Tropical Cyclone Report
Tropical Storm Harvey
(AL082011)
19 - 22 August 2011

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**Updated on 15 July 2012 for deaths in Mexico

Harvey was a short-lived tropical storm that made landfall with 55-kt winds in Belize and weakened as it moved across the southern Yucatan Peninsula. It re-strengthened into a tropical storm over the extreme southern portion of the Bay of Campeche before moving into southeastern Mexico, with floods causing five fatalities in that country.

a. Synoptic History

The precursor to Harvey was a tropical wave that departed the coast of Africa on 10 August. This system initially showed signs of organization with abundant convection and an accompanying surface low. However, the wave lost convection on 12 August, perhaps due to dry air entrainment and easterly shear, and the low dissipated by the next day. As the system moved over warmer waters in the western tropical Atlantic, the wave regained some of its convective vigor on 14 August. Surface data indicated that the system lacked a closed surface circulation as it traversed the eastern and central Caribbean Sea, although intense convection caused the formation of a mid-level circulation center on 16 August south of Puerto Rico. The wave's forward speed decreased the next day, and convection increased in both coverage and organization near the mid-level center on 18 August when the system was in the western Caribbean Sea. Late that day, the final few visible satellite images indicated the formation of a closed surface low and it is estimated that a tropical depression formed by 0000 UTC 19 August about 70 n mi northeast of Cabo Gracias a Dios on the border of Nicaragua and Honduras. The "best track" chart of Harvey'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].

In an environment of moderate easterly wind shear and over very warm waters, the depression became a tropical storm 12 h after genesis. These conditions allowed the small tropical cyclone to gradually strengthen on 19 and 20 August. Meanwhile, a mid-level ridge over the Gulf of Mexico steered Harvey to the west-northwest just to the north of mainland Honduras and the Bay Islands. In the last several hours before landfall, convection became deeper near the center, and radar images from Belize (Fig. 4) along with aircraft reconnaissance fixes indicated that an eye was beginning to form. Although that feature did not solidify, reconnaissance and satellite data suggested Harvey reached a peak intensity of 55 kt by landfall

[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.

near Dangriga, Belize around 1730 UTC 20 August. The storm weakened into a tropical depression over northwestern Guatemala, although the continuation of its west-northwestward motion brought the center over the Bay of Campeche just before 1800 UTC 21 August. Harvey turned toward the west shortly after that time, and a large flare-up of convection near and west of the center caused the system to intensify slightly. Surface data from Mexico indicate that Harvey became a tropical storm again with 35-kt winds by 0000 UTC 22 August, and the storm made landfall around 0200 UTC 22 that day near Punta Roca Partida, Mexico. Harvey quickly weakened into a tropical depression within a few hours after landfall, and dissipated over the high terrain of Mexico shortly after 1200 UTC 22 August, when the system was located about 85 n mi southwest of Veracruz, Mexico.

b. Meteorological Statistics

Observations in Harvey (Figs. 2 and 3) include satellite-based Dvorak technique intensity estimates from the Tropical Analysis and Forecast Branch (TAFB) and the Satellite Analysis Branch (SAB), as well as the Advanced Dvorak Technique from the University of Wisconsin-Madison/Cooperative Institute for Meteorological Satellite Studies (UW-CIMSS). Data from five flights of the Air Force Reserve 53rd weather reconnaissance squadron was utilized for both the flight-level winds and stepped frequency microwave radiometer (SFMR) surface wind estimates. Data and imagery from NOAA polar-orbiting satellites including the Advanced Microwave Sounding Unit (AMSU), the NASA Tropical Rainfall Measuring Mission (TRMM), Defense Meteorological Satellite Program (DMSP) satellites, among others, were also useful in constructing the best track of Harvey.

The 55-kt estimated peak intensity of Harvey is partly based on an SFMR measurement of 52 kt 2 h before landfall in Belize as the reconnaissance plane was departing the area. The Belize radar showed a partial eye before landfall (Fig. 4), which was consistent with Harvey gradually intensifying. This intensity also matches the TAFB/SAB Dvorak satellite estimates of 55 kt. The CIMSS ADT seemed to have a high bias for this system and was not used.

The lowest minimum pressure of 994 mb was based on a center dropsonde that measured 997 mb with 32 kt of wind at the surface.

Perhaps due to the very small size of Harvey, there were no reports of tropical-storm-force winds in Belize. The only report of tropical-storm-force winds on land was measured at Sacrifice Island (SACV4), located just east of Veracruz. A 2-min sustained wind of 33 kt was reported at 0100 UTC 22 August, with a peak gust of 40 kt near that time. This observation is the basis for upgrading Harvey back to a tropical storm before the second landfall. A second observing station in Veracruz Harbor (VERV4) reported a peak wind gust of 41 kt at 0213 UTC 22 August and a 10-min sustained wind of 30 kt.

There were no ship reports of tropical-storm-force winds in association with Harvey.

c. Casualty and Damage Statistics

According to the Associated Press, high winds and heavy rain were noted in Dangriga, Belize during the storm, but there were no reports of damage or casualties there. In Mexico, three people were killed in San Lucas Zoquiapam, Oaxaca, due to a landslide hitting their home. Two other people were also killed from unknown causes in Mexico. Although no specific rainfall total are available, Harvey caused significant floods, and 334 homes were damaged in the municipality of Veracruz.

d. Forecast and Warning Critique

Initially, the genesis of Harvey was not well forecast. When the wave that spawned the tropical cyclone was just offshore of Africa, it was introduced in the Tropical Weather Outlook and reached the medium chance (30-50%) category of genesis for about a day. Subsequently, the system did not develop in the tropical Atlantic and it was dropped from the Outlook. However, the genesis forecast for the eventual formation of the tropical cyclone was outstanding. The wave was reintroduced about 84 h before genesis with a low (20%) chance of genesis, and this probably was increased to the medium category about 42 h before genesis and a high (60%) chance 24 h before formation.

A verification of NHC official track forecasts for Harvey is given in Table 2a. Official forecast track errors were near or above the mean official errors for the previous 5-yr period. However, the OCD5 (CLIPER) errors for this system were below their 5-yr averages, suggesting the track forecasts were generally easier than average. An inspection of the OFCL errors reveals that the official forecast positions were too far to the south. In addition, very few of the models showed the system emerging over the Bay of Campeche. A homogeneous comparison of the official track errors with selected guidance models is given in Table 2b. The NAM and the UKMET (EGRI) models had poor performances for this storm, while BAM medium and shallow and the various consensus models generally were a little better than the official forecast.

A verification of NHC official intensity forecasts for Harvey is given in Table 3a. Official forecast intensity errors were near the average 5-yr error at 12 h but considerably lower thereafter. The OCD5 errors suggested that Harvey's intensity was relatively easy to forecast, which is not surprising since the cyclone spent a lot of time over land and its intensity changes were well behaved. A homogeneous comparison of the official intensity errors with selected guidance models is given in Table 3b. The official forecast was bested slightly by much of the model guidance, although the significance of the errors is low due to the small sample size.

Watches and warnings associated with Harvey are in Table 4.

Table 1. Best track for Tropical Storm Harvey, 19 – 22 August 2011.

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
19 / 0000	15.4	82.0	1006	30	tropical depression
19 / 0600	15.7	82.7	1005	30	"
19 / 1200	15.9	83.4	1003	35	tropical storm
19 / 1800	16.0	84.1	1001	40	"
20 / 0000	16.1	84.9	995	45	"
20 / 0600	16.3	85.8	994	50	"
20 / 1200	16.6	87.0	998	50	"
20 / 1800	17.0	88.3	995	55	"
21 / 0000	17.3	89.6	1003	35	"
21 / 0600	17.6	90.8	1005	30	tropical depression
21 / 1200	18.0	92.0	1005	30	"
21 / 1800	18.5	93.3	1005	30	"
22 / 0000	18.7	94.8	1005	35	tropical storm
22 / 0200	18.7	95.2	1005	35	"
22 / 0600	18.6	96.2	1006	25	tropical depression
22 / 1200	18.1	97.2	1007	20	"
22 / 1800					dissipated
20 / 0600	16.3	85.8	994	50	minimum pressure
20 / 1800	17.0	88.3	995	55	maximum winds
20 / 1730	17.0	88.3	995	55	landfall near Dangriga, Belize
22 / 0200	18.7	95.2	1005	35	landfall near Punta Roca Partida, Mexico

Table 2a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) track forecast errors (n mi) for Harvey. 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 (Harvey)	37.0	**49.5**	76.8	100.1	146.2		
OCD5 (Harvey)	48.5	63.7	107.4	165.0	214.4		
Forecasts	13	11	8	7	3		
OFCL (2006-10)	31.0	50.6	69.9	89.5	133.2		
OCD5 (2006-10)	47.7	98.3	156.4	218.1	323.3		

Table 2b. Homogeneous comparison of selected track forecast guidance models (in n mi) for Harvey. 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	31.4	42.2	68.3	97.7			
OCD5	42.4	59.3	107.1	165.6			
GFSI	40.3	53.6	80.9	122.2			
GHMI	39.1	49.4	85.5	107.5			
HWFI	48.7	61.1	**67.7**	**87.1**			
NAMI	43.7	59.2	120.6	171.1			
NGPI	40.8	64.7	69.5	109.9			
EGRI	40.7	58.1	107.1	155.7			
EMXI	35.7	44.6	**63.9**	106.0			
AEMI	39.8	59.8	95.5	137.9			
TVCA	36.9	**39.5**	**64.2**	**86.8**			
TVCE	37.0	**39.6**	**60.6**	**83.8**			
TVCC	36.7	43.7	68.5	**90.6**			
LBAR	39.3	42.2	**52.2**	**66.6**			
BAMD	40.6	57.0	86.1	119.2			
BAMM	**28.6**	**36.4**	**60.2**	**86.0**			
BAMS	36.1	46.1	**66.7**	**82.1**			
Forecasts	10	6	5	4			

Table 3a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) intensity forecast errors (kt) for Harvey. 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 (Harvey)	7.3	**9.1**	**10.6**	**1.4**	**6.7**		
OCD5 (Harvey)	6.8	9.2	9.5	3.6	7.0		
Forecasts	13	11	8	7	3		
OFCL (2006-10)	7.2	11.0	13.2	15.1	17.2		
OCD5 (2006-10)	8.5	12.3	15.4	17.8	20.2		

Table 3b. Homogeneous comparison of selected intensity forecast guidance models (in kt) for Harvey. Errors smaller than the NHC forecast are shown in boldface type.

Model ID	Forecast Period (h)						
	12	24	36	48	72	96	120
OFCL	7.3	9.1	10.6	1.4	6.7		
OCD5	**6.8**	9.2	**9.5**	3.6	7.0		
GHMI	**6.3**	**8.3**	**9.6**	7.1	**6.3**		
HWFI	**5.9**	9.1	**8.5**	4.4	**4.3**		
DSHP	**6.1**	**8.4**	**8.4**	4.7	**5.0**		
LGEM	**6.7**	10.3	**10.0**	4.7	**5.0**		
ICON	**5.2**	**8.5**	**7.8**	2.4	**5.0**		
IVCN	**5.2**	**8.4**	**7.1**	2.9	**5.0**		
Forecasts	13	11	8	7	3		

Table 4. Watches and warnings issued for Harvey, 19 – 22 August 2011.

Date/Time (UTC)	Action	Location
19 / 0300	Tropical Storm Watch issued	Honduras to Guatemala
19 / 1500	Tropical Storm Watch issued	Dangriga, Belize to Belize/Guatemala border
19 / 1500	Tropical Storm Watch issued	Punta Gruesa to Chetumal, Mexico
19 / 1500	Tropical Storm Warning issued	Bay Islands
19 / 1800	Tropical Storm Watch discontinued	Dangriga to Belize/Guatemala border
19 / 1800	Tropical Storm Warning issued	Belize
19 / 2100	Tropical Storm Watch changed to Tropical Storm Warning	Punta Gruesa to Chetumal
19 / 2100	Tropical Storm Watch issued	Honduras/Guatemala border to Punta Patuca, Honduras
20 / 0300	Tropical Storm Watch changed to Tropical Storm Warning	Honduras/Guatemala border to Punta Patuca
20 / 0900	Tropical Storm Watch changed to Tropical Storm Warning	Guatemala
20 / 1200	Tropical Storm Warning discontinued	Punta Gruesa to Chetumal
20 / 1500	Tropical Storm Warning discontinued	Bay Islands
20 / 1500	Tropical Storm Warning modified to	Honduras/Guatemala border to Punta Sal, Honduras
20 / 2100	Tropical Storm Warning discontinued	Belize
20 / 2100	Tropical Storm Warning discontinued	Honduras/Guatemala border to Punta Sal
20 / 2100	Tropical Storm Warning discontinued	Guatemala
20 / 2100	Tropical Storm Warning issued	Belize City to Belize/Mexico border
21 / 0000	Tropical Storm Warning discontinued	All
21 / 2100	Tropical Storm Warning issued	Punta el Lagarto to Barra de Nautla, Mexico
22 / 1200	Tropical Storm Warning discontinued	All

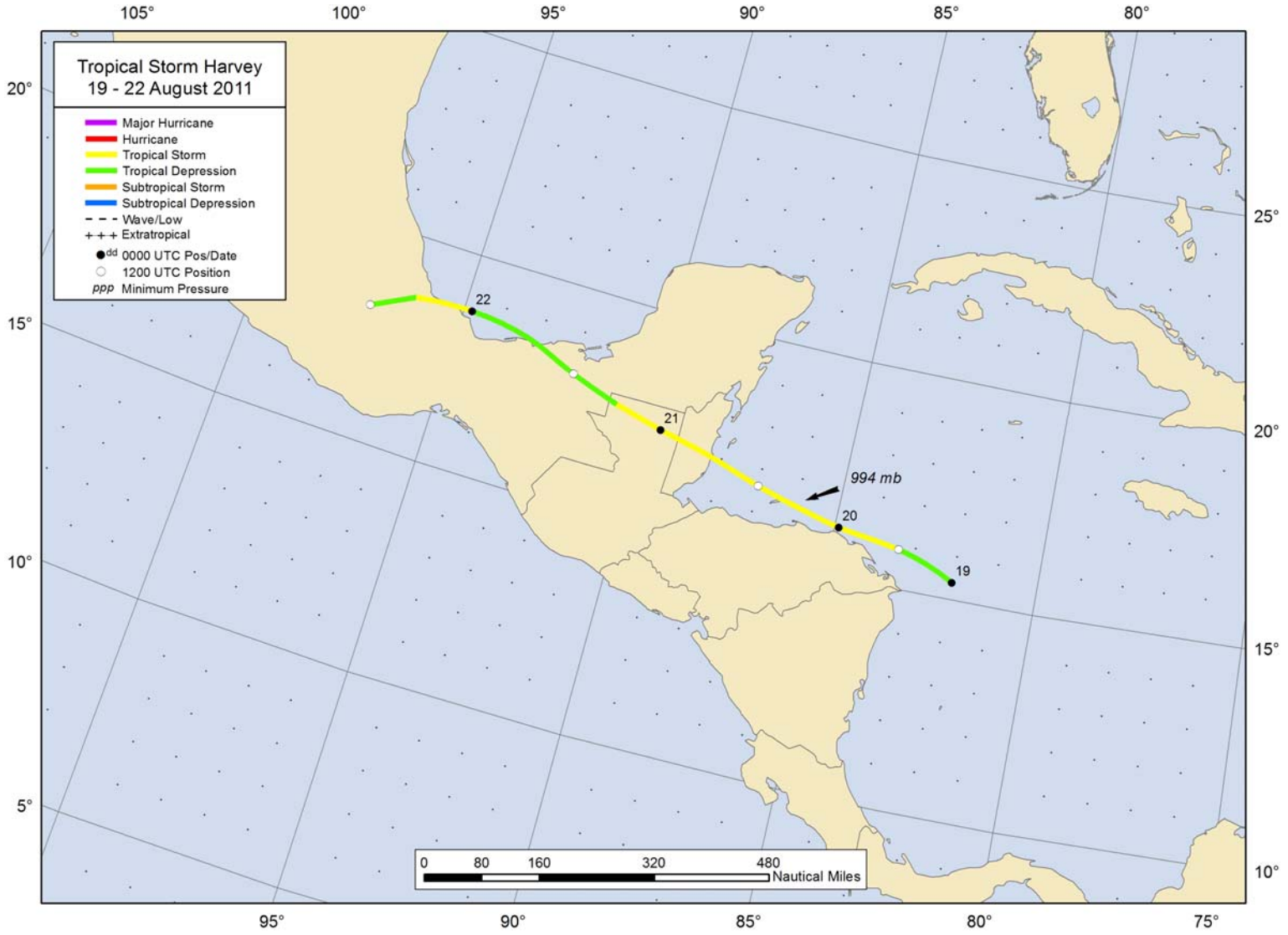

Figure 1. Best track positions for Tropical Storm Harvey, 19 – 22 August 2011.

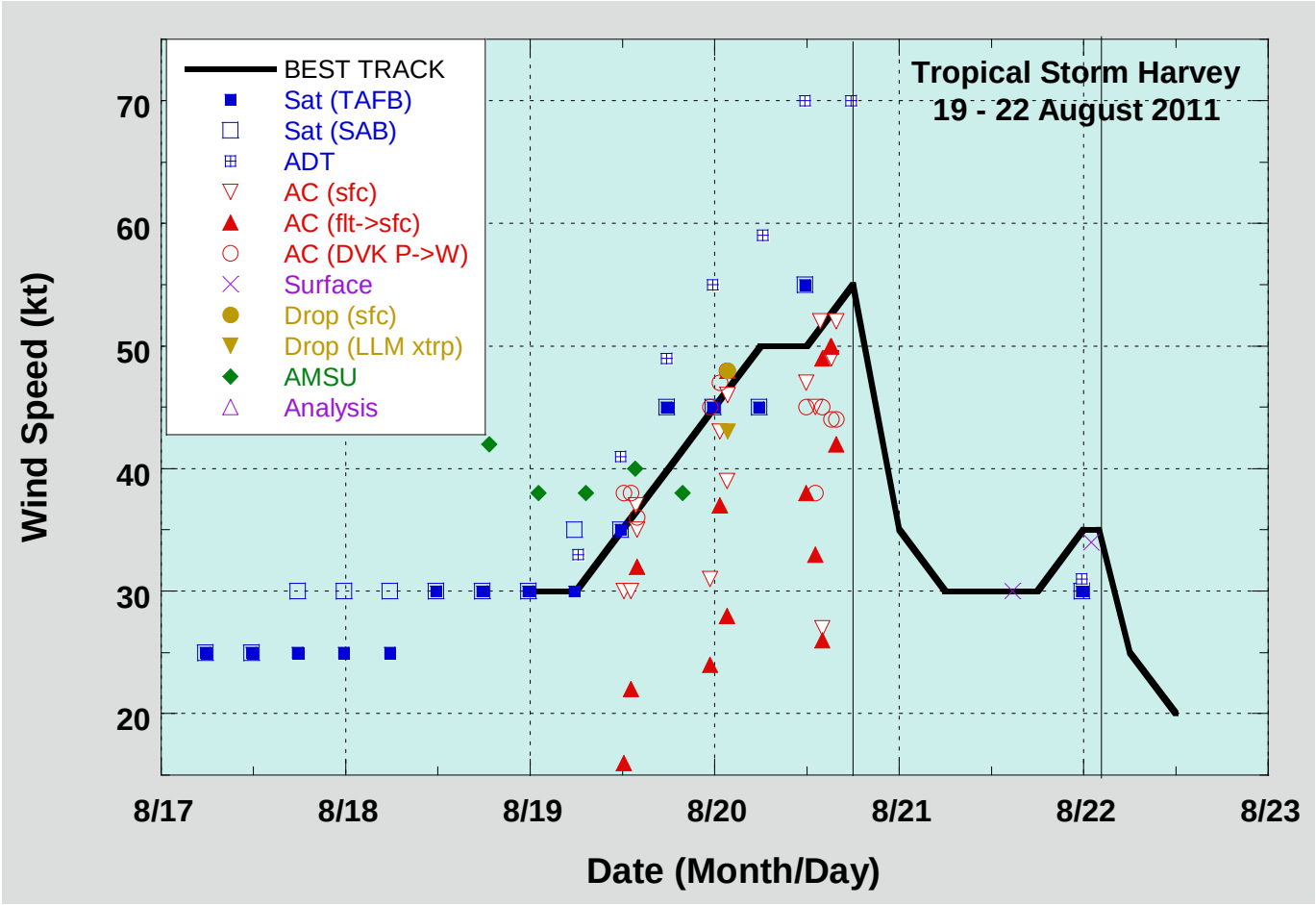

Figure 2. Selected wind observations and best track maximum sustained surface wind speed curve for Harvey. Advanced Dvorak Technique (ADT) estimates courtesy of UW-CIMSS. AMSU estimates are derived from the UW-CIMSS technique. Solid vertical lines represent when the cyclone made landfall. Dashed vertical lines correspond to 0000 UTC.

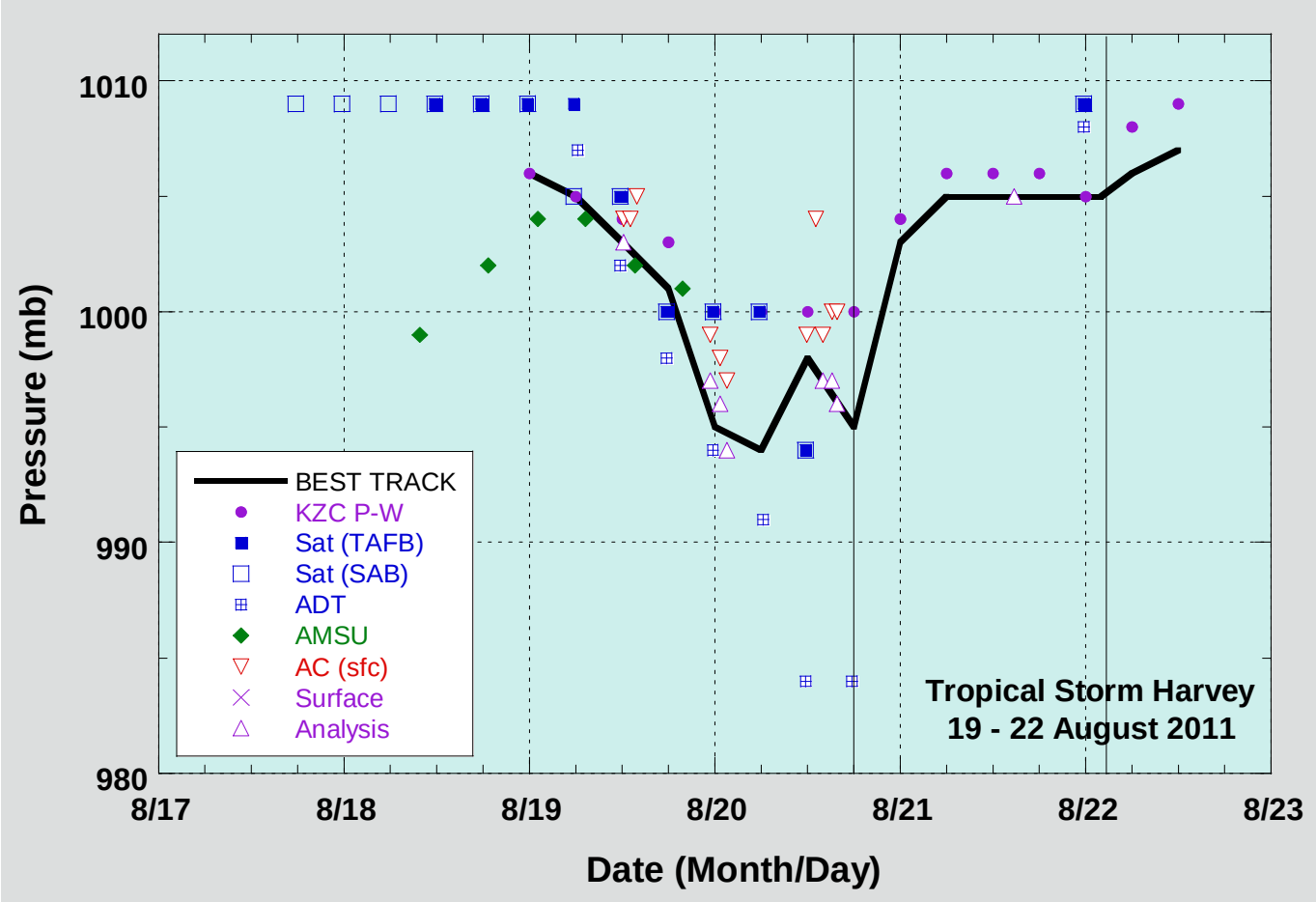

Figure 3. Selected pressure observations and best track minimum central pressure curve for Harvey. Advanced Dvorak Technique (ADT) estimates courtesy of UW-CIMSS. Dashed vertical lines correspond to 0000 UTC. Solid vertical lines represent when the cyclone made landfall. KZC P-W refers to pressure estimates derived by applying the Knaff-Zehr-Courtney pressure-wind relationship to the best track wind speeds. AMSU estimates are derived from the UW-CIMSS technique.

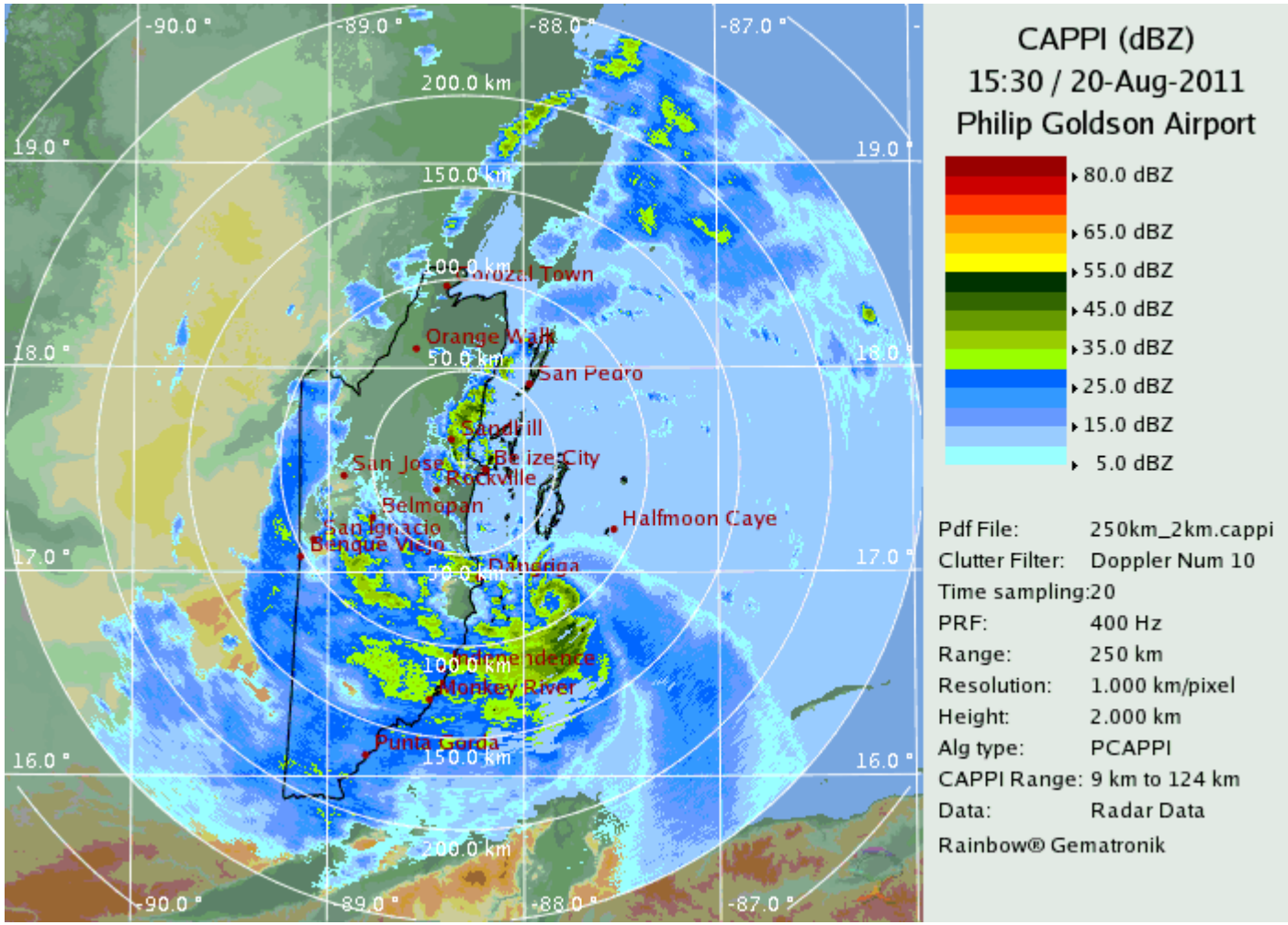

Figure 4. Radar image of Harvey near peak intensity at 1530 UTC 20 August 2011. Image courtesy of Brian McNoldy (Colorado State University) and the Belize National Meteorological Service.