NATIONAL HURRICANE CENTER
TROPICAL CYCLONE REPORT

TROPICAL STORM FIONA

(AL062016)

16 – 23 August 2016

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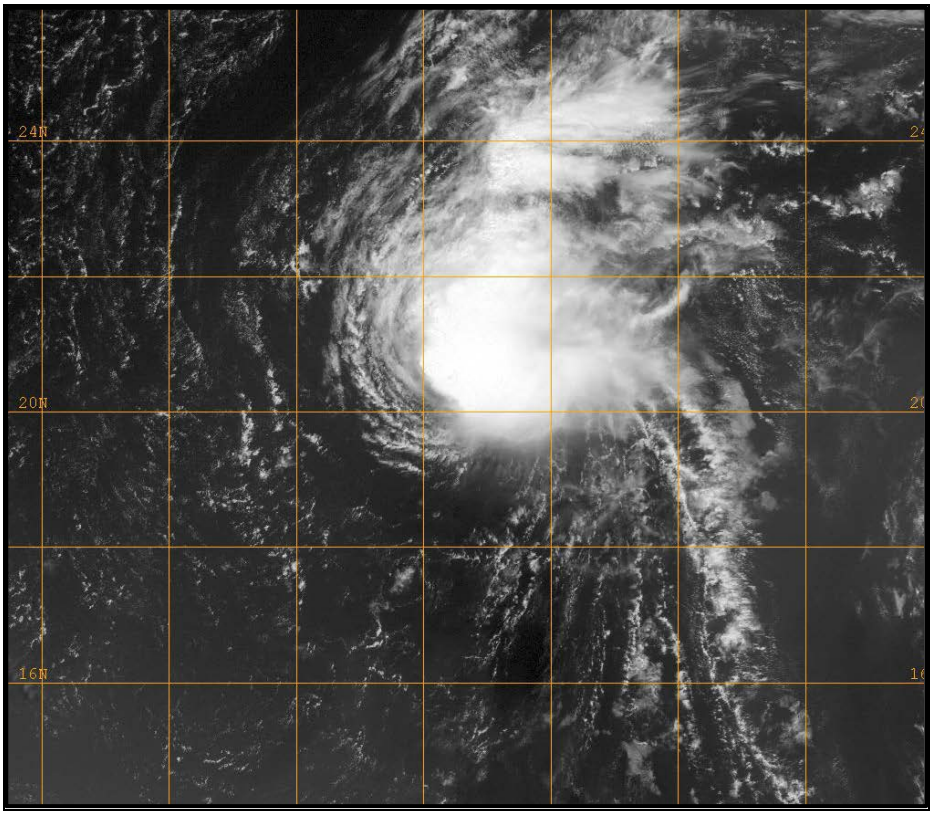

TROPICAL STORM FIONA NEAR PEAK INTENSITY AT 1415 UTC 20 AUGUST 2016. IMAGE COURTESY NRL.

Fiona was a tropical storm that formed in the far eastern Atlantic and moved west-northwestward without strengthening much. The storm reached the subtropical Atlantic and weakened primarily due to strong shear, dissipating nearly midway between Puerto Rico and Bermuda.

Tropical Storm Fiona

16 – 23 AUGUST 2016

SYNOPTIC HISTORY

A tropical wave, accompanied by 24-h pressure falls of 3 to 4 mb, moved off of the west coast of Africa late on 13 August. The wave was moving westward at around 15 kt a few hundred n mi south of Cabo Verde, when a burst of convection occurred near the wave axis late the next day. Even though the convection accelerated westward away from the wave and diminished, the convective burst resulted in the formation of a low- to mid-level cyclonic circulation just south of 10˚N by early on 15 August. Another convective burst occurred late that day, and an elongated surface circulation developed before the wave crossed 30˚W early on 16 August. Despite moderate easterly shear, the deep convection increased in organization and became concentrated in a small mass over the developing center of circulation later that day while the system was moving west-northwestward. A 2306 UTC ASCAT pass on 16 August confirmed that the low already had a well-defined circulation, and it is estimated that a tropical depression formed around 1800 UTC 16 August about 485 n mi west-southwest of the southernmost Cabo Verde Islands. The "best track" chart of the cyclone's path is given in Fig. 1, with the wind and pressure histories shown in Figs. 2 and 3, respectively. The best track positions and intensities are listed in Table 1[1].

The depression's cloud pattern increased further in organization by early on 17 August when a band formed over the northern half of the circulation. A 1238 UTC ASCAT pass indicated winds of tropical storm force, and it is estimated that the depression became a tropical storm by 1200 UTC. Over the next couple of days Fiona continued to move west-northwestward to the south of a subtropical high over the eastern Atlantic, with its forward speed decreasing as it approached a break in the ridge. Bursts of deep convection coinciding with the diurnal convective maximum were occurring daily, but Fiona's intensity only slightly increased during this time. On 19 August Fiona encountered an even less conducive environment for intensification, characterized by southwesterly shear and considerably lower mid-tropospheric moisture in association with a mid- to upper-level trough over the east-central Atlantic subtropics. Despite the shear, continued bursts of deep convection continued during the next few days while the low-level center remained partially or completely exposed to the west of the main convective mass. Fiona's forward speed increased again on 20 August as the low-level ridge re-strengthened. When the shear veered to westerly or northwesterly and became stronger on 22 August, Fiona's deep convection began to gradually diminish. Deep convection dissipated completely around 1200 UTC 23 August, and the cyclone degenerated into a remnant low while centered about 325 n mi south-southwest of Bermuda. The circulation of Fiona's remnant low was already losing definition that day, and the remnant low dissipated a few hundred n mi south-southwest of Bermuda around

[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.

1200 UTC 24 August. The remnants of Fiona moved slowly northwestward on 25 August and merged with a decaying frontal zone south of Bermuda, from which Tropical Depression Eight developed a couple of days later.

METEOROLOGICAL STATISTICS

Observations in Fiona (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 from the Cooperative Institute for Meteorological Satellite Studies/University of Wisconsin-Madison. 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 Fiona.

Fiona is estimated to have reached a peak intensity of 45 kt on two occasions. The first is analyzed at around 0000 UTC 19 August, based on a blend of satellite classifications of T3.0 from TAFB, UW-CIMSS ADT values and AMSU intensity estimates. The second analyzed peak of 45 kt is based on an 0107 UTC 21 August ASCAT pass that showed a maximum reliable wind of 47 kt. Since the cloud pattern appeared as well organized at that time as it had been 12 h before, the second peak of 45 kt is shown to have begun at 1200 UTC 20 August. It is worth noting that Fiona's cloud pattern at the time of the 21 August ASCAT pass was only T1.5 or T2.0.

There were no ship reports of winds of tropical storm force associated with Fiona.

CASUALTY AND DAMAGE STATISTICS

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

FORECAST AND WARNING CRITIQUE

The genesis of Fiona was reasonably well forecast in the short range, but not much lead time was given in the extended-range forecasts. Table 2 provides the number of hours in advance of formation associated with the first NHC Tropical Weather Outlook (TWO) forecast in each likelihood category. The wave from which Fiona developed was introduced in the Tropical Weather Outlook only 48 h prior to genesis in the extended range, and the likelihood of genesis was raised to the medium and high categories 24 and 18 h before genesis, respectively. The disturbance was raised to the medium category in the 48-h outlook 24 h prior to genesis and to the high category only 6 h before tropical cyclone formation. Global models showed some potential for tropical cyclone formation in the eastern tropical Atlantic several days prior to genesis, but they showed the system weakening before undergoing significant development. It was not until 14 August that the ECMWF model consistently indicated the likelihood of tropical

cyclone formation, and the GFS model did not show much of a signal until the following day. By the time the consensus of the dynamical models made a strong case that genesis was about to occur, there was little advance warning.

A verification of NHC official track forecasts for Fiona is given in Table 3a. Official forecast track errors were near or just below the mean official errors for the previous 5-yr period through 48 h, but were above the mean after that time. Early forecasts split the difference between the ECMWF model, which showed a weaker, shallower system taking a more westerly track, and the GFS-based guidance that took Fiona more poleward (Figure 4). These forecasts shifted toward the ECMWF solution when it became clearer that Fiona would remain relatively weak. A homogeneous comparison of the official track errors with selected guidance models is given in Table 3b. The multi-model consensus (TVCA), the Florida State Superensemble (FSSE), and the NOAA corrected consensus HCCA models exceled in forecasting Fiona's track relative to the other models. The EMXI and CMCI models were notable in that they forecast Fiona's track well in the extended range.

A verification of NHC official intensity forecasts for Fiona is given in Table 4a. Official forecast intensity errors were lower than the mean official errors for the previous 5-yr period at all times. Official forecasts accurately assessed the marginally conducive environment early in the lifecycle of Fiona and then anticipated the much less favorable environmental conditions after that. As a result, not much intensification was predicted. A homogeneous comparison of the official intensity errors with selected guidance models is given in Table 4b. Overall, the FSSE was the leading model for predicting Fiona's intensity, beating the official forecast at all times. HCCA also had a good showing at all times except 72 h. Interestingly, the global models EMXI and GFSI produced skillful intensity forecasts that either rivaled or performed better than the official forecast. The multi-model consensus aids, including DSHP, saw good results out to about 48 h.

No coastal tropical cyclone watches or warnings were issued in association with Fiona.

Table 1. Best track for Tropical Storm Fiona, 16 -23 August 2016.

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
16 / 1800	12.0	32.2	1009	25	tropical depression
17 / 0000	12.4	33.6	1008	30	"
17 / 0600	12.9	34.8	1008	30	"
17 / 1200	13.7	36.0	1007	35	tropical storm
17 / 1800	14.5	37.3	1007	35	"
18 / 0000	15.2	38.5	1007	35	"
18 / 0600	15.7	39.4	1006	40	"
18 / 1200	16.1	40.1	1006	40	"
18 / 1800	16.5	40.8	1005	40	"
19 / 0000	16.9	41.5	1004	45	"
19 / 0600	17.3	42.3	1004	45	"
19 / 1200	17.7	43.1	1005	40	"
19 / 1800	18.0	43.9	1006	40	"
20 / 0000	18.5	44.9	1005	40	"
20 / 0600	19.2	46.1	1005	40	"
20 / 1200	20.0	47.2	1004	45	"
20 / 1800	20.8	48.4	1004	45	"
21 / 0000	21.5	49.6	1004	45	"
21 / 0600	22.1	51.1	1005	40	"
21 / 1200	22.6	52.6	1006	35	"
21 / 1800	23.1	54.2	1006	35	"
22 / 0000	23.7	55.9	1007	35	"
22 / 0600	24.2	57.6	1008	30	tropical depression
22 / 1200	24.5	59.1	1008	30	"
22 / 1800	25.0	60.5	1009	30	"
23 / 0000	25.3	61.7	1010	30	"
23 / 0600	25.6	62.9	1012	25	"
23 / 1200	25.9	64.0	1014	20	low
23 / 1800	26.3	64.9	1015	20	"
24 / 0000	26.7	65.8	1016	20	"
24 / 0600	27.1	66.7	1016	20	"

24 / 1200					dissipated
19 / 0000	16.9	41.5	1004	45	minimum pressure and maximum winds

Table 2. 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%)	42	42
Medium (40%-60%)	24	24
High (>60%)	6	18

Table 3a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) track forecast errors (n mi) for Fiona. 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	72	96	120
OFCL	**24.7**	46.1	**60.3**	**70.7**	116.2	220.6	311.3
OCD5	34.8	74.8	128.6	186.8	245.5	295.3	365.2
Forecasts	24	22	20	18	14	10	6
OFCL (2011-15)	28.4	45.0	60.4	77.1	113.1	157.8	210.0
OCD5 (2011-15)	48.3	101.5	161.5	222.6	329.8	412.6	483.9

Table 3b. Homogeneous comparison of selected track forecast guidance models (in n mi) for Fiona. 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	27.0	46.3	60.4	71.3	114.2	218.2	327.5
OCD5	38.3	85.5	143.8	204.8	263.7	314.1	432.9
GFSI	**24.8**	**42.4**	**57.0**	73.3	128.4	271.8	403.0
GHMI	30.4	59.6	91.4	130.4	259.0	573.5	824.0
HWFI	**26.7**	**44.3**	**59.0**	74.0	134.1	241.5	**262.6**
EMXI	28.0	50.6	65.1	78.7	**94.3**	**142.1**	**254.8**
NVGI	**26.8**	50.5	79.9	122.3	198.1	306.2	381.0
CTCI	27.9	49.3	67.1	85.0	127.4	**182.4**	311.6
HCCA	**25.1**	**43.4**	**56.0**	**62.2**	**87.4**	**167.9**	**231.6**
GFNI	31.6	60.0	87.2	114.2	177.4	261.2	399.9
CMCI	27.5	**43.4**	**58.5**	78.6	124.1	**166.0**	**188.7**
TVCA	**25.0**	**43.7**	**57.0**	**67.0**	**110.9**	227.7	353.1
FSSE	**23.2**	**41.4**	**51.9**	**58.3**	**109.5**	243.0	377.1
AEMI	**23.8**	**42.8**	61.8	82.0	140.4	276.8	446.3
BAMS	28.0	48.9	77.9	113.3	179.3	304.0	432.3
BAMM	49.7	97.4	146.0	192.9	301.3	520.2	653.6
BAMD	74.6	155.3	246.1	338.6	533.6	899.5	1160.4
Forecasts	17	17	17	16	11	6	3

Table 4a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) intensity forecast errors (kt) for Fiona. 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	72	96	120
OFCL	**3.5**	**4.8**	**5.5**	**6.4**	**2.9**	**4.0**	**8.3**
OCD5	4.2	6.2	8.6	12.7	17.6	25.1	29.2
Forecasts	24	22	20	18	14	10	6
OFCL (2011-15)	6.2	9.4	11.5	13.3	14.6	14.6	15.8
OCD5 (2011-15)	7.3	10.8	13.3	15.3	17.7	17.8	17.6

Table 4b. Homogeneous comparison of selected intensity forecast guidance models (in kt) for Fiona. 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	4.4	5.0	5.0	6.3	2.3	5.0	10.0
OCD5	5.3	6.9	9.5	14.1	17.9	27.0	32.7
HWFI	4.6	5.7	5.5	6.7	7.6	7.3	**5.3**
GHMI	5.8	**4.4**	6.5	7.4	12.8	29.3	41.0
DSHP	5.3	**4.9**	**4.4**	**5.5**	4.6	11.5	23.0
LGEM	5.6	5.5	5.3	**6.2**	3.8	5.2	17.3
ICON	4.8	**4.0**	**3.4**	**4.5**	3.5	10.2	20.0
IVCN	4.4	**3.8**	**3.5**	**4.4**	2.6	7.5	15.3
GFNI	6.2	7.2	7.9	8.9	6.3	7.8	**9.3**
GFSI	4.9	**4.8**	**4.5**	**3.3**	5.3	**4.3**	12.0
EMXI	5.1	**4.8**	**4.0**	**3.4**	4.7	**2.2**	**4.7**
FSSE	**3.9**	**4.1**	**4.2**	**4.5**	3.1	**3.2**	**5.0**
HCCA	4.5	**4.3**	**3.9**	**4.4**	5.5	**4.0**	**5.7**
CTCI	**3.2**	5.3	5.4	**5.4**	7.0	6.0	**3.3**
Forecasts	17	17	17	15	11	6	3

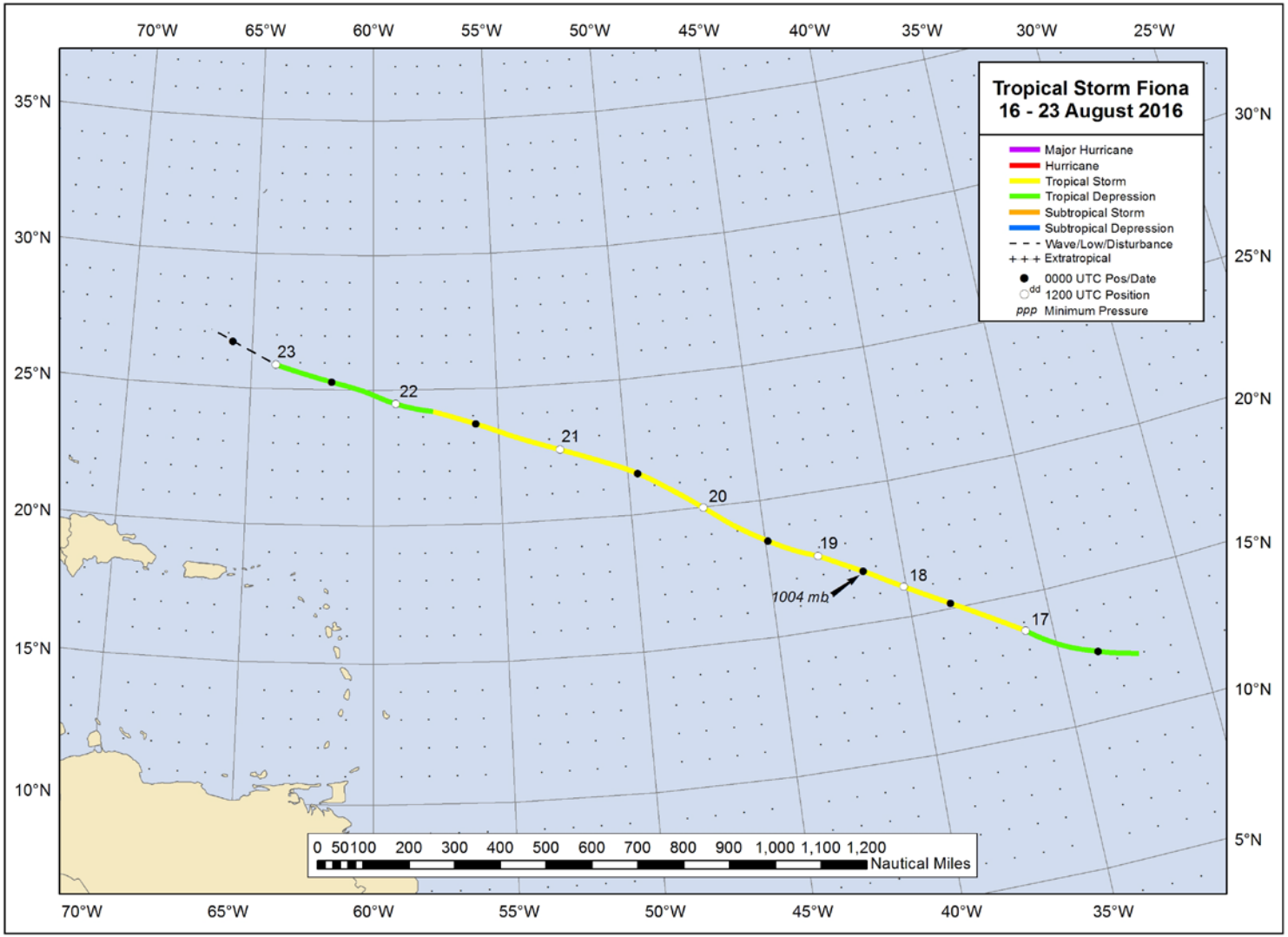

Figure 1. Best track positions for Tropical Storm Fiona, August 16 – 23, 2016.

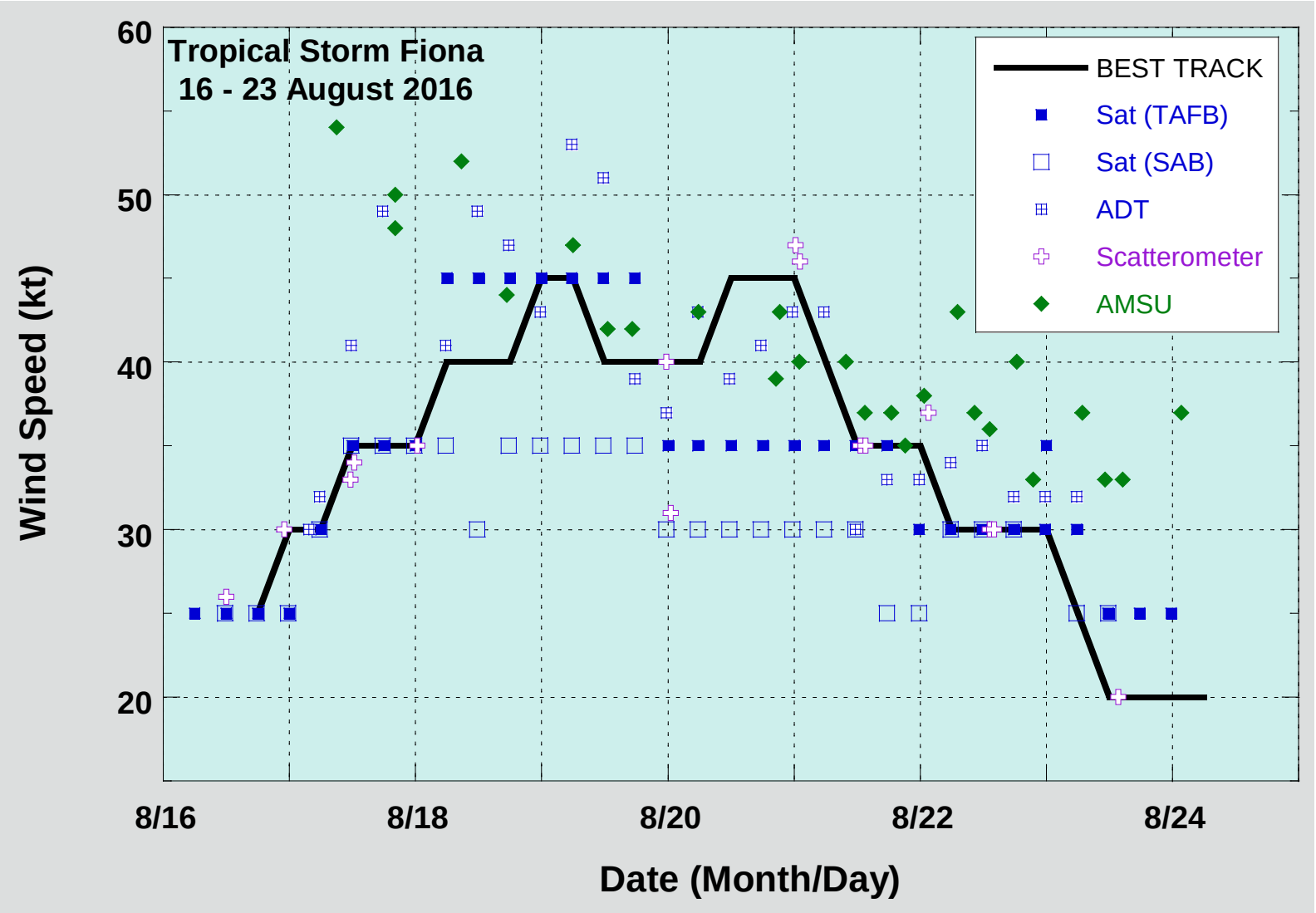

Figure 2. Selected wind observations and best track maximum sustained surface wind speed curve for Tropical Storm Fiona, 16- 23 August, 2016. Advanced Dvorak Technique estimates represent the Current Intensity at the nominal observation time. AMSU intensity estimates are from the Cooperative Institute for Meteorological Satellite Studies technique.

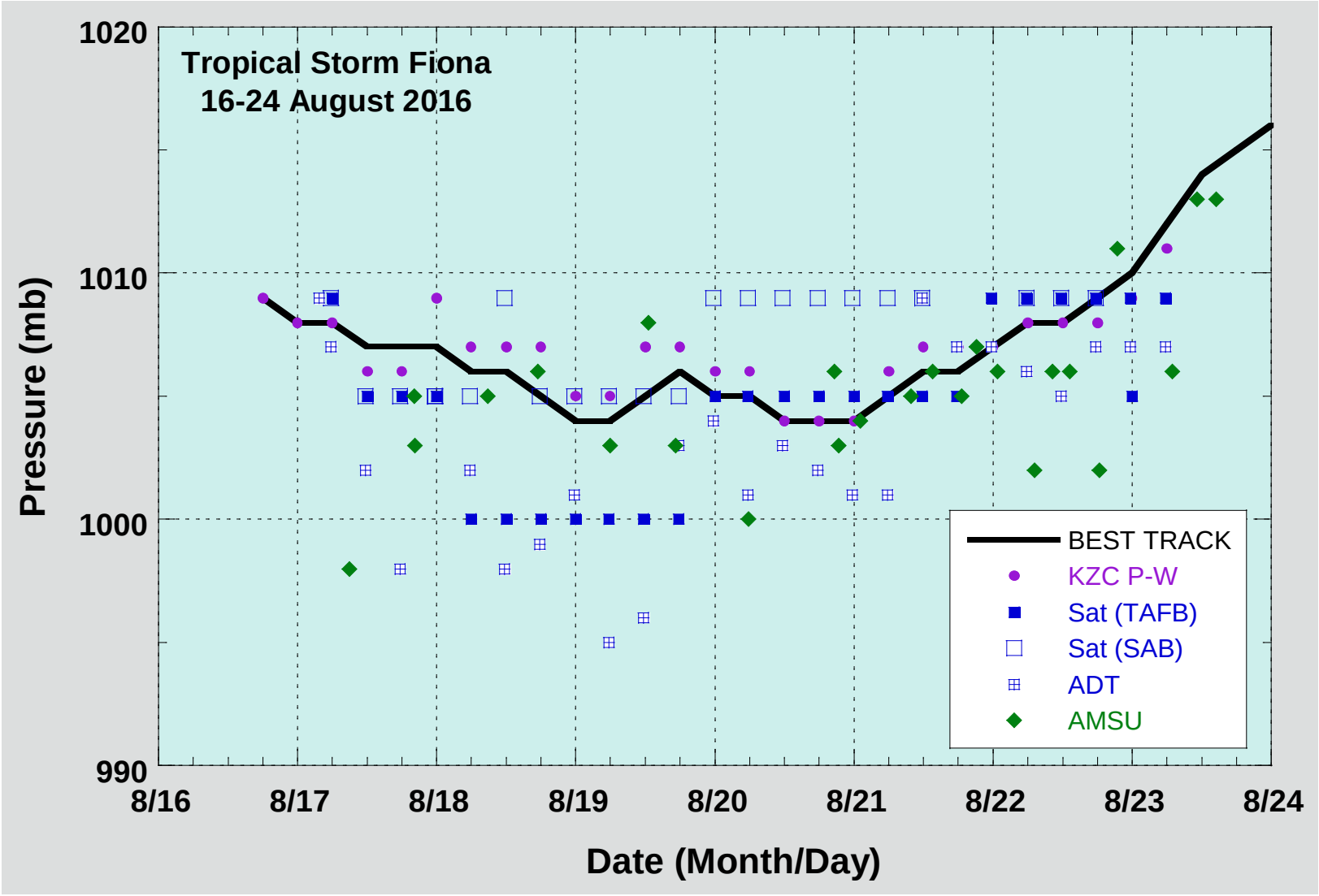

Figure 3. Selected pressure observations and best track minimum central pressure curve for Tropical Storm Fiona 16-23 August, 2016. Advanced Dvorak Technique estimates represent the Current Intensity at the nominal observation time. AMSU intensity estimates are from the Cooperative Institute for Meteorological Satellite Studies technique. KZC P-W refers to pressure estimates derived using the Knaff-Zehr-Courtney pressure-wind relationship.

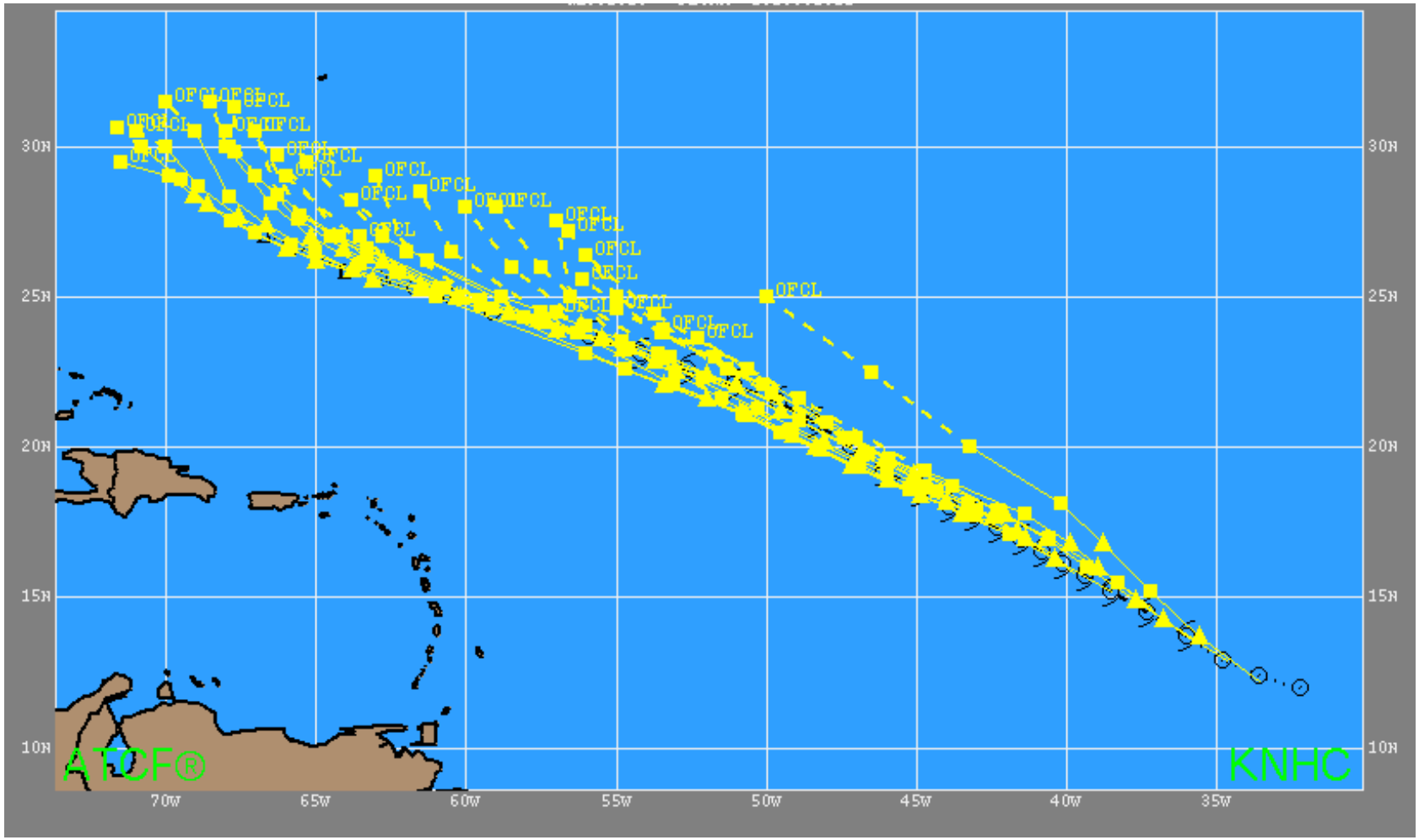

Figure 4. NHC official track forecasts (dashed yellow lines, with 0, 12, 24, 36, 48, 72, 96, and 120 h positions indicated) for Fiona, 16-23 August. The best track is given by the dotted black line with best track positions given at 6 h intervals.