Tropical Cyclone Report
Tropical Storm Fiona
(AL082010)
30 August – 3 September 2010

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Fiona became a tropical storm over the central tropical Atlantic Ocean and threatened the northern Leeward Islands before recurving over the western Atlantic and degenerating into a post-tropical cyclone near Bermuda.

a. Synoptic History

Fiona developed from a large and convectively active tropical wave that moved off the west coast of Africa on 25 and 26 August. Surface observations indicated that the wave had a well-defined cyclonic circulation while it was over western Africa, and an area of low pressure was analyzed along the wave axis on 27 August after it moved off the coast. The broad low moved westward for the next couple of days, and most of the showers and thunderstorms dissipated for a 24-h period beginning on 29 August. The low acquired a well-defined center and deep convection re-developed early on 30 August, and it is estimated that a tropical depression formed at 1200 UTC while centered about 900 n mi east of the Lesser Antilles. The depression became Tropical Storm Fiona by 1800 UTC after research aircraft and satellite data indicated that the system was producing tropical-storm-force winds. The "best track" chart of Fiona'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].

Located on the southwestern periphery of a mid-level ridge over the central Atlantic, Fiona moved quickly west-northwestward at 20 to 25 kt for the next 24 h and began to steadily strengthen after 1200 UTC 31 August as it moved closer to the northern Leeward Islands. The cyclone reached the western edge of the ridge on 1 September and turned toward the northwest with its center passing within about 55 n mi northeast of the island of Barbuda at 1200 UTC (Fig. 4). Even though northeasterly vertical shear had begun to increase earlier in the day, Fiona strengthened to an estimated peak intensity of 55 kt by 1800 UTC as it began to move away from the northern Leeward Islands (Fig. 5).

With waning deep convection and continued northeasterly shear, Fiona was unable to hold its peak intensity for long, and it began to weaken late on 1 September. The cyclone continued to move toward the northwest for another 24 h but turned toward the north-northwest and then north on 2 and 3 September as it was steered between the mid-level ridge and the large

[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.

circulation associated with Hurricane Earl, which was located off the coast of the Carolinas. The upper-level outflow associated with Earl blasted Fiona with about 30 kt of shear, and Fiona's low-level center became exposed early on 3 September. All deep convection dissipated just after 1800 UTC that day, and Fiona became a post-tropical cyclone with 35 kt winds at 0000 UTC 4 September while centered about 95 n mi south of Bermuda. The winds dropped below gale force 6 h later, and Fiona moved northeastward as a remnant low before dissipating by 0000 UTC 5 September about 175 n mi northeast of Bermuda.

b. 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 Dvorak estimates from the Cooperative Institute for Meteorological Satellite Studies/University of Wisconsin-Madison (UW-CIMSS), as well as 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. National Science Foundation/National Center for Atmospheric Research (NSF/NCAR) dropwindsonde data from the PRE-Depression Investigation of Cloud-systems in the Tropics (PREDICT) field experiment were valuable, particularly in assessing Fiona's genesis. Data and imagery from NOAA polar-orbiting satellites, the NASA Tropical Rainfall Measuring Mission (TRMM) and Aqua, the European Space Agency's Advanced Scatterometer (ASCAT), Defense Meteorological Satellite Program (DMSP) satellites, and the NRL WindSat, among others, were also useful in constructing the best track of Fiona.

Fiona's strengthening to a tropical storm by 1800 UTC 30 August is based on an ASCAT pass at 1208 UTC, which showed 30 to 35 kt winds, and data from a dropwindsonde released by an NSF/NCAR G-V aircraft in the PREDICT field experiment at 1513 UTC. The dropwindsonde measured a surface wind of 35 kt and an average wind of 39 kt over the lowest 150 mb of the drop, which reduces to a surface wind estimate of about 32 kt.

Fiona's estimated peak intensity of 55 kt at 1800 UTC 1 September is based on a maximum 850 mb flight-level wind of 70 kt at 1747 UTC and the highest credible SFMR measurement of 53 kt at 1943 UTC. The estimated minimum pressure is based on an extrapolated pressure of 998 mb from the Hurricane Hunter aircraft around 1200 UTC 1 September.

The only ship that reported tropical-storm-force winds in association with Fiona was the *Johannes Maersk* (call sign OWFD2), which reported 35-kt winds and a pressure of 1010.0 mb at 1800 UTC 31 August while located in a rainband about 155 n mi southeast of the cyclone's center.

c. Casualty and Damage Statistics

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

d. Forecast and Warning Critique

The genesis of Fiona was anticipated well in advance; however the system developed significantly later than initially expected. The precursor disturbance was first given a "low" (0 to 20%) chance of genesis in the Tropical Weather Outlook at 1800 UTC 26 August. The chance of genesis was raised to "high" (greater than 50%) only 6 h later at 0000 UTC 27 August—3.5 days before the disturbance became a tropical cyclone. The low did not maintain organized deep convection for a couple of days as it moved westward across the Atlantic, which led to a delay in tropical cyclone formation.

A verification of NHC official track forecasts for Fiona is given in Table 2a. Official forecast track errors were lower than the mean official errors for the previous five-year period between 24 and 96 h, even though CLIPER5 errors were considerably higher than those for an average cyclone over the past five years. A homogeneous comparison of the official track errors with selected guidance models is given in Table 2b. None of the track or track consensus models had substantially lower errors than the official forecasts. The best guidance, relatively speaking, was the NOGAPS (NGPI), ECMWF (EMXI), Florida State Superensemble (FSSE), and the consensus TVCN and TVCC. The Global Forecast System (GFSI) and the UKMET model (UKMI/EGRI) trackers did not follow the circulation center of Fiona as well as the other dynamical models, and those models were not sufficiently available to meet the 2/3 homogeneity requirement for verification. As a result, TCON, TCCN, GUNA, and AEMI were also unavailable.

NHC official intensity forecasts for Fiona were spectacular. A verification of these forecasts is given in Table 3a. Official errors were no higher than about 7 kt (at 24 and 36 h) and were lower than the mean official errors for the previous five-year period at all forecast times. A homogeneous comparison of the official intensity errors with selected guidance models is given in Table 3b. No model or model consensus beat the official forecasts through 48 h. Only the HWRF had lower errors than the official forecasts at 72 h, but there were only two verified forecasts at that forecast time.

Watches and warnings associated with Fiona are given in Table 4. The governments of Antigua and Barbuda and the Netherlands Antilles issued tropical storm watches for parts of the northern Leeward Islands early on 31 August since Fiona was forecast to move near that area. The government of France issued tropical storm warnings for the French northern Leeward Islands later that day. Tropical-storm-force winds, however, stayed northeast of the islands as Fiona passed by on 1 September. The Bermuda Weather Service issued a tropical storm watch and then a warning for Bermuda on 2 September, but Fiona weakened to a remnant low just as it was passing to the southeast of that island on 4 September.

Table 1. Best track for Tropical Storm Fiona, 30 August – 3 September 2010.

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
30 / 0000	14.0	41.8	1007	25	low
30 / 0600	14.1	43.8	1007	30	"
30 / 1200	14.4	45.7	1007	30	tropical depression
30 / 1800	14.9	47.7	1007	35	tropical storm
31 / 0000	15.5	50.0	1007	35	"
31 / 0600	15.9	52.5	1006	35	"
31 / 1200	16.1	54.8	1006	35	"
31 / 1800	16.3	56.9	1006	40	"
01 / 0000	16.6	58.5	1004	45	"
01 / 0600	17.2	59.8	1001	50	"
01 / 1200	18.2	61.0	998	50	"
01 / 1800	19.5	62.5	999	55	"
02 / 0000	21.0	63.8	1000	50	"
02 / 0600	22.3	64.9	1001	45	"
02 / 1200	23.6	65.9	1002	45	"
02 / 1800	25.0	66.6	1003	45	"
03 / 0000	26.3	67.0	1005	40	"
03 / 0600	27.5	67.0	1007	40	"
03 / 1200	28.5	66.7	1010	35	"
03 / 1800	29.6	66.0	1011	35	"
04 / 0000	30.7	65.0	1011	35	low
04 / 0600	31.8	63.9	1011	30	"
04 / 1200	32.9	62.9	1011	25	"
04 / 1800	34.1	62.0	1011	25	"
05 / 0000					dissipated
01 / 1200	18.2	61.0	998	50	minimum pressure
01 / 1800	19.5	62.5	999	55	maximum wind

Table 2a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) track forecast errors (n mi) for Tropical Storm Fiona, 30 August – 3 September 2010. Mean errors for the five-year period 2005-9 are shown for comparison. Official errors that are smaller than the five-year means are shown in boldface type.

	Forecast Period (h)						
	12	24	36	48	72	96	120
OFCL	39.1	**48.2**	**54.7**	**74.5**	**106.7**	**164.3**	
OCD5	61.9	115.5	184.2	279.9	422.5	660.6	
Forecasts	15	13	11	9	5	1	
OFCL (2005-9)	31.8	53.4	75.4	96.8	143.8	195.6	
OCD5 (2005-9)	46.9	97.3	155.4	211.6	304.8	387.9	

Table 2b. Homogeneous comparison of selected track forecast guidance models (in n mi) for Tropical Storm Fiona, 30 August – 3 September 2010. 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 2a due to the homogeneity requirement.

Model ID	Forecast Period (h)						
	12	24	36	48	72	96	120
OFCL	39.3	46.2	52.0	84.5	70.6		
OCD5	56.4	107.4	175.6	290.5	375.4		
GHMI	53.5	68.4	76.4	**83.7**	**14.0**		
HWFI	39.6	55.5	73.2	98.4	95.9		
GFNI	55.4	93.3	138.0	175.8	139.5		
NGPI	**37.1**	**44.9**	58.2	**81.6**	103.9		
EMXI	39.9	**41.2**	**51.8**	85.8	149.7		
CMCI	**36.2**	53.3	88.4	174.3	392.3		
FSSE	**36.6**	47.2	58.9	**82.5**	**55.7**		
TVCN	**36.8**	48.4	53.0	**76.7**	**49.8**		
TVCC	**38.6**	46.2	**51.7**	**78.9**	**64.0**		
LBAR	53.0	81.7	105.8	163.5	161.8		
BAMD	73.1	122.9	177.5	256.0	400.1		
BAMM	53.1	74.4	104.1	136.5	163.5		
BAMS	44.1	64.6	101.4	147.9	362.7		
Forecasts	8	7	6	5	2		

Table 3a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) intensity forecast errors (kt) for Tropical Storm Fiona, 30 August – 3 September 2010. Mean errors for the five-year period 2005-9 are shown for comparison. Official errors that are smaller than the five-year means are shown in boldface type.

	Forecast Period (h)						
	12	24	36	48	72	96	120
OFCL	**4.7**	**7.3**	**7.3**	**5.6**	**5.0**	**5.0**	
OCD5	8.4	12.3	13.0	14.6	32.4	11.0	
Forecasts	15	13	11	9	5	1	
OFCL (2005-9)	7.0	10.7	13.1	15.2	18.6	18.7	
OCD5 (2005-9)	8.6	12.5	15.8	18.2	21.0	22.7	

Table 3b. Homogeneous comparison of selected intensity forecast guidance models (in kt) for Tropical Storm Fiona, 30 August – 3 September 2010. 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	5.4	8.2	7.8	5.0	7.5		
OCD5	8.8	13.3	14.6	17.1	30.5		
GHMI	6.2	10.8	21.6	29.0	22.5		
HWFI	10.1	11.8	12.1	12.0	**1.5**		
GFNI	6.2	8.2	9.9	14.1	14.5		
FSSE	7.1	9.5	12.3	15.3	16.0		
DSHP	6.4	8.3	9.1	11.6	11.5		
LGEM	7.2	10.0	12.2	14.4	16.5		
ICON	7.2	9.2	11.0	14.1	12.5		
IVCN	6.7	8.7	9.6	12.6	13.0		
Forecasts	13	11	9	7	2		

Table 4. Watch and warning summary for Tropical Storm Fiona, 30 August – 3 September 2010.

Date/Time (UTC)	Action	Location
31 / 0300	Tropical Storm Watch issued	Anguilla / Antigua and Barbuda / Montserrat / St. Kitts and Nevis
31 / 0300	Tropical Storm Watch issued	Saba / Sint Maarten / Sint Eustatius
31 / 1200	Tropical Storm Warning issued	St. Barthélemy / St. Martin
1 / 2100	Tropical Storm Watch discontinued	All
1 / 2100	Tropical Storm Warning discontinued	All
2 / 0900	Tropical Storm Watch issued	Bermuda
2 / 1500	Tropical Storm Watch changed to Tropical Storm Warning	Bermuda
4 / 0000	Tropical Storm Warning discontinued	All

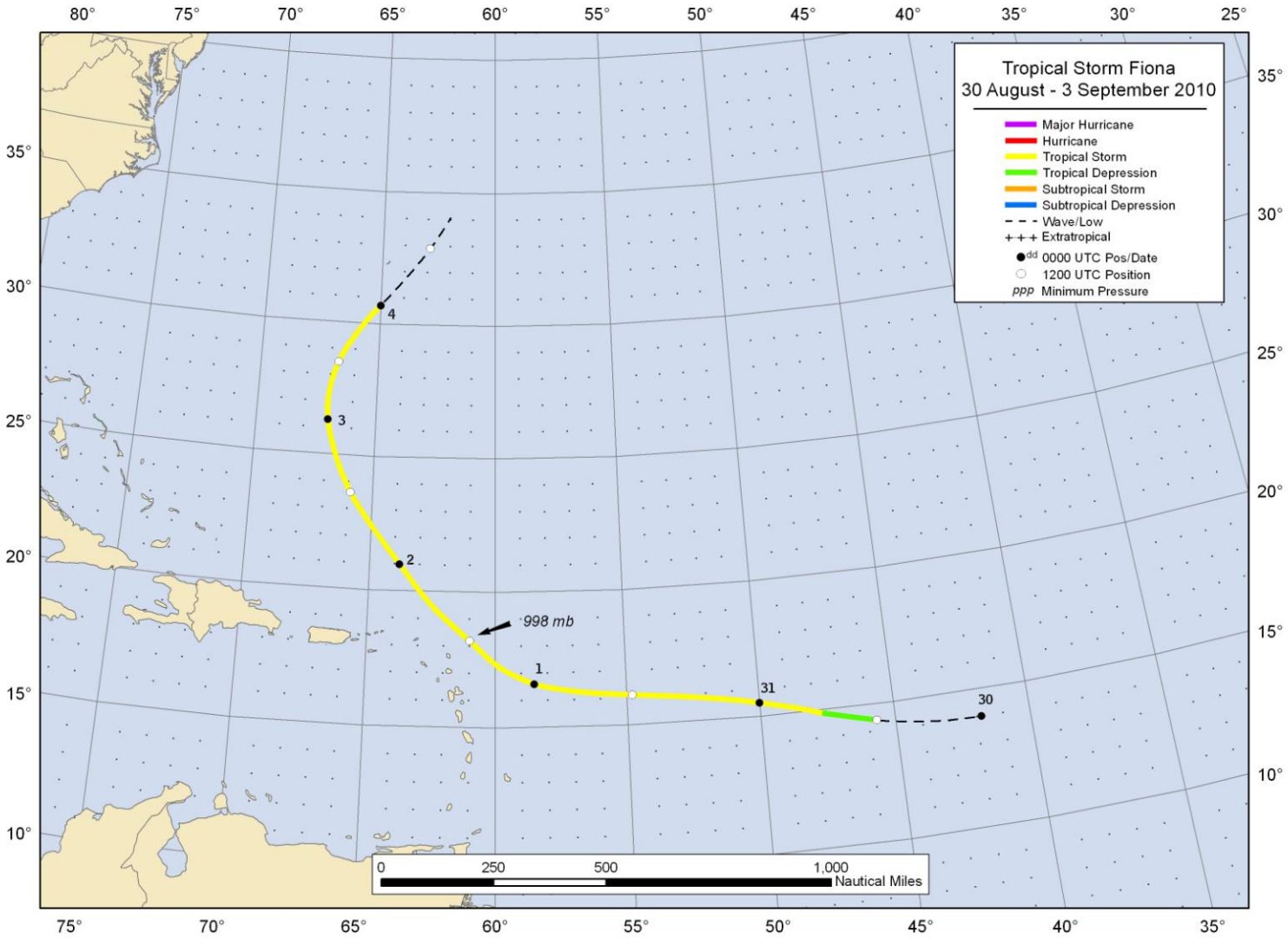

Figure 1. Best track positions for Tropical Storm Fiona, 30 August – 3 September 2010.

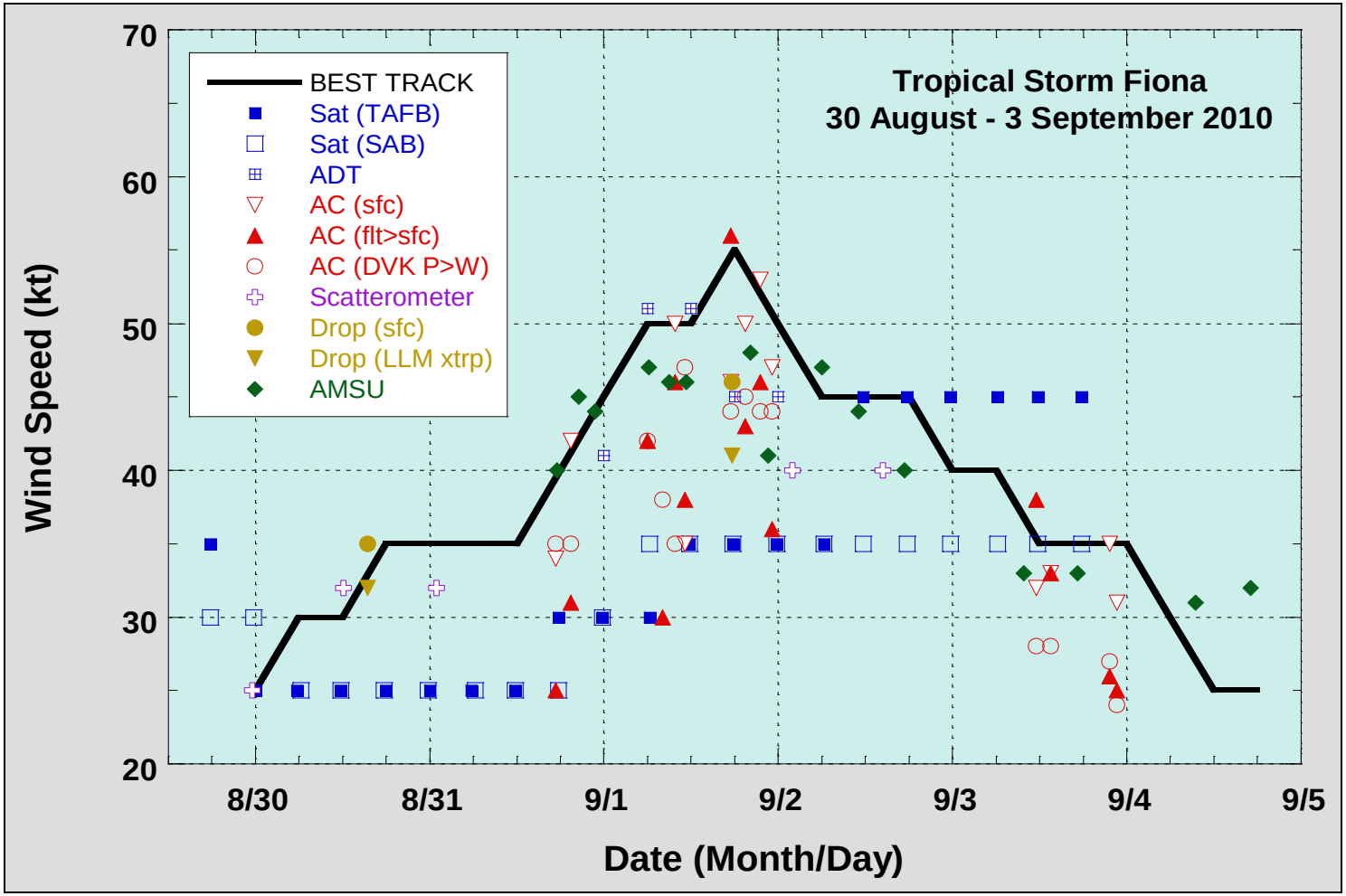

Figure 2. Selected wind observations and best track maximum sustained surface wind speed curve for Tropical Storm Fiona, 30 August – 3 September 2010. Aircraft observations have been adjusted for elevation using an 80% adjustment factor for observations from 850 mb and 1500 ft. Dropwindsonde observations 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 (ADT) estimates represent linear averages over a three-hour period centered on the nominal observation time. Dashed vertical lines correspond to 0000 UTC.

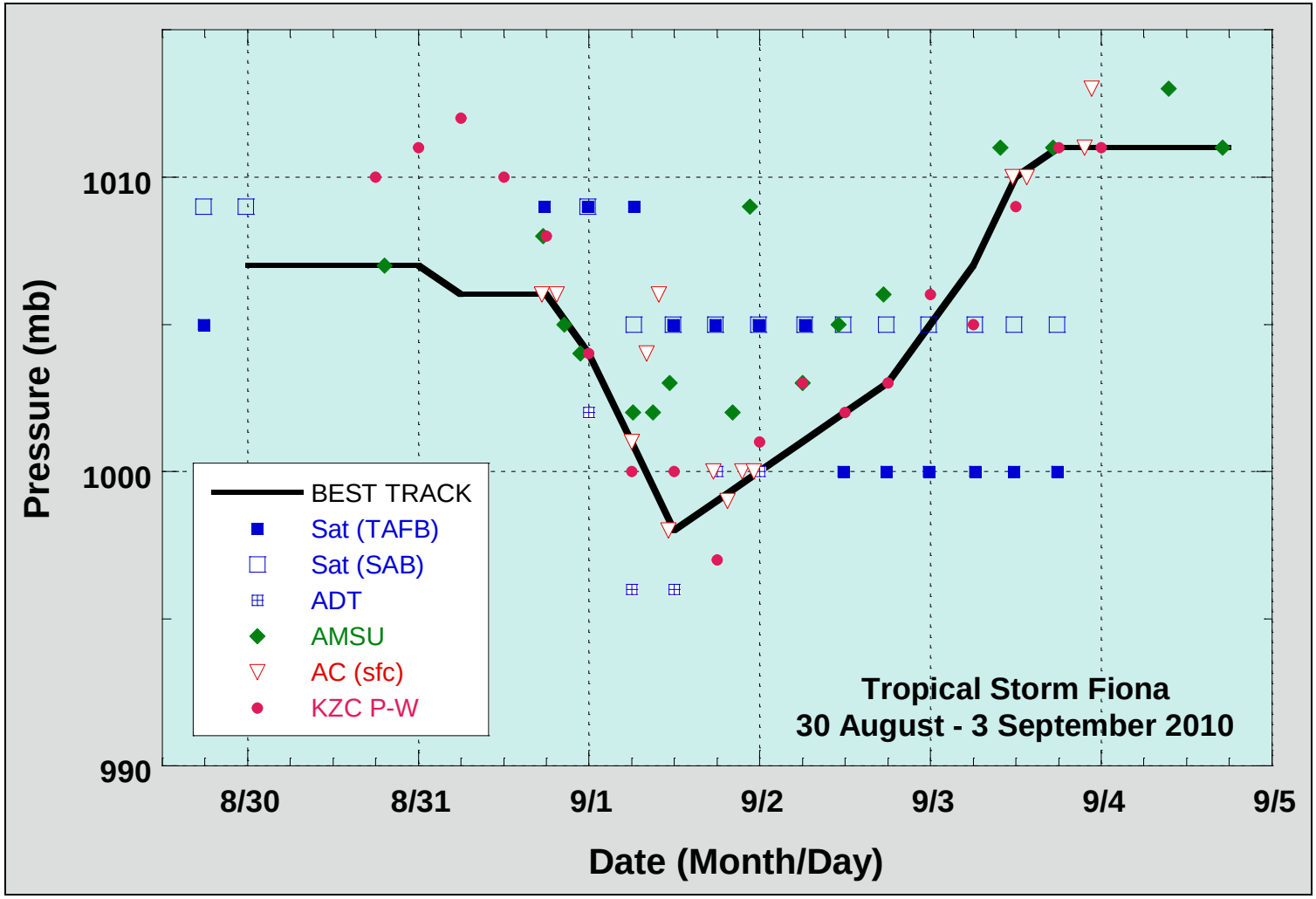

Figure 3. Selected pressure observations and best track minimum central pressure curve for Tropical Storm Fiona, 30 August – 30 September 2010. ADT points represent linear averages of UW-CIMSS Advanced Dvorak Technique estimates over a three-hour period centered on the nominal observation time. AMSU intensity estimates are from the UW-CIMSS technique. Dashed vertical lines correspond to 0000 UTC. KZC P-W refers to pressure estimates derived using the Knaff-Zehr-Courtney pressure-wind relationship.

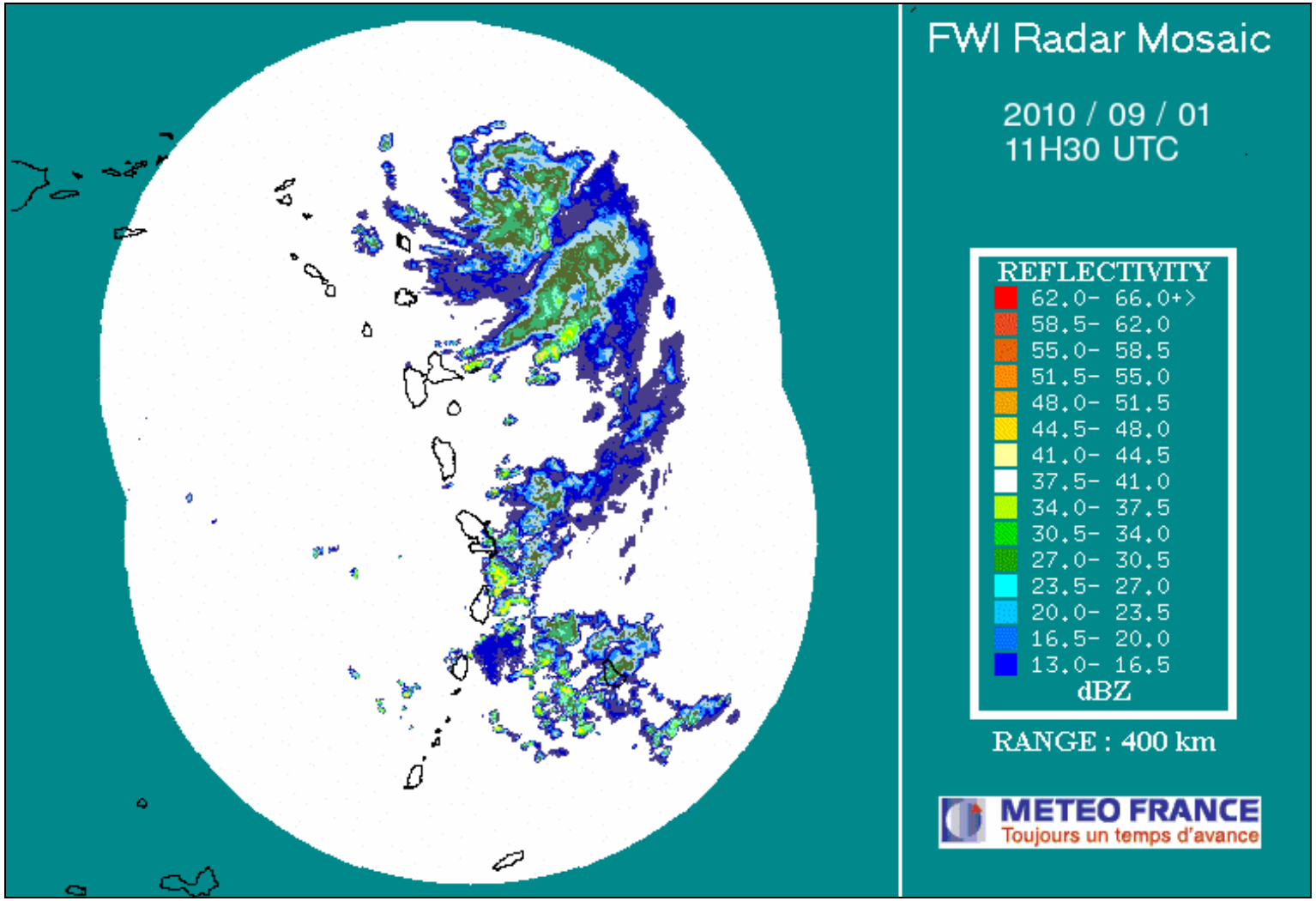

Figure 4. Meteo-France radar mosaic from Guadeloupe and Martinique at 1130 UTC 1 September 2010, about 6 h before Tropical Storm Fiona reached its estimated peak intensity of 55 kt. An eye-like feature is evident in the radar presentation to the northeast of the island of Barbuda in the upper part of the image. Image courtesy of Meteo-France.

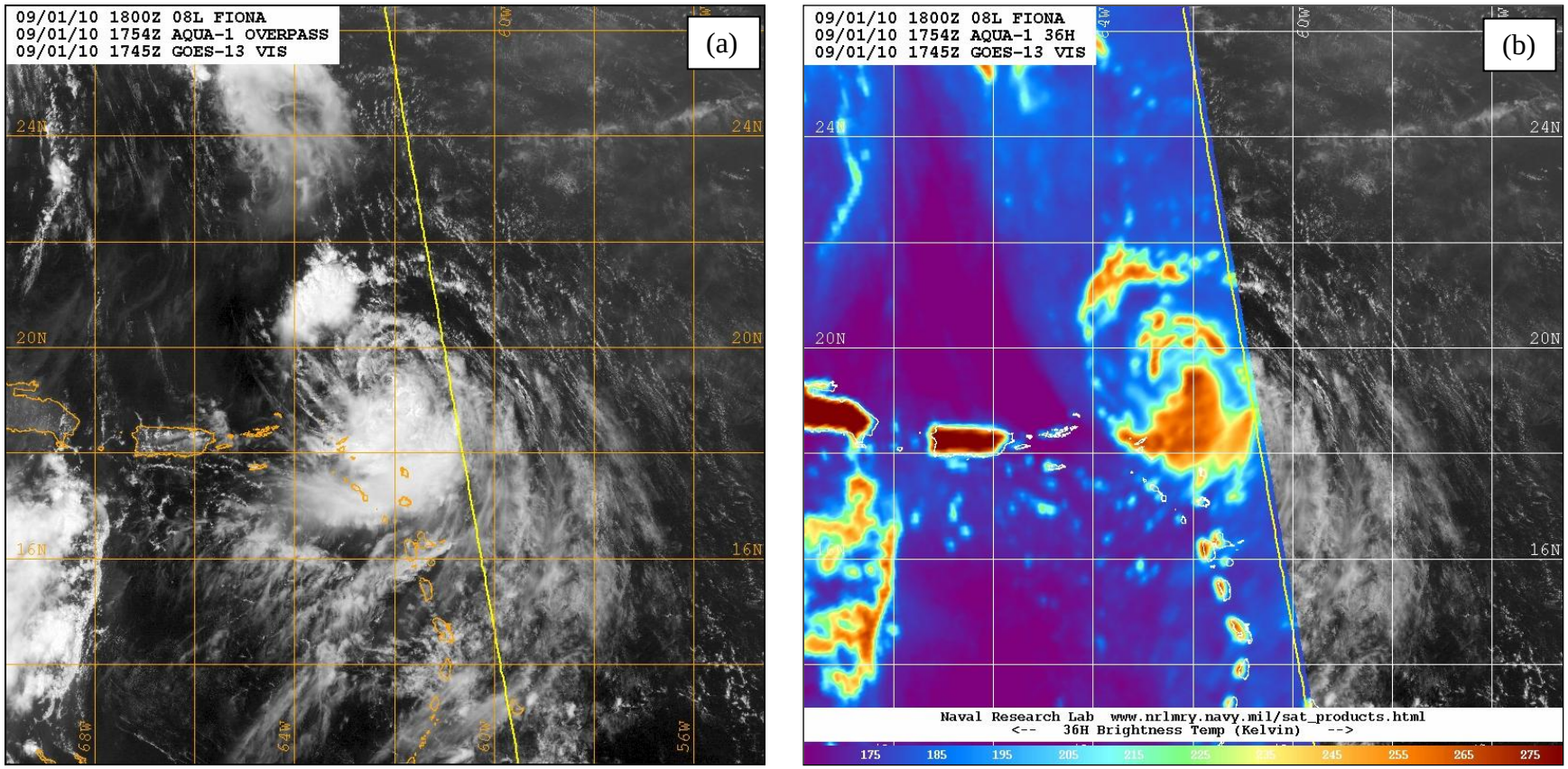

Figure 5. (a) Visible and (b) 36-H GHz AMSR-E imagery of Tropical Storm Fiona at 1754 UTC 1 September 2010, when the cyclone reached its estimated peak intensity of 55 kt. Images courtesy of the Naval Research Laboratory in Monterey, CA.