Tropical Cyclone Report
Tropical Storm Cindy
(AL032011)
20-22 July 2011

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Cindy was a short-lived tropical storm that developed east of Bermuda and moved quickly northeastward over the cooler waters of the North Atlantic.

a. Synoptic History

Cindy originated from the remnants of a cold front that moved off the southeast coast of the United States on 14 July. This feature first spawned the low pressure area from which Tropical Storm Bret developed. Cindy's incipient disturbance was first identified in satellite imagery late on 17 July, when an area of relatively concentrated cloudiness and showers developed about 300 n mi west-southwest of Bermuda. The disturbance formed along the decaying front as a weak mid- to upper-level trough moved over the western Atlantic. The next day a broad low pressure area formed to the northwest of Bermuda as the disturbance moved east-northeastward. Shower and thunderstorm activity became better organized as the system passed just north of Bermuda, and early on 20 July the low pressure area developed a well-defined center. This resulted in the formation of a tropical depression about 265 n mi east of Bermuda at 0600 UTC 20 July. The "best track" chart of the tropical 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 moved east-northeastward at 20 to 25 kt and became a tropical storm 6 h later. Shortly thereafter, Cindy turned northeastward in mid-latitude southwesterly flow over the central Atlantic, and it remained on this general heading throughout the remainder of its existence. After becoming a tropical storm Cindy gradually strengthened as seen in geostationary and microwave satellite imagery showing thunderstorm activity becoming better organized. Cindy reached a peak intensity of 60 kt at 1800 UTC 21 July. At that time, a ring of convection was seen in microwave imagery around the center (Fig. 4), while in visible satellite imagery a band of deep convection wrapped nearly around the center and a ragged eye-like feature appeared (Fig. 5). The convective ring remained evident in the microwave data for about 6 to 8 h.

Around 0000 UTC 22 July, Cindy moved over sea surface temperatures of less than 26°C and during the next 24 h, the convection associated with Cindy gradually waned and became less

[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.

organized. The remaining convection dissipated late on 22 July and Cindy became a post-tropical cyclone with winds still near 40 kt, about 855 n mi southwest of the coast of southwestern Ireland. The post-tropical cyclone weakened further and the circulation opened up into a trough of low pressure in the strong southwesterly flow over the North Atlantic by 1200 UTC 22 July.

b. Meteorological Statistics

Observations in Cindy (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). Data and imagery from NOAA polar-orbiting satellites, including Advanced Microwave Sounding Unit (AMSU) intensity estimates from the Cooperative Institute for Meteorological Satellite Studies (CIMSS), the NASA Tropical Rainfall Measuring Mission (TRMM) and Aqua, 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 Cindy.

An ASCAT pass at 0058 UTC 21 July revealed several 40 to 42 kt surface winds. Based on these data the intensity of Cindy is estimated to have been 45 kt at that time. This is higher than the corresponding Dvorak intensity estimates of 35 kt and 30 kt from TAFB and SAB, respectively. The structure and organization of the cyclone improved considerably during the following 12 to 18 h and Cindy is estimated to have strengthened and reached peak intensity during that time. Although Dvorak classifications during the time of maximum organization were between 35 and 45 kt, the estimated peak intensity of 60 kt is based on the earlier ASCAT data and the improved structure seen in satellite data. An AMSU satellite intensity estimate of 57 kt from the CIMSS technique at 1647 UTC 21 July also supports the 60-kt peak intensity.

In Bermuda, the precursor disturbance produced a wind gust to 29 kt and 1.16 inches of rain at the official observing site at L.F. Wade International Airport on 19 July.

c. Casualty and Damage Statistics

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

d. Forecast and Warning Critique

The development of Cindy was not anticipated. The disturbance from which Cindy formed was first introduced into the Tropical Weather Outlook at 0000 UTC 20 July, only 6 h before genesis. The disturbance was initially assigned a low chance (<30%) of formation. The chance of development was raised to the medium category (30%-50%) around the time of formation as analyzed in the post-storm analysis.

A verification of NHC official track forecasts for Cindy is given in Table 2a. Only 7, 5, 3, and 1 official forecasts verified at 12, 24, 36, and 48 h, respectively. The official forecast track errors were comparable to the mean official errors for the previous 5-yr period. A homogeneous comparison of the official track errors with selected guidance models is given in Table 2b.

A verification of the few NHC official intensity forecasts for Cindy is given in Table 3a. The official forecast intensity errors were lower than the mean official errors for the previous 5-yr period. A homogeneous comparison of the official intensity errors with selected guidance models is given in Table 3b. The mean official intensity errors were lower than nearly all of the intensity guidance models at 12, 24, and 36 h.

No coastal tropical cyclone watches or warnings were required for Cindy.

Table 1. Best track for Tropical Storm Cindy, 20-22 July 2011.

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
20 / 0600	33.0	59.5	1010	30	tropical depression
20 / 1200	33.4	57.0	1008	35	tropical storm
20 / 1800	34.5	54.7	1006	40	"
21 / 0000	35.8	52.5	1003	45	"
21 / 0600	37.4	50.5	999	50	"
21 / 1200	39.4	48.4	996	55	"
21 / 1800	41.3	46.1	994	60	"
22 / 0000	42.6	43.7	995	55	"
22 / 0600	43.8	41.2	997	50	"
22 / 1200	45.1	38.6	999	45	"
22 / 1800	46.7	35.6	1001	40	"
23 / 0000	48.4	32.1	1003	40	low
23 / 0600	50.0	27.8	1005	35	"
23 / 1200					disposition
21 / 1800	41.3	46.1	994	60	minimum pressure and maximum winds

Table 2a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) track forecast errors (n mi) for Tropical Storm Cindy, 20-22 July 2011. Mean errors for the 5-yr period 2006-10 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	33.5	67.0	71.7	97.4			
OCD5	48.3	95.8	141.5	268.1			
Forecasts	7	5	3	1			
OFCL (2006-10)	31.0	50.6	69.9	89.5	133.2	174.2	214.8
OCD5 (2006-10)	47.7	98.3	156.4	218.1	323.3	402.2	476.1

Table 2b. Homogeneous comparison of selected track forecast guidance models (in n mi) for Tropical Storm Cindy, 20-22 July 2011. 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	34.2	61.8					
OCD5	58.6	99.7					
GFSI	**32.4**	66.3					
GHMI	36.0	83.8					
HWFI	**30.1**	**45.5**					
NGPI	39.0	**60.8**					
UKMI	60.1	113.2					
EGRI	60.1	113.2					
EMXI	**19.4**	**45.4**					
NAMI	**31.7**	**34.8**					
FSSE	36.2	80.2					
AEMI	36.5	**57.6**					
TVCA	34.2	64.4					
TVCC	**33.5**	**56.3**					
LBAR	**22.9**	**43.3**					
BAMD	**30.5**	**52.3**					
BAMM	34.5	72.7					
BAMS	57.2	97.2					
Forecasts	3	2					

Table 3a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) intensity forecast errors (kt) for Tropical Storm Cindy, 20-22 July 2011. Mean errors for the 5-yr period 2006-10 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	**6.4**	**6.0**	**5.0**	**5.0**			
OCD5	5.7	11.0	10.3	7.0			
Forecasts	7	5	3	1			
OFCL (2006-10)	7.2	11.0	13.2	15.1	17.2	17.9	18.7
OCD5 (2006-10)	8.5	12.3	15.4	17.8	20.2	21.9	21.7

Table 3b. Homogeneous comparison of selected intensity forecast guidance models (in kt) for Tropical Storm Cindy, 20-22 July 2011. 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	7.0	6.0	5.0	5.0			
OCD5	7.0	11.0	10.3	7.0			
HWFI	8.8	10.6	12.0	12.0			
GHMI	14.2	16.4	19.3	18.0			
DSHP	**5.2**	9.0	7.7	**1.0**			
LGEM	7.2	11.2	9.7	**4.0**			
ICON	8.4	8.8	10.7	8.0			
IVCN	8.6	8.6	9.7	8.0			
NF	5	5	3	1			

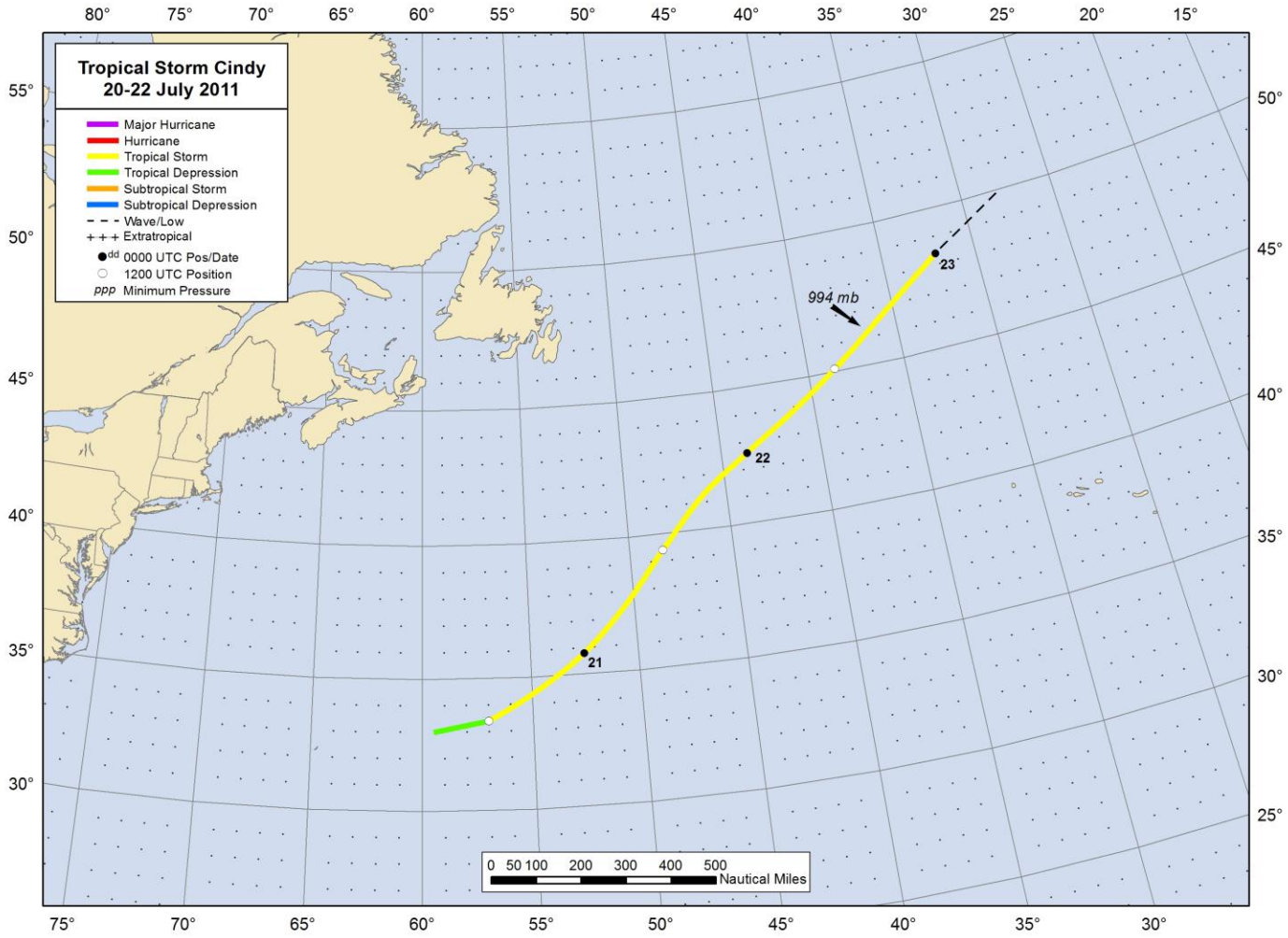


Figure 1. Best track positions for Tropical Storm Cindy, 20-22 July 2011.

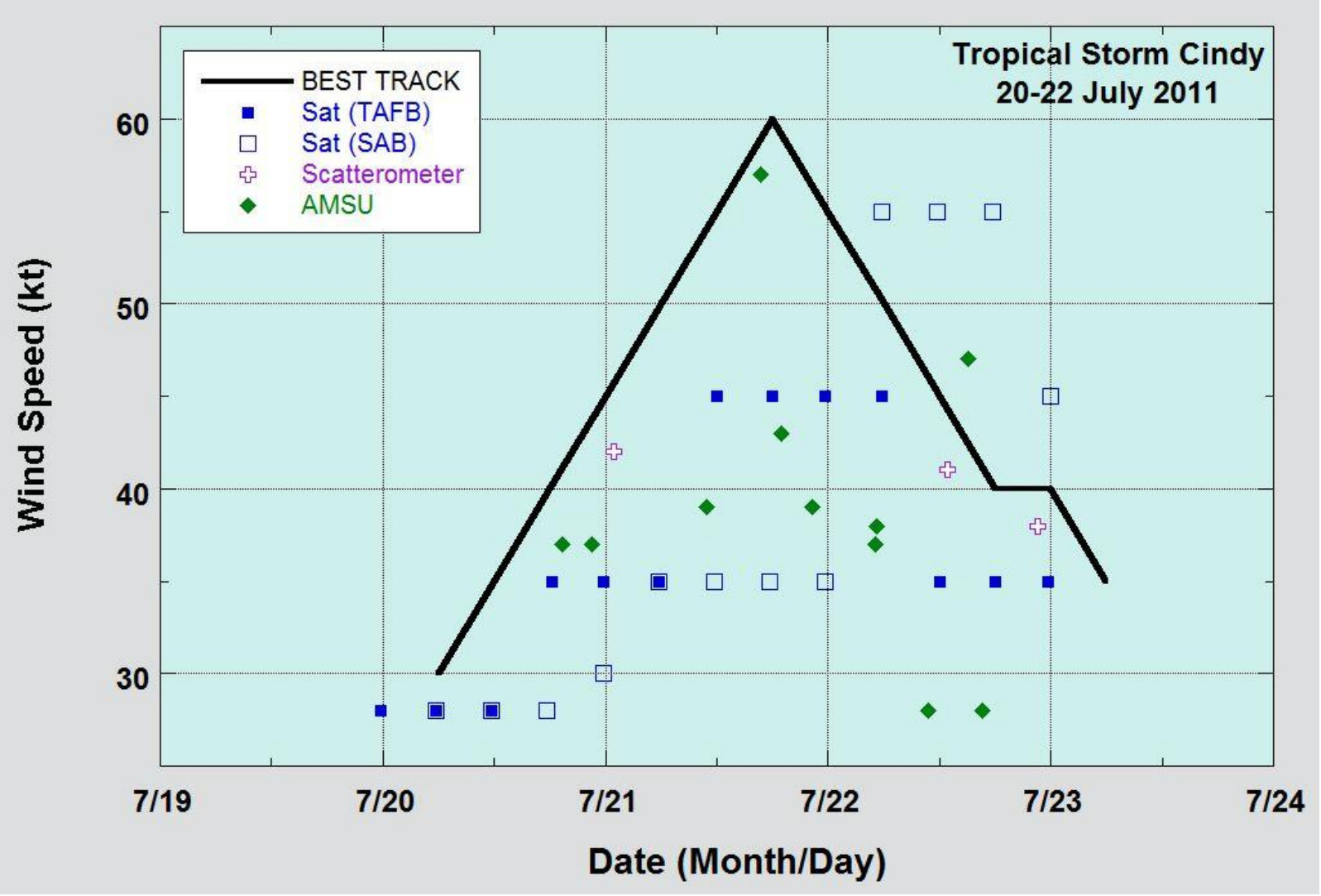


Figure 2. Selected wind observations and best track maximum sustained surface wind speed curve for Tropical Storm Cindy, 20-22 July 2011. AMSU intensity estimates are from the Cooperative Institute for Meteorological Satellite Studies technique. Dashed vertical lines correspond to 0000 UTC.

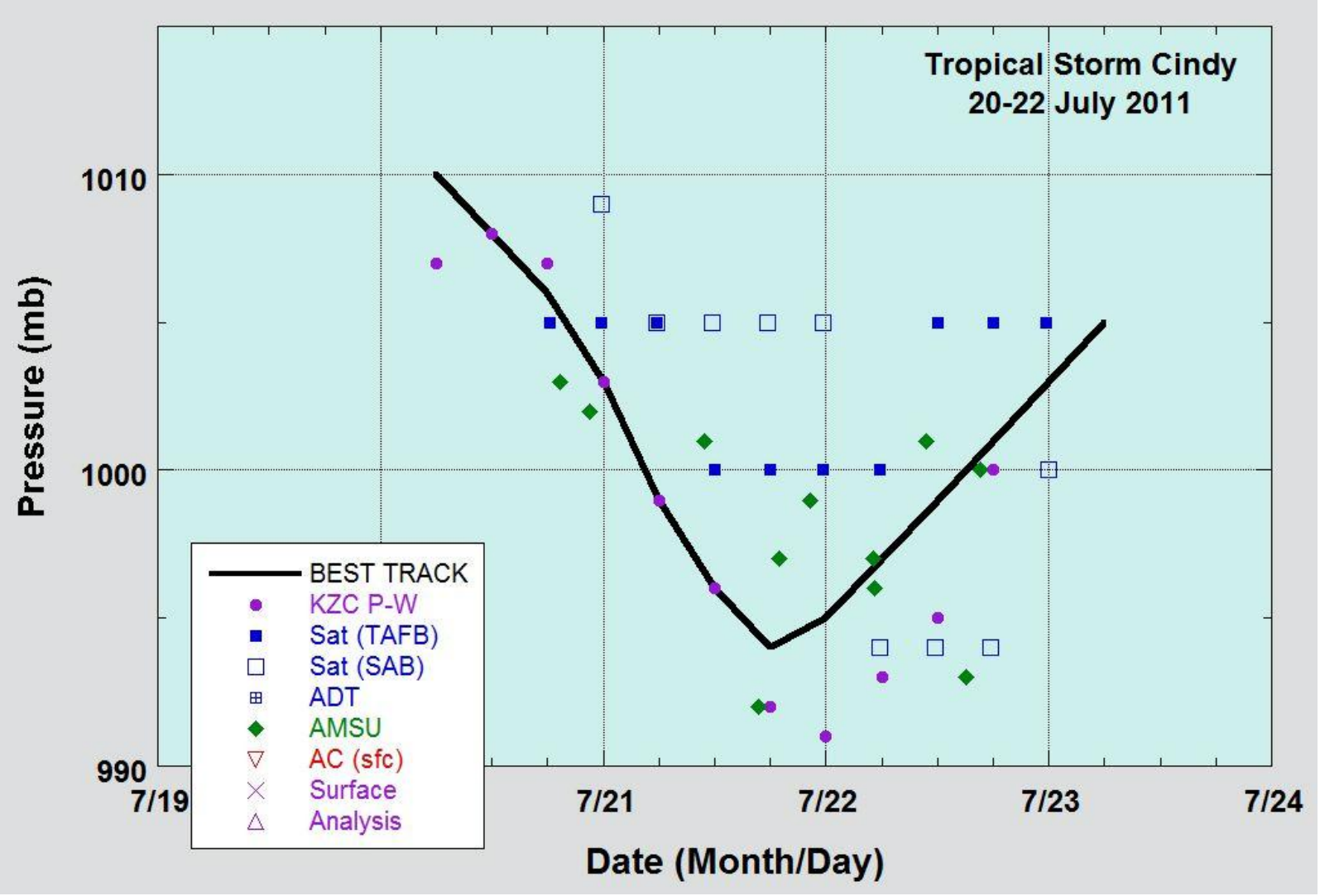
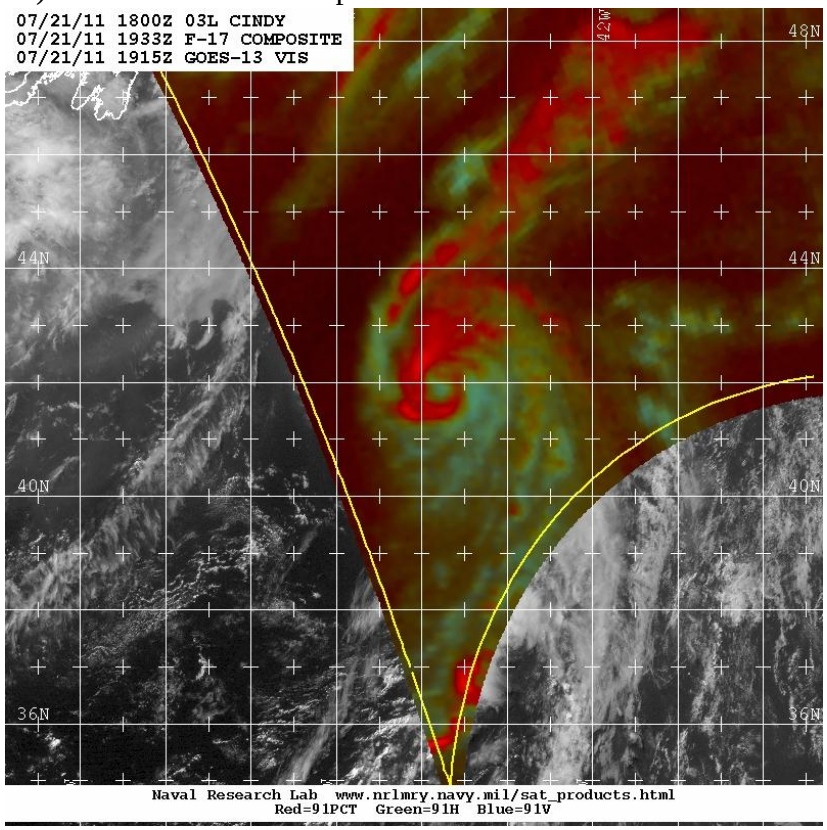


Figure 3. Selected pressure observations and best track minimum central pressure curve for Tropical Storm Cindy, 20-22 July 2011. AMSU intensity estimates are from the Cooperative Institute for Meteorological Satellite Studies technique. Dashed vertical lines correspond to 0000 UTC.

A) SSM/IS 91 GHz composite



B) Windsat 37 GHz composite

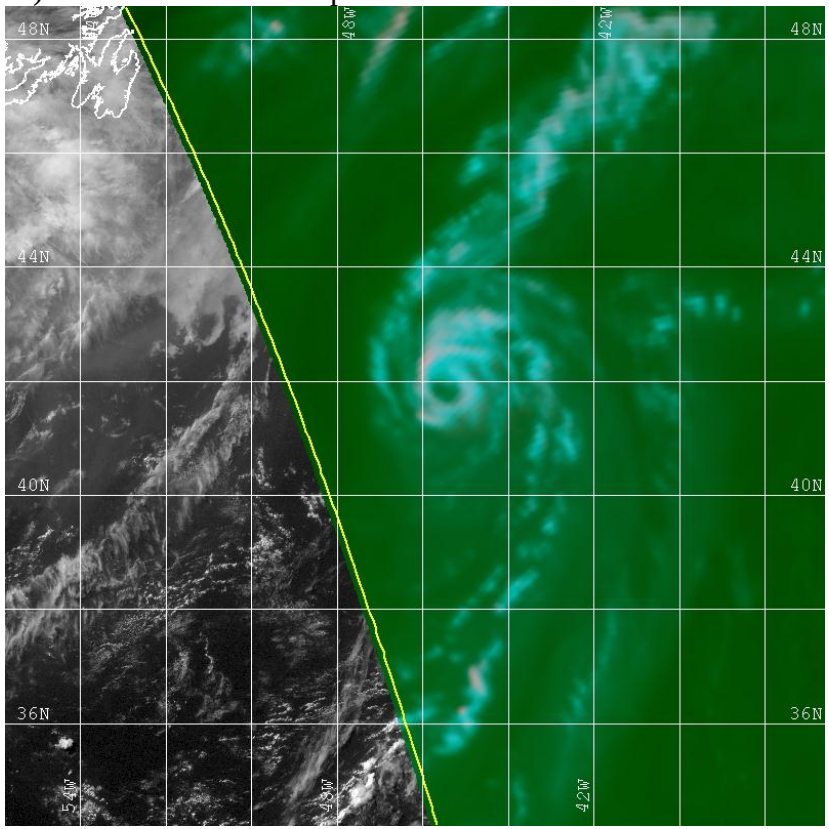


Figure 4. Microwave imagery of Tropical Storm Cindy near peak intensity. (A) Special Sensor Microwave Imager/Sounder (SSMIS) 91-GHz composite image of Tropical Storm Cindy at 1933 UTC 21 July. (B) Windsat 37-GHz composite image of Cindy at 2006 UTC 21 July. Images courtesy of the Navy Research Laboratory.

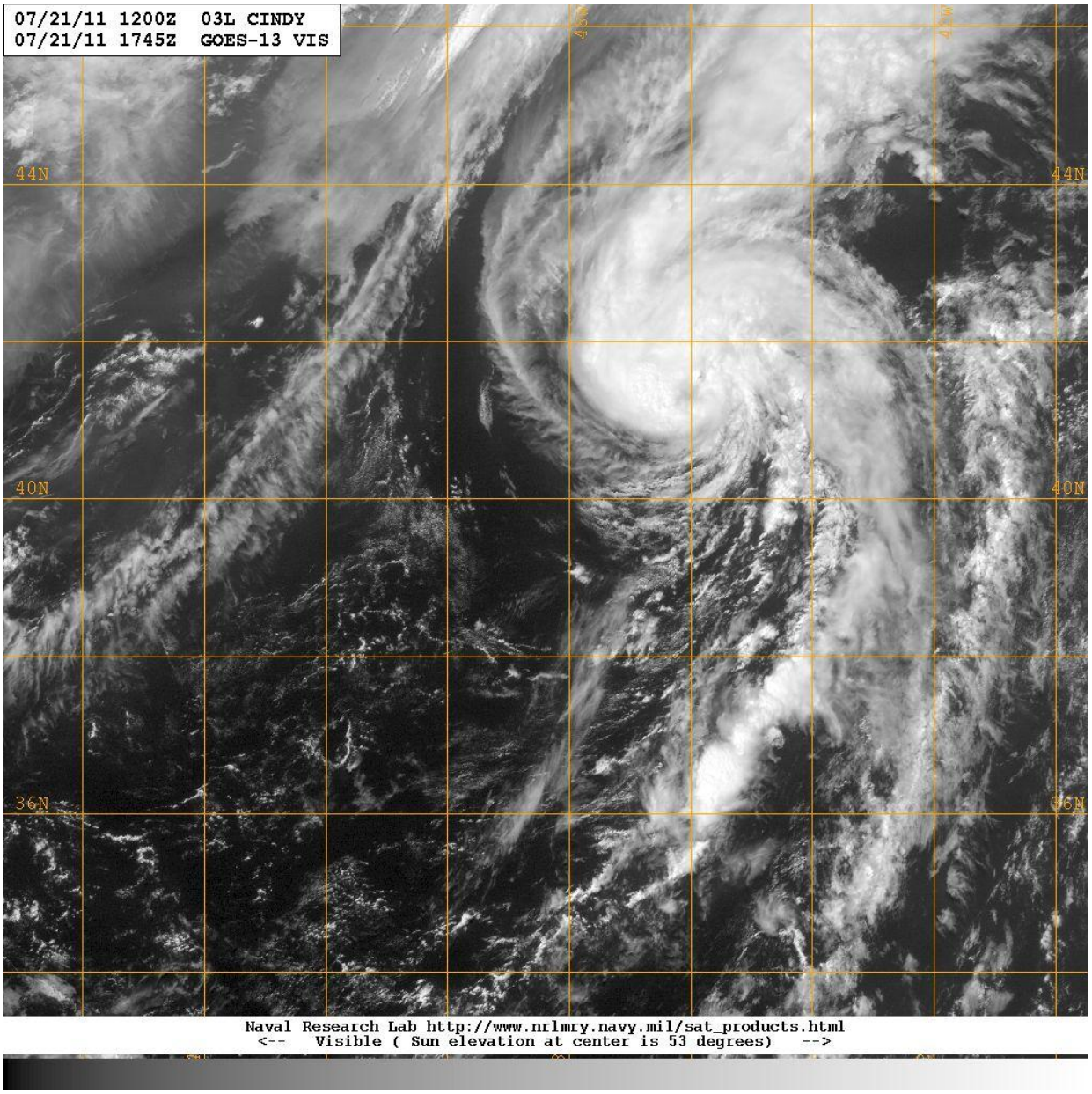


Figure 5. GOES-13 visible satellite image of Cindy at 1745 UTC 21 July 2011, near the time of peak intensity. Image courtesy of the Navy Research Laboratory.