

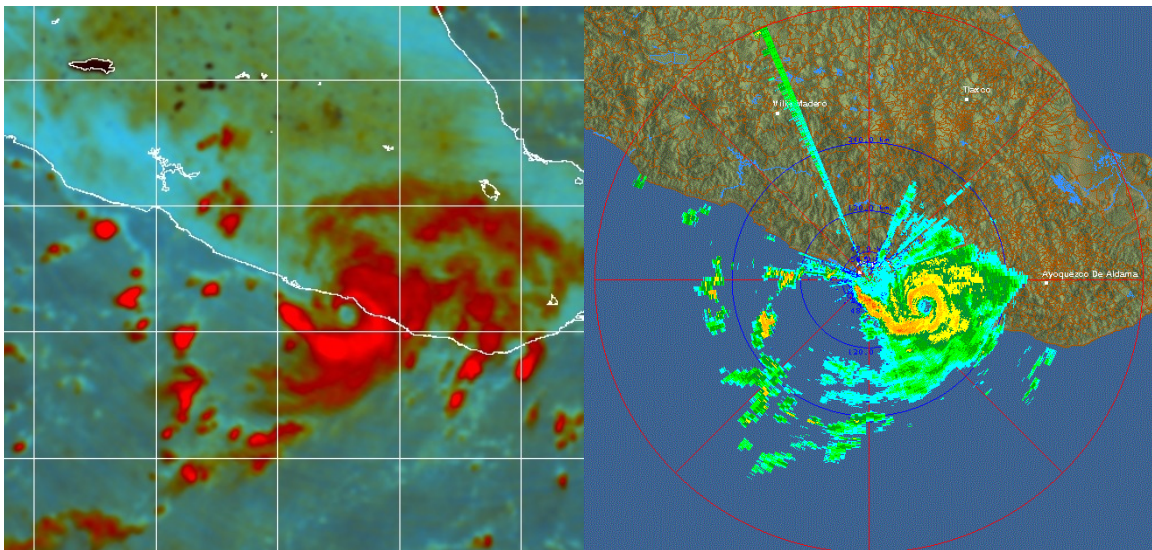


# NATIONAL HURRICANE CENTER TROPICAL CYCLONE REPORT

## TROPICAL STORM TRUDY (EP202014)

17-19 October 2014

Daniel P. Brown  
National Hurricane Center  
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COMPOSITE 89 GHZ MICROWAVE IMAGE (LEFT) AND ACAPULCO, MEXICO, RADAR IMAGE (RIGHT) OF TRUDY NEAR THE TIME OF LANDFALL ALONG THE SOUTHERN PACIFIC COAST OF MEXICO.

Trudy was a short-lived tropical storm that quickly strengthened before making landfall along the southern coast of Mexico.

# Tropical Storm Trudy

17-19 OCTOBER 2014

## SYNOPTIC HISTORY

The development of Trudy appears to have resulted from the combination of a pre-existing broad low pressure area over the far eastern Pacific, a Gulf of Tehuantepec gap wind event<sup>1</sup>, and a convectively coupled Kelvin wave. During the first week of October, a broad low pressure area became established over the far eastern Pacific Ocean and adjacent portions of Central America. This system moved slowly westward and by 10 October was centered about 150 n mi south of the coast of Guatemala, where it remained nearly stationary during the next several days. Early on 15 October, high pressure building southward behind a cold front over the Gulf of Mexico produced a Gulf of Tehuantepec gap wind event. This event, along with the passage of an eastward-moving atmospheric Kelvin wave caused, a significant increase in convection a few hundred n mi to the south of the Gulf of Tehuantepec later that day. Over the next couple of days, the now-elongated low pressure system and associated area of disorganized convection moved slowly west-northwestward to northwestward. Early on October 17, the convection became more concentrated and the circulation became better defined about 185 n mi south-southeast of Acapulco, Mexico. Shortly thereafter, the system acquired a well-defined circulation and organized convection, which resulted in the formation of a tropical depression at 1200 UTC 17 October. 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<sup>2</sup>.

The tropical depression was located over 29°-30°C waters, and in an environment of very low vertical wind shear and abundant low- to mid-level moisture. The depression strengthened to a tropical storm by 1800 UTC 17 October while it moved north-northwestward around the western portion of a mid-level ridge centered over Central America. During the next 12 h, microwave satellite imagery and radar data from Acapulco, Mexico, show that Trudy rapidly developed an inner core, and a ragged eye became apparent in radar images around 0300 UTC 18 October. Shortly after that, Trudy turned north-northeastward and approached the coast of southern Mexico while it continued to strengthen and its eye became better defined (cover photos). Trudy reached its estimated peak intensity of 55 kt as it made landfall just southeast of Marquelia, Mexico, at 0915 UTC (Figure 4). After landfall, steady weakening occurred and Trudy

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<sup>1</sup> Gulf of Tehuantepec gap wind events occur when cold air outbreaks surge southward and are blocked by the Sierra Madre Mountains in southern Mexico. The low-level flow funnels through a gap in the mountain chain between the Gulf of Mexico and the Pacific Ocean. These wind events often produce gale-force winds over a small portion of the eastern Pacific over and near the Gulf of Tehuantepec.

<sup>2</sup> 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 *bt* directory, while previous years’ data are located in the *archive* directory.

became a tropical depression by 1800 UTC. The tropical depression dissipated over the mountains of southern Mexico by 0600 UTC 19 October.

The mid-level remnants of Trudy moved northeastward over Mexico and entered the Gulf of Mexico on 20 October, where they developed into Atlantic basin Tropical Depression Nine on 21 October over the Bay of Campeche, which later became Tropical Storm Hanna over the northwestern Caribbean Sea.

## METEOROLOGICAL STATISTICS

Observations in Trudy (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 (UW/CIMSS). Data and imagery from NOAA polar-orbiting satellites including the Advanced Microwave Sounding Unit (AMSU), the NASA Tropical Rainfall Measuring Mission (TRMM), 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 Trudy.

The estimated 55-kt peak intensity of Trudy is based on Advanced Dvorak Technique linear 3-h average T-number of 3.4 or 53 kt centered on the landfall time. Since the satellite and radar presentation of Trudy continued to improve through landfall, the 3-h average T-number centered on the landfall time is likely a better estimate of Trudy's intensity than the Current Intensity (CI) number, which represents a 3-hour averaged Final T-number after various ADT rules and constraints are applied.

Although no reports of tropical-storm-force winds have been received from land-based observing sites, tropical-storm-force winds likely occurred over a small area of the southeastern portion of the Mexican state of Guerrero. One ship report of winds of tropical storm force was received; the ship *CMB Biwa* (call sign ONED) reported 37 kt winds at 1800 UTC 17 October about 60 n mi southeast of the center.

Trudy produced rainfall amounts of 5 to 10 inches over southeastern Guerrero and western portions of Oaxaca, Mexico. The heaviest rainfall occurred in the mountainous regions of these states on 17 and 18 October. The highest rainfall total reported by a Mexican Comisión Nacional del Agua, Servicio Meteorológico Nacional (CONAGUA) weather station was 25.41 inches (645.5 mm) at Ometepec, Guerrero, which was recorded from 0800 local time 16 October to 0800 local time 19 October (Table 2, Fig. 5). The town of Copala received 14.02 inches (356 mm), and 11.76 inches (298.8 mm) was recorded at Río Verde in the state of Oaxaca.

## CASUALTY AND DAMAGE STATISTICS

Media reports indicate that rains from Trudy and its remnants caused significant flooding over portions of southern Mexico. Officials with the Civil Protection Service of Mexico reported seven direct deaths in association with the flooding, with at least six of the deaths occurring in the state of Guerrero. The media reports indicate that a landslide in Tlacoachistlahuaca killed a 23-year-old man. Landslides in Ometepec and Cochoapa killed a total of four people, including two children, and a 70-year-old man was swept away in a swollen stream near Ometepec. Media reports do not provide the circumstance or location of one of the fatalities that was reported by the Civil Protection officials.

The flooding affected 5000 homes, and at least 4000 people were evacuated to temporary shelters during the event. Heavy rains and landslides caused cuts in seven roads in the Costa Chica region of Guerrero. Emergency declarations were made in 35 municipalities in the state of Guerrero, and in over 100 municipalities in the state of Oaxaca. There have been no monetary damage estimates received as of this writing.

## FORECAST AND WARNING CRITIQUE

The genesis of Trudy was fairly well predicted. The disturbance from which Trudy formed was introduced into the Tropical Weather Outlook at 0000 UTC 14 October. At that time it was assessed to have a medium chance (30-50%) of formation during the next five days. The five-day formation potential was raised to the high category 66 h before development occurred. The disturbance was assigned a medium chance of formation for the 48 h time period 66 h before genesis, and raised to the high category (>50%) about 36 h before development occurred. However, the chance of formation was decreased slightly a day before genesis and the system was assessed a 50% (medium) 48-h chance of formation 6 h before the system became a tropical depression in the best track. Table 3 shows the number of hours in advance of formation that the NHC Tropical Weather Outlook first forecast the indicated likelihood category. Note that the timings for the “Low” category do not include forecasts of a 0% chance of genesis.

A verification of NHC official track forecasts for Trudy is given in Table 4. Official forecast track errors were greater than mean official errors for the previous 5-yr period, albeit for only four verifying 12 h forecasts and two 24 h forecasts. A verification of NHC official intensity forecasts for Trudy is shown in Table 5. Official forecast intensity errors were greater than the mean official errors for the previous 5-yr period. The two NHC forecasts issued prior to Trudy’s landfall did not predict as much intensification as what occurred. Due to the small number of verifying forecasts, a meaningful comparison of the official track and intensity errors with selected guidance models is not possible.

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



## ACKNOWLEDGEMENTS

Carlos Garrido from Mexico's CONAGUA (Comisión Nacional del Agua, Servicio Meteorológico Nacional) provided rainfall data and maps.

Table 1. Best track for Tropical Storm Trudy, 17-19 October 2014.

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
17 / 0600	13.9	98.6	1007	25	low
17 / 1200	14.6	98.8	1005	30	tropical depression
17 / 1800	15.3	99.0	1003	35	tropical storm
18 / 0000	15.8	99.0	1001	40	"
18 / 0600	16.2	98.9	999	50	"
18 / 0915	16.5	98.8	998	55	"
18 / 1200	16.7	98.7	1001	45	"
18 / 1800	17.1	98.4	1005	30	tropical depression
19 / 0000	17.3	98.2	1007	25	"
19 / 0600					dissipated
18 / 0915	16.5	98.8	998	55	maximum winds, minimum pressure, and landfall just southeast of Marquelia, Mexico

Table 2. Selected rainfall totals in the Mexican states of Guerrero and Oaxaca for the 72 h period from 0800 local time 16 October to 0800 local time 19 October.

Location and State	Rainfall
Ometepec, Guerrero (16.68°N 98.43°W)	25.41 in (645.5 mm)
Copala, Guerrero (16.61°N 98.97°W)	14.02 in (356 mm)
Río Verde, Oaxaca (16.10°N 97.73°W)	11.76 in (298.8 mm)
Pinotepa, Oaxaca (16.35°N 98.05°W)	9.94 in (252.6 mm)
Huatulco, Oaxaca (15.81°N 96.13°W)	6.07 in (154.1 mm)
Revolución, Guerrero (16.80°N 99.20°W)	5.12 in (130.0 mm)
Puerto Angel, Oaxaca (15.67°N 96.50°W)	5.00 in (127.2 mm)
Unión Hidalgo (16.45°N 94.83°W)	4.47 in (113.5 mm)
Petacalco, Guerrero (17.98°N 102.12°W)	3.90 in (99.0 mm)



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 (<30%)	78	-
Medium (30%-50%)	66	84
High (>50%)	36	66



Table 4. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) track forecast errors (n mi) for Tropical Storm Trudy, 17-19 October 2014. Mean errors for the previous 5-yr period are shown for comparison.

	Forecast Period (h)						
	12	24	36	48	72	96	120
OFCL	31.0	60.9					
OCD5	33.3	76.7					
Forecasts	4	2					
OFCL (2009-13)	25.7	41.4	55.0	68.6	97.8	134.2	167.1
OCD5 (2009-13)	37.2	74.8	118.0	162.5	249.4	332.6	413.3

Table 5. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) intensity forecast errors (kt) for Tropical Storm Trudy, 17-19 October 2014. Mean errors for the previous 5-yr period are shown for comparison.

	Forecast Period (h)						
	12	24	36	48	72	96	120
OFCL	11.3	12.5					
OCD5	10.8	2.5					
Forecasts	4	2					
OFCL (2009-13)	6.1	10.4	13.4	14.5	15.0	16.4	16.1
OCD5 (2009-13)	7.7	12.7	16.4	18.8	20.5	20.3	20.8

Table 6. Watch and warning summary for Mexico in association with Tropical Storm Trudy, 17-19 October 2014.

Date/Time (UTC)	Action	Location
17 / 2100	Tropical Storm Warning issued	Tecpan de Galeana to Laguna de Chacahua
18 / 0900	Hurricane Watch issued	Acapulco to Laguna de Chacahua
18 / 1500	Hurricane Watch discontinued	Acapulco to Laguna de Chacahua
18 / 1500	Tropical Storm Warning modified to	Acapulco to Laguna de Chacahua
18 / 2100	Tropical Storm Warning discontinued	All

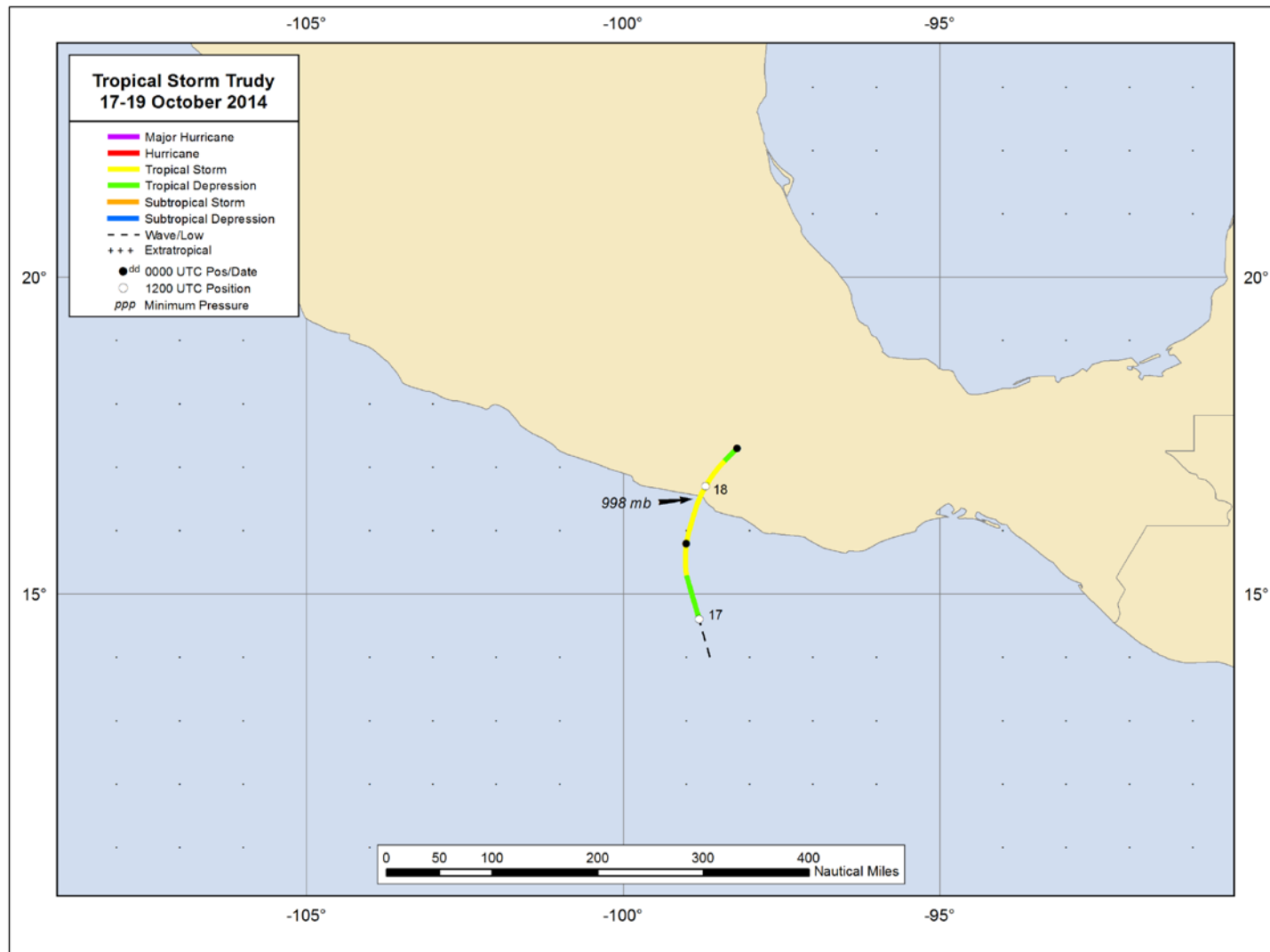


Figure 1. Best track positions for Tropical Storm Trudy, 17-19 October 2014.

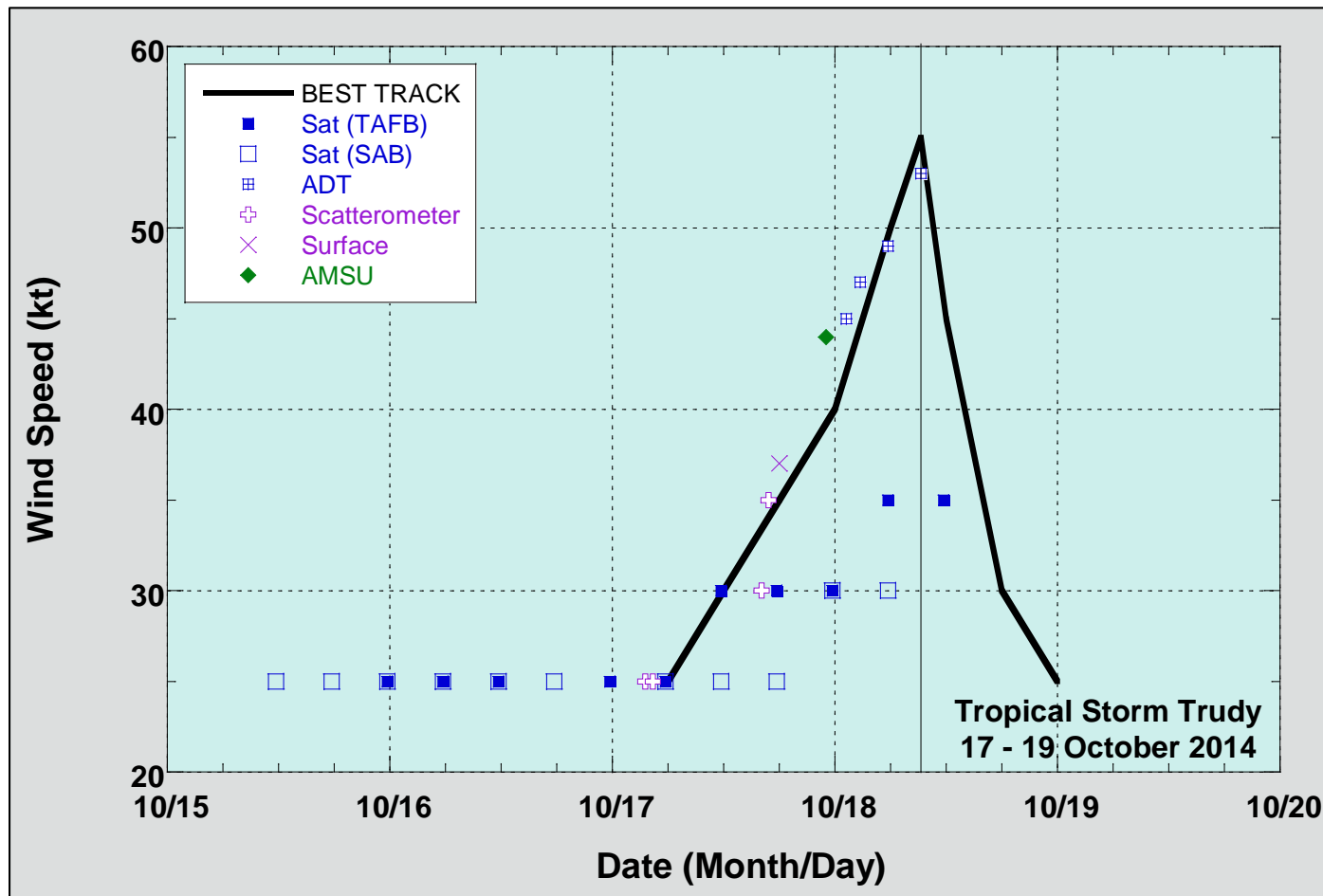


Figure 2. Selected wind observations and best track maximum sustained surface wind speed curve for Tropical Storm Trudy, 17-19 October 2014. Advanced Dvorak Technique estimates represent linear averages over a three-hour period centered on the nominal observation time. AMSU intensity estimates are from the Cooperative Institute for Meteorological Satellite Studies technique. Dashed vertical lines correspond to 0000 UTC, and the solid vertical line corresponds to landfall.

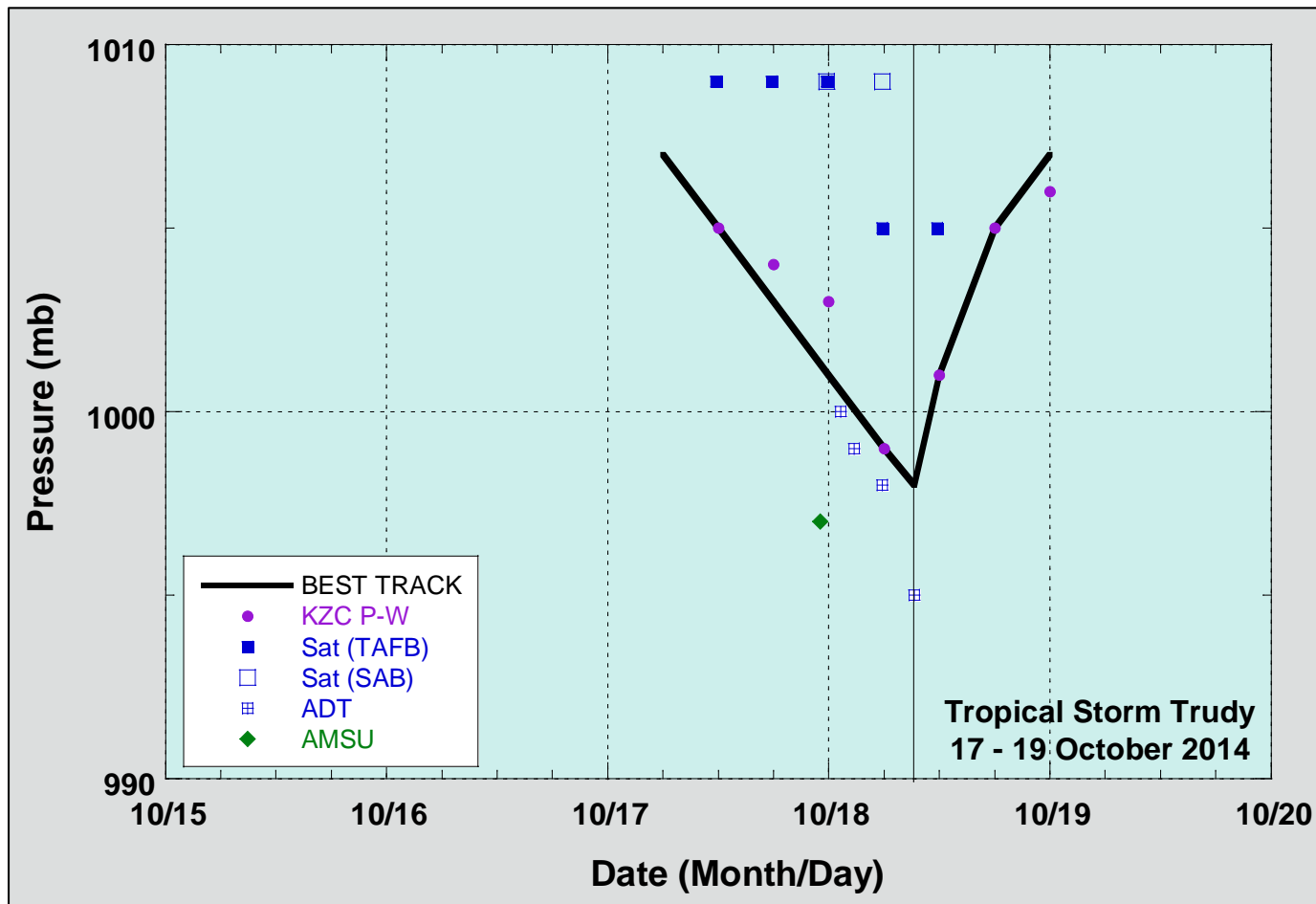


Figure 3. Selected pressure observations and best track minimum central pressure curve for Tropical Storm Trudy, 17-19 October 2014. Advanced Dvorak Technique estimates represent linear averages over a three-hour period centered on the nominal observation time. AMSU intensity estimates are from the Cooperative 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.

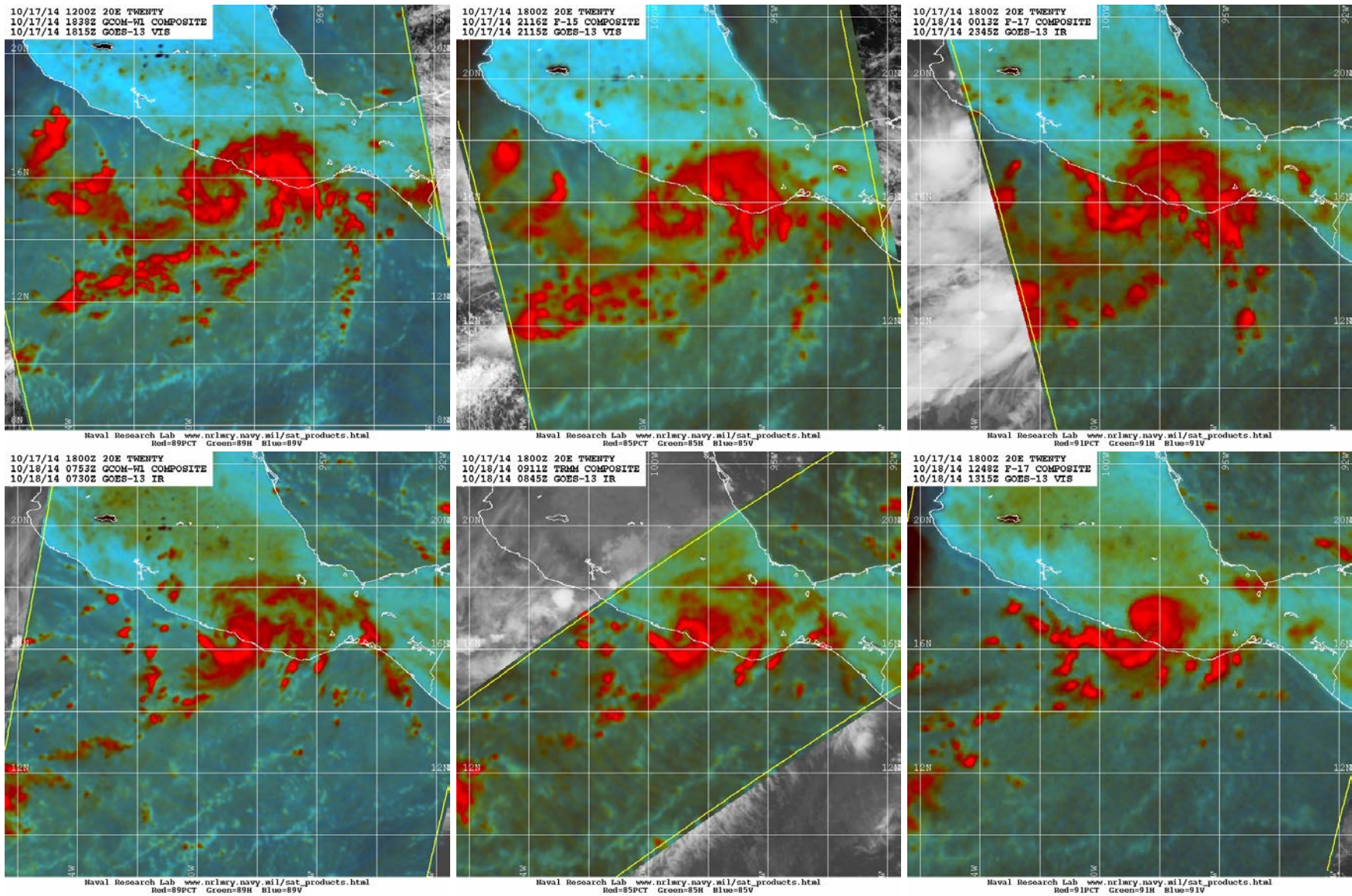


Figure 4. Composite 85-91 GHz microwave images between 1838 UTC 17 October and 1248 UTC 18 October rapid increase in organization of the inner core of Trudy through landfall along the southern coast of Mexico. Images courtesy of the Naval Research Laboratory.

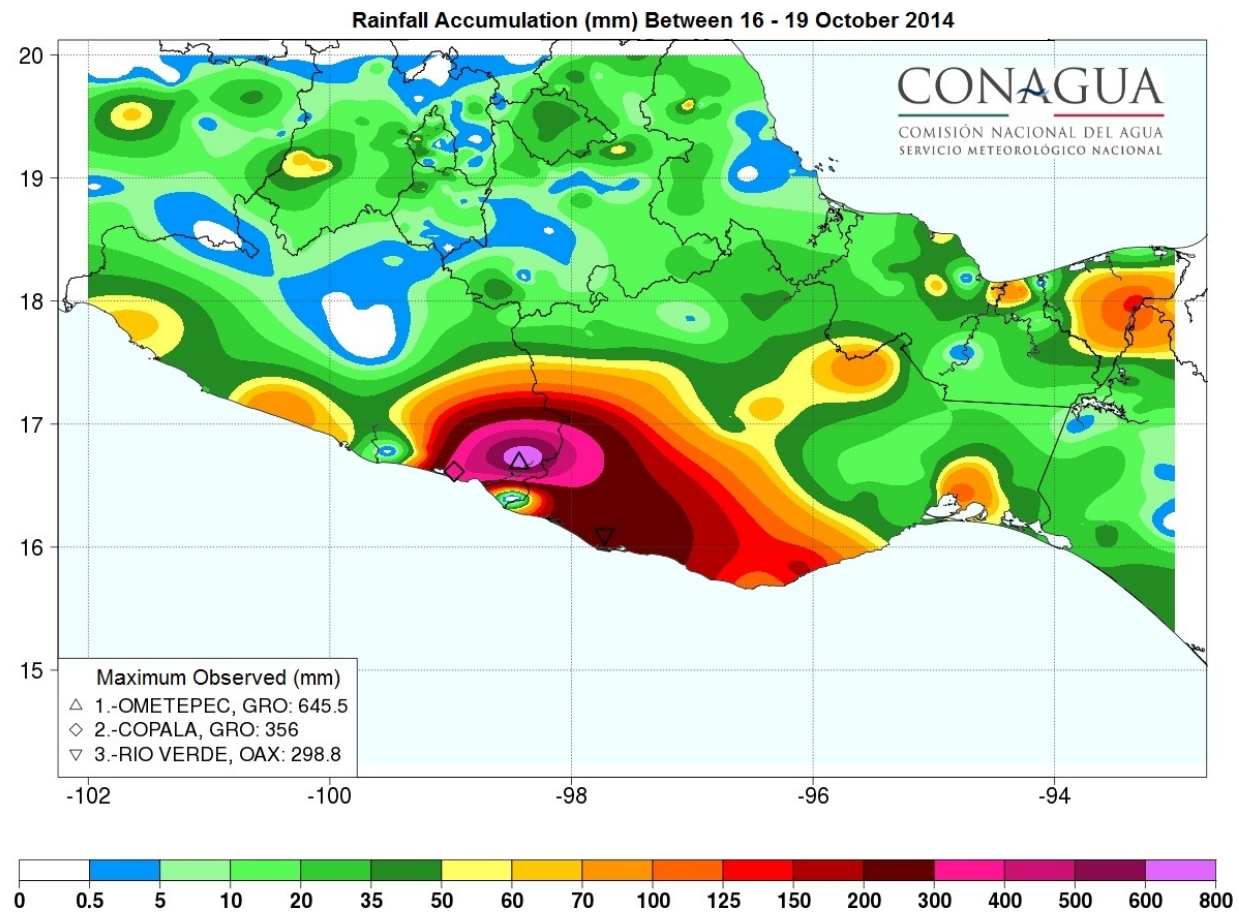


Figure 5. Rainfall accumulation (mm) in southern Mexico from 0800 local time 16 October to 0800 local time 19 October 2014. Data and map provided by CONAGUA.