359.6		
GFEX	**24.9**	**56.5**	**83.5**	**120.5**	146.6	238.4		
TVCE	**22.5**	**58.3**	94.7	**89.0**	**106.3**	234.1		
TVCX	**22.8**	**56.5**	91.9	**91.5**	**109.4**	224.7		
TVDG	**22.8**	**57.1**	91.7	**96.2**	111.9	223.5		
TABD	33.0	102.2	158.1	193.2	144.6	313.9		
TABM	34.8	108.1	153.7	158.1	148.7	322.1		
TABS	54.0	140.9	206.9	259.4	258.8	387.9		
Forecasts	12	10	7	4	2	3		

Table 5a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) intensity forecast errors (kt) for Hurricane John, 22–27 September 2024. 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	10.4	23.6	17.5	23.0	38.3	18.3	45.0	
OCD5	11.9	25.5	19.1	17.4	30.3	13.0	36.0	
Forecasts	14	11	8	5	3	3	1	
OFCL (2019-23)	5.5	8.7	10.8	12.7	14.5	15.6	17.1	18.0
OCD5 (2019-23)	7.2	12.2	15.9	18.6	19.9	20.0	19.6	18.7

Table 5b. Homogeneous comparison of selected intensity forecast guidance models (in kt) for Hurricane John, 22–27 September 2024. 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	11.2	25.5	20.0	23.8	38.3	18.3		
OCD5	11.7	26.3	20.7	**21.0**	**30.3**	**13.0**		
HWFI	13.3	**18.2**	**15.1**	**14.5**	**20.0**	19.0		
HFAI	13.3	**20.6**	**12.9**	**5.5**	**6.7**	**16.0**		
HFBI	12.8	**17.2**	**11.9**	**4.5**	**5.0**	**14.3**		
IVCN	12.5	**17.9**	**12.9**	**12.0**	**16.7**	**13.3**		
IVDR	12.8	**17.1**	**12.6**	**11.2**	**15.0**	**13.0**		
HCCA	12.3	**17.6**	**11.7**	**8.0**	**15.0**	**13.7**		
GFSI	18.1	**21.0**	**15.9**	**11.2**	**9.7**	**7.7**		
EMXI	15.2	**20.9**	**15.6**	**14.0**	**12.0**	**4.0**		
Forecasts	13	10	7	4	3	3		

Table 6. Watch and warning summary for Hurricane John, 22–27 September 2024.

Date/Time (UTC)	Action	Location
22 / 2100	Tropical Storm Watch issued	Salina Cruz to Punta Maldonado
23 / 0900	Tropical Storm Watch modified to	Salina Cruz to Bahias de Huatulco
23 / 0900	Tropical Storm Warning issued	Bahias de Huatulco to Punta Maldonado
23 / 0900	Hurricane Watch issued	Bahias de Huatulco to Punta Maldonado
23 / 1200	Tropical Storm Watch changed to Tropical Storm Warning	Salina Cruz to Bahias de Huatulco
23 / 1200	Tropical Storm Warning changed to Hurricane Warning	Bahias de Huatulco to Punta Maldonado
23 / 1200	Hurricane Watch discontinued	All
23 / 1800	Tropical Storm Warning issued	Punta Maldonado to Acapulco
23 / 2100	Tropical Storm Warning discontinued	Punta Maldonado to Acapulco
23 / 2100	Hurricane Warning modified to	Bahias de Huatulco to Acapulco
24 / 0600	Tropical Storm Warning discontinued	All
24 / 0600	Hurricane Warning modified to	Lagunas de Chacahua to Acapulco
24 / 0900	Hurricane Warning changed to Tropical Storm Warning	Lagunas de Chacahua to Acapulco
24 / 1200	Tropical Storm Warning discontinued	Lagunas de Chacahua to Acapulco
24 / 1200	Tropical Storm Warning issued	Punta Maldonado to Zihuatanejo
24 / 1800	Tropical Storm Warning discontinued	All
25 / 1500	Tropical Storm Warning issued	Punta Maldonado to Lazaro Cardenas
25 / 1500	Hurricane Watch issued	Acapulco to Zihuatanejo
25 / 2100	Tropical Storm Warning modified to	Lazaro Cardenas to Punta San Telmo
25 / 2100	Hurricane Watch modified to	Acapulco to Tecpan de Galeana
25 / 2100	Hurricane Watch issued	Lazaro Cardenas to Punta San Telmo
25 / 2100	Hurricane Warning issued	Tecpan de Galeana to Lazaro Cardenas

Date/Time (UTC)	Action	Location
26 / 0300	Tropical Storm Warning discontinued	Lazaro Cardenas to Punta San Telmo
26 / 0300	Hurricane Watch discontinued	All
26 / 0300	Hurricane Warning modified to	Tecpan de Galeana to Punta San Telmo
26 / 0900	Tropical Storm Warning issued	Punta San Telmo to Manzanillo
26 / 1500	Hurricane Watch issued	Punta San Telmo to Manzanillo
27 / 0000	Tropical Storm Warning modified to	Punta Maldonado to Zihuatanejo
27 / 0000	Hurricane Warning modified to	Zihuatanejo to Punta San Telmo
27 / 0300	Tropical Storm Warning modified to	Punta Maldonado to Manzanillo
27 / 0300	Hurricane Watch discontinued	All
27 / 0300	Hurricane Warning discontinued	All
27 / 2100	Tropical Storm Warning discontinued	All

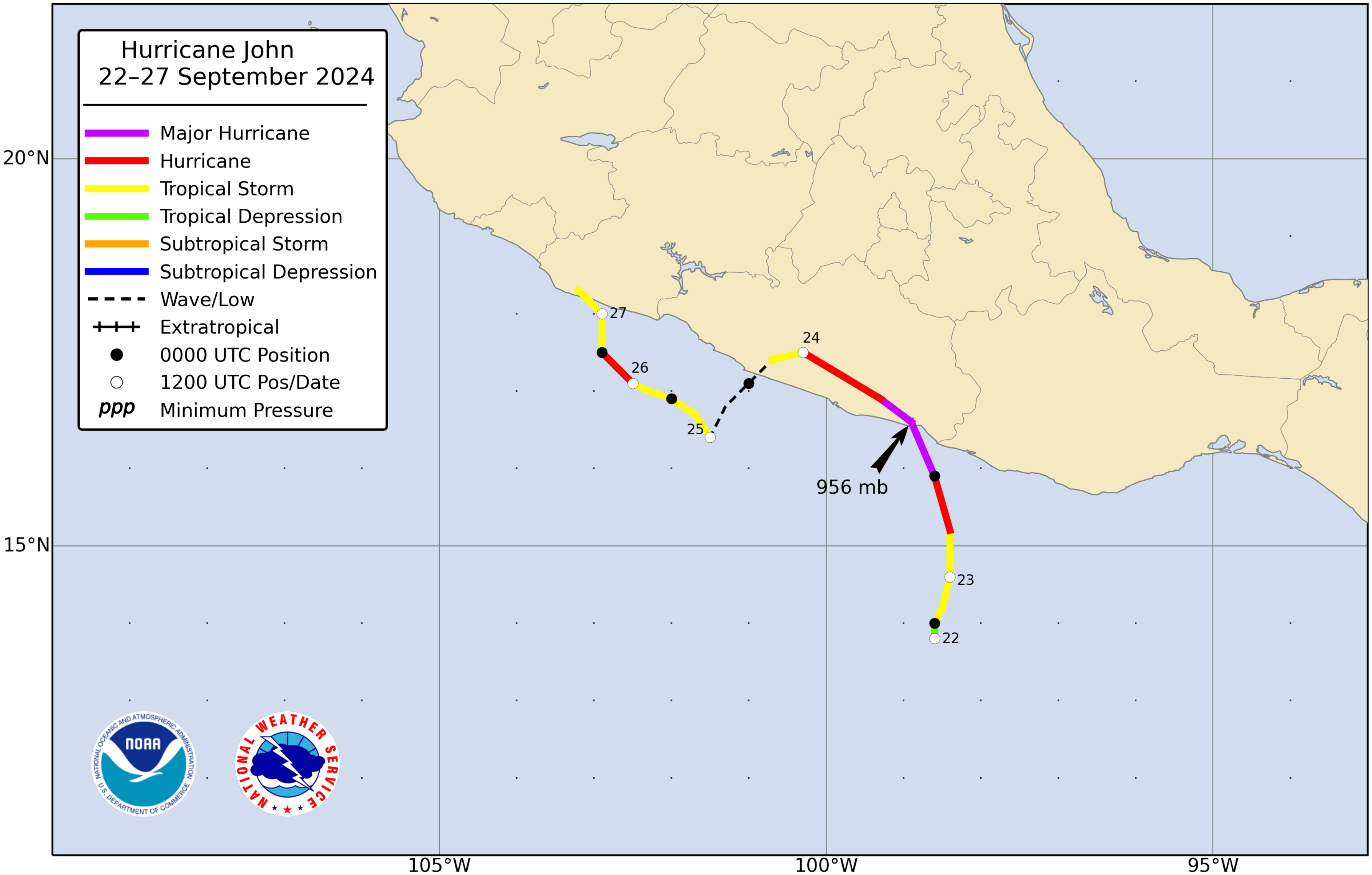

Figure 1. Best track positions for Hurricane John, 22–27 September 2024.

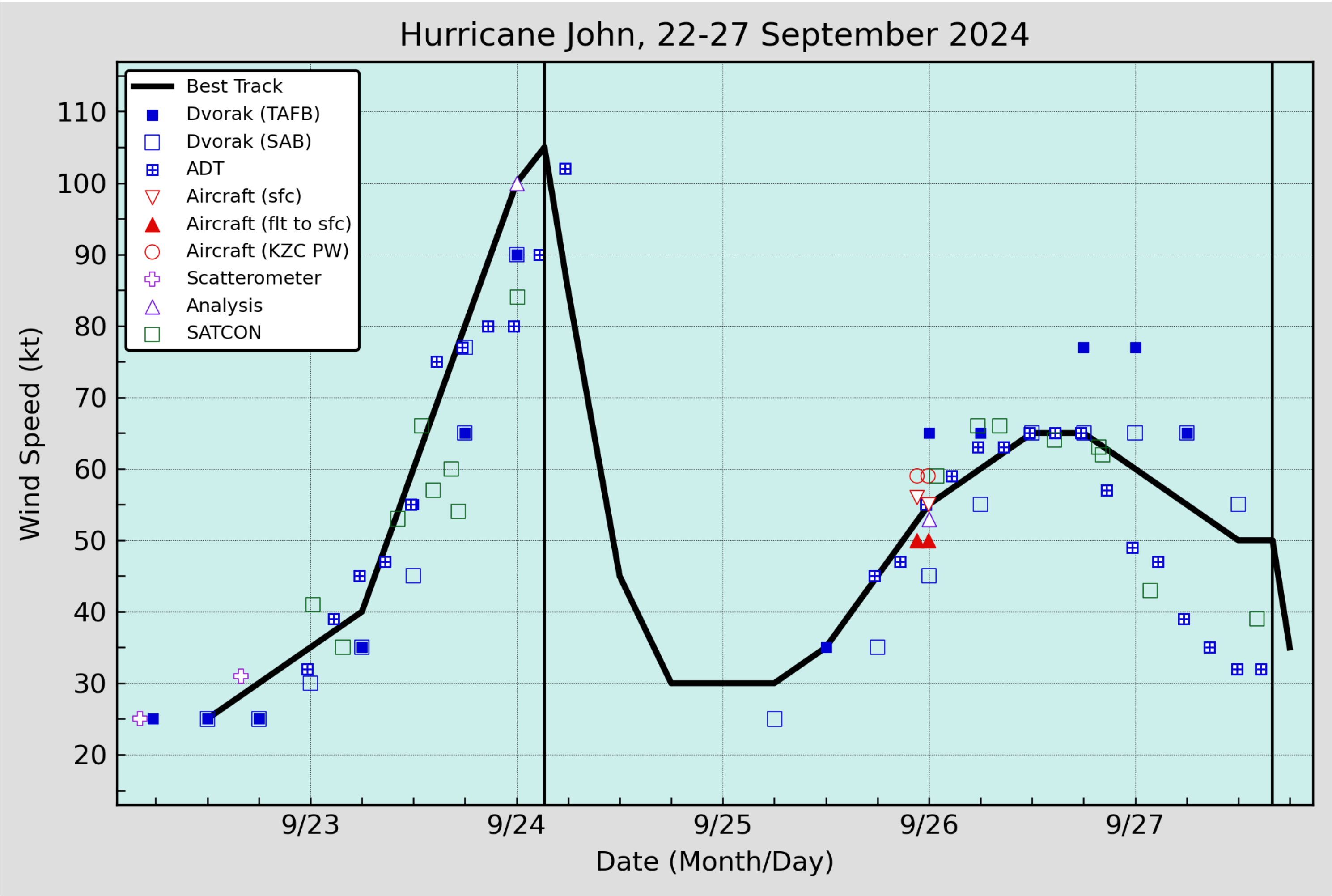

Figure 2. Selected wind observations and best track maximum sustained surface wind speed curve for Hurricane John, 22–27 September 2024. Aircraft observations have been adjusted for elevation using 90%, 80%, and 75% adjustment factors for observations from 700 mb, 850 mb, and 925 mb, respectively. Advanced 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.

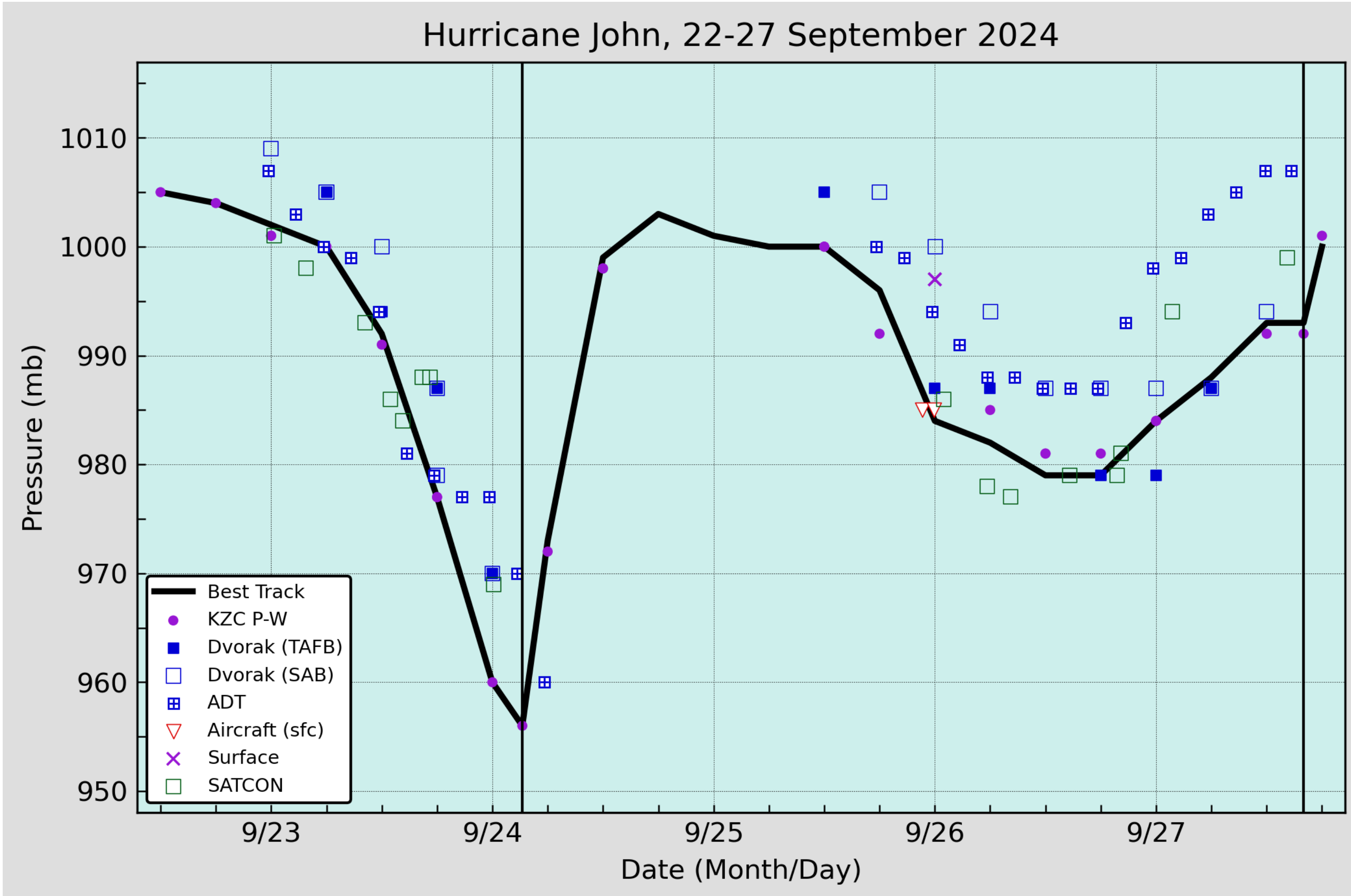

Figure 3. Selected pressure observations and best track minimum central pressure curve for Hurricane John, 22–27 September 2024. Advanced Dvorak Technique estimates represent the Current Intensity at the nominal observation time. SATCON intensity estimates are from the Cooperative Institute for Meteorological 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.

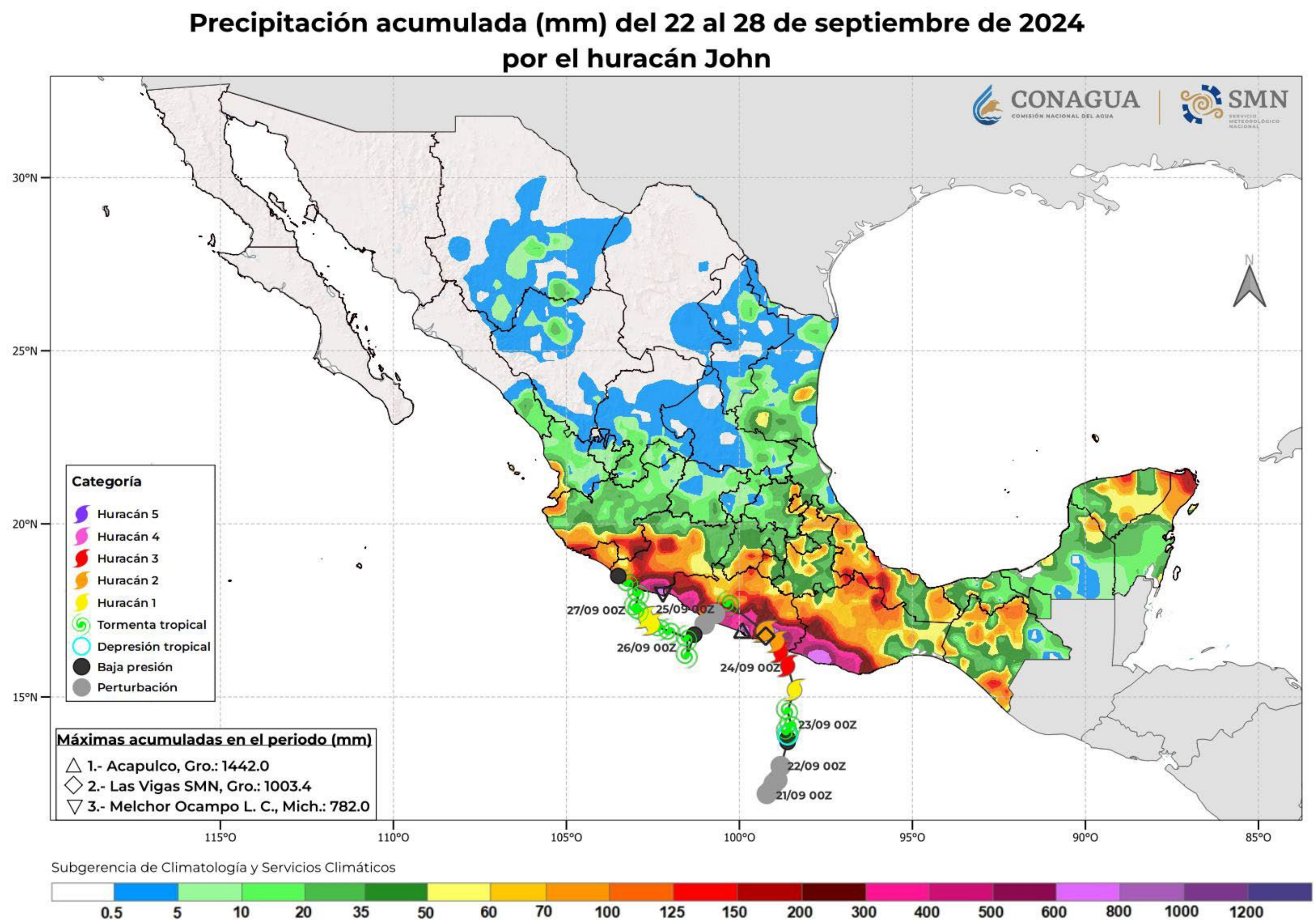

Figure 4. Rainfall totals for John in Mexico. Figure courtesy of CONAGUA. Note that not all of the rainfall shown was associated with John. The track is based on the NHC operational assessments.

Figure 5. Landslide in Acapulco, Mexico. Courtesy Reuters.

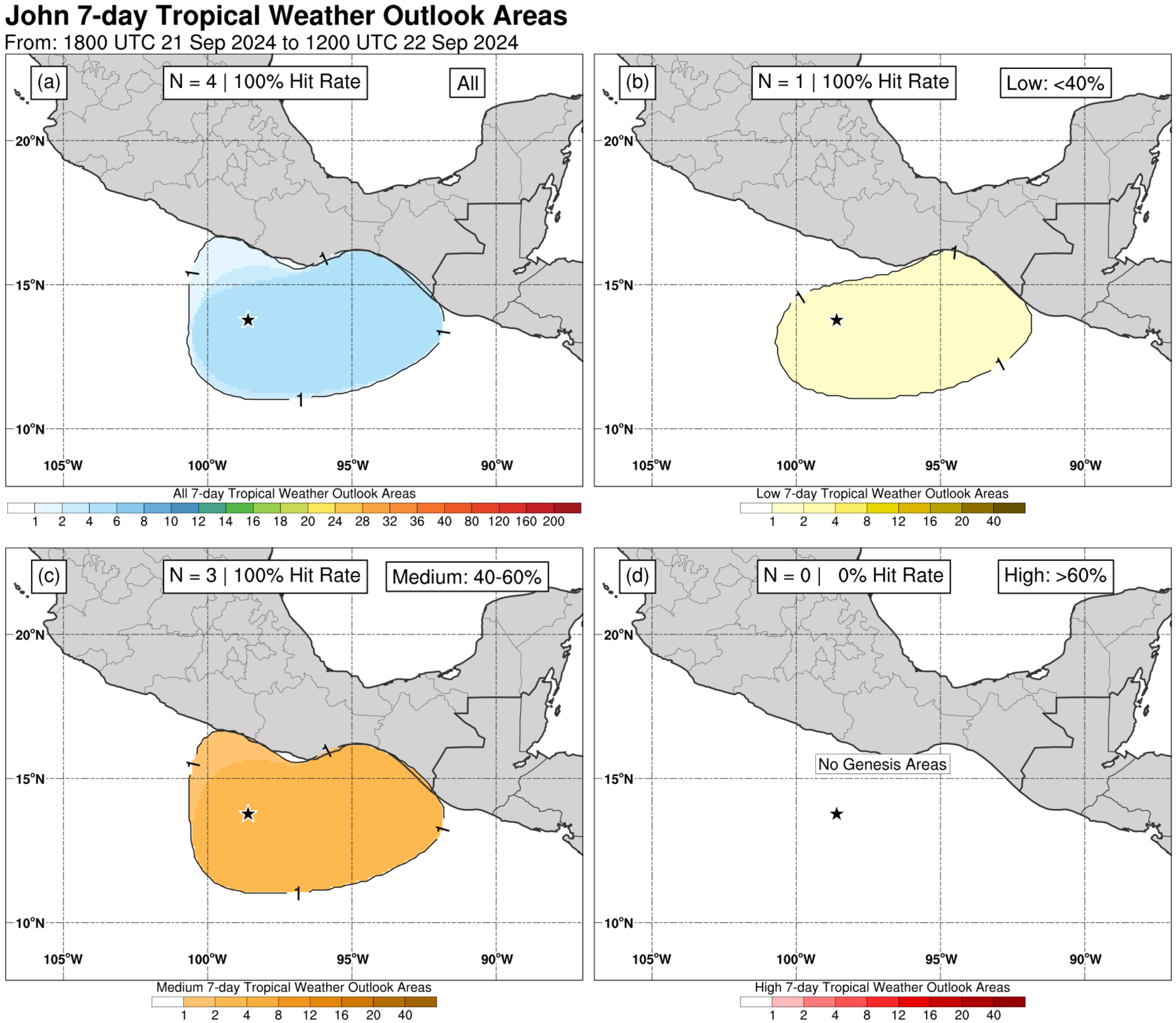

Figure 6a. Composites of 7-day tropical cyclone genesis areas depicted in NHC's Tropical Weather Outlooks prior to the first formation of John for (a) all probabilistic genesis categories, (b) the low (<40%) category, (c) medium (40–60%) category, and (d) high (>60%) category. The location of genesis is indicated by the black star.

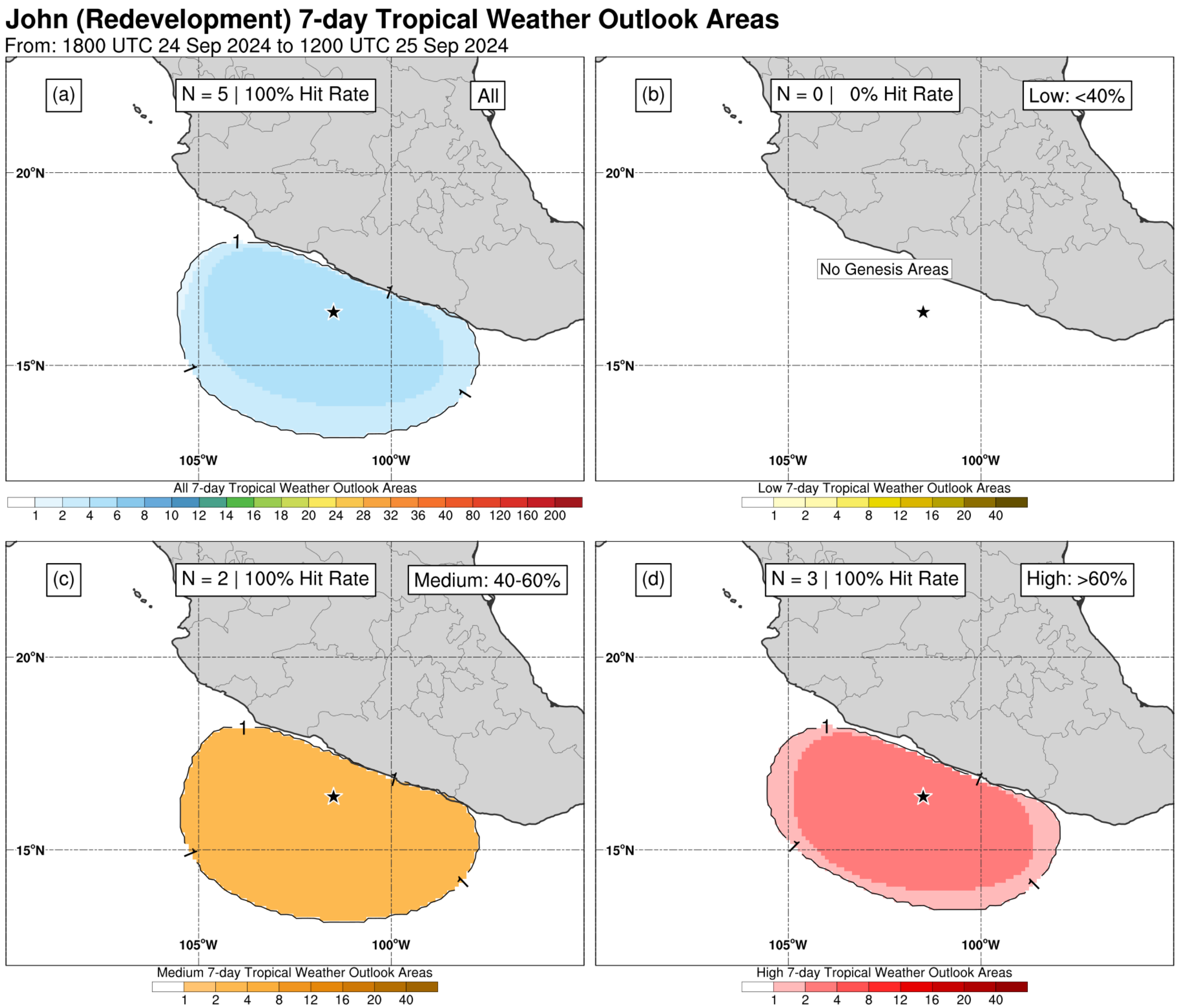

Figure 6b. Composites of 7-day tropical cyclone genesis areas depicted in NHC's Tropical Weather Outlooks prior to the second formation of John for (a) all probabilistic genesis categories, (b) the low (<40%) category, (c) medium (40–60%) category, and (d) high (>60%) category. The location of genesis is indicated by the black star.

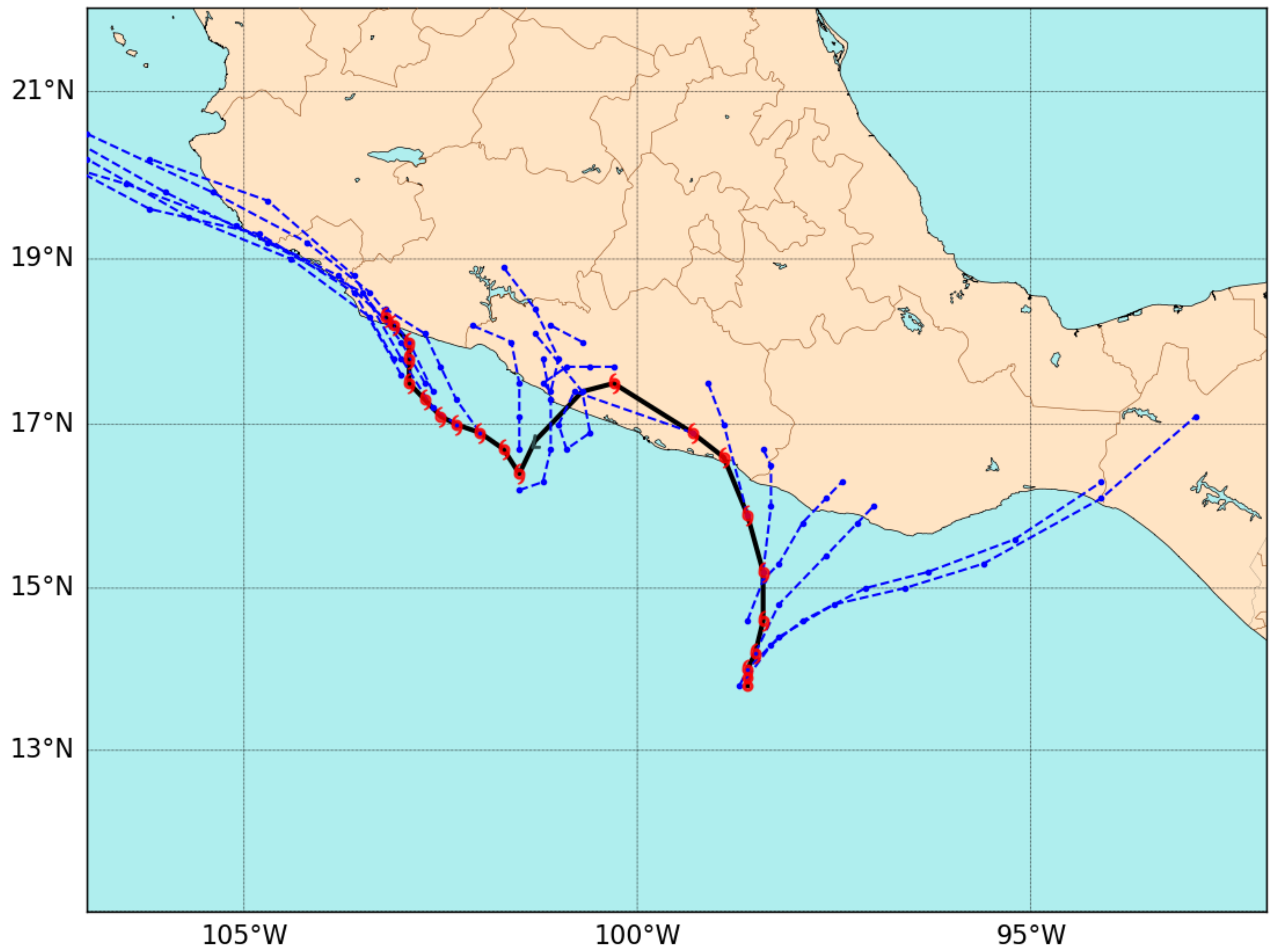

Figure 7. Official track forecasts (dashed blue lines) for John from 1800 UTC 22 September through 1200 UTC 27 September 2024. The best track is given by the solid black line with positions at 6-h intervals.

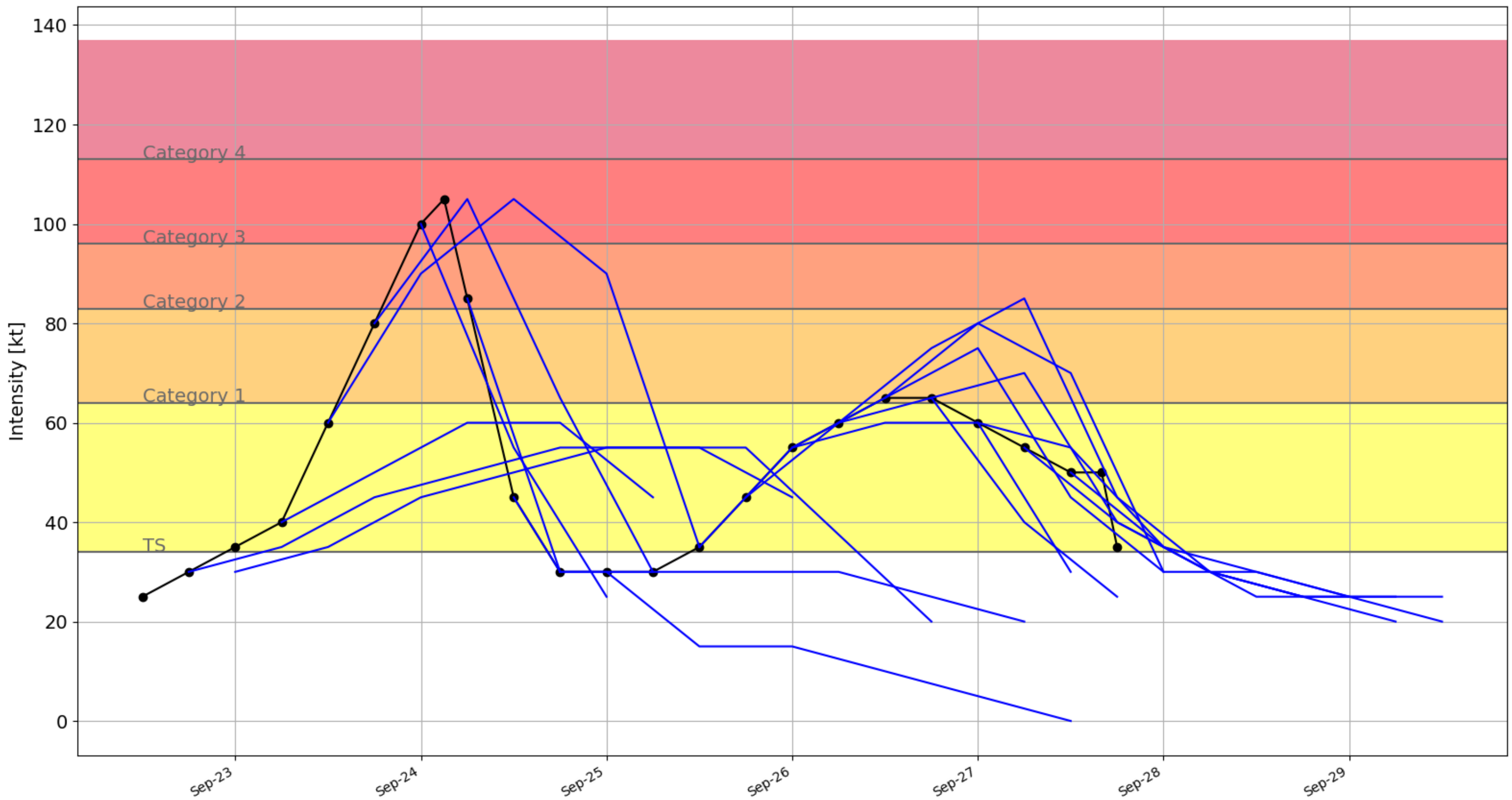

Figure 8. Official intensity forecasts (blue lines) for John from 1800 UTC 22 September through 1200 UTC 27 September 2024. The best track is given by the solid black line with intensities given at 6-h intervals.