Tropical Cyclone Report
Hurricane Nadine
(AL142012)
10 September – 3 October 2012

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Nadine was an unusually long-lived tropical cyclone that completed three loops over the eastern subtropical Atlantic. Nadine attained hurricane strength on two occasions, a record thirteen days apart.

a. Synoptic History

Nadine formed from a tropical wave that departed the west coast of Africa on 7 September. The wave produced disorganized showers and thunderstorms as it passed south of the Cape Verde Islands the next day. On 9 September, a broad area of low pressure developed in association with the wave, and thunderstorm activity began to increase later that day. The deep convection continued to become organized and the low became better defined on 10 September, leading to the formation of a tropical depression by 1200 UTC that day, about 770 n mi west of the Cape Verde Islands. The depression moved west-northwestward to the south of a large subtropical ridge over the central and eastern Atlantic. The "best track" chart of the tropical cyclone's path is given in Fig. 1, with the wind and pressure histories shown in Figs. 2a, 2b, 3a, and 3b. The best track positions and intensities are listed in Table 1[1].

The cyclone was slow to strengthen after genesis, possibly due to some dry mid-level air that caused the thunderstorm activity to decrease late on 10 September. The next day, deep convection redeveloped, which resulted in gradual strengthening. Geostationary satellite imagery and scatterometer data indicate that the depression became a tropical storm by 0000 UTC 12 September. Nadine quickly intensified over the next 24 h, when it was within a low-shear environment and over warm waters. While moving northwestward toward a break in the subtropical ridge, Nadine reached an intensity of 60 kt by 0000 UTC 13 September, but the strengthening episode came to an end when Nadine entered a region of moderate southwesterly shear. Early on 14 September, Nadine turned northward around the western portion of the ridge. Despite the moderate shear, the inner-core convective structure gradually improved that day, and Nadine became a hurricane by 1800 UTC 14 September.

The hurricane intensified a little more and reached an intensity of 70 kt 6 h later. Nadine remained a hurricane during the next couple of days as it moved eastward around the northern side of the subtropical ridge. Early on 17 September, as Nadine turned east-northeastward and

[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.

decelerated, the associated deep convection became less symmetric and separated from the low-level center due to moderate to strong westerly shear. This caused Nadine to weaken below hurricane strength. Shortly thereafter, mid-level dry air associated with a shortwave trough moving across the central Atlantic caused the thunderstorm activity to decrease near the center, and Nadine's peak winds decreased to 50 kt at 0000 UTC 18 September, when it was located about 415 n mi southwest of the Azores. The tropical storm remained around that intensity for the next several days.

Nadine moved slowly northeastward, and then northward on 18-19 September before a blocking ridge developed to the north of the tropical storm; at this time Nadine was centered about 130 n mi south-southwest of Flores in the western Azores. On 20 September, when the ridge weakened and a mid- to upper-level trough deepened over the northeastern Atlantic, Nadine began moving east-southeastward. A cold front associated with the trough passed through the western and central Azores and approached the tropical storm from the northwest. When this occurred, Nadine's wind field expanded as it interacted with an upper-level low. Although scatterometer and surface data indicate that the front did not reach the center of Nadine, the associated dry air wrapped into the circulation and caused the deep convection to diminish. Now lacking organized deep convection, Nadine lost tropical cyclone status and became a non-tropical low pressure area at 1800 UTC 21 September about 225 n mi south-southwest of Santa Maria Island in the Azores.

The low weakened slightly, but maintained an intensity of 45 kt during the next day or so while it moved south-southeastward in the low-level flow. On 23 September, the system turned eastward and slowed down yet again. The low moved over slightly warmer waters and into a more conducive shear environment, and deep convection redeveloped and gained enough organization by 0000 UTC 23 September for the system to be considered a tropical cyclone again. Another blocking ridge developed over the central Atlantic on 24 September, which caused Nadine to complete a cyclonic loop and then move slowly west-northwestward. During this time, the maximum wind speed of the storm decreased to 40 kt.

By 26 September, Nadine began moving south-southwestward to southwestward around the southeastern portion of a mid- to upper-level ridge located over the western Atlantic. Thunderstorm activity began to increase in coverage and organization on 27 September while Nadine moved over waters warmer than 26°C, and gradual strengthening ensued over the next couple of days. Nadine turned westward, then northwestward as the mid- to upper-level ridge to the north of the cyclone moved eastward across the Atlantic. The shower and thunderstorm activity continued to gradually become organized around the center and a banding eye developed. Nadine became a hurricane for a second time by 1200 UTC 28 September.

Nadine continued moving northwestward around the southwestern portion of the mid- to upper-level ridge that was now centered over the eastern Atlantic. Within a favorable environment for strengthening, the hurricane gradually intensified while the convection became deeper and more symmetric. Nadine reached its estimated peak intensity of 80 kt at 1200 UTC 30 September (Fig. 4) about 365 n mi west-southwest of Flores Island. Shortly thereafter, Nadine slowed down yet again when it became trapped between ridges to the east and west and a trough to the north. While Nadine drifted southward late on 30 September and early on 1

October, the waters beneath the cyclone cooled due to upwelling. This led to a reduction in the coverage and intensity of the deep convection, which caused Nadine to weaken to a tropical storm by 1200 UTC 1 October. The next day, Nadine turned to the southeast and then east ahead of a deep-layer trough that was moving off of the coast of Atlantic Canada. Strong upper-level winds ahead of the trough produced an increase in vertical wind shear, and the tropical storm's intensity weakened to 45 kt at 0600 UTC 3 October. As Nadine turned east-northeastward and began to accelerate on 3 October, the deep convection dissipated due to cooler waters and the strong shear. Nadine became a post-tropical low by 0000 UTC 4 October, about 170 n mi southwest of central Azores. The post-tropical cyclone began accelerating northeastward, and scatterometer data indicate that the low degenerated into a trough of low pressure shortly before 1200 UTC 4 October, just prior to it passing through the central Azores. The trough merged with a cold front soon thereafter.

b. Meteorological Statistics

Observations in Nadine (Figs. 2a, 2b, 3a, and 3b) 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 from the Cooperative Institute for Meteorological Satellite Studies/University of Wisconsin-Madison (CIMSS). Data and imagery from NOAA polar-orbiting satellites including the Advanced Microwave Sounding Unit (AMSU), the NASA Tropical Rainfall Measuring Mission (TRMM), 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 Nadine. The NASA Global Hawk unmanned aircraft flew five surveillance missions into Nadine. The aircraft released about 70 to 80 dropwindsondes on each flight, except on the first flight when technical issues prevented only about half that number to be launched. Unfortunately, telemetry problems with many of the sondes caused the low-level wind measurements to fail, and it is difficult to determine the accuracy of the data and the height that data terminated.

Nadine's estimated peak intensity of 80 kt is based on a blend of subjective Dvorak T-numbers of 4.5 (77 kt) from TAFB and SAB, and an objective T-number of 4.8 (85 kt) from the CIMSS ADT.

On 21 September, Nadine's wind field became much larger when a frontal boundary approached the system from the northwest. During this time, Nadine became co-located with an upper-level low. Operationally, Nadine was briefly classified as a subtropical storm, but since the deep convection diminished quickly and Nadine weakened during its interaction with the upper-level low, the final best-track shows Nadine degenerating to a post-tropical cyclone at 1800 UTC 21 September, when it no longer had the required convective organization of a tropical or subtropical cyclone.

There were no reports of tropical-storm-force winds in the central and western Azores on 19-20 September when the center of Nadine was within 130 to 150 n mi of those islands. After

Nadine's wind field expanded late on 20 September, a peak sustained wind of 54 kt with a gust to 70 kt was observed at 0110 UTC 21 September at Horta on Faial Island in the central Azores.

A minimum pressure of 993 mb was reported at 0740 UTC 4 October at Pico in the central Azroes when the remnants of Nadine passed by. In addition, a sustained wind of 33 kt was observed at São Miguel at 1520 UTC 4 October, and a wind gust to 49 kt was reported at Nordeste on São Miguel Island. A wind gust of 76 kt was reported at an elevated observing site at the Wind Power Plant on Santa Maria Island.

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

Nadine's 22.25 (non-consecutive) days as a tropical cyclone makes it the fourth longest-lived Atlantic basin tropical cyclone on record. The 20.75 days Nadine spent as a tropical storm and hurricane makes it the third-longest-lived named storm on record. Only the unnamed 1899 hurricane and Ginger (1971) lasted longer.

c. Casualty and Damage Statistics

There were no reports of damage or casualties associated with Nadine.

d. Forecast and Warning Critique

The development of Nadine was somewhat well anticipated. The tropical wave from which Nadine formed was introduced into the Tropical Weather Outlook with a low chance (<30%) of development at 0000 UTC 8 September, about 60 h before formation. The chance of development was raised to the medium category (30-50%) 48 h before genesis, but to the high category (>50%) only 6 h before formation occurred.

A verification of NHC official track forecasts for Nadine is given in Table 3a. Official forecast track errors were lower than the mean official errors for the previous 5-yr period at all forecast times. The errors are most noticeably lower through 72 h, where they are between 16 and 38% lower than the long-term average. The unusual track of Nadine caused the climatology-persistence (OCD5) errors to be much larger than their long-term average, indicating that the NHC forecasts for Nadine were quite skillful. A homogeneous comparison of the official track errors with selected guidance models is given in Table 3b. The NHC forecasts had lower mean errors than nearly all the individual track models at all lead times. Only the Global Forecast System (GFSI) and the European Centre for Medium-Range Weather Forecasts (EMXI) models had slightly lower errors at 12 h, with the GFSI the only individual model to perform better than the official forecast at 24 h. The TVCA multi-model consensus slightly bettered the NHC forecasts through 36 h and the Florida State University Super Ensemble (FSSE) exhibited lower average errors through 72 h.

While the overall track forecast errors were lower than the long-term means, there were a couple of distinct periods in which the NHC forecasts had 4- and 5-day track errors that were

much larger than the 5-yr average. The first period occurred during the early portion of Nadine's time as a tropical cyclone. Although these forecasts had low cross-track errors, they did not indicate enough eastward acceleration of Nadine after the cyclone rounded the subtropical ridge. The second period occurred when Nadine approached the Azores for the first time. Near the end of that 5-day forecast period, Nadine was expected to interact with an amplifying mid-latitude trough over the northeastern Atlantic. The model guidance displayed a significant spread at this time with some of the models moving Nadine eastward, and then northeastward ahead of the trough. Meanwhile, other models indicated Nadine would not be picked up by the trough, and would instead turn southward and southwestward around a developing deep-layer ridge over the north-central Atlantic. Figure 5 illustrates the dichotomy of the track guidance during this time. Initially, the traditionally more reliable track models indicated that Nadine would move eastward, and the NHC forecast leaned in that direction for a few days. This led to some 5-day track errors of the official forecast of about 250-425 n mi.

A verification of NHC official intensity forecasts for Nadine is given in Table 4a. The NHC forecasts for Nadine were quite good, with the errors much lower than the long-term mean. The climatology-persistence (OCD5) errors were also much lower than their long-term mean, indicating that the intensity forecasts for Nadine were easier than normal. The only large NHC intensity errors occurred in the forecasts leading up to the time of Nadine's peak intensity. Although the NHC forecasts a few days before Nadine re-intensified into a hurricane anticipated an increase in strength, they did not predict as much of an increase in wind speed as what occurred. A homogeneous comparison of the official intensity errors with selected guidance models is given in Table 4b. The NHC forecasts outperformed the majority of the intensity guidance at all lead times.

Tropical storm watches and warnings issued by the Portuguese Weather Service for the Azores in association with Nadine are given in Table 5.

e. Acknowledgements

Sandy Delgado assisted with the quality control of the satellite fixes. The Portuguese Weather Service provided the wind and pressure observations in the Azores.

Table 1. Best track for Hurricane Nadine, 10 September – 3 October 2012.

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
10 / 1200	15.5	38.0	1008	25	tropical depression
10 / 1800	15.6	39.4	1007	25	"
11 / 0000	15.8	40.8	1007	25	"
11 / 0600	16.0	41.9	1007	25	"
11 / 1200	16.4	42.8	1006	30	"
11 / 1800	16.9	43.7	1006	30	"
12 / 0000	17.5	44.8	1004	35	tropical storm
12 / 0600	18.1	45.9	1001	45	"
12 / 1200	18.8	47.1	997	50	"
12 / 1800	19.5	48.3	994	55	"
13 / 0000	20.2	49.5	990	60	"
13 / 0600	21.0	50.6	990	60	"
13 / 1200	22.0	51.7	990	60	"
13 / 1800	23.2	52.6	989	60	"
14 / 0000	24.4	53.4	989	60	"
14 / 0600	25.6	54.0	987	60	"
14 / 1200	27.0	54.0	986	60	"
14 / 1800	28.3	53.7	984	65	hurricane
15 / 0000	29.6	53.3	981	70	"
15 / 0600	30.5	52.2	980	70	"
15 / 1200	30.8	50.7	980	70	"
15 / 1800	30.8	49.1	980	70	"
16 / 0000	30.7	47.5	981	70	"
16 / 0600	30.6	45.4	984	65	"
16 / 1200	30.6	43.0	985	65	"
16 / 1800	30.8	40.6	985	65	"
17 / 0000	31.1	38.8	986	60	tropical storm
17 / 0600	31.7	37.1	987	60	"
17 / 1200	32.5	35.9	988	55	"
17 / 1800	33.1	35.1	988	55	"
18 / 0000	33.5	34.5	989	50	"
18 / 0600	33.9	33.9	989	50	"
18 / 1200	34.3	33.3	989	50	"
18 / 1800	34.9	32.7	989	50	"
19 / 0000	35.5	32.3	989	50	"
19 / 0600	36.1	32.0	989	50	"
19 / 1200	36.7	32.0	989	50	"
19 / 1800	37.1	32.0	987	50	"
20 / 0000	37.2	31.6	986	50	"
20 / 0600	36.9	30.9	986	50	"

20 / 1200	36.5	30.0	986	50	"
20 / 1800	36.2	29.0	984	55	"
21 / 0000	35.9	28.2	984	55	"
21 / 0600	35.4	27.4	984	55	"
21 / 1200	34.6	27.3	984	50	"
21 / 1800	33.6	27.2	984	50	low
22 / 0000	32.5	26.9	985	45	"
22 / 0600	31.8	26.7	986	45	"
22 / 1200	31.0	26.4	987	45	"
22 / 1800	30.5	26.2	987	45	"
23 / 0000	30.4	25.9	987	45	tropical storm
23 / 0600	30.4	25.6	987	50	"
23 / 1200	30.6	25.4	987	50	"
23 / 1800	30.9	25.8	988	50	"
24 / 0000	31.1	26.2	990	45	"
24 / 0600	31.3	26.7	992	45	"
24 / 1200	31.5	27.4	995	45	"
24 / 1800	31.8	28.1	996	45	"
25 / 0000	32.1	28.8	996	40	"
25 / 0600	32.1	29.5	996	40	"
25 / 1200	32.0	29.9	997	40	"
25 / 1800	31.7	30.1	997	40	"
26 / 0000	31.4	30.3	998	40	"
26 / 0600	31.1	30.4	998	40	"
26 / 1200	30.7	30.5	995	45	"
26 / 1800	30.2	30.7	993	50	"
27 / 0000	29.6	31.0	993	50	"
27 / 0600	29.1	31.4	993	50	"
27 / 1200	28.7	31.9	993	50	"
27 / 1800	28.5	32.5	993	55	"
28 / 0000	28.5	33.2	993	55	"
28 / 0600	28.7	33.9	991	60	"
28 / 1200	29.2	34.4	988	65	hurricane
28 / 1800	29.7	34.8	988	65	"
29 / 0000	30.5	35.3	988	65	"
29 / 0600	31.4	35.7	988	65	"
29 / 1200	32.6	36.1	988	65	"
29 / 1800	33.8	36.6	986	70	"
30 / 0000	35.0	37.1	983	75	"
30 / 0600	36.0	37.6	982	75	"
30 / 1200	36.8	38.3	978	80	"
30 / 1800	37.2	38.9	978	80	"
01 / 0000	36.9	39.4	980	75	"
01 / 0600	36.4	39.4	988	65	"
01 / 1200	35.9	39.4	991	60	tropical storm

01 / 1800	35.4	39.4	995	55	"
02 / 0000	34.8	39.1	995	55	"
02 / 0600	34.5	38.5	995	55	"
02 / 1200	34.3	37.9	995	55	"
02 / 1800	34.3	37.1	995	55	"
03 / 0000	34.4	36.2	998	50	"
03 / 0600	34.6	35.3	1000	45	"
03 / 1200	34.9	34.0	1000	45	"
03 / 1800	35.4	32.5	1000	40	"
04 / 0000	36.3	30.9	998	40	low
04 / 0600	37.6	29.1	996	40	"
04 / 1200					dissipated
30 / 1200	36.8	38.3	978	80	minimum pressure

Table 2. Selected ship reports with winds of at least 34 kt for Hurricane Nadine, 10 September – 3 October 2012.

Date/Time (UTC)	Ship call sign	Latitude (°N)	Longitude (°W)	Wind dir/speed (kt)	Pressure (mb)
20 / 0600	WRYC	40.4	31.9	010 / 35	1016.8
20 / 2100	WKAB	41.3	28.2	050 / 39	1014.2
21 / 0000	WRYC	40.6	34.2	020 / 37	1020.0
21 / 0000	WKAB	41.6	29.4	050 / 36	1017.6
21 / 0300	WKAB	41.8	30.8	050 / 37	1019.0
21 / 0600	WKAB	41.9	31.9	050 / 37	1020.1
21 / 1200	WRYC	40.1	29.5	020 / 37	1016.5
23 / 1800	2BLY2	33.5	27.5	040 / 37	1012.6
04 / 0100	BATFR1	35.3	27.4	170 / 35	1008.9
04 / 0200	BATFR1	35.1	27.5	180 / 36	1009.9

Table 3a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) track forecast errors (n mi) for Hurricane Nadine, 10 September – 3 October 2012. Mean errors for the 5-yr period 2007-11 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	72	96	120
OFCL	**18.8**	**32.5**	**46.0**	**62.7**	**104.5**	**159.8**	**208.5**
OCD5	47.6	122.2	211.3	296.9	413.2	509.7	634.3
Forecasts	80	76	73	71	67	63	59
OFCL (2007-11)	30.4	48.4	65.9	83.1	124.4	166.5	213.4
OCD5 (2007-11)	46.9	95.2	151.7	211.6	316.8	404.3	485.2

Table 3b. Homogeneous comparison of selected track forecast guidance models (in n mi) for Hurricane Nadine, 10 September – 3 October 2012. 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 3a due to the homogeneity requirement.

Model ID	Forecast Period (h)						
	12	24	36	48	72	96	120
OFCL	18.0	31.2	44.7	61.4	105.2	161.8	187.0
OCD5	46.8	122.1	212.8	301.2	421.1	508.4	621.7
GFSI	**17.9**	**31.0**	45.4	62.5	110.6	194.3	272.0
GHMI	23.6	44.4	69.5	99.8	197.3	340.4	492.6
HWFI	22.4	43.6	61.7	83.4	151.3	235.4	291.9
EGRI	21.6	41.1	67.4	96.9	131.8	185.9	223.0
EMXI	**17.8**	31.8	47.4	64.0	112.8	166.8	213.1
CMCI	25.1	47.1	68.1	96.5	171.4	223.3	283.5
AEMI	18.3	32.3	47.1	65.2	115.5	177.3	233.2
FSSE	**16.0**	**27.5**	**41.6**	**58.5**	**98.2**	162.5	198.8
TVCA	**16.2**	**30.1**	**45.1**	64.2	111.9	184.0	240.1
BAMD	51.7	97.3	145.5	192.7	329.4	619.5	864.9
BAMM	32.2	60.1	89.9	116.3	139.2	234.2	299.9
BAMS	43.2	84.7	122.8	158.8	205.2	241.2	328.4
Forecasts	75	70	68	65	55	47	40

Table 4a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) intensity forecast errors (kt) for Hurricane Nadine, 10 September – 3 October 2012. Mean errors for the 5-yr period 2007-11 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	72	96	120
OFCL	**4.1**	**6.8**	**7.3**	**7.3**	**8.4**	**8.5**	**8.6**
OCD5	4.9	7.1	7.8	7.6	8.6	11.1	11.8
Forecasts	80	76	73	71	67	63	59
OFCL (2007-11)	7.1	10.8	13.0	15.0	16.9	17.1	18.1
OCD5 (2007-11)	8.4	12.4	15.4	17.7	20.5	21.5	21.2

Table 4b. Homogeneous comparison of selected intensity forecast guidance models (in kt) for Nadine. 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	72	96	120
OFCL	4.1	6.7	7.0	7.3	8.6	8.7	9.3
OCD5	4.8	7.0	7.4	**7.2**	**8.5**	10.0	12.9
GHMI	5.9	8.6	10.7	11.2	12.9	13.5	12.6
HWFI	5.5	7.9	8.9	9.5	10.9	15.0	18.1
DSHP	4.7	**6.4**	7.7	8.6	10.2	10.8	9.3
LGEM	4.9	6.7	7.8	8.9	10.1	9.8	10.7
ICON	4.7	**6.5**	7.4	7.5	9.5	10.9	11.1
IVCN	4.7	**6.5**	7.4	7.5	9.5	10.9	11.1
FSSE	4.6	6.7	8.0	8.0	8.7	9.7	11.0
Forecasts	76	72	69	67	61	54	47

Table 5. Watch and warning summary for Hurricane Nadine, 10 September – 3 October 2012.

Date/Time (UTC)	Action	Location
18 / 1000	Tropical Storm Watch issued	Islands of Flores and Corvo in the Northwest Azores
18 / 2100	Tropical Storm Watch discontinued	Islands of Flores and Corvo in the Northwest Azores
18 / 2100	Tropical Storm Warning issued	Azores Islands of Flores, Corvo, Faial, Pico, Sao Jorge, Graciosa, and Terceira
19 / 1500	Tropical Storm Warning issued	Azores Islands of Sao Miguel and Santa Maria
21 / 2100	Tropical Storm Warning discontinued	All
01 / 1500	Tropical Storm Watch issued	All of the Azores
02 / 0000	Tropical Storm Watch changed to Tropical Storm Warning	All of the Azores
04 / 1500	Tropical Storm Warning discontinued	All of the Azores

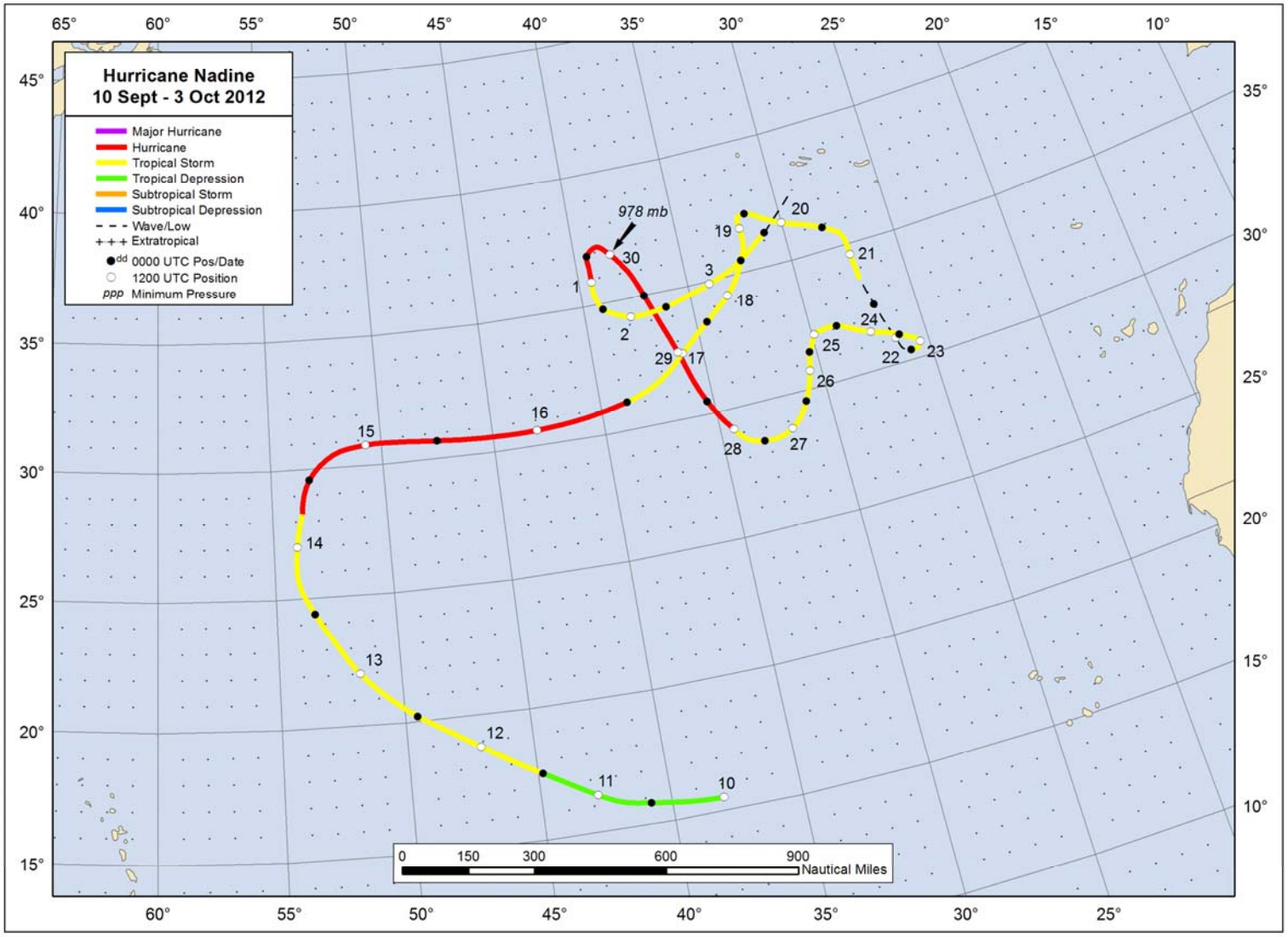

Figure 1. Best track positions for Hurricane Nadine, 10 September – 3 October 2012.

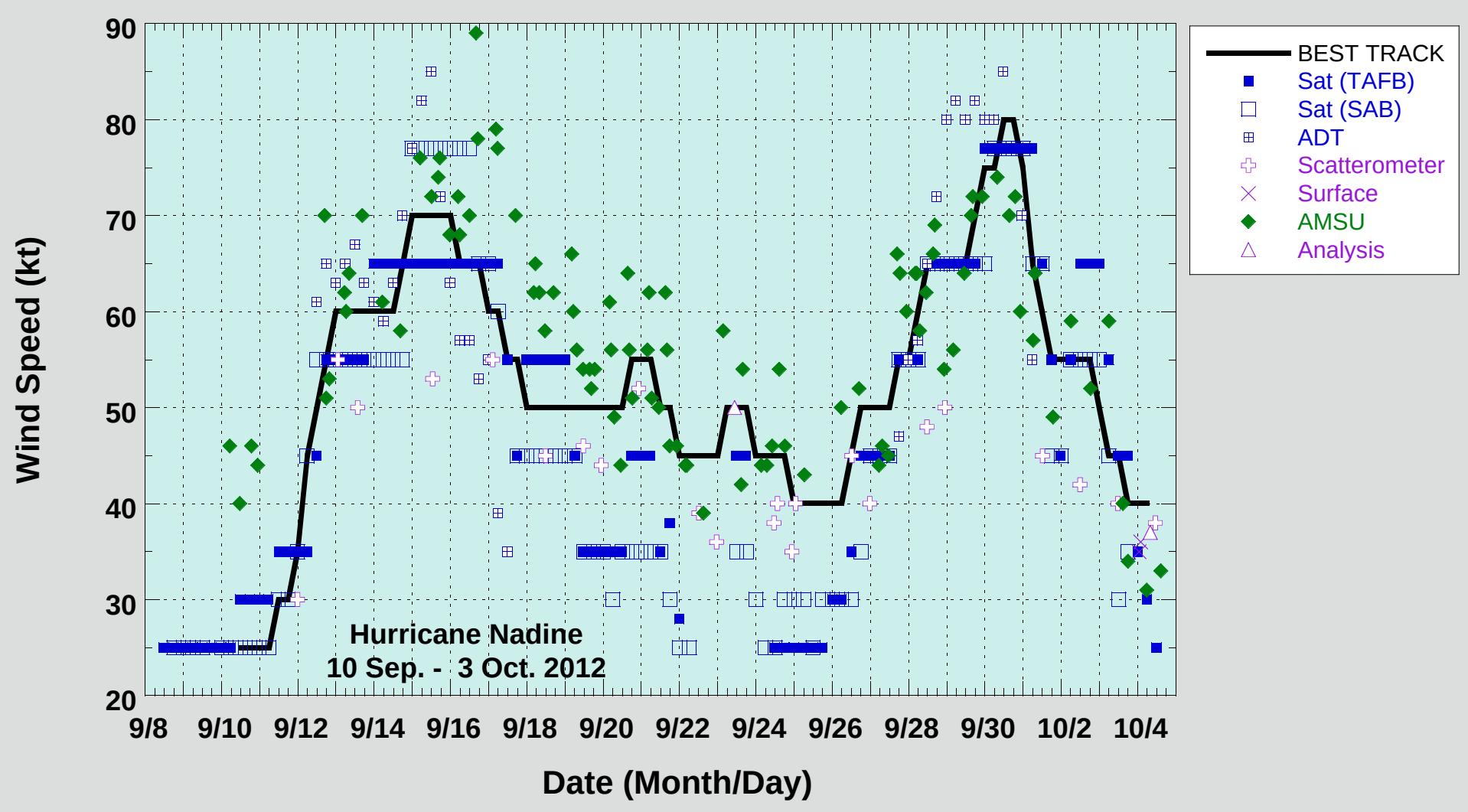

Figure 2a. Selected wind observations and best track maximum sustained surface wind speed curve for Hurricane Nadine, 10 September – 3 October 2012. Advanced Dvorak Technique estimates represent CI numbers. AMSU intensity estimates are from the Cooperative Institute for Meteorological Satellite Studies technique. Estimates during the extratropical stage are based on analyses from the NOAA Ocean Prediction Center. Dashed vertical lines correspond to 0000 UTC.

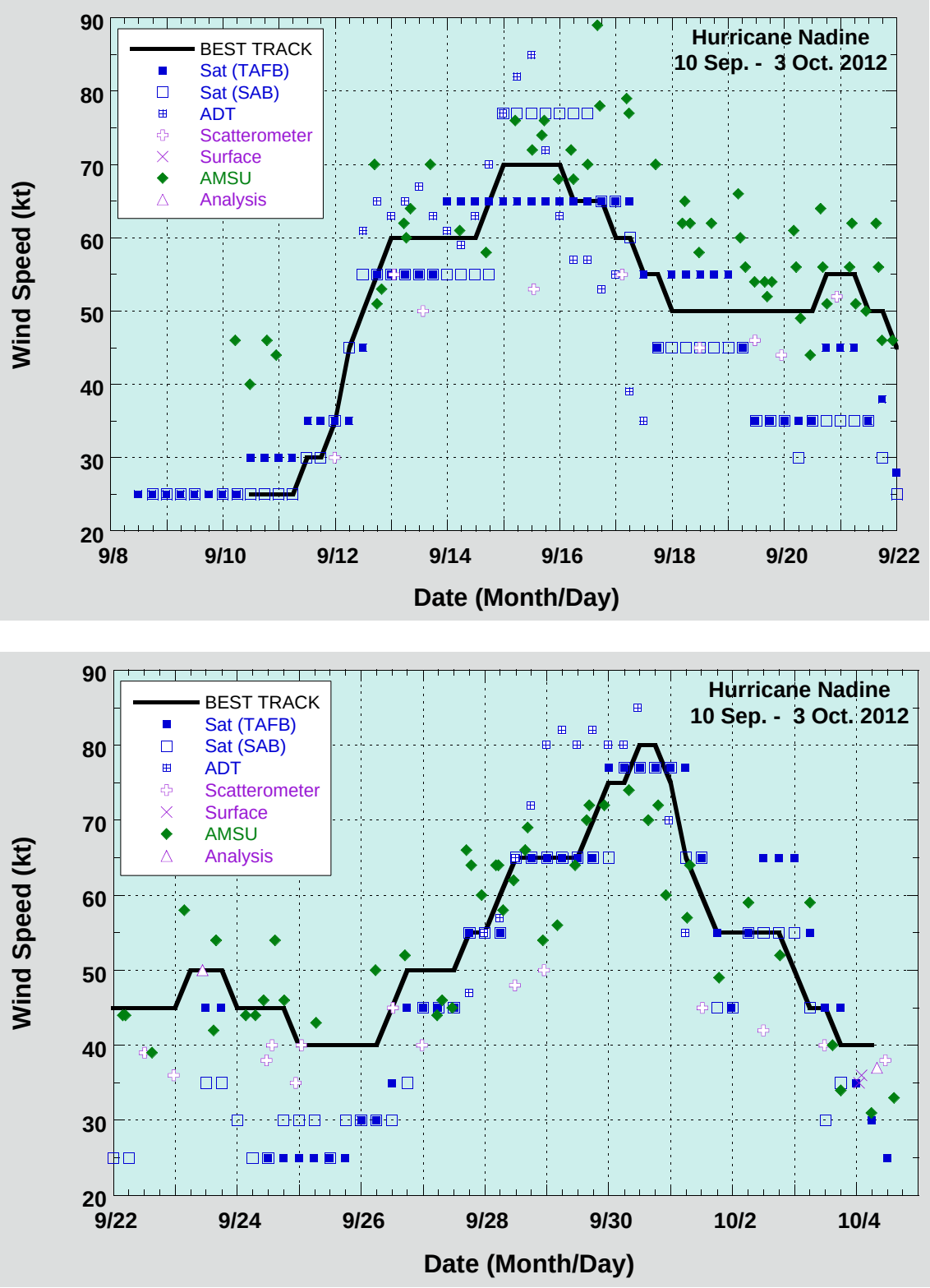

Figure 2b. Same as Figure 2a, except separated by date. Top portion shows wind curve from 10-22 September and bottom portion from 22 September to 4 October 2012.

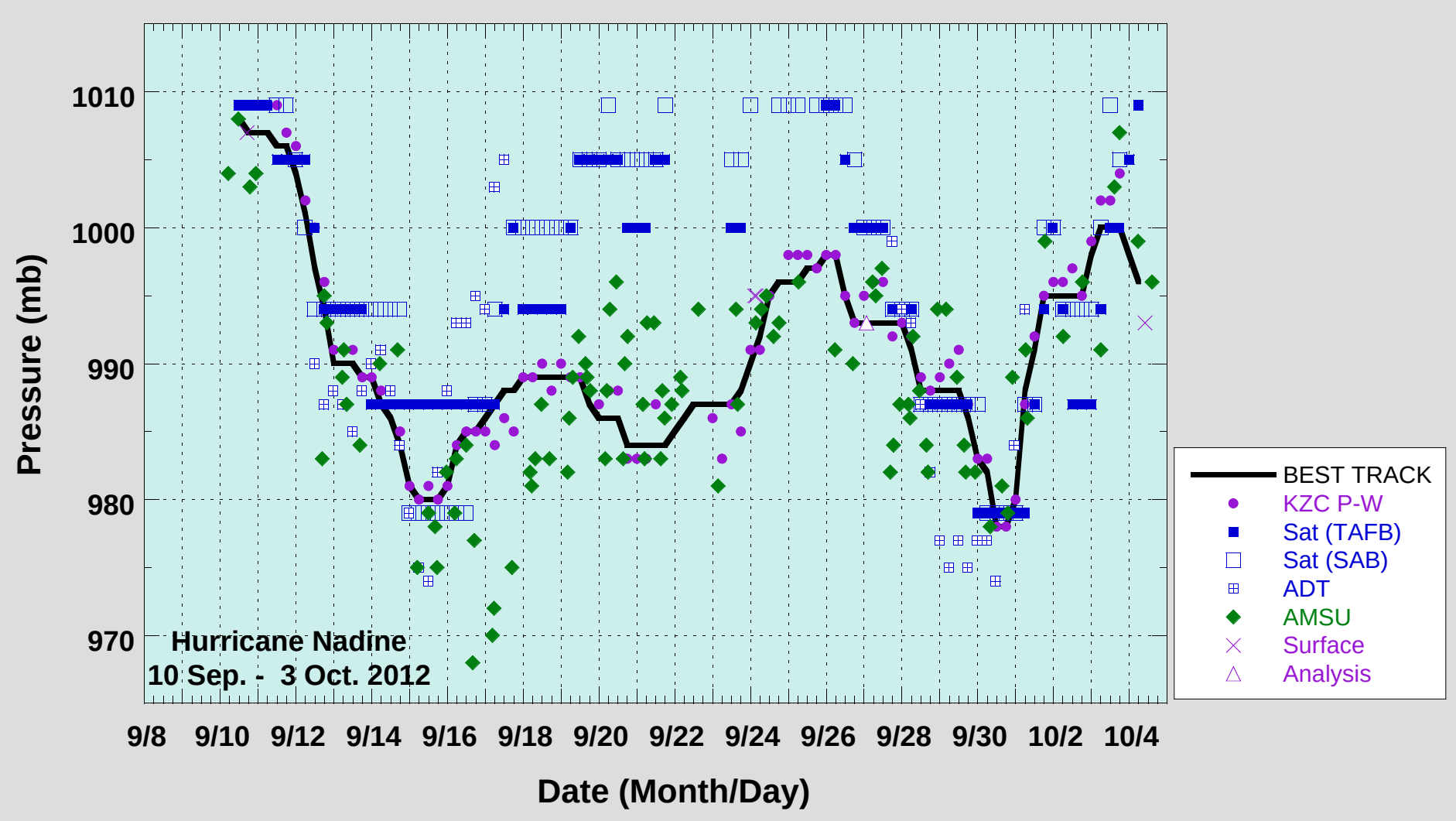

Figure 3a. Selected pressure observations and best track minimum central pressure curve for Hurricane Nadine, 10 September – 3 October 2012. Advanced Dvorak Technique estimates represent CI numbers. AMSU intensity estimates are from the Cooperative Institute for Meteorological Satellite Studies technique. The KZC P-W values are obtained by applying the Knaff-Zehr-Courtney pressure-wind relationship to the best track wind data. Dashed vertical lines correspond to 0000 UTC.

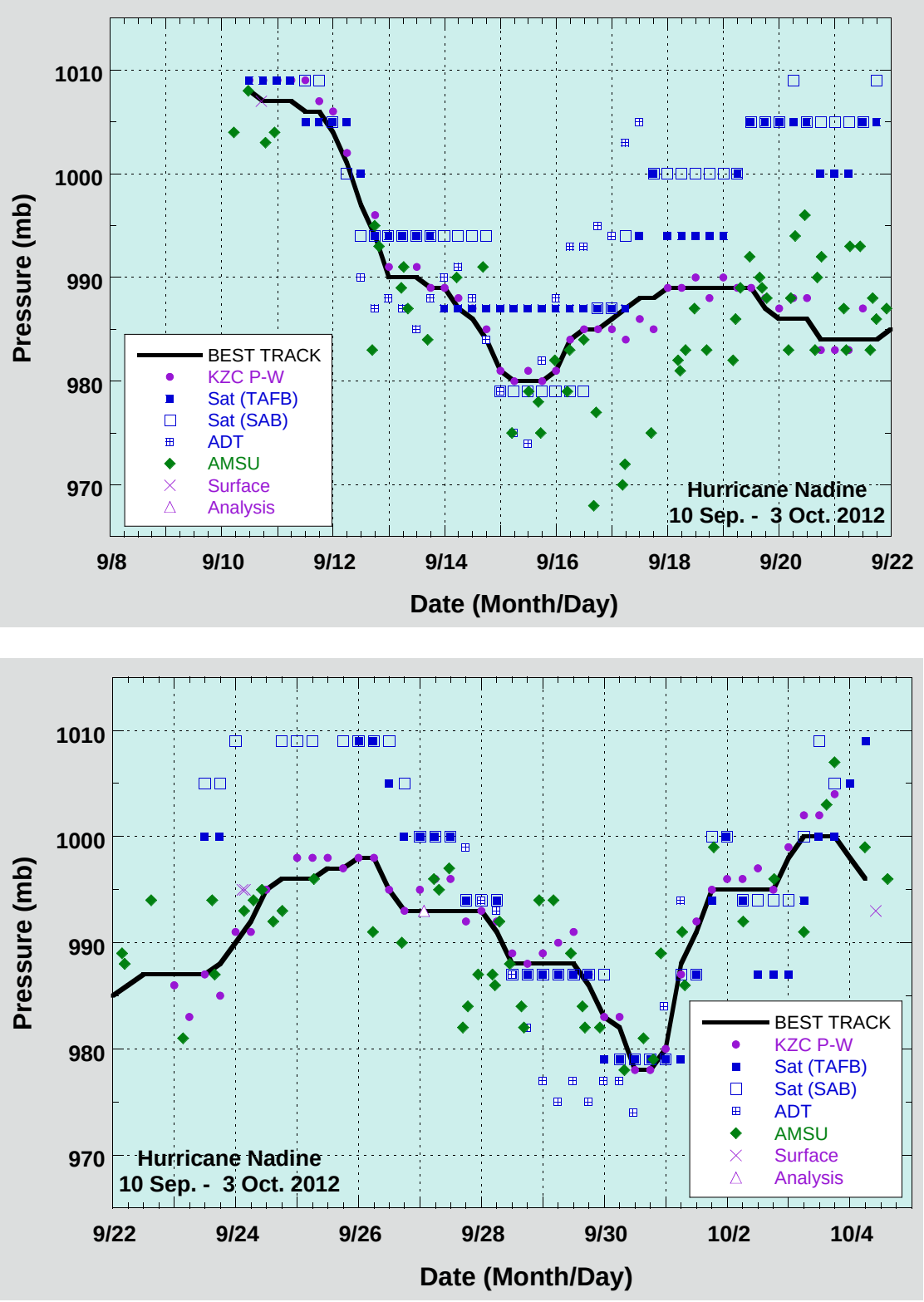

Figure 3b. Same as Figure 3a, except separated by date. Top portion shows pressure curve from 10-22 September and bottom portion from 22 September to 4 October 2012.

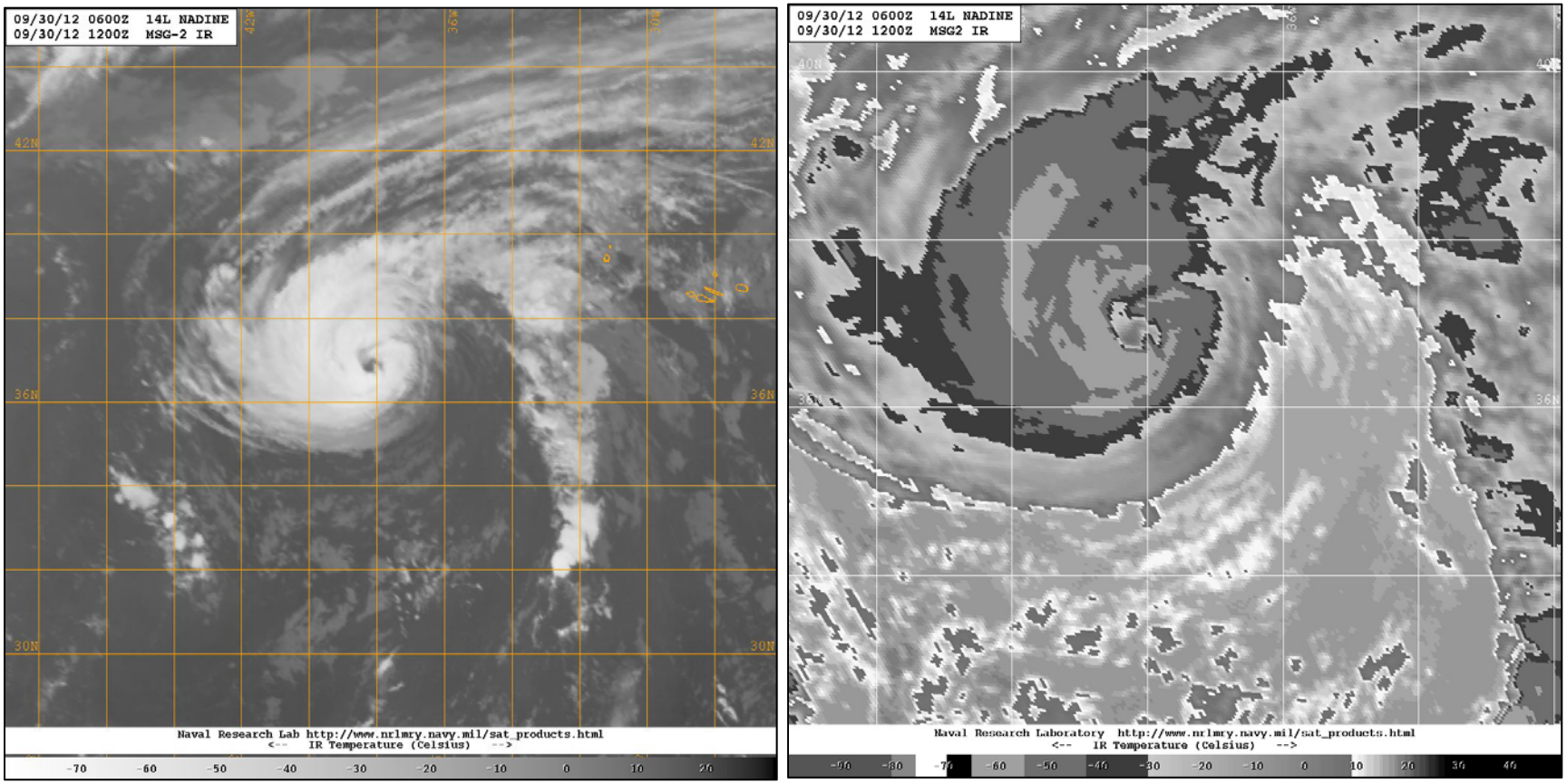

Figure 4. Infrared satellite images of Hurricane Nadine near its estimated peak intensity of 80 kt at 1200 UTC 30 September 2012. The Dvorak BD enhancement has been applied to the image on the right. Images courtesy of the Navy Research Laboratory.

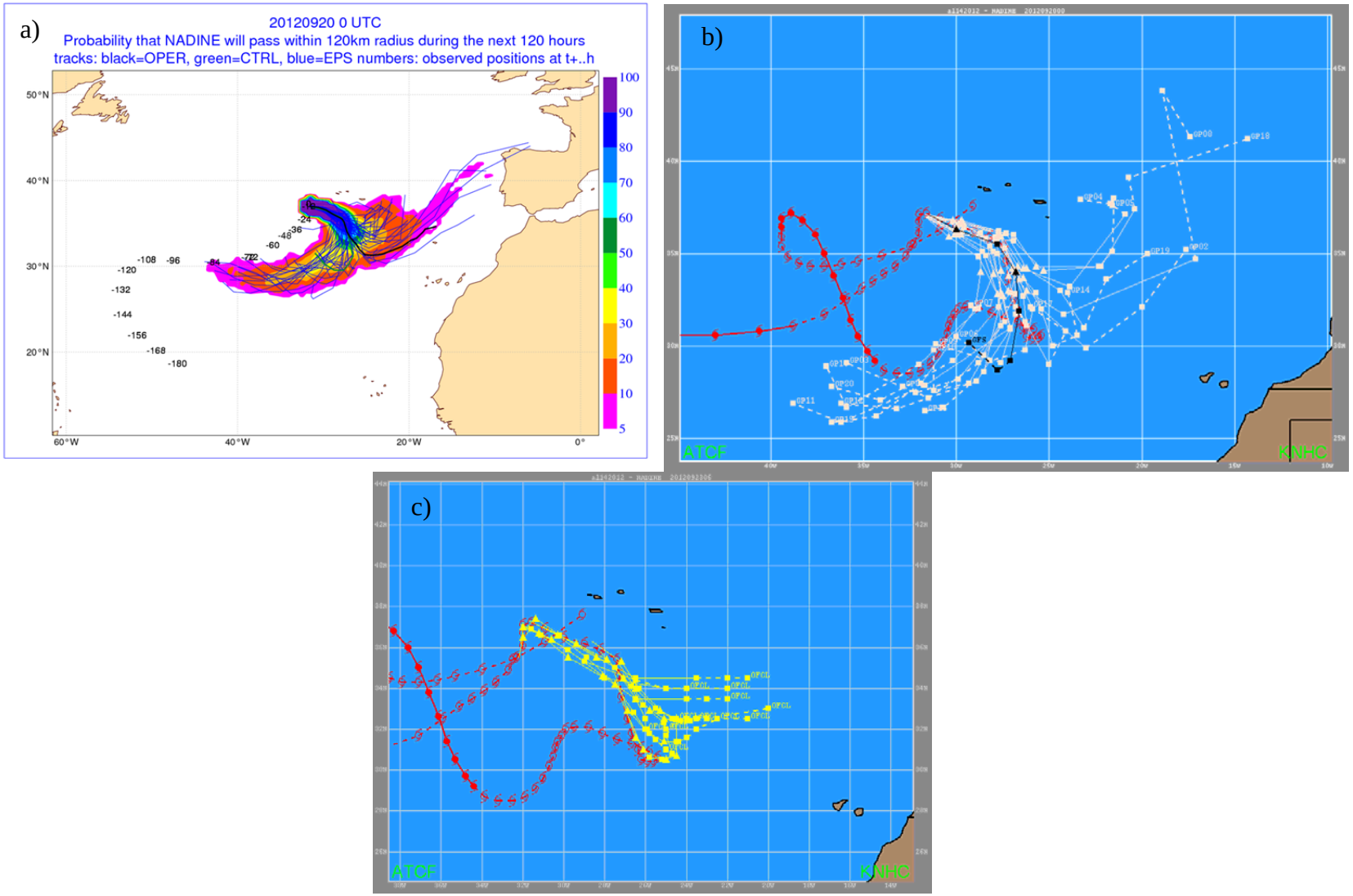

Figure 5. ECMWF (a) and GFS (b) ensemble member track forecasts for Nadine at 0000 UTC 20 September 2012. The operational ECMWF and GFS model tracks are shown in black. Note the large spread in the ensemble tracks and the opposing forecasts of the ECMWF and GFS models at this time. The bottom image (c) displays the NHC forecasts from 0000 UTC 20 September through 1200 UTC 21 September. Since both the GFS and ECMWF initially suggested Nadine would move eastward, the NHC forecasts leaned in that direction.