NATIONAL HURRICANE CENTER
TROPICAL CYCLONE REPORT

HURRICANE LISA

(AL152022)

31 October–5 November 2022

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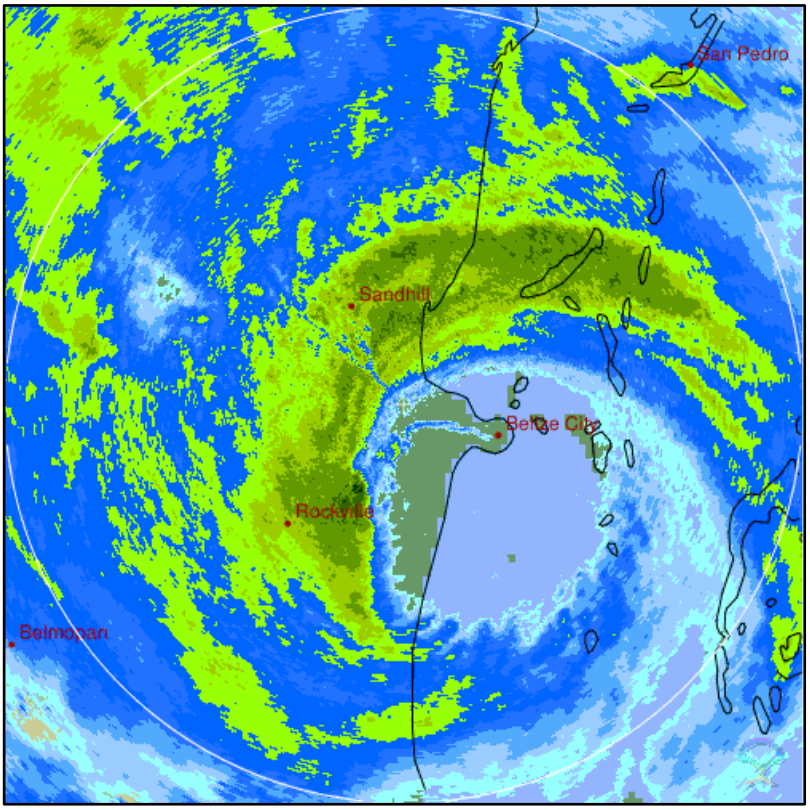
National Hurricane Center
14 March 2023



RADAR REFLECTIVITY IMAGE OF LISA AT 2138 UTC 2 NOV 2022, JUST AFTER MAKING LANDFALL IN BELIZE. IMAGE COURTESY OF THE BELIZE NATIONAL METEOROLOGICAL SERVICE

Hurricane Lisa formed over the western Caribbean Sea on 31 October, intensified gradually while it moved west-northwestward, and became a hurricane before making landfall in Belize on 2 November with an intensity of about 80 kt. Although Lisa caused about $100 million (USD) of damage in Belize, there were no reports of casualties.

Hurricane Lisa

31 OCTOBER–5 NOVEMBER 2022

SYNOPTIC HISTORY

The formation of Lisa can be traced first to a low-latitude, westward-moving tropical wave that departed the coast of west Africa early on 17 October. This system was accompanied by considerable cloudiness and occasional thunderstorms during the next several days, but westerly shear prevented any significant organization. The wave crossed the Lesser Antilles on 25 October and slowed down due to a weaker subtropical ridge originating from a large mid-level trough extending from the mid-latitudes into the central Caribbean Sea. The combination of the southern end of this trough moving eastward over the eastern Caribbean and the tropical wave led to the formation of a broad area of surface low pressure over the southeastern Caribbean Sea early on 28 October. Environmental conditions were initially hostile to formation due to plentiful mid-level dry air advected over the Caribbean Sea from the trough and westerly shear. The low-pressure area continued moving slowly westward and was located over the central Caribbean Sea by 30 October, with abundant convection near and east of the surface trough axis. By this time, the environment had become somewhat more conducive for genesis, but data from aircraft reconnaissance on that day showed the broad surface circulation was still elongated from northeast to southwest, albeit with gale-force winds. A more concentrated area of deep convection developed near the low early on 31 October, leading to the formation of a well-defined surface center by 1200 UTC that day and marking the formation of a tropical storm about 150 n mi south of Kingston, Jamaica. The "best track" chart of Lisa'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].

Lisa only slowly intensified for about a day after formation due to the continuation of westerly wind shear and dry air intrusions in the middle- and upper-levels of the circulation. The cyclone also turned west-northwestward beneath a mid-level ridge to the north. By midday 1 November, the small storm began to steadily strengthen, with a more symmetric appearance on satellite imagery and expanding outflow, seemingly linked to both a reduction in the dry air intrusions and a change to weaker southerly shear. Lisa became a hurricane by 1200 UTC 2 November, about 120 n mi east of the Belize coast, as measured by Hurricane Hunter aircraft data, and began to intensify quickly. An eye was noted on microwave and conventional radar images that afternoon, and Lisa reached a peak intensity of about 80 kt as it made landfall near the mouth of the Sibun River, about 10 n mi southwest of Belize City, around 2130 UTC 2 November (cover).

[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.

The hurricane weakened over Central America, becoming a tropical storm early on 3 November and then a tropical depression by 1200 UTC that day near the northwestern border of Guatemala with Mexico. The depression moved over land for almost 36 h, although the system kept 30-kt winds due to a portion of the circulation remaining over water, and it emerged over the extreme southern Gulf of Mexico just after 0600 UTC 4 November. While a large burst of convection formed near the depression's circulation over water, Lisa actually weakened that day due to increasing southwesterly shear and dry air entrainment. The depression turned northward and slowed down, and the circulation center became exposed by the evening. Little convection re-developed near the circulation overnight, and first-light visible images showed that the system degenerated into a trough of low pressure before 1200 UTC 5 November, about 90 n mi northeast of Veracruz, Mexico.

METEOROLOGICAL STATISTICS

Observations in Lisa (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 nine flights of the 53rd Weather Reconnaissance Squadron of the U.S. Air Force Reserve Command and four flights from the NOAA Aircraft Operations Center. 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 Lisa.

Selected surface observations from land stations are given in Table 2. There were no ship reports of tropical-storm-force winds while Lisa was a tropical cyclone.

Winds and Pressure

Lisa was intensifying quickly just prior to landfall at 2130 UTC 2 November. The last reconnaissance aircraft about 3 h before landfall had peak 78-kt flight-level winds at 700 mb, along with a maximum SFMR value near 71 kt at 1855 UTC 2 November and an extrapolated minimum pressure estimate of 993 mb. Operationally, a 75-kt landfall intensity was estimated, with a central pressure of 990 mb, based on the improvement in the eyewall radar structure and satellite imagery before landfall (after the plane departed). However, two surface observations just north of the landfall location reported pressures of ~987 mb without any calm conditions (wind speeds unknown), suggesting the hurricane had a minimum pressure of about 985 mb. Thus, the landfall intensity is raised slightly to 80 kt, which is close to the last TAFB satellite classification and an intensity based on the Knaff-Zehr-Courtney pressure-wind relationship (analysis marker in Fig. 2). These winds likely occurred in the northern eyewall, to the north of Belize City, based on radar imagery.

One sustained hurricane-force wind observation was reported in Lisa (Table 2), near the Port of Belize, about an hour after landfall in the eastern eyewall. The minimum central pressure recorded by any land-based instrument was 986.9 mb by Josh Morgerman (iCyclone) near Belize City, with the nearby Port of Belize station also reporting 987 mb at about 2135 UTC.

Storm Surge

The National Meteorological Service of Belize estimated that 3-5 ft of storm surge occurred over portions of the eastern Belize coast, leading to flooding especially in Belize City and Ladyville. No specific measurements are available, but this value is based on water marks on some properties and debris on a portion of the Phillip Goldson Highway near the seaside. Media reports also indicated that most of downtown Belize City was underwater at the height of the hurricane (Fig. 4).

Rainfall and Flooding

Although Lisa was a small hurricane, there were still reports of heavy rain. Up to 9 inches (~230 mm) of rain are estimated to have fallen in northeastern Belize (Fig. 5), and the peak measured amount was 8.43 inches (214 mm) at Altun Ha. This rainfall, in combination with the 3-5 ft of storm surge, caused flooding in the Belize District, especially in Belize City and Ladyville.

CASUALTY AND DAMAGE STATISTICS

Lisa caused significant damage in Belize. Several schools and businesses reported complete roof failure, along with damage to roads, power lines, a downed communication tower (Fig. 6), and a loss of the water supply for up to a day. Strong winds penetrated well inland with reports of fallen trees, power lines and roof damage even in parts of the Cayo District in western Belize. About 500 houses were completely destroyed, and approximately 5,000 houses were damaged in Belize due to flood water or high winds. Roughly 6,500 families were significantly affected by Lisa, and the total damage estimated for Belize is $100 million (USD) by the National Meteorological Service of Belize. There were no casualties or major injuries reported in association with Lisa.

FORECAST AND WARNING CRITIQUE

The genesis of Lisa was very well forecast at all time periods. The system was introduced in the Tropical Weather Outlook (TWO) at 1200 UTC 25 October with a low chance (<40%) of development over the next 5 days, 144 h before genesis occurred (Table 3). The system was assessed a 5-day medium (40-60%) chance of formation 114 h before development, and it reached the high category (>60%) 72 h before tropical cyclone formation took place. The 2-day probability of development reached the medium and high categories 48 and 24 h before formation, respectively. While the initial graphical 5-day genesis forecasts did not include the area in which Lisa actually formed (Fig. 7b), outlooks made in the medium and high periods completely covered the area where Lisa finally formed (Figs. 7c-d).

A verification of NHC official track forecasts for Lisa is given in Table 4a. Official track forecast errors (OFCL) were lower than the mean official errors for the previous 5-year period through 60 h, then larger at 72 and 96 h. The NHC predictions had a small southward bias for many forecast positions near and over Central America and Mexico (including landfall), perhaps due to the system becoming deeper as it neared Belize and feeling the effects of southerly winds at higher levels (Fig. 8). A homogeneous comparison of the official track errors with selected guidance models is given in Table 4b. The consensus models had the lowest errors for Lisa, below almost any deterministic model or the OFCL track forecast average. The HMON model had a good performance for this hurricane, while the ECMWF model generally had higher errors than the GFS model beyond 24 h.

A verification of NHC official intensity forecasts for Lisa is given in Table 5a. Official intensity errors were considerably below the mean official errors for the previous 5-year period at all forecast times. The OCD5 (climatology/persistence) errors were generally lower than their respective 5-year means, suggesting that Lisa's intensity was more predictable than for a typical Atlantic tropical cyclone over the past 5 years. A homogeneous comparison of the official intensity errors with selected guidance models is given in Table 5b. The NHC official intensity forecasts were some of the best performers overall, only occasionally outperformed by the HCCA corrected-consensus aid. Many of the models did slightly better than NHC at 72 h, perhaps due to the previously mentioned southward bias of the official forecasts, showing less weakening than which actually occurred over Central America.

Coastal watches and warnings issued in association with Lisa are shown in Table 6. Potential tropical cyclone advisories were initiated at 2100 UTC 30 October, about 15 h before this system became a tropical cyclone, concurrent with the issuance of Tropical Storm Watches for Jamaica and Grand Cayman.

Table 1. Best track for Hurricane Lisa, 31 October-5 November 2022.

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
30 / 1800	15.7	73.3	1005	35	low
31 / 0000	15.7	74.4	1005	35	"
31 / 0600	15.6	75.5	1005	35	"
31 / 1200	15.5	76.7	1003	35	tropical storm
31 / 1800	15.5	77.8	1002	40	"
01 / 0000	15.6	78.8	1002	40	"
01 / 0600	15.9	79.9	1003	40	"
01 / 1200	16.2	81.2	1002	45	"
01 / 1800	16.5	82.5	1001	50	"
02 / 0000	16.7	84.1	993	55	"
02 / 0600	17.0	85.5	992	60	"
02 / 1200	17.1	86.7	990	70	hurricane
02 / 1800	17.3	87.7	988	75	"
02 / 2130	17.4	88.3	985	80	"
03 / 0000	17.5	88.6	990	65	"
03 / 0600	17.7	89.6	998	45	tropical storm
03 / 1200	17.9	90.6	1008	30	tropical depression
03 / 1800	18.0	91.7	1008	30	"
04 / 0000	18.1	92.7	1008	30	"
04 / 0600	18.3	93.6	1008	30	"
04 / 1200	18.7	94.5	1008	25	"
04 / 1800	19.2	95.2	1008	25	"
05 / 0000	19.4	95.4	1008	25	"
05 / 0600	19.7	95.4	1008	25	"
05 / 1200					dissipated

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
02 / 2130	17.4	88.3	985	80	minimum pressure, maximum winds, and landfall near the mouth of the Sibun River, Belize

Table 2. Selected surface observations for Hurricane Lisa, 31 October- 5 November 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)	
Belize- official						
Belize Municipal Airstrip (17.52N 88.20W)	02/2130	990	02/2118	59 (1 min)	80	7.09
Port of Belize (17.47N 88.20W)	02/2135	987	02/2228	64 (1 min)	75	6.76
Phillip Goldson Intl Airport (WMO 78583) (17.54N 88.31W)	02/2205	993*	02/2100	43* (10 min)	69*	5.91
Altun Ha (17.76N 88.33W)						8.43
Belize- public reports						
Corozal District, Ambergris Key (17.97N 87.92W)			03/0250		47 (8 m)	7.92
San Pedro (17.91N 87.97W)			02/1850		40 (13 m)	
iCyclone, Josh Morgerman Belize City (17.49N 88.19W)	02/2134	986.9				

[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.
* Incomplete

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%)	72	144
Medium (40%-60%)	48	114
High (>60%)	24	72

Table 4a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) track forecast errors (n mi) for Hurricane Lisa, 31 October-5 November 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	**15.4**	**20.4**	**29.4**	**43.1**	**68.5**	96.5	170.9	
OCD5	30.6	58.9	81.6	106.3	174.4	279.7	324.2	
Forecasts	18	16	14	12	10	8	2	0
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 Lisa, 31 October-5 November 2022. Errors smaller than the NHC official forecast are shown in boldface type. The number of forecasts shown here is 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	15.4	20.4	29.4	43.1	79.3	93.7		
OCD5	30.6	58.9	81.6	106.3	198.3	278.0		
GFSI	20.0	30.0	29.9	44.0	86.9	101.8		
EMXI	18.2	24.8	40.8	58.5	88.3	104.8		
HWFI	23.9	28.1	39.6	49.6	90.1	123.7		
HMNI	22.2	29.6	33.2	48.5	**73.2**	**85.6**		
NVGI	30.3	44.8	67.2	89.1	115.9	117.6		
AEMI	19.1	28.1	36.8	61.4	**78.9**	104.3		
HCCA	16.9	22.4	30.7	**40.7**	**75.3**	**88.9**		
GFEX	17.8	24.2	33.1	48.7	85.3	95.7		
TVCA	16.6	**18.7**	**25.0**	**37.9**	**76.4**	95.6		
TVCX	16.0	**18.6**	**25.8**	**37.9**	**75.2**	**92.0**		
TVDG	16.6	**18.7**	**24.3**	**38.0**	**76.2**	93.8		
TABD	28.6	54.0	72.6	72.2	**46.2**	**86.4**		
TABM	22.6	36.1	55.5	83.2	137.8	183.6		
TABS	25.8	43.3	75.2	122.6	200.6	271.0		
Forecasts	18	16	14	12	8	7	0	0

Table 5a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) intensity forecast errors (kt) for Hurricane Lisa, 31 October-5 November 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	**3.6**	**2.5**	**5.4**	**6.2**	**3.5**	**5.0**	**2.5**	
OCD5	4.1	4.2	6.6	10.0	14.6	20.0	7.5	
Forecasts	18	16	14	12	10	8	2	0
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 Lisa, 31 October-5 November 2022. Errors smaller than the NHC official forecast are shown in boldface type. The number of official forecasts shown here can 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	3.6	2.5	5.4	6.2	3.5	5.0	5.0	
OCD5	4.1	4.2	6.6	10.0	14.6	20.0	7.0	
HWFI	5.2	6.3	8.3	10.7	11.7	9.2	**2.0**	
HMNI	6.1	7.9	10.1	9.3	6.5	5.1	5.0	
DSHP	3.7	4.6	7.4	8.0	3.5	**3.1**	**2.0**	
LGEM	3.6	4.7	7.9	9.1	5.6	**3.1**	**2.0**	
ICON	3.6	3.2	5.5	7.6	5.5	**3.5**	**0.0**	
IVCN	3.6	3.9	6.5	8.3	5.8	**4.0**	**0.0**	
IVDR	3.8	4.4	7.1	8.6	5.5	**4.6**	**2.0**	
HCCA	**3.4**	2.5	**5.1**	7.3	5.2	5.0	**2.0**	
GFSI	5.7	9.7	11.6	11.4	7.6	**4.9**	7.0	
EMXI	6.8	12.0	14.6	14.8	11.7	6.6	**3.0**	
Forecasts	18	16	14	12	10	8	1	0

Table 6. Watch and warning summary for Hurricane Lisa, 31 October–5 November 2022.

Date/Time (UTC)	Action	Location
30 / 2100	Tropical Storm Watch issued	Jamaica
30 / 2100	Tropical Storm Watch issued	Grand Cayman
31 / 1500	Tropical Storm Watch discontinued	Grand Cayman
31 / 2100	Tropical Storm Watch issued	Honduras
31 / 2100	Tropical Storm Watch issued	Guatemala
31 / 2100	Tropical Storm Watch issued	Chetumal to Punta Herrero
31 / 2100	Tropical Storm Warning issued	Bay Islands of Honduras
31 / 2100	Hurricane Watch issued	Bay Islands of Honduras
31 / 2100	Hurricane Watch issued	Puerto Barrios to Chetumal
1 / 0300	Tropical Storm Watch discontinued	Jamaica
1 / 0300	Tropical Storm Watch discontinued	Honduras
1 / 0300	Tropical Storm Watch issued	Punta Castilla to Honduras/Guatemala Border
1 / 0300	Tropical Storm Warning issued	Nicaragua/Honduras Border to Punta Castilla
1 / 0900	Tropical Storm Watch discontinued	Punta Castilla to Honduras/Guatemala Border
1 / 0900	Tropical Storm Warning modified to	Nicaragua/Honduras Border to Honduras/Guatemala Border
1 / 1500	Tropical Storm Watch changed to Tropical Storm Warning	Guatemala
1 / 1500	Tropical Storm Watch changed to Tropical Storm Warning	Chetumal to Punta Herrero
1 / 1500	Tropical Storm Warning changed to Hurricane Warning	Bay Islands of Honduras
1 / 1500	Hurricane Watch discontinued	Bay Islands of Honduras
1 / 1500	Hurricane Watch modified to	Puerto Barrios to Puerto Costa Maya
1 / 1800	Hurricane Watch modified to	Chetumal to Puerto Costa Maya
1 / 1800	Hurricane Warning issued	Puerto Barrios to Chetumal

Date/Time (UTC)	Action	Location
2 / 0300	Tropical Storm Warning discontinued	Chetumal to Punta Herrero
2 / 0300	Tropical Storm Warning issued	Puerto Costa Maya to Punta Allen
2 / 0300	Hurricane Watch discontinued	All
2 / 0300	Hurricane Warning modified to	Puerto Barrios to Puerto Costa Maya
2 / 1500	Hurricane Warning changed to Tropical Storm Warning	Bay Islands of Honduras
2 / 1500	Tropical Storm Warning modified to	Punta Castilla to Honduras/Guatemala Border
2 / 2100	Tropical Storm Warning discontinued	Bay Islands of Honduras
2 / 2100	Tropical Storm Warning discontinued	Punta Castilla to Honduras/Guatemala Border
3 / 0000	Tropical Storm Warning discontinued	Guatemala
3 / 0300	Hurricane Warning changed to Tropical Storm Warning	Puerto Barrios to Puerto Costa Maya
3 / 0900	Tropical Storm Warning discontinued	All

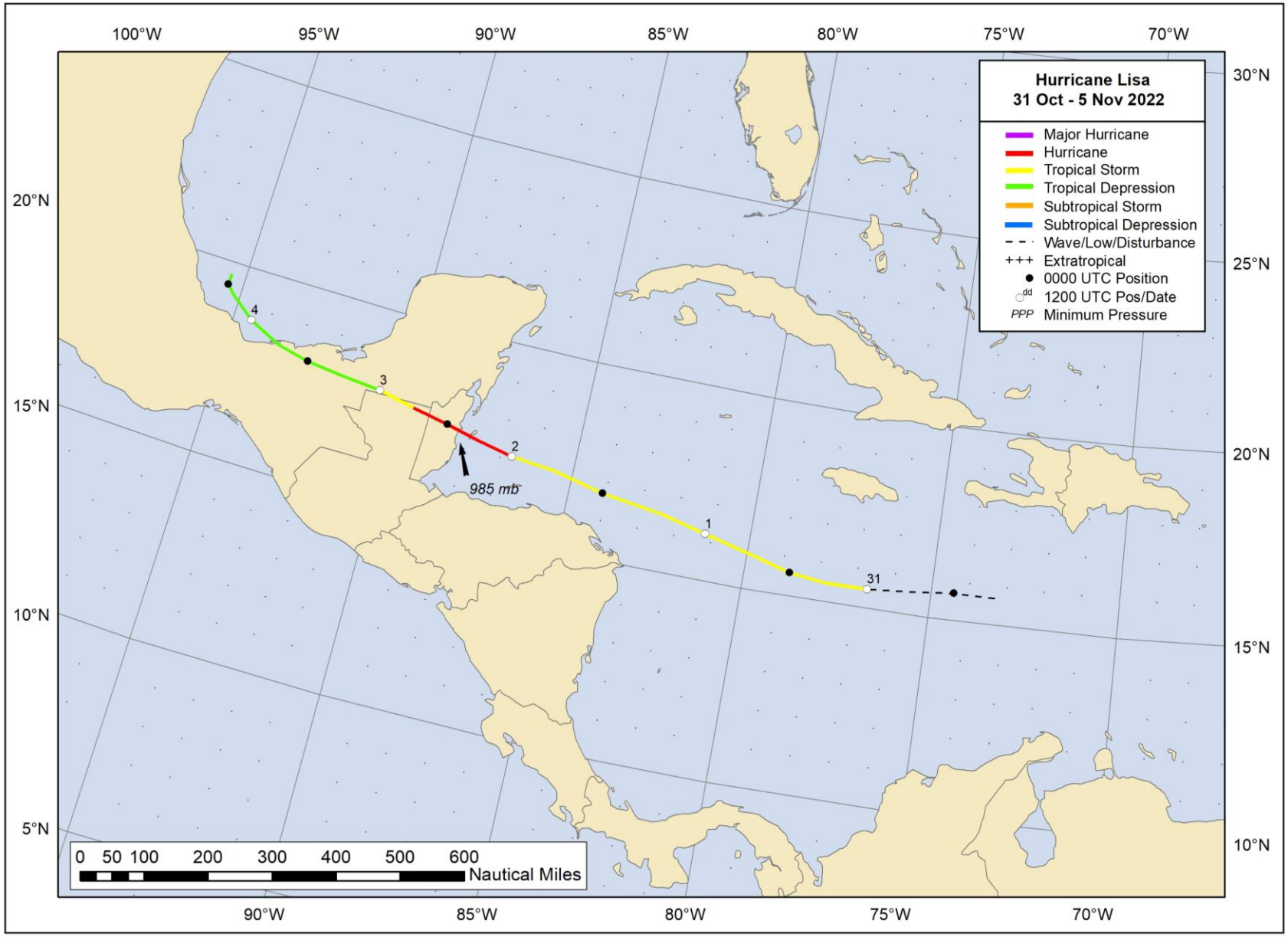


Figure 1. Best track positions for Hurricane Lisa, 31 October- 5 November 2022.

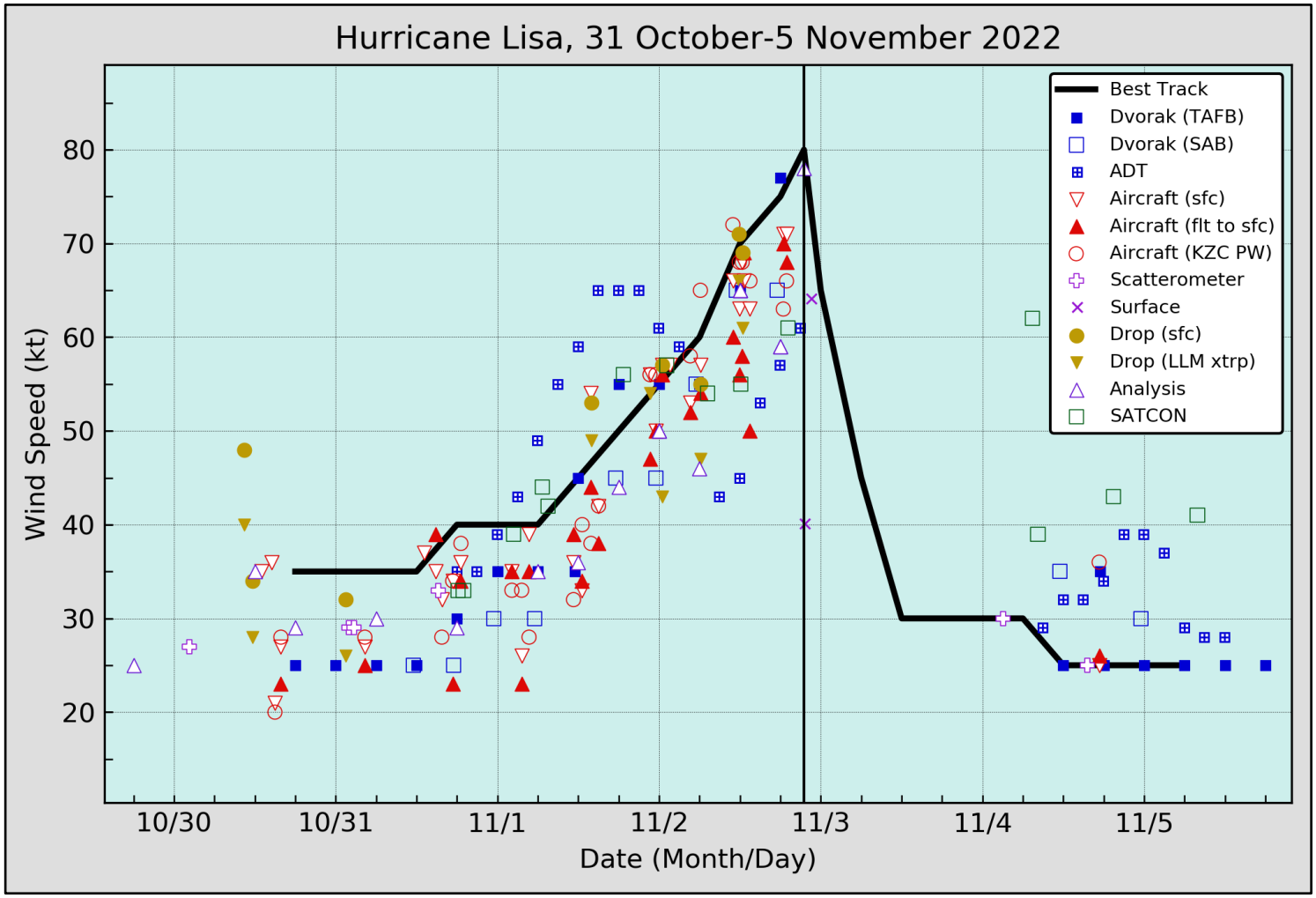


Figure 2. Selected wind observations and best track maximum sustained surface wind speed curve for Hurricane Lisa. Aircraft observations have been adjusted for elevation using 90%, 80%, 80%, and 75% adjustment factors for observations from 700 mb, 850 mb, 1500 ft, and 925 mb, respectively. Dropwindsonde 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 the solid line denotes landfall.

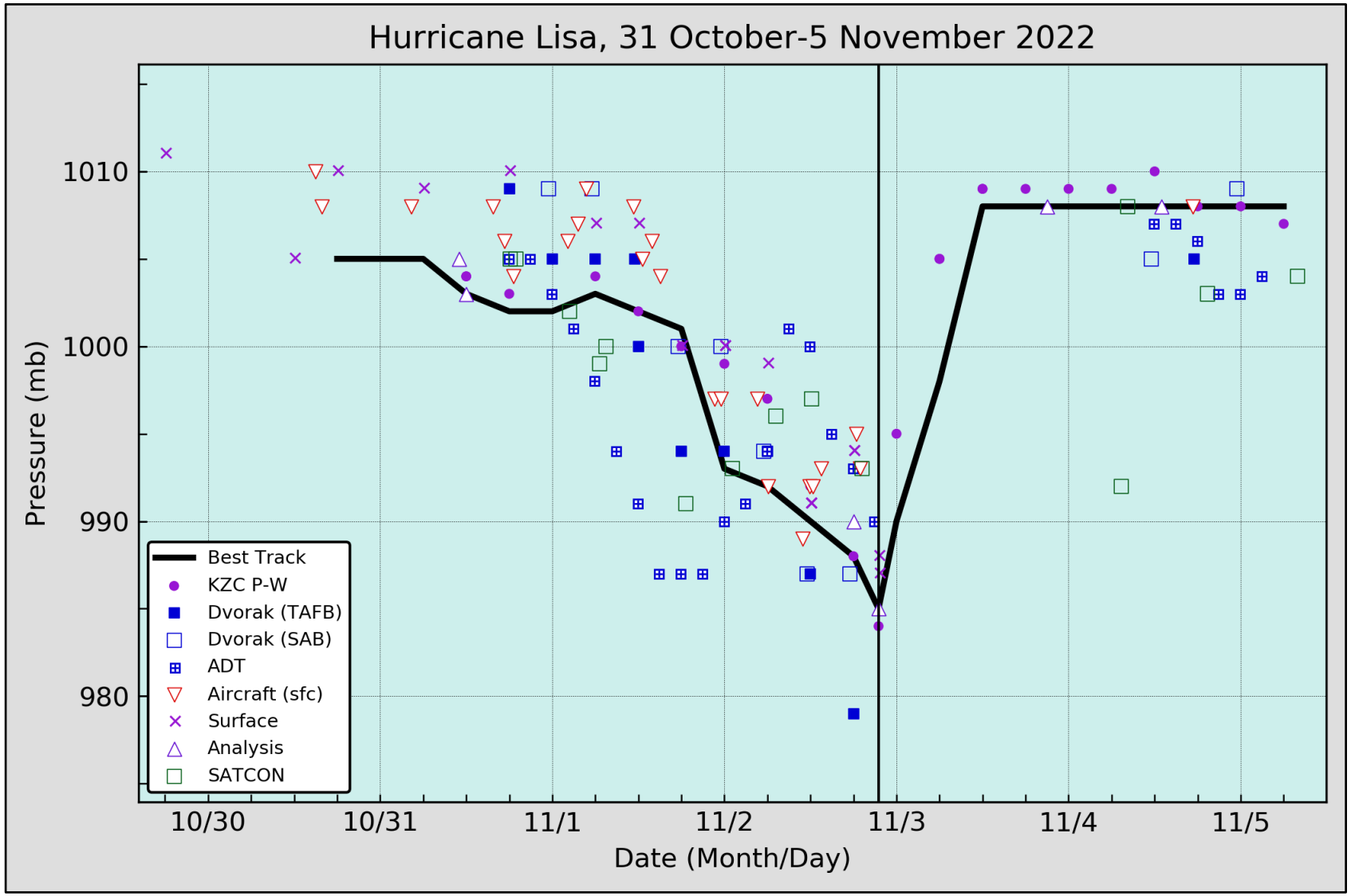


Figure 3. Selected pressure observations and best track minimum central pressure curve for Hurricane Lisa. Advanced Dvorak Technique estimates represent the Current Intensity at the nominal observation time. SATCON intensity estimates are from the Cooperative Institute for Meteorological Satellite Studies. KZC P-W refers to pressure estimates derived using the Knaff-Zehr-Courtney pressure-wind relationship. Dashed vertical lines correspond to 0000 UTC, and the solid line denotes landfall.

Figure 4. Storm surge in downtown Belize City on the late afternoon of 2 November. Image courtesy of Josh Morgerman (iCyclone).

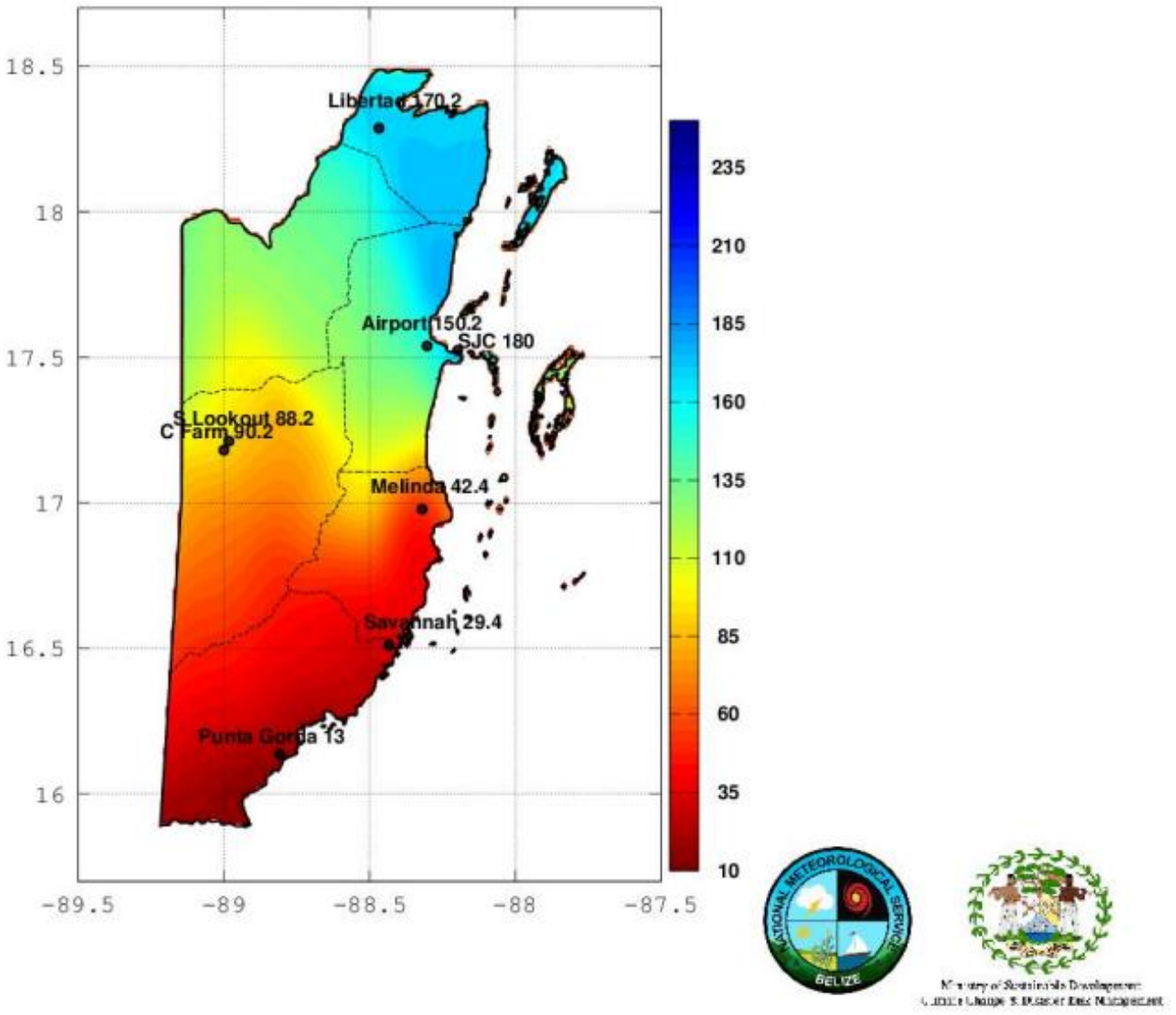


Figure 5. Rainfall totals (mm) in Belize from 1-3 November 2022 associated with Lisa. Image courtesy of the National Meteorological Service of Belize.

Figure 6. A downed metal communication tower in downtown Belize City. Image courtesy of Josh Morgerman (iCyclone).

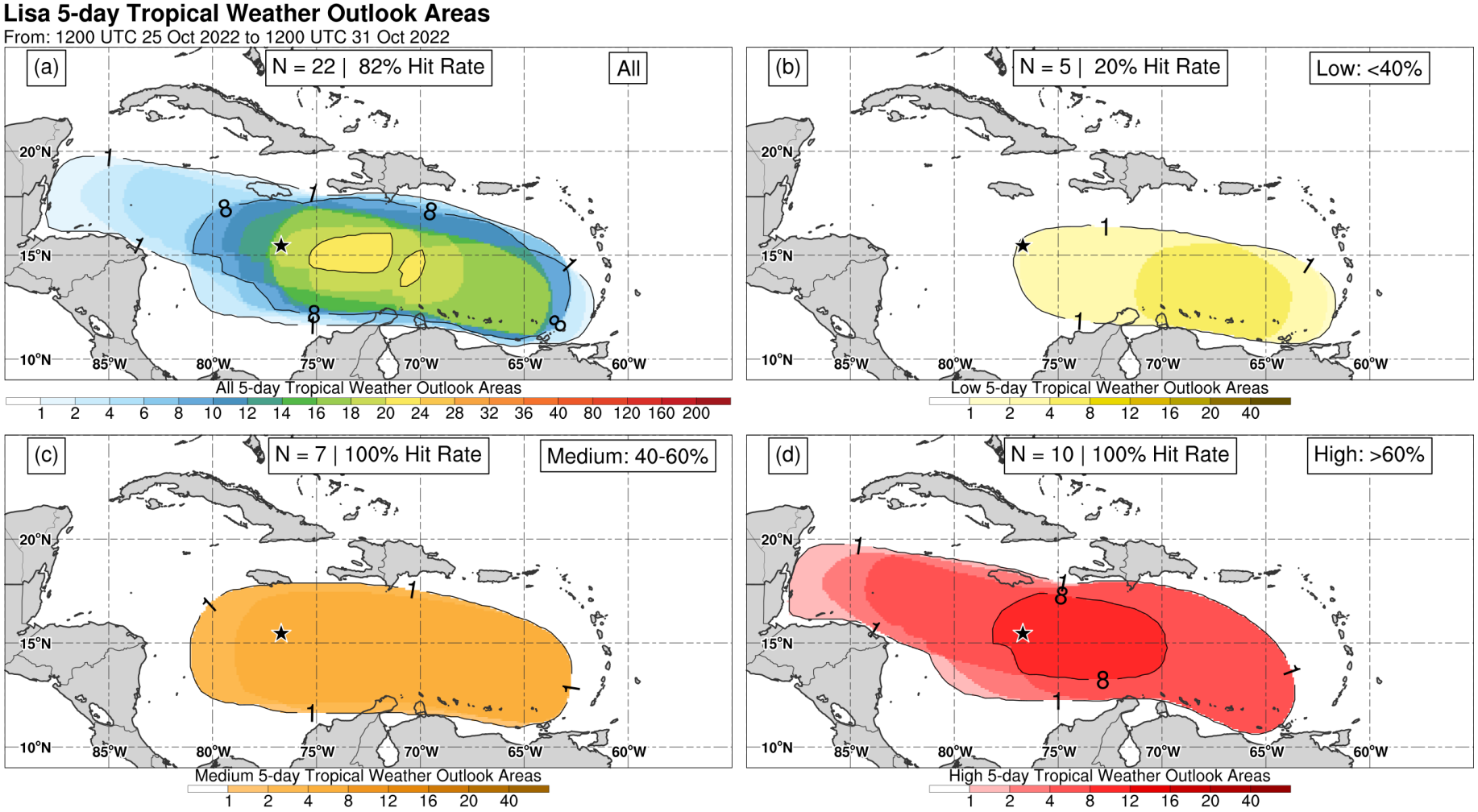


Figure 7. Composites of 5-day tropical cyclone genesis areas depicted in NHC's Tropical Weather Outlooks prior to the formation of Hurricane Lisa for (a) all probabilistic genesis categories, (b) the low (<40%) category, (c) medium (40–60%) category, and (d) high (>60%) category. Lisa's location of genesis is indicated by the black star.

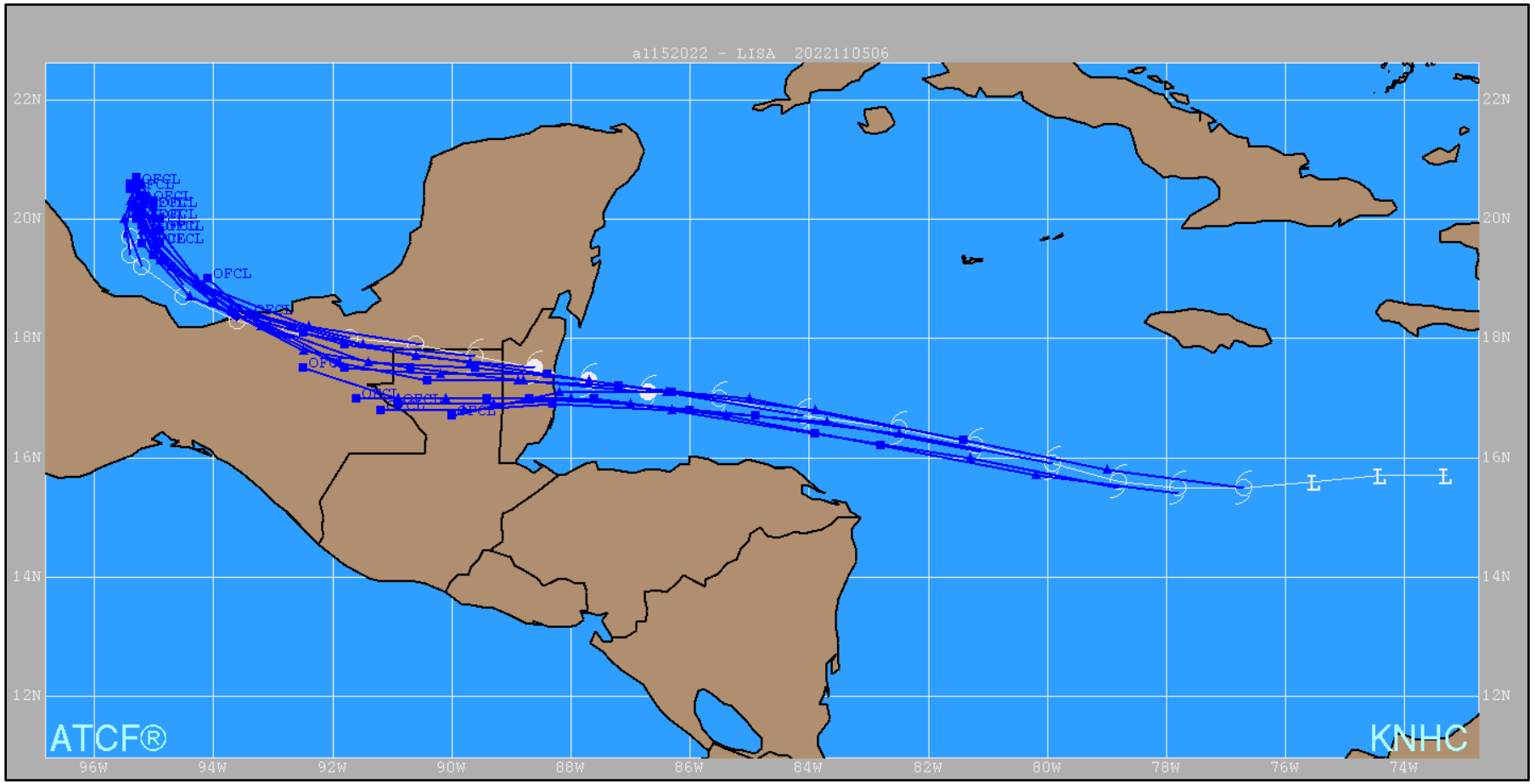


Figure 8. NHC 72-h track forecasts (blue lines) for Lisa after genesis (not including potential tropical cyclone forecasts). The verifying positions are shown in white.