NATIONAL HURRICANE CENTER
TROPICAL CYCLONE REPORT

TROPICAL STORM BEATRIZ

(EP022017)

31 May – 2 June 2017

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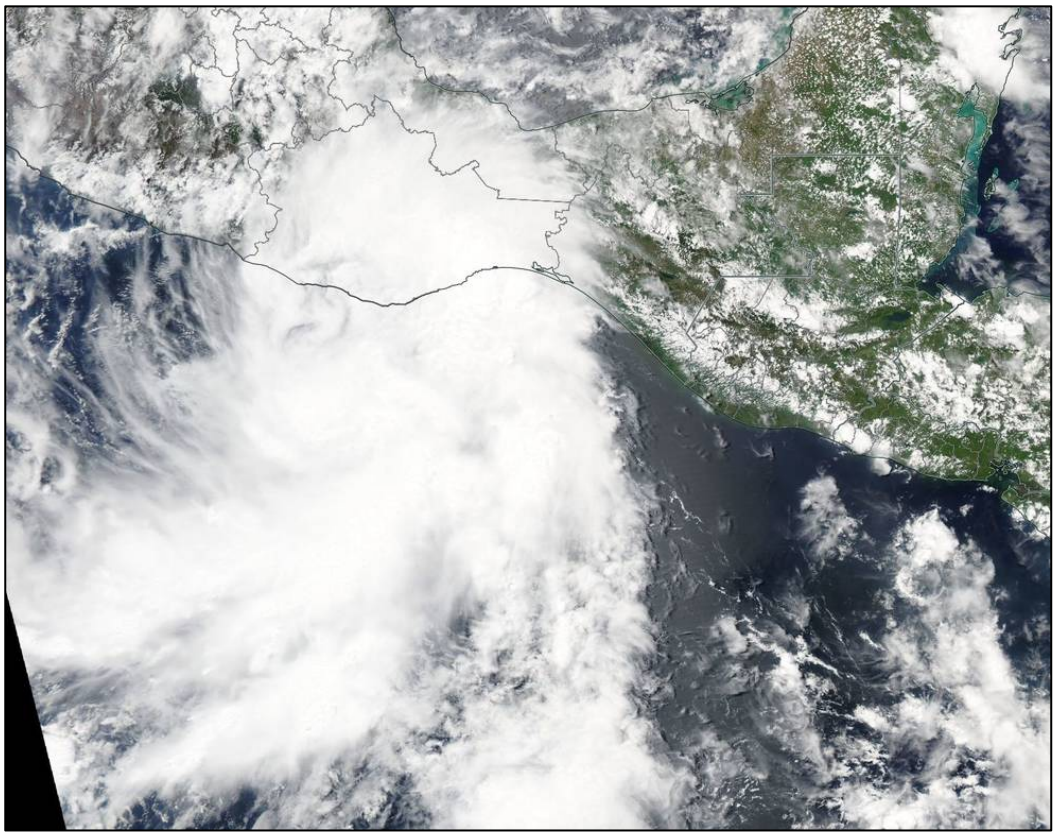

VISIBLE SATELLITE IMAGE OF TROPICAL STORM BEATRIZ AT 1710 UTC 1 JUNE 2017 FROM THE MODIS INSTRUMENT ON THE NASA TERRA SATELLITE. IMAGE COURTESY OF THE NASA GODDARD MODIS RAPID RESPONSE TEAM.

Beatriz was a short-lived tropical storm that made landfall in the Mexican state of Oaxaca. Heavy rainfall from the storm produced flash floods and mudslides over portions of southern Mexico that resulted in six fatalities.

Tropical Storm Beatriz

31 MAY – 2 JUNE 2017

SYNOPTIC HISTORY

The development of Beatriz can be traced to a tropical wave that departed the coast of Africa on 18 May. The wave moved westward across the tropical Atlantic Ocean and Caribbean Sea during the following week with minimal shower activity, but when the tropical wave crossed Central America on 25-26 May, it became more convectively active. On 28 May, the wave spawned a broad low pressure area several hundred n mi south-southeast of Acapulco, Mexico, and the shower and thunderstorm activity associated with the low gradually increased over the next couple of days while the circulation remained elongated. Early on 31 May, the thunderstorm activity increased and became better organized, and satellite data indicate that the circulation of the low became better defined, resulting in the formation of a tropical depression by 1200 UTC 31 May about 150 n mi southwest of Puerto Angel, Mexico. 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 slowly northeastward toward the Pacific coast of Mexico embedded within an area of deep-layer southwesterly flow around a large mid- to upper-level trough that was located over northern Mexico. In an environment characterized by warm water and light to moderate southerly wind shear, the cyclone slowly strengthened and became a tropical storm at 0600 UTC 1 June when it was located about 90 n mi southwest of Puerto Angel, Mexico. Beatriz reached its peak intensity of 40 kt six hours later and continued moving northeastward toward the coast of southern Mexico. Late that day, Beatriz began to move faster toward the northeast, and microwave imagery and surface observations indicate that the storm made landfall around 0000 UTC 2 June about 20 n mi west of Puerto Angel. The tropical storm rapidly weakened after landfall and became a tropical depression by 0600 UTC, and the low-level circulation dissipated shortly after that over the mountainous terrain of southern Mexico. The remnants of Beatriz, which included deep-layer moisture and a mid-level circulation center, continued northward over the Bay of Campeche where there it spawned a weak low pressure area a couple of days later. Strong upper-level westerly winds over of the southwestern Gulf of Mexico prevented re-development of the system.

METEOROLOGICAL STATISTICS

Observations in Beatriz (Figs. 2 and 3) include subjective satellite-based Dvorak technique intensity estimates from the Tropical Analysis and Forecast Branch (TAFB) and the Satellite

[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.

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 Beatriz.

The 40-kt estimated peak intensity of Beatriz is based on a blend of Dvorak classifications of T3.0 (45 kt) from SAB and T2.5 (35 kt) from TAFB, and scatterometer data that showed peak winds of 35 to 40 kt in association with the tropical cyclone just before 1800 UTC 1 June. The ship *Cap Palliser* (call sign A8OH4) reported 40-kt winds just northeast of the center at 2100 UTC 1 June. There were no other observations of sustained tropical-storm-force winds in association with Beatriz. A wind gust to 36 kt was reported at an automated weather station near Huatulco, Mexico, at 2100 UTC. A minimum pressure of 1003.5 mb was observed at Huatulco at 2300 UTC. The *Cap Palliser* reported a pressure of 1000.5 mb at 2100 UTC, but a history of that ship's observations suggest that the measured pressure could be a couple of millibars too low.

Beatriz produced a widespread area of 5 to 10 inches of rainfall across the Mexican states of Oaxaca, Tabasco, and Chiapas during the 48-h period ending at 8 am CDT 2 June (Table 2 and Fig. 4). Slightly lesser amounts fell over the state of Veracruz. Storm total rainfall amounts of greater than 10 inches were recorded at several observing sites along the Pacific coast of Mexico in the state of Oaxaca. The highest 48-h rainfall reports were 19.07 inches at Huatulco, 16.06 inches at a gauge along Mexico Highway 190 that runs between the cities of Tehuantepec and Oaxaca, and 12.24 inches at Las Pilas. The highest reported rainfall total in the state of Chiapas was 9.72 inches at Sierra Morena, and the highest in the state of Tabasco was 9.89 inches at La Posta. Additional rainfall was observed within deep southwesterly flow both before Beatriz formed and after dissipation. This resulted in 5-day (8 AM CDT 28 May – 8 AM CDT 2 June) rainfall amounts of 24.88 inches at the observing site along Highway 190 and 21.31 inches at Huatulco. These rains resulted in flash flooding and mudslides over much of southern Mexico.

CASUALTY AND DAMAGE STATISTICS

Local officials and reports from the *Mexico Daily News* indicate that Beatriz was responsible for six direct fatalities[2] in Mexico. Four women and two children perished in mudslides in the mountainous communities of San Francisco Ozolotepec, San Pedro Quiatoni, San Marcial Ozolotepec, and San Carlos Yautepec in the Mexican state of Oaxaca. The news reports indicate that hundreds of mudslides occurred across the region and that 127 of the state's 570 municipalities suffered damage. Dozens of roads were impassable due to mudslides and flooding (Fig. 5), including several sections of Federal Highway 200 that runs along Mexico's Pacific coast.

[2] Deaths occurring as a direct result of the forces of the tropical cyclone are referred to as "direct" deaths. These would include those persons who drowned in storm surge, rough seas, rip currents, and freshwater floods. Direct deaths also include casualties resulting from lightning and wind-related events (e.g., collapsing structures). Deaths occurring from such factors as heart attacks, house fires, electrocutions from downed power lines, vehicle accidents on wet roads, etc., are considered indirect" deaths.

A portion of the Oaxaca-Tehuantepec Highway was washed away, and the Tequisistlán Bridge on the same highway was damaged (Figs. 6 and 7). Several rivers in the state overflowed their banks, which affected homes in several communities. One benefit to the heavy rainfall, according to the Oaxaca Civil Protection Agency, was the filling of the Benito Juárez Reservoir, the region's primary water supply, to 70% capacity after a two-year drought and months of the reservoir being less than 20% full.

FORECAST AND WARNING CRITIQUE

The genesis of Beatriz was fairly well forecast, but the system's formation occurred sooner than anticipated. The potential for tropical cyclone development was first mentioned in the Tropical Weather Outlook at 1800 UTC 26 May, a little less than 5 days before formation. The 5-day probability of formation was increased to the medium category (40-60%) 66 h before development, and to the high category 18 h before formation occurred (Table 3). The 48-h probability of formation did not reach the medium category until 18 h before formation and the high category only 12 h before development took place.

Given the short duration of Beatriz as a tropical cyclone, there are only six verifying forecasts at 12 h, four at 24 h, and two at 36 h. The average NHC forecast track errors were 21.6 n mi, 33.5 n mi, and 63.7 n mi at 12, 24 and 36 h, respectively (Table 4a). These errors are comparable to the mean official errors for the previous 5-yr period at 12 and 24 h, and slightly higher than the long-term mean at 36 h. A homogeneous comparison of the official track errors with selected guidance models is given in Table 4b. The first couple of NHC forecasts exhibited larger along-track (i.e., speed) errors as Beatriz moved faster toward the northeast than forecast. This resulted in the tropical storm conditions reaching the coast as much as a couple of days sooner than initially anticipated.

A verification of NHC official intensity forecasts for Beatriz is given in Table 5a. Official forecast intensity errors were slightly 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 5b. The NHC intensity forecasts correctly projected that Beatriz would remain a low-end tropical storm, however the first couple of forecasts predicted a higher peak intensity than what occurred since it was thought that Beatriz would remain offshore longer.

Watches and warnings associated with Beatriz are given in Table 6.

ACKNOWLEDGEMENTS

Pamela Garcia of the National Meteorological Service of Mexico provided the rainfall reports and graphics from Mexico.

Table 1. Best track for Tropical Storm Beatriz, 31 May – 2 June 2017.

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
31 / 1200	13.8	97.9	1007	25	tropical depression
31 / 1800	14.0	97.7	1006	30	"
01 / 0000	14.2	97.5	1004	30	"
01 / 0600	14.5	97.3	1003	35	tropical storm
01 / 1200	14.8	97.1	1001	40	"
01 / 1800	15.1	96.9	1001	40	"
02 / 0000	15.7	96.6	1001	40	"
02 / 0600	16.3	96.3	1006	30	tropical depression
02 / 1200					dissipated
01 / 1200	14.8	97.1	1001	40	maximum winds and minimum pressure
02 / 0000	15.7	96.6	1001	40	landfall 20 n mi west of Puerto Angel, Mexico

Table 2. Selected 48-h rainfall observations from Mexico for Tropical Storm Beatriz. Observations cover the period from 8 am CDT 31 May through 8 am CDT 2 June.

Location	Rainfall (in)	Location	Rainfall (in)
State of Oaxaca		**State of Tabasco**	
Huatulco	19.07	La Posta	9.89
33 KM along Highway 190	16.06	Villahermosa	8.43
Las Pilas	12.24	Puente Gil Perez	6.93
Presidente Benito Juárez	10.91	Laguana San Julian	6.02
Puerto Angel	10.75	González	5.72
Salina Cruz	10.69	San Pedro	5.26
El Marqués	10.43	El Porvenir	4.29
Tehuantepec	9.49	Pigua	4.06
Juchitan	8.74		
Ayutla	7.64	**State of Veracruz**	
Laguna Chacahua	7.17	Jesús Carranza	4.13
Zacatepec	6.71		
Ixtepec	6.53		
Matías Romero	6.03		
Unión Hidalgo	5.71		
Chicapa	5.40		
Río Manso Lalana	5.19		
Ostuta	4.70		
Oaxaca Centro	4.42		
Zanatepec	4.27		
State of Chiapas			
Sierra Morena	9.72		
Tres Picos	7.90		
Arriaga	7.64		
Pijijiapan	7.64		
La Encrucijada	6.11		
Paredón	5.61		
Finca la Paz	5.47		
Juan de Grijalva	4.47		
Rosendo Salazar	4.30		
Sayula	4.11		

Table 3. 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	114
Medium (40%-60%)	18	66
High (>60%)	12	18

Table 4a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) track forecast errors (n mi) for Beatriz. 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	**21.6**	**33.5**	63.7				
OCD5	28.7	55.1	117.0				
Forecasts	6	4	2				
OFCL (2012-16)	22.2	33.9	43.8	54.8	80.0	108.9	145.1
OCD5 (2012-16)	35.7	72.0	112.2	150.2	217.0	271.0	340.2

Table 4b. Homogeneous comparison of selected track forecast guidance models (in n mi) for Beatriz. 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	26.6	25.4	63.7				
OCD5	27.0	58.1	117.0				
GFSI	44.0	26.9	**51.1**				
HWFI	**20.6**	40.0	81.2				
EMXI	**15.2**	33.0	**57.2**				
CMCI	41.8	37.5	**59.4**				
NVGI	34.9	78.7	144.6				
GFNI	**22.0**	55.6	100.2				
AEMI	44.3	**22.8**	**33.7**				
HCCA	**26.4**	28.0	**47.6**				
TVCX	**20.4**	**15.2**	**20.3**				
GFEX	**23.2**	**14.9**	**43.2**				
TVCE	**20.8**	**20.3**	**22.5**				
TABS	39.8	74.3	106.8				
TABM	42.1	90.1	115.3				
TABD	47.5	100.6	141.1				
Forecasts	3	2	2				

Table 5a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) intensity forecast errors (kt) for Beatriz. 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	6.7	**6.3**	**5.0**				
OCD5	5.5	3.0	9.5				
Forecasts	6	4	2				
OFCL (2012-16)	5.8	9.4	11.8	13.2	15.0	15.7	14.9
OCD5 (2012-16)	7.6	12.2	15.7	18.1	20.6	21.8	20.0

Table 5b. Homogeneous comparison of selected intensity forecast guidance models (in kt) for Beatriz. 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 5a due to the homogeneity requirement.

Model ID	Forecast Period (h)						
	12	24	36	48	72	96	120
OFCL	5.0	5.0	5.0				
OCD5	**3.3**	**4.5**	9.5				
GFSI	9.3	15.5	11.5				
HWFI	**4.3**	**2.5**	**3.0**				
EMXI	8.0	15.5	15.5				
GFNI	6.7	16.0	14.5				
DSHP	**4.7**	6.5	13.0				
LGEM	6.7	11.0	10.5				
ICON	**4.3**	6.5	8.5				
IVCN	**4.0**	6.5	11.0				
HCCA	**4.7**	5.0	7.0				
Forecasts	3	2	2				

Table 6. Watch and warning summary for Tropical Storm Beatriz, 31 May – 2 June 2017.

Date/Time (UTC)	Action	Location
31 / 1500	Tropical Storm Watch issued	Salina Cruz to Puerto Escondido
01 / 0300	Tropical Storm Watch changed to Tropical Storm Warning	Salina Cruz to Puerto Escondido
02 / 0600	Tropical Storm Warning discontinued	Salina Cruz to Puerto Escondido

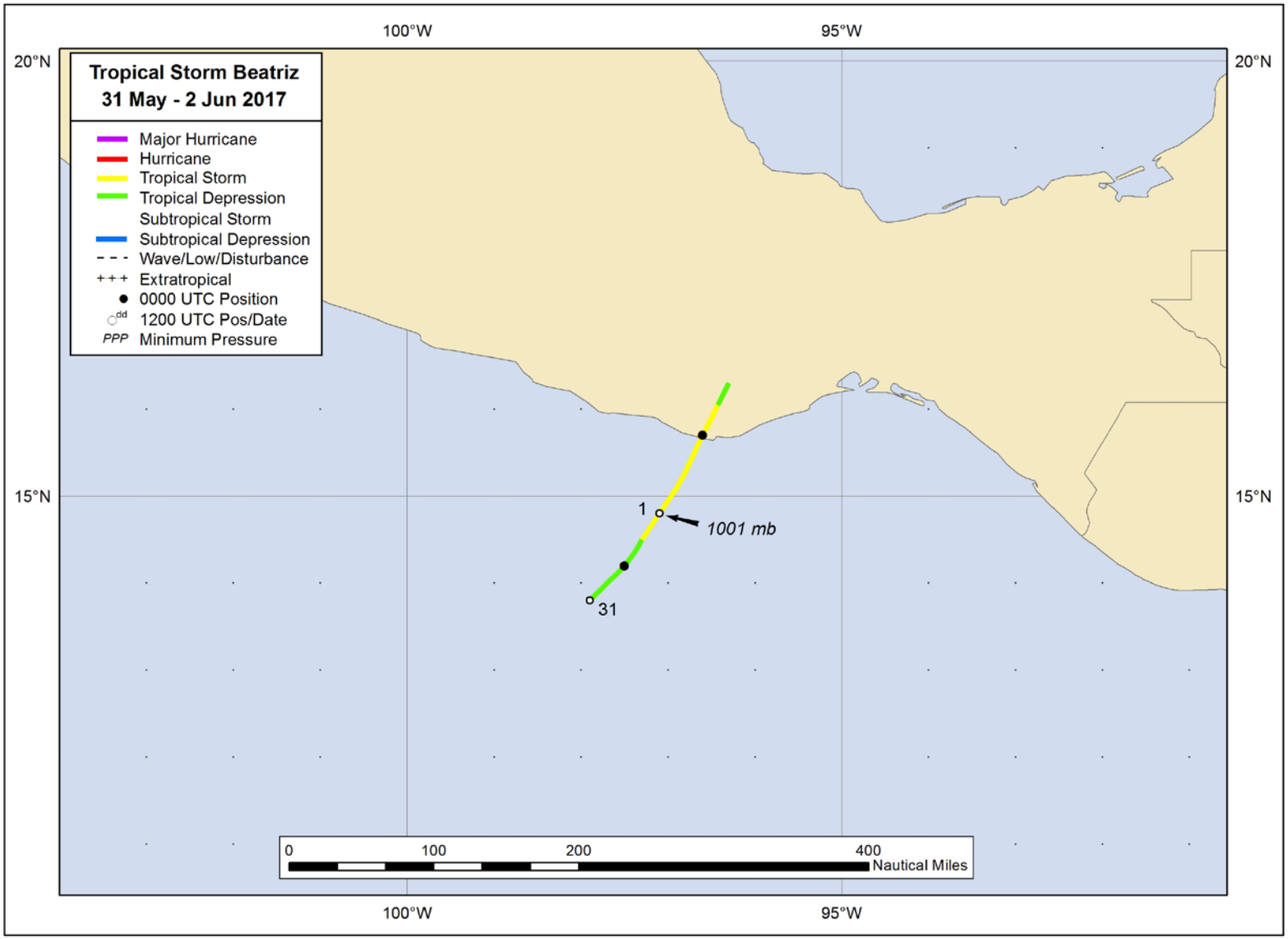

Figure 1. Best track positions for Tropical Storm Beatriz, 31 May – 2 June 2017.

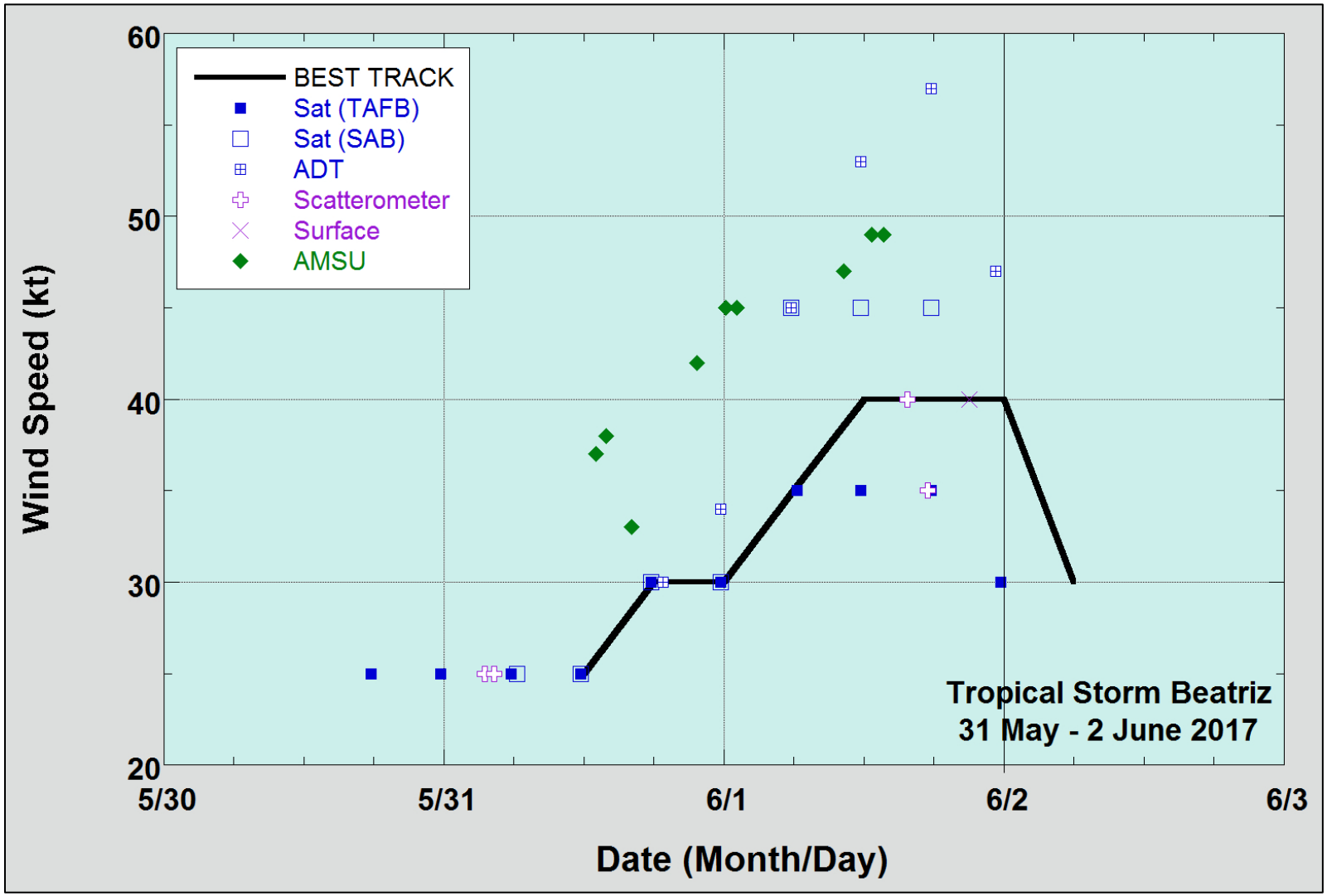

Figure 2. Selected wind observations and best track maximum sustained surface wind speed curve for Tropical Storm Beatriz, 31 May – 2 June 2017. Advanced Dvorak Technique estimates represent the Current Intensity at the nominal observation time. AMSU intensity estimates are from the Cooperative Institute for Meteorological Satellite Studies technique. Dashed vertical lines correspond to 0000 UTC, and the solid vertical line corresponds to landfall.

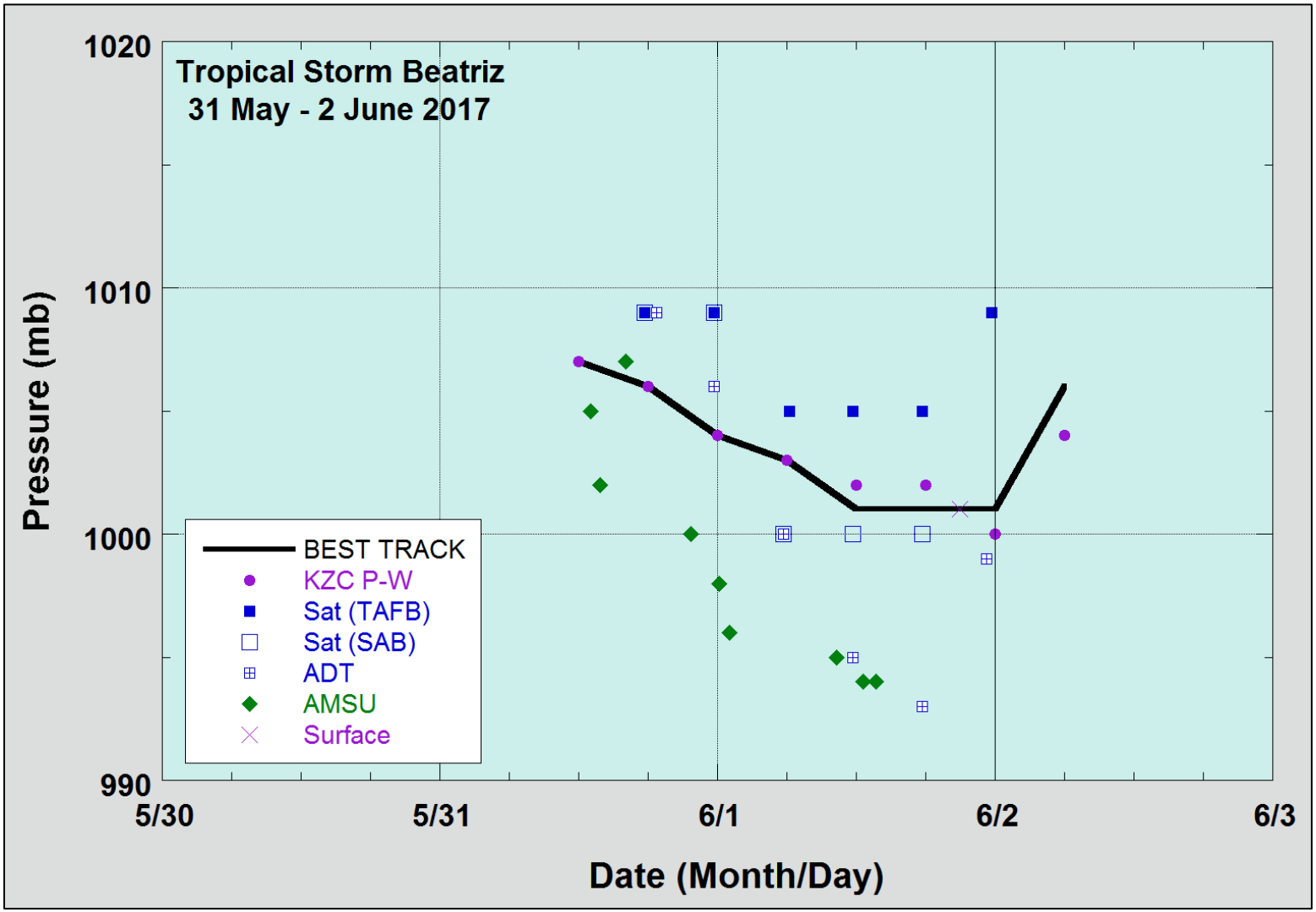

Figure 3. Selected pressure observations and best track minimum central pressure curve for Tropical Storm Beatriz, 31 May – 2 June 2017. Advanced Dvorak Technique estimates represent the Current Intensity at the nominal observation time. AMSU intensity estimates are from the Cooperative Institute for Meteorological Satellite Studies technique. KZC P-W refers to pressure estimates derived using the Knaff-Zehr-Courtney pressure-wind relationship. Dashed vertical lines correspond to 0000 UTC, and the solid vertical line corresponds to landfall.

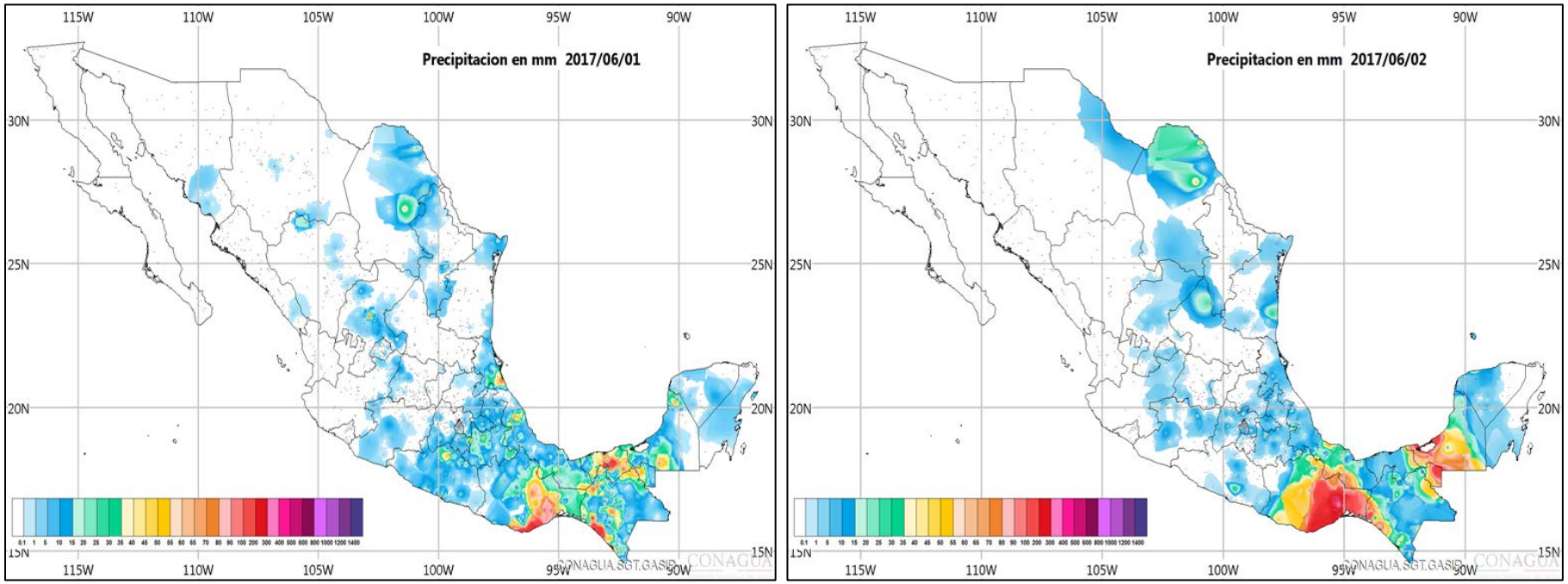

Figure 4. Observed rainfall (mm) in Mexico for the 24-h periods ending at 8 am CDT 1 June 2017 (left) and 8 am CDT 2 June 2017 (right). Images courtesy of the National Meteorological Service of Mexico.

Figure 5. Photo of a mudslide covering a road in the Mexican state of Oaxaca. Photo courtesy of the Oaxaca Civil Protection Agency.

Figure 6. A portion of the Oaxaca-Tehuantepec Highway (No. 190) was washed out near San Jose de Garcia. Photos courtesy of the *Mexico Daily News* and *NVI Noticias*.

Figure 7. Damaged bridge on the Oaxaca-Tehuantepec Highway (No. 190) near Tequisistlán. Photos courtesy of *Mexico Daily News* and *NVI Noticias*.