NATIONAL HURRICANE CENTER TROPICAL CYCLONE REPORT

HURRICANE NANA

(AL162020)

1–3 September 2020

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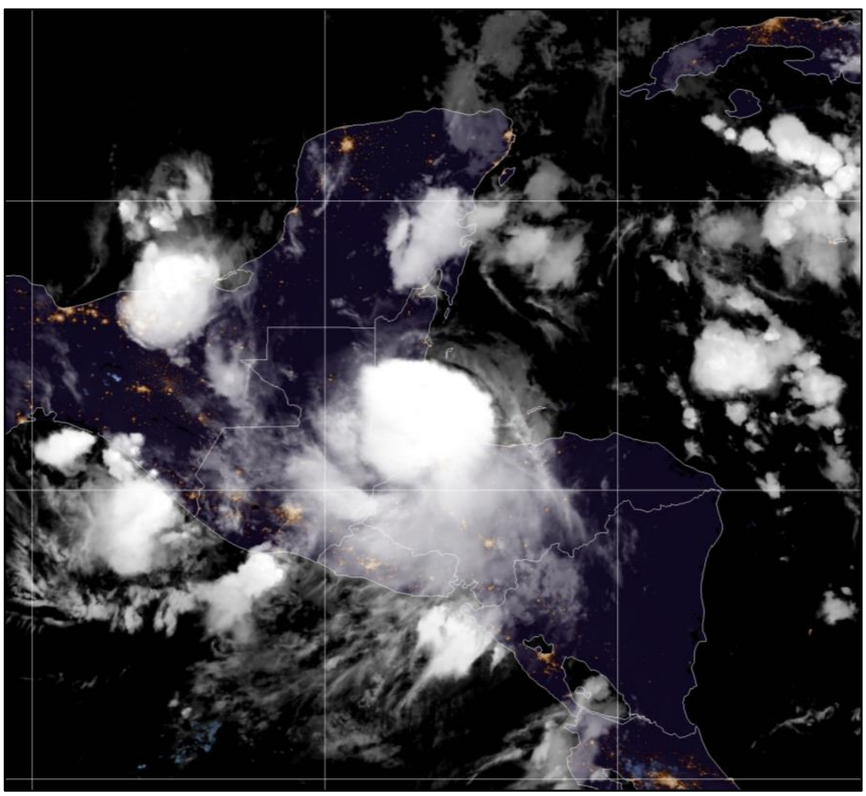

GOES-16 GEOCOLOR SATELLITE IMAGE OF HURRICANE NANA AT 0600 UTC 3 SEPTEMBER 2020 AROUND THE TIME IT MADE LANDFALL IN BELIZE.

Nana was a category 1 hurricane (on the Saffir-Simpson Hurricane Wind Scale) that made landfall along a sparsely populated stretch of the coast of Belize, about 45 n mi south of Belize City. There were no reports of fatalities or injuries associated with Nana, and damage was mostly confined to agricultural losses.

Hurricane Nana

1–3 SEPTEMBER 2020

SYNOPTIC HISTORY

Nana formed from a tropical wave that departed the west coast of Africa late on 23 August. The wave moved quickly westward across the tropical Atlantic over the next couple of days, producing a noticeable growth in deep convection along the Intertropical Convergence Zone. Early on 27 August, shower and thunderstorm activity increased further in association with the wave when it was located about midway between the Cabo Verde Islands and the Lesser Antilles, which resulted in some amplification of the wave. The system continued to produce disorganized showers and thunderstorms while it moved westward across the western portion of the tropical Atlantic, reaching the Lesser Antilles on 30 August. After entering the far eastern Caribbean Sea later that day, shower and thunderstorm activity increased significantly, but surface observations and satellite-derived wind data showed that the system remained an open wave. This increase in deep convection resulted in the development of a fairly well-defined mid-level circulation that moved across the east-central Caribbean Sea. After briefly waning early on 31 August, deep convection redeveloped and became quite concentrated near the mid-level circulation center later that day. By 0600 UTC 1 September, the system acquired a closed surface circulation and sufficiently organized deep convection to be classified as a tropical cyclone when it was located about 155 n mi southeast of Kingston, Jamaica. Satellite wind data from around that time indicated that the system was already producing tropical-storm-force winds, making the cyclone a tropical storm at the time of formation. The "best track" chart of Nana'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].

After formation, the tropical storm continued to strengthen while it was located within an area of moderate northeasterly vertical wind shear and the deep warm waters of the northwestern Caribbean Sea. Nana initially moved west-northwestward to the south of a subtropical ridge that extended from the western Atlantic across Florida. Aircraft reconnaissance data during the late morning and afternoon of 1 September indicated that Nana reached an intensity of 50 kt by 1800 UTC that day, but the tropical-storm-force wind field was quite small, extending no more than 60 n mi from the center. Shortly thereafter, Nana turned westward when the aforementioned ridge built westward across the eastern Gulf of Mexico. Moderate northeasterly shear and intrusions of dry mid-level air prevented further strengthening over the next 24 h as Nana passed about 135 n mi south of the Cayman Islands.

On 2 September, the shear briefly caused the center to become exposed to the northeast of the primary convective mass; however, by late that day the shear began to abate, and deep

[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.

convection began to increase over the low-level center. This resulted in strengthening, and Nana reached an intensity of 60 kt by 0000 UTC 3 September when it was located about 85 n mi east-southeast of Belize City, Belize. Around this time, the ridge over the Gulf of Mexico became oriented east-northeastward to west-southwestward, and this caused Nana to turn west-southwestward. Data from an Air Force Reserve Hurricane Hunter aircraft showed that Nana continued to strengthen and attained hurricane status by 0300 UTC 3 September. A few hours later, the hurricane made landfall with estimated maximum winds of 65 kt along a sparsely populated stretch of the coastline of Belize near Sittee Point, about 45 n mi south of Belize City. Nana continued to move west-southwestward, and the cyclone rapidly weakened after landfall. The center of the tropical storm moved over Guatemala by 1200 UTC 3 September, and Nana weakened to a tropical depression near the Guatemala/Mexico border by 1800 UTC that day. The depression degenerated into a post-tropical remnant low by 0000 UTC 4 September, and the low-level center dissipated over the mountainous terrain of western Guatemala shortly thereafter. The remnants of Nana moved over the eastern Pacific Ocean near the Gulf of Tehuantepec the next day and were responsible for the formation of eastern Pacific basin Tropical Storm Julio on 5 September.

METEOROLOGICAL STATISTICS

Observations in Nana (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), 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 five flights of the 53rd Weather Reconnaissance Squadron of the U.S. Air Force Reserve Command and one flight of the NOAA WD-P3 Hurricane Hunter aircraft from the NOAA Aircraft Operations Center. A total of 16 center fixes were provided by reconnaissance aircraft during Nana's lifecycle. 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 Nana.

Selected surface observations from land stations and data buoys are given in Table 2.

There was one ship report of winds of tropical-storm force or greater in association with Nana. The ship *British Sponsor* (call sign MAOR4) reported 35-kt winds just northeast of Nana's center at 0800 UTC 1 September.

Winds and Pressure

Aircraft reconnaissance data were crucial in determining that Nana reached hurricane strength before reaching the coast of Belize. The hurricane's estimated peak intensity of 65 kt is based on a peak 700-mb flight-level wind of 72 kt measured by an Air Force Reserve reconnaissance aircraft a few hours before the storm's landfall. Using the standard 700-mb flight-level to surface wind reduction for that peak wind yields an estimated peak surface wind of 65 kt.

The aircraft also measured a peak SFMR wind of 62 kt during the flight. The aircraft did not measure any stronger winds during its final two center penetrations on that flight, and Nana's landfall intensity is estimated to have been 65 kt. Several dropwindsondes released by the aircraft supported a minimum pressure of around 994 mb in the final hours before landfall.

Nana made landfall along a sparsely populated stretch of coastline in Belize, and given the small core of the cyclone it is not surprising that there were no reports of hurricane-force winds at any observing sites. The strongest winds measured in Belize were on one of the offshore islands, Carrie Bow Cay, where sustained winds of 53 kt and a gust to 65 kt were observed (Table 2). That observing site reported a minimum pressure of 997.5 mb when the center passed just south of that location around 0530 UTC. Farther north along the coast of Belize, a sustained wind of 33 kt and a gust to 41 kt was reported at Belize City. There were no reports received of tropical-storm-force winds along the coast of Honduras or the east coast of Yucatan peninsula of Mexico.

Storm Surge

Although it is likely that some inundation from storm surge occurred near and to the north of where Nana made landfall in Belize, the National Meteorological Service of Belize did not report any significant storm surge. High waves near Placencia, Belize, caused minor damage to some piers.

Rainfall and Flooding

A swath of 3 to 5 inches (76 to 127 mm) of rainfall was reported over the southern portions of Belize to the south of Nana's track within the Toledo district. The displacement of the heaviest rainfall to the south of the track was due to light-to-moderate northerly shear that caused the deep convection to be displaced to the south of the center. The highest rainfall totals were 5.67 in (144 mm) at Corazon, 4.20 in (106.6 mm) at Blue Creek, and 3.87 in (98.4 mm) at PG Agric.

Heavy rainfall spread inland over portions of Guatemala and southeastern Mexico in association with Nana. In Guatemala, 5 to 7 inches (127 to 178 mm) of rainfall was reported near the Pacific coast of that country as the center of Nana passed northwest of that area. The maximum rainfall totals in Guatemala were 7.20 in (183 mm) at Trinidad, 6.22 in (158.1 mm) at Ingenio Concepión, and 5.84 in (148.4 mm) at Costa Brava.

CASUALTY AND DAMAGE STATISTICS

There were no reports of casualties or injuries associated with Nana. Damage to infrastructure was mostly minor, but there were significant agriculture losses in the region. The National Meteorological Service of Belize reported that wind damage was limited to the immediate area of landfall which was just south of Hopkins Village in the Stann Creek district. In that area, there was some roof damage and limited structural damage to residences in the village. Media reports indicate that more than 4,000 people rode out the storm in government shelters. Reports also indicate that strong winds resulted in significant damage to banana, plantain, avocado, corn, and citrus crops within the region. As of this writing, no monetary damage estimates have been received from Belize.

There were no reports of damage in Guatemala associated with Nana.

FORECAST AND WARNING CRITIQUE

The genesis of Nana was not particularly well forecast. The wave from which Nana developed was first introduced into the Tropical Weather Outlook with a low chance (<40%) of development within the next 2- and 5-days at 1800 UTC 27 August, about 4.5 days before genesis (Table 3). The 2- and 5-day probabilities remained in the low category until a Special Tropical Weather Outlook was issued around 1600 UTC 30 August to raise the development chances to the medium category (40–60%) for both time ranges. A couple of hours later, the development chances were raised to the high category (>60%), which provided about 36 h lead time for the formation of the tropical cyclone. The short lead time of the medium and high chances of genesis were the result of poor dynamical model forecasts that initially showed little development of the system over the northwestern Caribbean Sea.

A verification of NHC official track forecasts for Nana is given in Table 4a. Official forecast track errors were near the long-term mean at 12 and 24 h, but larger than the 5-year mean at 36 and 48 h, albeit for relatively few verifying forecasts due to Nana's short lifespan as a tropical cyclone. A homogeneous comparison of the official track errors with selected guidance models is given in Table 4b. The NHC track forecast performed better than the GFSI, but was bested by the EMXI, HWFI, and HMNI at most verifying lead times. The official forecast performed as well as, or slightly better than, most of the track consensus aids except for the TVCX (which double weights the EMXI) from 24 to 48 h, and the HFIP corrected consensus model (HCCA) at 48 h. The NHC forecasts generally exhibited smaller cross-track (left-right) than along-track (speed) errors for Nana. The official forecasts initially predicted a slower forward motion than what occurred, but consistently showed landfall in southern Belize (Fig. 4).

A verification of NHC official intensity forecasts for Nana is given in Table 5a. Official forecast intensity errors were generally comparable to the mean official errors for the previous 5-yr period, except at 48 h where it was larger than the 5-year mean. A homogeneous comparison of the official intensity errors with selected guidance models is given in Table 5b. The NHC intensity forecast errors were comparable to the various consensus aids at 12 and 24 h, but had larger errors than most of the intensity models at 48 h, albeit for only two verifying forecasts. The NHC forecasts accurately predicted that Nana would reach hurricane strength before landfall in Belize beginning with the second forecast advisory; however, since the official forecasts indicated that Nana would move at a slower forward speed, the hurricane made landfall and weakened inland sooner than anticipated, which led to a high bias of the 48-h intensity forecasts.

Watches and warnings associated with Nana are given in Table 6. The government of Belize issued a Hurricane Watch for a portion of the coast of Belize at 2100 UTC 1 September and upgraded a portion of the watch to a Hurricane Warning at 1500 UTC 2 September.

Acknowledgements

The National Meteorological Service of Belize provided data and damage information for Belize that was useful in Nana's post-analysis and the damage section of this report. The National Institute of Seismology, Volcanology, and Meteorology and Hydrology of Guatemala provided a summary of rainfall information for that country.

Table 1. Best track for Hurricane Nana, 1–3 September 2020.

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
01 / 0600	15.9	75.2	1006	35	tropical storm
01 / 1200	16.3	76.8	1004	40	"
01 / 1800	16.7	78.4	1002	50	"
02 / 0000	17.0	80.1	1000	50	"
02 / 0600	17.0	81.9	998	50	"
02 / 1200	17.1	83.7	998	50	"
02 / 1800	17.1	85.3	998	50	"
03 / 0000	17.0	86.8	994	60	"
03 / 0300	16.9	87.5	994	65	hurricane
03 / 0600	16.8	88.3	994	65	"
03 / 1200	16.4	89.6	1001	45	tropical storm
03 / 1800	16.1	90.5	1005	30	tropical depression
04 / 0000	15.8	91.4	1007	20	low
04 / 0600					dissipated
03 / 0300	16.9	87.5	994	65	minimum pressure and maximum winds
03 / 0600	16.8	88.3	994	65	landfall near Sittee Point, Belize

Table 2. Selected surface observations for Hurricane Nana, 1–3 September 2020.

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)	
Belize						
Carrie Bow Cay	03/0530	997.5	03/0542	53	65	1.83
Baldy Beacon			03/0600	44	51	0.90
Belize City			03/0500	33	41	0.69
Dangriga			03/0535	32	46	0.51
Placencia			03/0525		43	2.12
Corazon						5.67
Blue Creek						4.20
PG Agric						3.87
Bella Vista						2.75
Golden Stream						1.41
PGIA						0.66
Guatemala						
Trinidad						7.20
Ingenio Concepcion						6.22
Costa Brava						5.84
Puyumate						5.80
Cenizas						5.59
Concepcion						5.56
Proecto Jicaro						4.01
San Jose Airport						3.46
Machaquila						2.13
Poptuin						1.76
Offshore						
NOAA Buoys						
42057 (16.9°N 81.4°W)	02/430	1002.7	02/0530	31 (3.8m, 1 min)	39	

[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%)	108	108
Medium (40%-60%)	38	38
High (>60%)	36	36

Table 4a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) track forecast errors (n mi) for Hurricane Nana, 1–3 September 2020. 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	24.8	45.6	67.4	104.1				
OCD5	25.6	65.4	134.7	231.0				
Forecasts	8	6	4	2				
OFCL (2015-19)	24.1	36.9	49.6	65.1	80.7	96.3	133.2	171.6
OCD5 (2015-19)	44.7	96.1	156.3	217.4	273.9	330.3	431.5	511.9

Table 4b. Homogeneous comparison of selected track forecast guidance models (in n mi) for Hurricane Nana 1–3 September 2020. 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	25.3	45.6	67.4	104.1				
OCD5	28.0	65.4	134.7	231.0				
GFSI	48.7	94.5	163.7	283.5				
HMNI	29.5	**41.5**	**63.2**	**101.5**				
HWFI	26.5	**33.9**	**42.4**	**86.3**				
EMXI	**23.5**	**41.9**	**53.2**	**50.9**				
HCCA	26.4	46.2	69.0	**96.3**				
TVCX	28.2	**44.8**	**65.8**	**102.6**				
GFEX	33.8	63.4	97.8	150.2				
TVCA	29.7	48.6	72.3	109.6				
TVDG	30.4	52.6	83.1	130.1				
TABD	**23.3**	54.4	90.4	133.3				
TABM	**21.9**	**44.2**	**66.4**	**70.7**				
TABS	25.3	56.2	89.1	**102.5**				
Forecasts	7	6	4	2				

Table 5a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) intensity forecast errors (kt) for Hurricane Nana, 1–3 September 2020. 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	5.6	**7.5**	10.0	17.5				
OCD5	6.8	5.0	7.5	16.0				
Forecasts	8	6	4	2				
OFCL (2015-19)	5.2	7.7	9.4	10.7	11.9	13.0	14.4	15.5
OCD5 (2015-19)	6.8	10.8	14.1	17.0	18.8	20.6	22.5	24.6

Table 5b. Homogeneous comparison of selected intensity forecast guidance models (in kt) for Hurricane Nana, 1–3 September 2020. 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	4.3	7.5	10.0	17.5				
OCD5	6.4	**5.0**	**7.5**	**16.0**				
HMNI	8.0	10.0	11.8	**6.0**				
HWFI	7.9	10.3	10.8	**11.0**				
DSHP	6.4	**6.8**	12.0	**16.0**				
LGEM	7.1	**6.7**	13.2	18.0				
ICON	7.1	**6.7**	**6.8**	**12.5**				
IVCN	6.7	8.0	**8.2**	**16.0**				
IVDR	6.7	9.2	**9.8**	**14.5**				
GFSI	7.9	11.2	18.8	**11.5**				
EMXI	8.3	8.8	17.5	**13.5**				
HCCA	7.0	**5.5**	**6.0**	**10.5**				
Forecasts	7	6	4	2				

Table 6. Watch and warning summary for Hurricane Nana, 1–3 September 2020.

Date/Time (UTC)	Action	Location
1 / 1500	Tropical Storm Watch issued	Punta Patuca Honduras to Guatemala/Honduras border
1 / 1500	Tropical Storm Watch issued	Bay Islands of Honduras
1 / 1800	Tropical Storm Watch issued	Belize
1 / 2100	Tropical Storm Watch changed to Tropical Storm Warning	Belize
1 / 2100	Hurricane Watch issued	Belize
1 / 2100	Tropical Storm Watch issued	Guatemala
1 / 2100	Tropical Storm Warning issued	Puerto Costa Maya to Chetumal
2 / 1500	Tropical Storm Watch changed to Tropical Storm Warning	Guatemala
2 / 1500	Tropical Storm Warning and Hurricane Watch modified to	Belize City to Belize/Mexico border
2 / 1500	Hurricane Warning issued	Belize City to Belize/Guatemala border
2 / 2100	Tropical Storm Watch changed to Tropical Storm Warning	Bay Islands of Honduras
3 / 1200	Tropical Storm Warning discontinued	Belize/Mexico Border to Belize City
3 / 1200	Tropical Storm Warning discontinued	Puerto Costa Maya to Chetumal
3 / 1200	Hurricane Watch discontinued	All
3 / 1200	Hurricane Warning discontinued	All
3 / 1500	Tropical Storm Watch discontinued	All
3 / 1500	Tropical Storm Warning discontinued	All

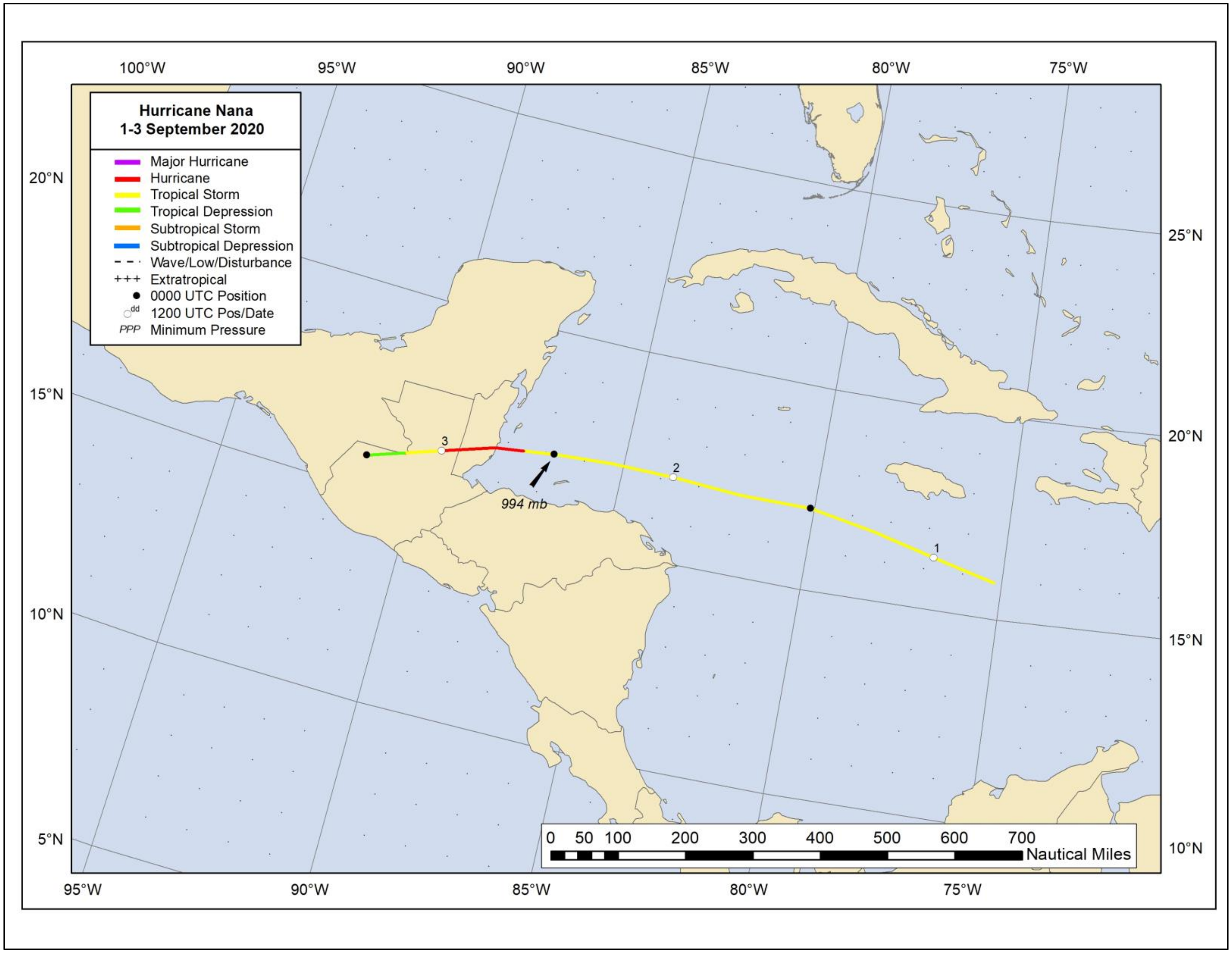

Figure 1. Best track positions for Hurricane Nana, 1–3 September 2020.

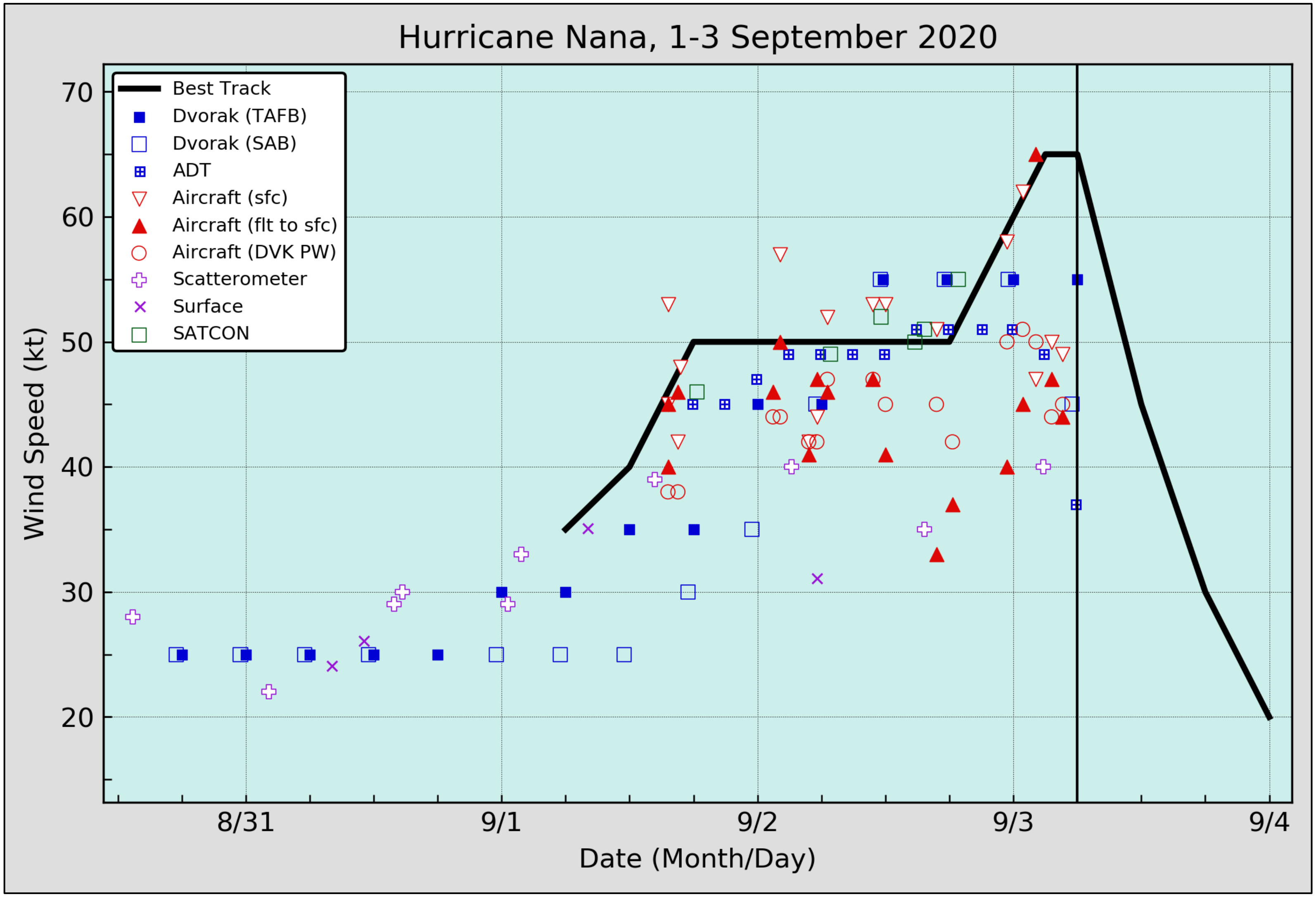

Figure 2. Selected wind observations and best track maximum sustained surface wind speed curve for Hurricane Nana, 1–3 September 2020. Aircraft observations have been adjusted for elevation using 90%, 80%, and 80% adjustment factors for observations from 700 mb, 850 mb, and 1500 ft, respectively. Advanced 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.

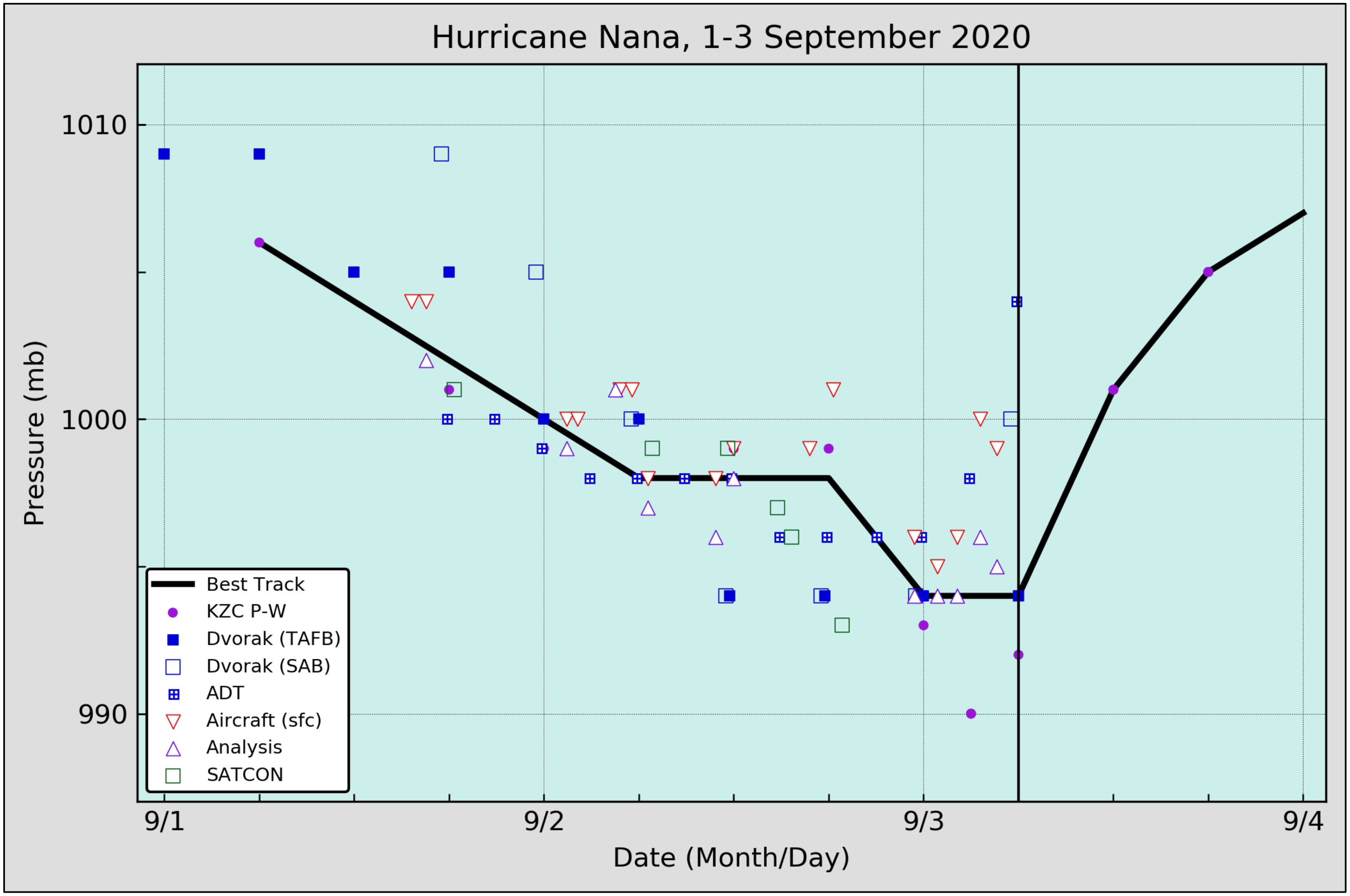

Figure 3. Selected pressure observations and best track minimum central pressure curve for Hurricane Nana, 1–3 September 2020. Advanced Dvorak Technique estimates represent the Current Intensity at the nominal observation time. SATCON intensity estimates are from the Cooperative Institute for Meteorological 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.

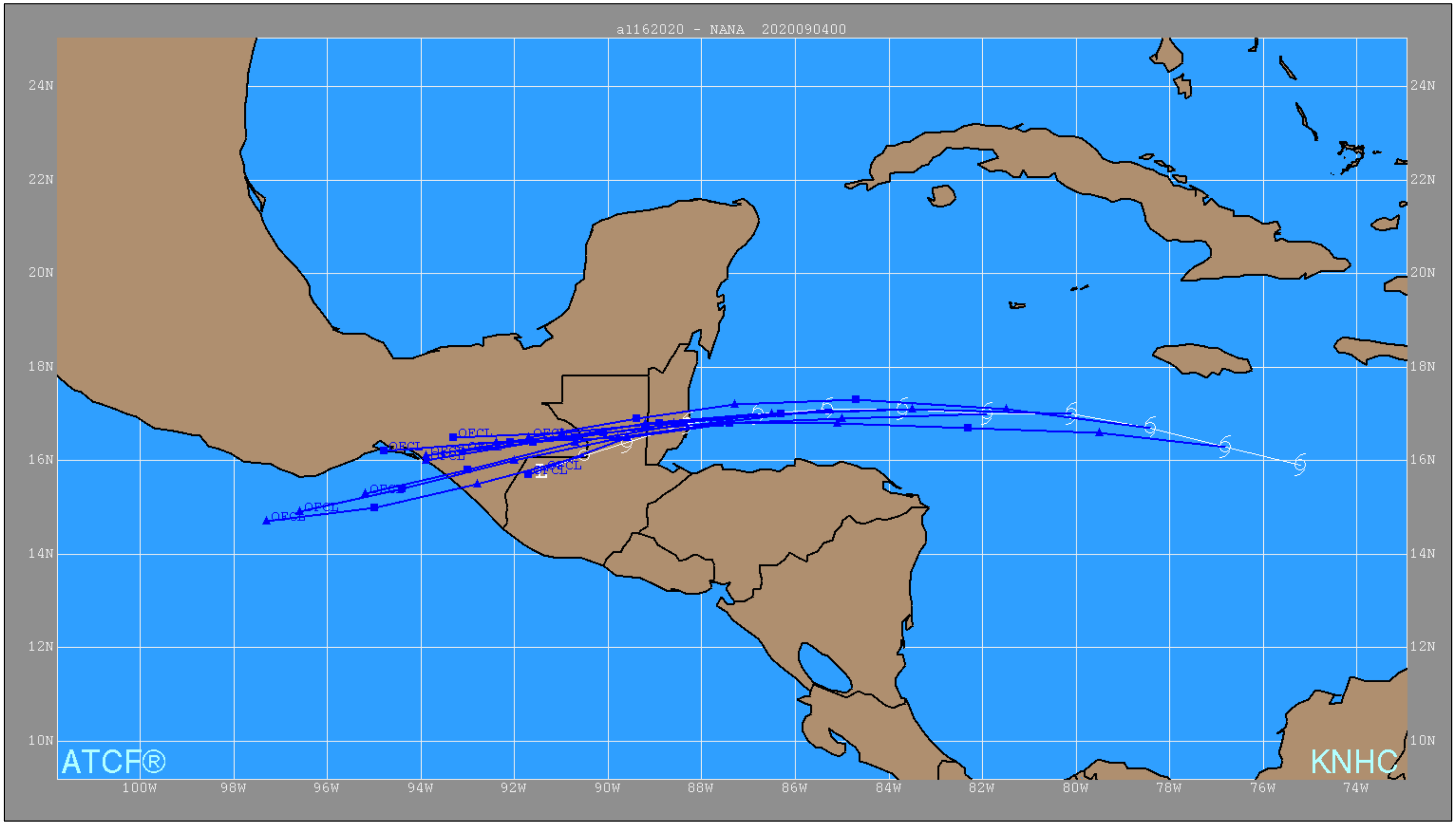

Figure 4. NHC official track forecasts (solid blue lines) for Hurricane Nana, 1–3 September 2020. The best track is given by the solid white line with positions given at 6 h intervals. Note the consistency of the official forecasts, which accurately predicted landfall in southern Belize.