NATIONAL HURRICANE CENTER TROPICAL CYCLONE REPORT

TROPICAL STORM CRISTOBAL

(AL032020)

1–9 June 2020

Robbie Berg
National Hurricane Center
13 January 2021

PHOTO OF TROPICAL STORM CRISTOBAL TAKEN FROM THE INTERNATIONAL SPACE STATION ON JUNE 8, 2020 (IMAGE COURTESY OF NASA AND ASTRONAUT CHRIS CASSIDY [@ASTRO_SEAL])

Tropical Storm Cristobal, in conjunction with a larger weather system over Central America and Tropical Storm Amanda over the eastern Pacific Ocean, produced significant rainfall and flooding over portions of Central America and southeastern Mexico. Cristobal then went on to affect portions of the central U.S. Gulf coast with tropical-storm-force winds, significant storm surge, and heavy rainfall. Cristobal took the lives of six people in the United States and Mexico.

Tropical Storm Cristobal

1–9 JUNE 2020

SYNOPTIC HISTORY

In late May, a Central American gyre[1] developed and became centered near the Mexico/Guatemala border, while Tropical Storm Amanda concurrently formed over the far eastern North Pacific off the coasts of Guatemala and El Salvador. Amanda moved northeastward within the gyre and made landfall on the Pacific coast of Guatemala on 31 May, with its center dissipating over the mountainous terrain of that country late in the day. The remnant low pressure area continued to rotate northward and then northwestward across northern Guatemala and southeastern Mexico within the Central American gyre, emerging over the Bay of Campeche south of the city of Campeche, Mexico, around midday on 1 June. The low acquired a well-defined center and sufficiently organized deep convection soon after moving over water, marking the regeneration[2] of a tropical depression at 1800 UTC 1 June about 35 n mi southwest of Campeche. The depression moved generally westward over the Bay of Campeche and strengthened to a tropical storm by 1200 UTC 2 June while centered about 65 n mi northwest of Ciudad del Carmen, 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[3].

Because Tropical Storm Cristobal was still embedded within the Central American gyre, it proceeded to make a slow counterclockwise loop over the Bay of Campeche and southeastern Mexico over the next several days, initially moving slowly southward and then southeastward on 2 and 3 June after becoming a tropical storm. Cristobal gradually strengthened during that period while over the warm waters of the Bay of Campeche, and it reached an estimated peak intensity of 50 kt by 0600 UTC 3 June. The storm maintained that intensity through landfall, which occurred around 1300 UTC near the town of Atasta, Mexico, just to the west of Ciudad del Carmen. Cristobal gradually weakened while it moved southeastward across the states of Campeche and Tabasco, and it became a tropical depression by 1200 UTC 4 June just before reaching the Guatemala border. The center continued on its counterclockwise track, moving eastward and then northeastward across far northern Guatemala and back over Mexico late on 4 June and early on 5 June.

---

[1] A Central American gyre (CAG) is a broad lower-tropospheric cyclonic circulation occurring near Central America. For more information, please refer to Papin, P., L. F. Bosart, R. D. Torn, 2017: A Climatology of Central American Gyres. *Mon. Wea. Rev.*, 145, 1983–2000.
http://journals.ametsoc.org/doi/pdf/10.1175/MWR-D-16-0411.1

[2] Protocol dictates that if the remnants of a former tropical cyclone regenerate in a new basin, the regenerated tropical cyclone is given a new designation. Since Amanda dissipated over Central America, the regenerated tropical cyclone was designated with the next name on the Atlantic list, Cristobal. (*National Hurricane Operations Plan*, Office of the Federal Coordinator for Meteorological Services and Supporting Research (OFCM)).

[3] 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.

On the morning of 5 June, winds increased to tropical storm force in the eastern part of Cristobal's circulation along the eastern coast of the Yucatan Peninsula, and it is estimated that the system restrengthened to a tropical storm at 0600 UTC, even though its center was still over land about 80 n mi south-southeast of Campeche. Cristobal then turned northward, and its center remained over land for another 12 to 15 h before re-emerging over the southern Gulf of Mexico near Progreso, Mexico, late on 5 June. Cristobal's maximum winds continued to increase in a convective band over the waters north of the Yucatan Peninsula even before the center re-emerged over the Gulf of Mexico, and the storm reached another estimated peak intensity of 50 kt at 0000 UTC 6 June while centered about 45 n mi north-northwest of Progreso.

Cristobal's maximum winds decreased slightly to 45 kt by 1200 UTC 6 June while the storm moved northward across the central Gulf of Mexico through a break in the subtropical ridge. Even though deep-layer shear over the Gulf of Mexico was relatively low and sea surface temperatures were between 27°C and 28°C, Cristobal's broad structure, and possibly some dry air in the middle levels of the atmosphere, did not favor re-intensification. Consequently, the cyclone's intensity held steady at 45 kt until landfall in Plaquemines Parish, Louisiana, just east of Grand Isle, around 2200 UTC 7 June. A blocking high caused Cristobal to slow down and turn northwestward while its center moved across the New Orleans metropolitan area, and the cyclone weakened to a tropical depression by 1200 UTC 8 June when it was centered near the Louisiana/Mississippi border about 10 n mi west-northwest of Natchez, Mississippi.

An advancing deep-layer trough over the Rocky Mountains pushed the blocking high eastward, and Cristobal subsequently moved northward and north-northeastward across Arkansas, Missouri, and southeastern Iowa on 8 and 9 June. Cristobal was absorbed within the trough and became an extratropical low by 0000 UTC 10 June while centered about 15 n mi north-northwest of Dubuque, Iowa, just before crossing the border into Wisconsin. During 10 June, the extratropical low turned northeastward across Wisconsin, the Upper Peninsula of Michigan, and eventually Ontario, Canada, producing gale-force winds across portions of Lake Superior and Lake Michigan. The low then slowed down and meandered when it reached southern Hudson Bay on 11 June, and it dissipated soon after 0600 UTC 12 June about 30 n mi south-southwest of Wemindji, Quebec.

METEOROLOGICAL STATISTICS

Observations in Cristobal (Figs. 2 and 3) include subjective satellite-based Dvorak technique intensity estimates from the Tropical Analysis and Forecast Branch (TAFB), and objective Advanced Dvorak Technique (ADT) estimates and Satellite Consensus (SATCON) estimates from the Cooperative Institute for Meteorological Satellite Studies/University of Wisconsin-Madison. Observations also include flight-level, stepped frequency microwave radiometer (SFMR), and dropwindsonde observations from seven flights of the 53rd Weather Reconnaissance Squadron of the U.S. Air Force Reserve Command and two flights of the NOAA Aircraft Operations Center (AOC) WP-3D aircraft. 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 Cristobal.

Ship reports of winds of tropical storm force associated with Cristobal are given in Table 2, and selected surface observations from land stations and data buoys are given in Table 3. Rainfall totals from southeastern Mexico and Central America are provided in Table 4.

Winds and Pressure

Cristobal's first estimated peak intensity of 50 kt from 0600 UTC until landfall at 1300 UTC 3 June along the coast of Mexico is based on a blend of a peak 850-mb flight-level wind of 55 kt (which adjusts to about 45 kt at the surface) and SFMR-measured winds of 52 kt. Height-adjusted winds of 45 to 50 kt were measured at a couple of Mexican oil rigs early on 3 June and also support Cristobal's estimated peak intensity of 50 kt.

Surface observations and scatterometer data indicate that Cristobal regained tropical storm status while its center was still over southeastern Mexico, with tropical-storm-force winds occurring along the eastern coast of the Yucatan Peninsula on the morning of 5 June. A Weatherflow station at Cancun measured a sustained wind of 40 kt at 1451 UTC, while an ASCAT pass around the same time showed surface winds as high as 38 kt.

Cristobal's second estimated peak intensity of 50 kt north of the Yucatan Peninsula is based on a peak 850-mb flight-level wind of 68 kt (which adjusts to about 54 kt at the surface) and an SFMR wind of 52 kt, which were measured in a convective band by an Air Force Reserve aircraft as it began heading back to base at the end of its mission early on 6 June. These data allow for the possibility that the peak intensity was even a little higher than 50 kt, but the aircraft's sampling within the convective environment well away from the center of circulation argues that higher measurements may not be as representative of the cyclone's intensity.

Cristobal's estimated intensity of 45 kt at its landfall on the Louisiana coast at 2200 UTC 7 June is based on aircraft reconnaissance data from earlier that morning, surface observations from southeastern Louisiana and southern Mississippi, and NWS Doppler radar velocity data. During the Air Force Reserve Hurricane Hunter mission that morning, the plane measured a peak 1000-ft flight-level wind of 62 kt (which adjusts to about 47 kt at the surface) and a surface wind of 41 kt from the SFMR. Later that day, an observing site on Ship Island, Mississippi, measured a peak sustained wind of 42 kt at a height of 12 m at 2107 UTC. Adjusted WSR-88D velocity data from Slidell, Louisiana, suggested that peak surface winds were likely between 40 and 50 kt, but some of the strongest winds aloft may not have been mixed to the surface due to a lack of strong convection. The combination of these data supports an estimated intensity of 45 kt at landfall.

Due to Cristobal's broad nature as it moved to the north, its minimum central pressure did not occur coincidently with its maximum winds. The storm's central pressure fell to 990 mb just before landfall along the coast of Louisiana, with an observing station at Bayou Bienvenue reporting a pressure of 990.4 mb at 0043 UTC 8 June. Cristobal's central pressure rose slightly after landfall but began to fall again at the beginning of extratropical transition and reached 988 mb just before the transition was complete.

Tropical-storm-force winds likely occurred over portions of the Mexican states of Campeche, Tabasco, and possibly northern Chiapas. However, sustained tropical-storm-force winds were not reported at any observing sites in those states. A gust to 48 kt occurred at Ciudad del Carmen the morning of 3 June soon after Cristobal made landfall. Sustained tropical-storm-force winds were reported along the east coast of the state of Quintana Roo, with Weatherflow sites at Cancun and Puerto Morelos reporting sustained winds of 40 kt and 36 kt, respectively, on the morning of 5 June. The Cancun station also reported a wind gust of 54 kt. A sustained wind of 37 kt was reported on Isla Perez, a small island off the north coast of the Yucatan Peninsula, later that day.

In the United States, Cristobal produced sustained tropical-storm-force winds across portions of southeastern Louisiana, southern Mississippi, southern Alabama, and the far western Florida Panhandle late on 7 June and early on 8 June (Fig. 4). The highest sustained winds reported in each state at a standard (or near-standard) 10-m height were 34 kt at New Orleans Lakefront Airport and Shell Beach, Louisiana; 42 kt at Ship Island, Mississippi; 41 kt at Middle Bay Lighthouse, Alabama; and 35 kt at Panama City Beach, Florida. A wind gust to 56 kt was measured at the Ship Island station.

Storm Surge[4]

Even though Cristobal made landfall in Louisiana as a 45-kt tropical storm, it produced significant storm surge flooding along portions of the northern Gulf coast due to its large size and that area's vulnerability to storm surge as a result of a shallow nearshore bathymetry. The highest measured storm surge from Cristobal was 6.16 ft above normal tide levels at a NOAA National Ocean Service (NOS) gauge at Shell Beach, Louisiana.

The combination of the surge and tides produced inundation levels of 3 to 6 ft above ground level along the coasts of southeastern Louisiana, Mississippi, and Alabama. Figure 5 shows maximum water levels measured from NOS tide gauges referenced as feet above Mean Higher High Water (MHHW), which is used as a proxy for inundation on normally dry ground along the immediate coastline. The Shell Beach gauge on Lake Borgne in Louisiana measured a peak water level of 6.2 ft MHHW. Storm surge was also pushed into Lake Pontchartrain, with the NOS gauge at the Interstate-10 Bonnet Carre Floodway measuring a peak water level of 4.6 ft MHHW. Along the Mississippi coast, a peak water level of 5.7 ft MHHW was measured by an NOS gauge at the Bay Waveland Yacht Club, and a maximum of 3.8 ft MHHW was measured along the Alabama coast by an NOS gauge at Coast Guard Sector Mobile.

[4] Several terms are used to describe water levels due to a storm. **Storm surge** is defined as the abnormal rise of water generated by a storm, over and above the predicted astronomical tide, and is expressed in terms of height above normal tide levels. Because storm surge represents the deviation from normal water levels, it is not referenced to a vertical datum. **Storm tide** is defined as the water level due to the combination of storm surge and the astronomical tide, and is expressed in terms of height above a vertical datum, i.e. the North American Vertical Datum of 1988 (NAVD88) or Mean Lower Low Water (MLLW). **Inundation** is the total water level that occurs on normally dry ground as a result of the storm tide, and is expressed in terms of height above ground level. At the coast, normally dry land is roughly defined as areas higher than the normal high tide line, or Mean Higher High Water (MHHW).

Minor coastal flooding of 1 to 3 ft above ground level also occurred along the Louisiana coast west of the mouth of the Mississippi River and along portions of the Florida Panhandle coast. A peak water level of 3.0 ft MHHW was measured by the NOS gauge at Berwick on the Atchafalaya River in Louisiana, and in Florida, an NOS gauge at Pensacola measured a peak water level of 2.6 ft MHHW.

Rainfall and Flooding

Significant heavy rainfall occurred over portions of Central America and southeastern Mexico over a nine-day period (29 May–7 June) due to Tropical Storm Cristobal, eastern Pacific Tropical Storm Amanda, and the Central American gyre that both cyclones were embedded in. Table 4 provides selected rainfall totals for the entire event, while Figure 6 provides an analysis of the total rainfall over southeastern Mexico and Central America.

In Mexico, the most significant rainfall occurred in the states of Yucatan, Campeche, Tabasco, and Chiapas. During the period of Cristobal (1–6 June), the maximum rainfall totals recorded in each state were 24.54 inches (623.3 mm) at Valladolid, Yucatan; 24.09 inches (611.9 mm) at Ocotepec, Chiapas; 22.32 inches (566.9 mm) at Hopelchén, Campeche; and 16.02 inches (406.9 mm) at Boca del Cerro, Tabasco. A maximum of 11.01 inches (279.7 mm) was also measured in the state of Veracruz near the city of Coatzacoalcos. For the entire combined event, covering the period from 28 May to 6 June, maximum rainfall accumulations of 34.80 inches (883.9 mm) and 30.89 inches (784.6 mm) were recorded at Ocotepec and Sayula, respectively, in the state of Chiapas. Amounts greater than 25 inches (650 mm) were also recorded at several sites in the states of Campeche and Yucatan.

High rainfall totals occurred over parts of Central America as well, particularly in El Salvador, Guatemala, Honduras, and Belize. In El Salvador, 20.10 inches (510.54 mm) of rain fell at Volcán Conchagua during the period of Cristobal, and that location ended up with a combined total of 42.80 inches (1087.1 mm) for the entire event. Guatemala had a peak rainfall amount of 14.68 inches (372.9 mm) registered at Jutiapa, with an event-total amount of 26.48 inches (672.6 mm). Cristobal produced a maximum of 11.02 inches (279.9 mm) in Honduras at Sabana Grande, which also recorded a total of 13.73 inches (348.7 mm) for the entire event. Lastly, in Belize, the highest rainfall measured during Cristobal was 10.19 inches (258.8 mm) at Yo Chen, and that site had an event-total accumulation of 13.89 inches (352.8 mm). Additional information on the rains that occurred in Central America can be found in the NHC Tropical Cyclone Report for Tropical Storm Amanda[5].

High rainfall totals occurred over portions of the southeastern United States, particularly to the east of the path of Cristobal's center. More than a foot of rain was measured at sites in southeastern Louisiana, southern Mississippi, and northern Florida, and just under a foot was measured in southern Alabama and southern Georgia. For the period from 7 to 9 June, the maximum rainfall totals recorded during Cristobal were 13.65 inches near Caesar, Mississippi; 13.55 inches near Madison, Florida; and 13.38 inches near Pearl River, Louisiana. Figure 7

[5] The Tropical Cyclone Report for Tropical Storm Amanda can be found at https://www.nhc.noaa.gov/data/tcr/EP022020_Amanda.pdf

provides an analysis of rainfall from Cristobal in the United States, over a longer period from 2 to 10 June. This extended period includes a maximum rainfall total of 15.20 inches near Stuart, Florida.

Tornadoes

There were 13 tornadoes reported in the United States during Cristobal, which are listed in Table 5. Eleven of the tornadoes occurred in Florida on 6 and 7 June within Cristobal's outer rainbands. The most significant tornado, an EF1 (on the Enhanced Fujita Scale), started as a waterspout over Lake Conway and moved northward across eastern portions of the Orlando metropolitan area. The tornado had a path length of just over 5 miles and caused about $956,000 of property damage. The other tornadoes in Florida were all rated EF0. One tornado in Clearwater caused $30,000 in damage, and one in Oxford caused $40,000 in damage.

Two tornadoes of unknown intensity occurred in eastern Illinois late on 9 June, just before Cristobal became extratropical. No damage was reported from either tornado.

Cristobal's remnants and the associated moisture also helped initiate a derecho which moved eastward across parts of the Great Lakes and Ohio Valley on 10 June. Wind gusts of 60 to 80 mph were reported in Michigan, Indiana, Ohio, Kentucky, and western New York, and a few tornadoes occurred in Ohio and Pennsylvania.

CASUALTY AND DAMAGE STATISTICS

Cristobal is known to have taken the lives of six people. After Amanda caused 40 deaths in El Salvador, Guatemala, and Honduras, Cristobal caused another three deaths[6] in Mexico. A 54-year-old man drowned while attempting to swim across a flooded street in Santa María, Yaxcabá, Yucatan state, and a 10-year-old Venezuelan boy drowned when his family attempted to drive through the overflow of the Chumpán River in Campeche state[7]. In Chiapas state, a motorcyclist died when a tree fell on him on a highway in San Cristóbal de las Casas[8]. In the

[6] 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.

[7] Reportan dos muertos por afectaciones de "Cristóbal" en sureste. *La Jornada Maya*. https://www.jornada.com.mx/ultimas/estados/2020/06/07/reportan-una-muerte-por-el-paso-de-cristobal-en-yaxcaba-yucatan-717.html

[8] Tormenta tropical "Cristóbal" deja un muerto en Chiapas. *El Universal*. https://www.eluniversal.com.mx/nacion/tormenta-tropical-cristobal-deja-un-muerto-en-chiapas

United States, two brothers, ages 8 and 10, drowned in a rip current at a beach in Grand Isle, Louisiana[9]. A 17-year-old boy also drowned in rough surf at Crystal Beach, Texas[10].

Mexico's Comisión Nacional del Agua (CONAGUA) indicates that 112 municipalities across the states of Tabasco, Campeche, Yucatan, Quintana Roo, and Chiapas were affected by severe flash and river flooding. At least 619 people, of which 508 were in Campeche, were evacuated, with more than 200 houses and 3 hospitals damaged in these states. Several landslides were reported, particularly in the state of Chiapas[11].

The NOAA National Centers for Environmental Information (NCEI) estimates that damage from Cristobal totaled about $310 million in the United States. Storm surge flooding inundated roadways along the coasts of southeastern Louisiana, Mississippi, Alabama, and the Florida Panhandle. Wave action caused beach erosion and damaged many piers, and some homes in the area were damaged from flooding and downed trees. In Grand Isle, Louisiana, Cristobal eroded sand and damaged about 2,000 feet of the protective levee on the west side of the island, and rural levees were overtopped or breached in some parts of Louisiana, including a breach in a levee in Delacroix in St. Bernard Parish. Ten people were rescued and another 19 were evacuated from Fontainebleau State Park on the north side of Lake Pontchartrain after storm surge surrounded the cabins. The Mississippi Emergency Management Agency (MEMA) reported that 23 homes, 30 businesses, 23 roads, and 13 public buildings sustained damage in Hancock, Harrison, and Jackson Counties, amounting to a total of $5.7 million of damage in the state.

FORECAST AND WARNING CRITIQUE

The genesis of Cristobal was not forecast with much lead time. Table 6 provides the number of hours in advance of formation with the first NHC Tropical Weather Outlook (TWO) forecast in each likelihood category. A low (<40%) chance of genesis in the southwestern Gulf of Mexico during the next 5 days was first indicated in a Special TWO 42 h before Cristobal formed. At the time, Tropical Depression Two-E (soon-to-be Amanda) had formed over the far eastern Pacific Ocean off the coasts of Guatemala and El Salvador and was forecast to move inland and dissipate over Guatemala, with its remnants expected to rotate within a larger gyre located over Central America. However, due to potential land interaction and the influence of the gyre, it was unclear if the remnants would regenerate into a tropical cyclone over the Gulf of Mexico. The 2- and 5-day chances of genesis were raised to the medium (40–60%) category 30 h before genesis, and to the high (>60%) category only 6 and 12 h, respectively, before genesis.

---

[9] Tropical Storm Cristobal spawns damaging tornado in Orlando; Louisiana brothers, 8 and 10, killed in rip current. *Fox News*. https://www.foxnews.com/us/tropical-storm-cristobal-tornado-orland-florida-outer-band-rip-current-louisiana-brothers-killed

[10] Teen drowns at Crystal Beach after grandmother lost sight of him. *ABC13*. https://abc13.com/ewn-galveston-county-grandmother-grandson-drowns/6236817/

[11] Mexico - Tropical Storm CRISTOBAL update (GDACS, NOAA, SMN, CNPC, media) (ECHO Daily Flash of 04 June 2020). ReliefWeb. https://reliefweb.int/report/mexico/mexico-tropical-storm-cristobal-update-gdacs-noaa-smn-cnpc-media-echo-daily-flash-04

A verification of NHC official track forecasts for Cristobal is given in Table 7a. Official forecast track errors were between 10 and 26% lower than the mean official errors for the previous 5-yr period at all forecast times. The OCD5 errors were a little higher than their respective 5-year means from 12 through 60 h, indicating that the short-term forecasts of Cristobal's track were a little more difficult than usual. A homogeneous comparison of the official track errors with selected guidance models is given in Table 7b. Overall, the NHC official track forecasts performed better than the individual deterministic models, with the exception of the GFS, which had lower errors between 36 and 96 h. The official forecasts were unable to beat the simple and corrected consensus models, most of which had lower errors than the official forecasts at nearly every forecast time.

A verification of NHC official intensity forecasts for Cristobal is given in Table 8a. Official forecast intensity errors were significantly lower than the mean official errors for the previous 5-yr period at all forecast times (as much as 58% lower at 60 h). However, OCD5 errors were lower than their respective 5-yr means by a similar margin, suggesting that Cristobal's intensity was easier to forecast than for a typical Atlantic tropical cyclone. A homogeneous comparison of the official intensity errors with selected guidance models is given in Table 8b. The short-term NHC intensity forecasts were quite skillful and bested the individual dynamical and statistical-dynamical models from 12 through 60 h. However, these models generally had lower errors than the official forecasts from 72 to 120 h. Of the consensus aids, the variable intensity consensus (IVCN) and the HFIP Corrected Consensus aid (HCCA) had lower errors than the official forecasts at every forecast time.

Coastal wind watches and warnings associated with Cristobal are given in Table 9a. In the United States, a Tropical Storm Watch was first issued for the northern Gulf coast from Intracoastal City, Louisiana, eastward to the Alabama/Florida border at 1500 UTC 5 June. Later that day at 2100 UTC, a Tropical Storm Warning was issued from Morgan City, Louisiana, eastward to the Okaloosa/Walton County Line, Florida. Sustained tropical-storm-force winds are estimated to have first reached the coast within the warning area around 0300 UTC 7 June, indicating that the Tropical Storm Watch provided a lead time of 36 h and the Tropical Storm Warning provided a lead time of 30 h. These lead times were 12 and 6 h less than the respective typical lead times for coastal watches and warnings due to Cristobal moving a little faster and its wind field growing a little more than forecast.

Storm surge watches and warnings associated with Cristobal area given in Table 9b. A Storm Surge Watch was first issued for two separate segments of the northern Gulf coast at 1500 UTC 5 June: from Grand Isle, Louisiana, to Ocean Springs, Mississippi (including Lake Borgne) and from Indian Pass, Florida, to Arepika, Florida. A portion of the western segment, from the mouth of the Mississippi River to Ocean Springs (including Lake Borgne), was upgraded to a Storm Surge Warning later that day at 2100 UTC. Storm surge inundation of 3 feet or greater above normally dry ground (which NHC uses as a first-cut threshold for the storm surge watch/warning) occurred within the Storm Surge Warning area (Fig. 8). Inundation levels a little higher than 3 feet occurred outside of the warning area in the regions around Mobile Bay and Lake Pontchartrain. The eastern segment of the Storm Surge Watch from Indian Pass to Arepika was not upgraded to a warning, and tide stations along that portion of the coast did not register inundation levels higher than 3 feet.

IMPACT-BASED DECISION SUPPORT SERVICES (IDSS) AND PUBLIC COMMUNICATION

NHC provided impact-based decision support services (IDSS) for Cristobal to emergency managers from 3 June through 8 June, including calls, briefings, and federal video teleconferences with FEMA Headquarters, FEMA Region 4, FEMA Region 6, and impacted states. These IDSS briefings were coordinated through the FEMA Hurricane Liaison Team, embedded at the NHC.

After coordination with several countries in Central America for eastern Pacific Tropical Storm Amanda, NHC continued its international coordination with the meteorological service of Mexico for Cristobal for the issuance of tropical storm watches and warnings for portions of southeastern Mexico.

The Tropical Analysis and Forecast Branch of NHC provided nine live briefings to the U.S. Coast Guard Districts 7 and 8 between 2 and 7 June in support of their life-saving mission.

NHC provided 10 live interviews via Skype on 7 June to local media affiliates and national cable weather outlets. Two Facebook Live broadcasts were also conducted via the NHC Facebook page.

NHC provided key messages on Cristobal in its Tropical Cyclone Discussions and in graphical format on the NHC webpage and through social media posts from 1 through 8 June.

ACKNOWLEDGMENTS

Data in Table 3 were compiled from Post Tropical Cyclone Reports and Public Information Statements issued by NWS Forecast Offices (WFOs) and reports from the Weather Prediction Center, National Data Buoy Center, NOS Center for Operational Oceanographic Products and Services, and international meteorological services in Mexico, Belize, Guatemala, El Salvador, and Honduras.

Table 1. Best track for Tropical Storm Cristobal, 1–9 June 2020.

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
01 / 1800	19.4	90.9	1006	25	tropical depression
02 / 0000	19.6	91.6	1005	25	"
02 / 0600	19.6	92.1	1005	30	"
02 / 1200	19.5	92.5	1004	35	tropical storm
02 / 1800	19.2	92.6	1001	40	"
03 / 0000	19.0	92.5	996	45	"
03 / 0600	18.9	92.3	994	50	"
03 / 1200	18.8	92.2	993	50	"
03 / 1300	18.7	92.1	993	50	"
03 / 1800	18.5	91.9	994	45	"
04 / 0000	18.2	91.7	995	40	"
04 / 0600	17.9	91.5	997	35	"
04 / 1200	17.7	91.2	999	30	tropical depression
04 / 1800	17.6	90.8	999	30	"
05 / 0000	17.9	90.4	999	30	"
05 / 0600	18.6	90.1	998	35	tropical storm
05 / 1200	19.6	89.9	997	40	"
05 / 1800	20.8	89.9	997	45	"
06 / 0000	22.0	90.0	996	50	"
06 / 0600	23.0	90.1	994	50	"
06 / 1200	23.9	90.2	992	45	"
06 / 1800	24.8	90.2	992	45	"
07 / 0000	25.8	90.1	992	45	"
07 / 0600	26.9	90.0	992	45	"
07 / 1200	28.0	89.9	991	45	"
07 / 1800	29.0	89.8	990	45	"
07 / 2200	29.3	89.8	990	45	"
08 / 0000	29.8	89.9	990	45	"
08 / 0600	30.6	90.6	991	35	"
08 / 1200	31.7	91.5	993	30	tropical depression
08 / 1800	32.9	92.0	994	30	"
09 / 0000	34.2	92.1	994	25	"

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
09 / 0600	35.8	92.2	993	25	"
09 / 1200	38.0	92.1	991	25	"
09 / 1800	40.3	91.7	988	30	"
10 / 0000	42.6	90.8	986	30	extratropical
10 / 0600	45.0	89.3	983	35	"
10 / 1200	47.5	87.4	982	35	"
10 / 1800	49.8	85.1	982	35	"
11 / 0000	51.7	82.6	983	30	"
11 / 0600	52.7	81.2	985	30	"
11 / 1200	53.2	80.4	987	35	"
11 / 1800	53.4	79.8	989	35	"
12 / 0000	53.3	79.4	992	35	"
12 / 0600	52.5	79.1	998	35	"
12 / 1200					dissipated
03 / 0600	18.9	92.3	994	50	maximum winds
09 / 1800	40.3	91.7	988	30	minimum pressure
03 / 1300	18.7	92.1	993	50	landfall at Atasta, Campeche, Mexico
07 / 2200	29.3	89.8	990	45	landfall in Plaquemines Parish, Louisiana (about 10 n mi east of Grand Isle)

Table 2. Selected ship reports with winds of at least 34 kt for Tropical Storm Cristobal, 1–9 June 2020.

Date/Time (UTC)	Ship call sign	Latitude (°N)	Longitude (°W)	Wind dir/speed (kt)	Pressure (mb)
02 / 1500	9V9134	19.4	95.4	260 / 44	1013.0
03 / 0600	C6CL6	17.3	86.3	120 / 40	1008.0
03 / 0900	C6CL6	17.6	86.0	130 / 36	1007.2
06 / 0900	A8ZU9	27.5	87.6	100 / 36	1009.8
06 / 1100	9V6408	28.1	88.4	120 / 35	1010.4
07 / 0000	9V6408	26.9	86.8	140 / 35	1004.4
07 / 0100	9V6408	26.9	86.7	140 / 35	1004.4
07 / 0600	9V6408	26.4	86.0	140 / 36	1007.4
07 / 0800	9V6408	26.2	85.8	140 / 45	1007.4
07 / 0900	9V6408	26.1	85.7	140 / 45	1006.4
07 / 1000	9V6408	26.0	85.5	180 / 40	1009.4
07 / 1100	9V6408	25.4	85.4	170 / 38	1009.4
07 / 1200	9V6408	25.8	85.3	170 / 35	1009.4
07 / 1700	VRQO6	26.5	87.5	190 / 35	1006.0
07 / 1800	9V6408	24.9	84.9	140 / 35	1009.4

Table 3. Selected surface observations for Tropical Storm Cristobal, 1–9 June 2020.

Location	Minimum Sea Level Pressure		Maximum Surface Wind Speed			Storm surge (ft)[c]	Storm tide (ft)[d]	Estimated Inundation (ft)[e]	Total rain (in)
	Date/ time (UTC)	Press. (mb)	Date/ time (UTC)[a]	Sustained (kt)[b]	Gust (kt)				
Mexico									
International Civil Aviation Organization (ICAO) Sites									
Ciudad del Carmen (MMCE) (18.65N 91.80W)	3/2044	995.3	3/1343	29	48				
Cancun (MMUN) (21.03N 86.87W)	5/2043	1004.5	6/0048	28	38				
Hydrometeorological Automated Data System (HADS) Sites									
Isla Perez (IPZY1) (22.38N 89.68W)			5/2145	37	46				
Puerto Aventuras (PAVX4) (20.50N 87.23W)			6/0545		40				
Isla Mujeres (IMUX4) (21.25N 86.74W)			5/1600		36				
Rio Lagartos (LAGY1) (21.57N 88.16W)			6/0100		35				
Weatherflow Sites									
Cancun (21.06N 86.78W)	6/0011	1001.6	5/1451	40 (11 m)	54				
Puerto Morelos (20.83N 86.89W)	5/1039	1002.0	5/1354	36 (10 m)	49				
Xcaret Park (20.58N 87.12W)	5/2143	1001.7	5/1713	33 (11 m)	49				
Cozumel (20.53N 86.94W)	5/1035	1001.2	6/1645	20 (11 m)	38				
Xel-Ha Park (20.32N 87.36W)	5/1023	1000.3	5/1123	25 (10 m)	36				
Louisiana									
ICAO Sites									
New Orleans Lakefront Airport (KNEW) (30.04N 90.03W)	8/0139	993.2	7/1816	34[l]	42[l]				3.43
Alexandria (KAEX) (31.33N 92.56W)	8/1050	997.9	8/1942	26	42				0.66
Slidell (KASD) (30.35N 89.82W)	8/0141	993.6	8/0533	24	41				3.24
New Orleans Louis Armstrong Airport (KMSY) (29.98N 90.25W)	8/0240	994.9	7/1303	23	35				2.70

Location	Minimum Sea Level Pressure		Maximum Surface Wind Speed			Storm surge (ft)[c]	Storm tide (ft)[d]	Estimated Inundation (ft)[e]	Total rain (in)
	Date/ time (UTC)	Press. (mb)	Date/ time (UTC)[a]	Sustained (kt)[b]	Gust (kt)				
Patterson Memorial Airport (KPTN) (29.71N 91.34W)	7/2256	997.2	6/2105	28	35				3.64
Coastal-Marine Automated Network (C-MAN) Sites									
Southwest Pass (BURL1) (28.91N 89.43W)			7/1100	37 (38 m)	44				
National Ocean Service (NOS) Sites									
Shell Beach (SHBL1) (29.87N 89.67W)	7/2342	993.4	7/1130	34 (16 m)	41	6.16	6.91	6.2	
I-10 Bonnet Carre Floodway (BCFL1) (30.07N 90.39W)						4.58	5.07	4.6	
New Canal Station (NWCL1) (30.03N 90.11W)	8/0118	993.1	7/1218	33 (10 m)	41	3.96	4.27	4.0	
Pilot's Station East (PSTL1) (28.93N 89.41W)	7/2042	991.5	7/1030	41 (24 m)	55	2.67		3.2	
Berwick, Atchafalaya River (TESL1) (29.67N 91.24W)	7/2230	996.4	7/0130	22 (13 m)	30	2.18	5.17	3.0	
Pilottown (PILL1) (29.18N 89.26W)	7/2130	992.6	8/0800	28 (12 m)	34	2.44		2.8	
Grand Isle (GISL1) (29.26N 89.96W)			7/0054	25 (9 m)	34	2.14		2.5	
LAWMA, Amerada Pass (AMRL1) (29.45N 91.34W)	7/2318	996.6	6/1836	16 (11 m)	25	2.31	3.16	2.3	
Eugene Island (EINL1) (29.37N 91.38W)	7/2330	996.3	8/1654	32 (10 m)	40	2.05		2.1	
Port Fourchon (PTFL1) (29.11N 90.20W)						2.28		2.1	
Freshwater Canal Locks (FRWL1) (29.55N 92.31W)	8/0154	999.9	8/1906	22 (20 m)	31	1.84	2.88	2.0	
Frenier Landing (FREL1) (30.11N 90.42W)	8/0054	993.7	7/2018	30 (10 m)	37				
Weatherflow Sites									
Bayou Bienvenue (XBYU) (30.00N 89.90W)	8/0043	990.4	7/1743	38 (27 m)	50				
New Orleans Lakefront (XLKF) (30.04N 90.02W)	8/0107	991.7	7/1813	32 (10 m)	41				

Location	Minimum Sea Level Pressure		Maximum Surface Wind Speed			Storm surge (ft)[c]	Storm tide (ft)[d]	Estimated Inundation (ft)[e]	Total rain (in)
	Date/ time (UTC)	Press. (mb)	Date/ time (UTC)[a]	Sustained (kt)[b]	Gust (kt)				
Pontchartrain Causeway - Midlake (XPTN) (30.20N 90.12W)	8/0119	992.2	7/1934	28 (13 m)	36				
Mandeville (XMVL) (30.36N 90.09W)	8/0145	991.9	8/0755	27 (10 m)	34				
Other Sites									
Port Fourchon Heliport (KXPY) (29.12N 90.20W)			7/0620	25 (30 m)	36				
United States Geological Survey (USGS) Sites									
Gulf Intracoastal Waterway near Michoud (SBEL1) (30.01N 89.90W)							7.27		
Bayou Dupre near Violet (BDML1) (29.94N 89.84W)							7.20		
Breton Sound at Black Bay near Snake Island (PSIL1) (29.63N 89.56W)							6.59		
Mississippi Sound at Grand Pass (GRPL1) (30.12N 89.25W)							6.13		
Pearl River above Slidell (PRBL1) (30.30N 89.70W)							6.07		
Breton Sound Basin at Crooked Bayou near Delacroix (CBDL1) (29.71N 89.72W)							5.43		
Barataria Bay and Waterway at 13 NNE Grand Isle (NGIL1) (29.42N 89.95W)							4.22		
United States Army Corps of Engineer (USACE) Sites									
Lake Borgne at Chef Menteur Pass (CMPL1) (30.07N 89.80W)							5.79		
Lake Pontchartrain at Lakefront Airport (PLAL1) (30.04N 90.02W)							4.63		
Lake Pontchartrain near Mandeville (LPML1) (30.37N 90.09W)							4.63		

Location	Minimum Sea Level Pressure		Maximum Surface Wind Speed			Storm surge (ft)[c]	Storm tide (ft)[d]	Estimated Inundation (ft)[e]	Total rain (in)
	Date/ time (UTC)	Press. (mb)	Date/ time (UTC)[a]	Sustained (kt)[b]	Gust (kt)				
Breton Sound Basin at Caernarvon Sector Gate (CGWL1) (29.86N 89.91W)							4.57		
Lake Pontchartrain at Pass Manchac near Ponchatoula (PMPL1) (30.28N 90.40W)							3.84		
Hydrometeorological Automated Data System (HADS) Sites									
Pearl River (PERL1) (30.39N 89.74W)									13.38
Camp Covington (CGSL1) (30.60N 90.15W)									12.83
Folsom 4 SW (FLSL1) (30.62N 90.25W)									12.23
Bogalusa (BXAL1) (30.80N 89.82W)									11.74
Hammond 5 E (ROBL1) (30.51N 90.36W)									11.68
Hammond 5 W (NRBL1) (30.50N 90.55W)									11.58
Franklinton (FRNL1) (30.84N 90.16W)									11.25
Holden (HOLL1) (30.50N 90.68W)									10.73
Montpelier (MONL1) (30.69N 90.54W)									9.97
Amite (AMIL1) (30.73N 90.48W)									7.01
Community Collaborative Rain, Hail and Snow Network (CoCoRaHS) Sites									
Mandeville 0.8 WNW (LA-ST-25) (30.37N 90.09W)									9.17
Mississippi									
ICAO Sites									
Gulfport (KGPT) (30.40N 89.07W)	8/0154	995.6	7/2022	33	43				7.56
Meridian (KMEI) (32.34N 88.75W)			9/1858		42				2.59
Biloxi – Keesler AFB (KBIX) (30.42N 88.92W)	8/0130	996.2	8/1336	30	41				8.52

Location	Minimum Sea Level Pressure		Maximum Surface Wind Speed			Storm surge (ft)[c]	Storm tide (ft)[d]	Estimated Inundation (ft)[e]	Total rain (in)
	Date/ time (UTC)	Press. (mb)	Date/ time (UTC)[a]	Sustained (kt)[b]	Gust (kt)				
Pascagoula (KPQL) (30.46N 88.53W)	8/0153	998.3	8/0203	26	39				9.02
Jackson (KJAN) (32.31N 90.08W)			8/2047		39				3.19
Stennis (KHSA) (30.37N 89.45W)			7/1949	21	38				
Greenwood (KGWO) (33.49N 90.09W)			8/1131		36				1.11
Hattiesburg/Laurel (KPIB) (31.47N 89.34W)			8/0420		34				4.93
Hattiesburg (KHBG) (31.26N 89.25W)			8/0315		34				1.96
NOS Sites									
Bay Waveland Yacht Club (WYCM6) (30.33N 89.33W)	8/0030	995.0	7/2024	36 (10 m)	44	5.92	6.77	5.7	
Pascagoula NOAA Lab (PNLM6) (30.37N 88.56W)						4.19	4.50	3.6	
Petit Bois Island, Port of Pascagoula (PTBM6) (30.21N 88.51W)	8/0048	997.7	7/2112	36 (5 m)	50				
Weatherflow Sites									
Ship Island (XSHI) (30.23N 88.98W)	8/0052	994.0	7/2107	42 (12 m)	56				
Gulfport (XGPT) (30.36N 89.11W)	8/0137	994.3	7/2117	40 (10 m)	52				
Biloxi (XBIL) (30.44N 88.98W)	8/0118	993.3	8/0728	18 (15 m)	35				
USGS Sites									
Tchoutacabouffa River near D'Iberville (DIBM6) (30.48N 88.89W)							7.18		
Pearl River near Claiborne (EPCM6) (30.19N 89.53W)							6.75		
Pascagoula River at Old Fort Bayou at Ocean Springs (OFBM6) (30.42N 88.83W)							5.23		

Location	Minimum Sea Level Pressure		Maximum Surface Wind Speed			Storm surge (ft)[c]	Storm tide (ft)[d]	Estimated Inundation (ft)[e]	Total rain (in)
	Date/ time (UTC)	Press. (mb)	Date/ time (UTC)[a]	Sustained (kt)[b]	Gust (kt)				
HADS Sites									
Caesar 3 WSW (CREM6) (30.57N 89.59W)									13.65
McNeill 3 W (MNLM6) (30.66N 89.69W)									12.97
Gulfport 6 WNW (GLFM6) (30.40N 89.20W)									12.76
Lyman 4 E (LYMM6) (30.48N 89.03W)									12.52
D'Iberville 4 N (DIBM6) (30.48N 88.90W)									11.48
Monticello (MTCM6) (31.55N 90.08W)									10.35
Tylertown 9 NW (TYTM6) (31.18N 90.28W)									10.25
Runnelstown 3 S (RNTM6) (31.33N 89.11W)									9.91
Kiln 2 S (KLNM6) (30.39N 89.44W)									9.90
Pascagoula River at Graham Ferry (PGFM6) (30.61N 88.64W)									9.82
Gautier 6 NNW (PSHCM6) (30.45N 88.66W)									9.79
Osyka (OSYM6) (31.01N 90.46W)									9.79
Orange Grove 3 NNE (ORAM6) (30.46N 88.45W)									9.38
Merrill (MRRM6) (30.98N 88.73W)									8.79
Rockport 1 E (ROCM6) (31.78N 90.15W)									8.43
Gulfport (TCGM6) (30.42N 89.08W)									8.28
Waynesboro 3 WNW (WYNM6) (31.68N 88.68W)									7.93
Leakesville (LEKM6) (31.15N 88.56W)									7.91
Rosetta (RSAM6) (31.33N 91.10W)									7.74

Location	Minimum Sea Level Pressure		Maximum Surface Wind Speed			Storm surge (ft)[c]	Storm tide (ft)[d]	Estimated Inundation (ft)[e]	Total rain (in)
	Date/ time (UTC)	Press. (mb)	Date/ time (UTC)[a]	Sustained (kt)[b]	Gust (kt)				
Biloxi (BLXM6) (30.38N 88.98W)									7.17
Shubuta (SHBM6) (31.87N 88.70W)									7.16
Jackson 1 SSE (JACM6) (32.28N 90.18W)									7.09
CoCoRaHS Sites									
Ocean Springs 3.6 ESE (MS-JC-12) (30.38N 88.75W)									10.08
Gautier 4.9N (MS-JC-22) (30.46N 88.65W)									9.96
Ocean Springs 1.2 WNW (MS-JC-24) (30.41N 88.82W)									9.94
Ocean Springs 3.2 SE (MS-JC-8) (30.37N 88.77W)									9.92
Lucedale 13 SE (MS-GG-2) (30.79N 88.43W)									9.56
Biloxi 13.1 NNW (MS-HR-34) (30.57N 89.05W)									9.44
Ocean Springs 3.3 E (MS-JC-2) (30.41N 88.75W)									9.27
Pass Christian 5 N (MS-HR-19) (30.39N 89.25W)									9.08
Gulfport 5.3 NW (MS-HR-39) (30.44N 89.13W)									8.25
Pass Christian 9.8 NNW (MS-HR-37) (30.46N 89.28W)									7.77
Waveland 1.0 NW (MS-HC-18) (30.30N 89.40W)									7.70
Saucier 1.7 NNE (MS-HR-22) (30.66N 89.13W)									7.16
Kiln 3.3 N (MS-HC-9) (30.46N 89.43W)									6.93

Location	Minimum Sea Level Pressure		Maximum Surface Wind Speed			Storm surge (ft)[c]	Storm tide (ft)[d]	Estimated Inundation (ft)[e]	Total rain (in)
	Date/ time (UTC)	Press. (mb)	Date/ time (UTC)[a]	Sustained (kt)[b]	Gust (kt)				
NWS Cooperative Observer (COOP) Sites									
Gulfport (GLFM6) (30.39N 89.21W)									6.94
Alabama									
ICAO Sites									
Mobile Downtown (KBFM) (30.64N 88.07W)	7/2353	1001.1	8/0247	33	49				0.24
Gulf Shores (KJKA) (30.29N 87.67W)	8/0055	1002.4	7/2315	29	40				
Mobile / Bates Field (KMOB) (30.68N 88.25W)	8/0156	1000.5	8/0156	27	40				7.00
C-MAN Sites									
Dauphin Island (DPIA1) (30.25N 88.08W)	8/0100	999.8	7/1750	38 (14 m)	49				
NOS Sites									
Coast Guard Sector Mobile (MCGA1) (30.65N 88.06W)	8/0200	1001.2	7/2354	30 (9 m)	38	5.27	4.92	3.8	
Chickasaw Creek (CIKA1) (30.78N 88.07W)						4.99	5.02	3.7	
Mobile State Docks (OBLA1) (30.71N 88.04W)	8/0000	1001.0				4.64	4.75	3.6	
Dog River Bridge (BYSA1) (30.57N 88.09W)						4.69		3.3	
Bayou La Batre Bridge (BLBA1) (30.41N 88.25W)						4.33	4.11	3.2	
West Fowl River Bridge (WFRA1) (30.38N 88.16W)						4.16	4.01	3.1	
East Fowl River Bridge (EFRA1) (30.44N 88.11W)						4.16	3.93	3.1	
Weeks Bay, Mobile Bay (WBYA1) (30.42N 87.83W)						3.56		3.0	
Dauphin Island (DILA1) (30.25N 88.08W)	8/0118	999.4	7/1724	39 (11 m)	49	3.20	3.47	2.8	
Fort Morgan (FMOA1) (30.23N 88.03W)	7/2242	999.5	7/2230	44 (38 m)	54				

Location	Minimum Sea Level Pressure		Maximum Surface Wind Speed			Storm surge (ft)[c]	Storm tide (ft)[d]	Estimated Inundation (ft)[e]	Total rain (in)
	Date/ time (UTC)	Press. (mb)	Date/ time (UTC)[a]	Sustained (kt)[b]	Gust (kt)				
Weatherflow Sites									
Buccaneer Yacht Club (XBUC) (30.58N 88.07W)			8/0247	35 (10 m)	45				
Gulf Shores - Foley (XGLF) (30.36N 87.65W)			8/1555	23 (10 m)	43				
Dauphin Island Sea Lab Sites									
Middle Bay Lighthouse (MBLA1) (30.44N 88.01W)			7/2300	41 (14 m)	45				
Katrina Cut (KATA1) (30.26N 88.21W)			7/1800	38 (16 m)	46				
CoCoRaHS Sites									
Mobile 10 W (AL-MB-71) (30.67N 88.26W)									8.29
Mobile 1.2 WSW (AL-MB-49) (30.67N 88.11W)									8.22
Fairhope 2 NW (AL-BW-1) (30.54N 87.89W)									8.20
Mobile 5.5 SSW (AL-MB-85) (30.60N 88.11W)									7.82
Tillmans Corner 8.7 WNW (AL-MB-63) (30.61N 88.33W)									7.71
Wimer 7.9 SE (AL-MB-24) (30.74N 88.27W)									7.61
Mobile 2.6 WNW (AL-MB-4) (30.69N 88.13W)									7.39
Summerdale 2.7 WNW (AL-BW-85) (30.50N 87.74W)									7.35
Foley 0.5 ESE (AL-BW-9) (30.40N 87.68W)									7.34
Mobile 3.3 WNW (AL-MB-79) (30.70N 88.14W)									7.28
Mobile 5.8 SW (AL-MB-91) (30.62N 88.16W)									7.19

Location	Minimum Sea Level Pressure		Maximum Surface Wind Speed			Storm surge (ft)[c]	Storm tide (ft)[d]	Estimated Inundation (ft)[e]	Total rain (in)
	Date/ time (UTC)	Press. (mb)	Date/ time (UTC)[a]	Sustained (kt)[b]	Gust (kt)				
Mobile 11.2 WSW (AL-MB-72) (30.64N 88.27W)									7.09
Mobile 11.2 WSW (AL-MB-90) (30.62N 88.27W)									7.08
Loxley 0.4 SSW (AL-BW-26) (30.62N 87.76W)									6.94
Tillmans Corner 4.3 WNW (AL-MB-1) (30.61N 88.26W)									6.81
HADS Sites									
Chattahoochee River at Helen (HDCG1) (34.70N 83.73W)									9.77
Titus (TUSG1) (34.95N 83.62W)									6.16
NWS COOP Sites									
Big Creek Lake (30.72N 88.30W)									8.60
Personal Weather Stations									
West Mobile (KALMOBIL163) (30.64N 88.24W)									10.33
Dauphin Island (KALDAUPH12) (30.24N 88.10W)									6.31
Florida									
ICAO Sites									
Pensacola NAS (KNPA) (30.35N 87.32W)	7/2356	1003.6	7/1856	30	40				
Pensacola (KPNS) (30.47N 87.20W)	8/0053	1004.5	8/0153	29	39				4.06
Destin / Ft. Walton Beach (KDTS) (30.40N 86.47W)	8/0353	1007.4	8/0410	29	38				4.66
Mary Esther – Hurlburt Field (KHRT) (30.43N 86.68W)	8/0926	1007.2	8/0756	22	37				
Eglin AFB (KEGI) (30.65N 86.52W)	8/0446	1007.0	8/0446	21	34				
Milton – NAS Whiting Field North (KNSE) (30.72N 87.02W)	8/0056	1003.9	8/0142	23	35				

Location	Minimum Sea Level Pressure		Maximum Surface Wind Speed			Storm surge (ft)[c]	Storm tide (ft)[d]	Estimated Inundation (ft)[e]	Total rain (in)
	Date/ time (UTC)	Press. (mb)	Date/ time (UTC)[a]	Sustained (kt)[b]	Gust (kt)				
Hernando County Airport (KBKV) (28.47N 82.45W)									5.89
C-MAN Sites									
Tyndall AFB Tower C (SGOF1) (29.41N 84.86W)	7/1200	1008.9	6/1551	30 (35 m, 10 min)	35				
NOS Sites									
Pensacola (PCLF1) (30.40N 87.21W)	8/0006	1003.8	8/0518	23 (10 m)	30	3.18	3.53	2.6	
Panama City Beach (PCBF1) (30.21N 85.88W)	7/2048	1008.3	8/0406	35 (17 m)	42	2.34	3.36	2.4	
Apalachicola (APCF1) (29.73N 84.98W)	7/1124	1009.8	6/1606	20 (9 m)	25	2.03	3.23	2.4	
Cedar Key (CKYF1) (29.13N 83.03W)	7/0812	1010.5	7/1330	29 (12 m)	33	2.44	3.78	2.2	
Panama City (PACF1) (30.15N 85.67W)			7/2042	22 (10 m)	30	1.99	2.88	2.1	
Clearwater Beach (CWBF1) (27.98N 82.83W)	7/0754	1011.3	6/2154	27 (8 m)	32	1.85	2.90	2.0	
Weatherflow Sites									
Okaloosa Fishing Pier (XOPF) (30.39N 86.59W)			8/0206	34 (14 m)	43				
Fair Point Light (Pensacola Bay) (XFPL) (30.37N 87.21W)	8/0136	1003.5	8/0141	31 (5 m)	42				
Ft. Walton Beach (West Choctawhatchee Bay) (XFWB) (30.40N 86.56W)	7/2024	1003.2	8/0329	29 (7 m)	37				
Gulf Breeze (XGBZ) (30.36N 87.16W)			8/0024	24 (15 m)	40				
Crystal Beach (XCBS) (30.39N 87.41W)			8/0421	23 (15 m)	35				
HADS Sites									
Madison 8 S (HOPF1) (30.36N 83.44W)									13.54
Jasper 5 W (ALAF1) (30.53N 83.05W)									12.73
Ocala 8 SSE (OCAF1) (29.08N 82.08W)									9.57

Location	Minimum Sea Level Pressure		Maximum Surface Wind Speed			Storm surge (ft)[c]	Storm tide (ft)[d]	Estimated Inundation (ft)[e]	Total rain (in)
	Date/ time (UTC)	Press. (mb)	Date/ time (UTC)[a]	Sustained (kt)[b]	Gust (kt)				
Lake City 22 N (BTNF1) (30.51N 82.67W)									9.21
Jasper (JASF1) (30.52N 82.94W)									9.10
Monticello 1 NNE (MTCF1) (30.56N 83.86W)									8.71
Monticello 14 ENE (ASHF1) (30.62N 83.65W)									7.70
White Springs 7 N (WSGF1) (30.44N 82.78W)									7.70
Wacissa 2 E (WACF1) (30.37N 83.97W)									7.13
CoCoRaHS Sites									
Live Oak 6.6 NNE (FL-SW-14) (30.38N 82.94W)									11.68
Lakewood Ranch 3.5 E (FL-MA-29) (27.41N 82.37W)									10.89
Jacksonville 7.3 SW (FL-DV-26) (30.26N 81.74W)									10.36
White Springs 1.0 SSE (FL-CB-14) (30.32N 82.75W)									10.06
Parrish 5.5 SE (FL-MA-30) (27.52N 82.37W)									10.03
Live Oak 5.1 SSE (FL-SW-11) (30.23N 82.94W)									10.00
White Springs 1.0 SSE (FL-CB-10) (30.32N 82.75W)									9.79
Moore Haven 10.4 N (FL-GL-13) (26.98N 81.10W)									9.57
Silver Springs Shores 6.9 NNE (FL-MR-33) (29.19N 81.95W)									9.35
The Meadows 6.2 NE (FL-MA-32) (27.43N 82.40W)									8.98

Location	Minimum Sea Level Pressure		Maximum Surface Wind Speed			Storm surge (ft)[c]	Storm tide (ft)[d]	Estimated Inundation (ft)[e]	Total rain (in)
	Date/ time (UTC)	Press. (mb)	Date/ time (UTC)[a]	Sustained (kt)[b]	Gust (kt)				
Monticello 9.8 SW (FL-JF-6) (30.44N 83.99W)									8.71
Lamont 7.7 SW (FL-JF-7) (30.29N 83.90W)									8.62
Jacksonville 6.7 WSW (FL-DV-69) (30.30N 81.76W)									8.59
Leesburg 2.7 NW (FL-LK-30) (28.84N 81.91W)									8.27
Jacksonville 7.8 SW (FL-DV-63) (30.26N 81.75W)									8.05
Jacksonville 5.0 WSW (FL-DV-110) (30.32N 81.74W)									7.93
Jacksonville 5.9 SW (FL-DV-3) (30.28N 81.73W)									7.87
Jacksonville 10.3 SW (FL-DV-42) (30.24N 81.79W)									7.74
Sarasota 5.8 SE (FL-SS-10) (27.26N 82.49W)									7.74
Lake Sarasota 0.5 NE (FL-SS-69) (27.30N 82.43W)									7.73
Belleview 1.6 E (FL-MR-74) (29.06N 82.03W)									7.71
University West 2.0 WNW (FL-HB-40) (28.08N 82.46W)									7.70
Fruitville 2.6 ENE (FL-SS-68) (27.34N 82.42W)									7.69
Lutz 2.0 E (FL-HB-37) (28.14N 82.43W)									7.65
Monticello 2.9 WSW (FL-JF-10) (30.53N 83.92W)									7.62
Sarasota 1.4 E (FL-SS-47) (27.34N 82.52W)									7.57
Lutz 1.3 SSE (FL-HB-27) (28.12N 82.45W)									7.53

Location	Minimum Sea Level Pressure		Maximum Surface Wind Speed			Storm surge (ft)[c]	Storm tide (ft)[d]	Estimated Inundation (ft)[e]	Total rain (in)
	Date/ time (UTC)	Press. (mb)	Date/ time (UTC)[a]	Sustained (kt)[b]	Gust (kt)				
Monticello 4.3 ENE (FL-JF-9) (30.56N 83.80W)									7.52
Archer 5.5 E (FL-AL-2) (29.53N 82.43W)									7.52
Sarasota 4.8 ENE (FL-SS-63) (27.36N 82.47W)									7.42
Interlachen 8.8 S (FL-MR-46) (29.49N 81.90W)									7.13
Jacksonville 4.1 SW (FL-DV-94) (30.30N 81.71W)									7.13
Jacksonville 8.8 E (FL-DV-21) (30.36N 81.51W)									7.06
Georgia									
HADS Sites									
Fargo (FGOG1) (30.68N 82.56W)									11.81
Statenville (STNG1) (30.70N 83.03W)									8.23
Clayton (CLAG1) (34.88N 83.40W)									7.55
CoCoRaHS Sites									
Lake Park 2.8 W (GA-LW-4) (30.68N 83.24W)									9.19
Arkansas									
ICAO Sites									
Corning (K4M9) (36.40N 90.65W)			9/0235		39				
West Memphis (KAWM) (35.13N 90.23W)			9/0800		36				0.72
Pine Bluff (KPBF) (34.17N 91.93W)			8/1750		35				2.42
HADS Sites									
Imboden (IMBA4) (36.20N 91.17W)									7.68

Location	Minimum Sea Level Pressure		Maximum Surface Wind Speed			Storm surge (ft)[c]	Storm tide (ft)[d]	Estimated Inundation (ft)[e]	Total rain (in)
	Date/ time (UTC)	Press. (mb)	Date/ time (UTC)[a]	Sustained (kt)[b]	Gust (kt)				
Ravenden Springs (RVSA4) (36.35N 91.12W)									7.57
Newport – White River (NPTA4) (35.59N 91.28W)									7.13
Tennessee									
ICAO Sites									
Memphis (KMEM) (35.04N 89.98W)			8/2307		34				0.49
Missouri									
ICAO Sites									
Cape Girardeau (KCGI) (37.23N 89.57W)			9/1253		38				0.44
Malden (KMAW) (36.60N 89.99W)			9/1415		37				0.28
Poplar Bluff (KPOF) (36.77N 90.32W)			9/1238		35				1.06
St. Charles (KSET) (38.93N 90.43W)			9/1751		34				0.06
Missouri DOT (MODOT) Sites									
I-70 Wentzville (MO018) (38.80N 90.90W)			9/1800		41				
I-44 Waynesville (MO010) (37.85N 92.08W)			9/1335		39				
I-44 St. Louis (MO009) (38.60N 90.31W)			9/1905		36				
Illinois									
ICAO Sites									
Chicago – O'Hare (KORD) (41.98N 87.90W)			9/2023		52				0.56
University of Illinois - Willard (KCMI) (40.03N 88.28W)			9/1625		46				0.22
Chicago / Wheeling (KPWK) (42.12N 87.90W)			10/0135		46				0.36

Location	Minimum Sea Level Pressure		Maximum Surface Wind Speed			Storm surge (ft)[c]	Storm tide (ft)[d]	Estimated Inundation (ft)[e]	Total rain (in)
	Date/ time (UTC)	Press. (mb)	Date/ time (UTC)[a]	Sustained (kt)[b]	Gust (kt)				
Rantoul (KTIP) (40.29N 88.15W)			9/1715		44				
Aurora (KARR) (41.77N 88.48W)			9/2014		44				0.97
Rockford (KRFD) (42.19N 89.09W)			9/2003		43				1.18
West Chicago (KDPA) (41.90N 88.25W)			10/0037		43				
Mattoon / Charleston (KMTO) (39.48N 88.28W)			9/1753		41				
Decatur (KDEC) (39.83N 88.87W)			9/1454		41				0.53
Peru / LaSalle (KVYS) (41.353N 89.15W)			9/1955		41				
Rochelle (KRPJ) (41.89N 89.08W)			10/0055		41				
Springfield (KSPI) (39.85N 89.68W)			9/2052		40				0.11
Bloomington (KBMI) (40.48N 88.92W)			9/1840		40				0.40
Chicago - Midway (KMDW) (41.78N 87.76W)			9/2153		40				0.45
Indiana									
ICAO Sites									
South Bend (KSBN) (41.71N 86.32W)			9/2143		43				0.41
Kokomo (KOKK) (40.53N 86.07W)			9/1956		43				
Terre Haute (KHUF) (39.44N 87.32W)			9/1653		42				0.30
Angola (KANQ) (41.64N 85.09W)			9/2115		42				
Valparaiso (KVPZ) (41.45N 87.00W)			9/1820		40				0.10
NWS Citizen Weather Observing Program (CWOP) Sites									
Hebron (DW5677) (41.32N 87.20W)			9/1945		43				
Wisconsin									
ICAO Sites									
Fond Du Lac (KFLD) (43.77N 88.49W)			10/0553		42				0.37

Location	Minimum Sea Level Pressure		Maximum Surface Wind Speed			Storm surge (ft)[c]	Storm tide (ft)[d]	Estimated Inundation (ft)[e]	Total rain (in)
	Date/ time (UTC)	Press. (mb)	Date/ time (UTC)[a]	Sustained (kt)[b]	Gust (kt)				
Milwaukee (KMKE) (42.95N 87.90W)			10/0555		41				0.23
Sheboygan (KSBM) (43.77N 87.85W)			10/0753		40				0.56
Appleton-Outagamie (KATW) (44.26N 88.52W)			10/0635		40				0.70
Michigan									
ICAO Sites									
Frankfort (KFKS) (44.63N 86.20W)			10/0915		44				
Benton Harbor – SW Michigan Regional Arpt. (KBEH) (42.13N 86.42W)			9/2344		43				0.01
Traverse City (KTVC) (44.74N 85.57W)			10/0853		42				0.63
Pellston (KPLN) (44.74N 85.57W)			10/1315		42				0.44
Kalamazoo/Battle Creek (KAZO) (42.23N 85.55W)			9/2229		40				0.19
Cadillac (KCAD) (44.28N 85.42W)			10/0855		40				
Sault Ste. Marie (KANJ) (46.48N 84.36W)			10/1355		40				0.67
Houghton (KCMX) (47.17N 88.48W)			10/1321		40				1.57
Copper Harbor (KP59) (47.47N 87.88W)			10/1451		40				1.55
CWOP Sites									
Manistee (DW3748) (44.26N 86.32W)			10/0701		44				
Petoskey (AS614) (45.36N 84.95W)			10/1042		41				
Hart-Shelby (AU347) (43.64N 86.33W)			10/0453		40				
Gaylord (DW5664) (44.91N 84.72W)			10/1303		39				
HADS Sites									
Gran Marais Lakeshore (GRMM4) (46.68N 85.98W)			10/1620	36	49				

Location	Minimum Sea Level Pressure		Maximum Surface Wind Speed			Storm surge (ft)[c]	Storm tide (ft)[d]	Estimated Inundation (ft)[e]	Total rain (in)
	Date/ time (UTC)	Press. (mb)	Date/ time (UTC)[a]	Sustained (kt)[b]	Gust (kt)				
Grand Traverse Light near Northport (GTLM4) (45.21N 85.55W)			10/1110		42				
Fairport (FPTM4) (45.62N 86.66W)			10/0820		42				
Naubinway (NABM4) (46.09N 85.44W)			10/1150		41				
RAWS Sites									
Raco (RACM4) (46.36N 84.80W)			10/1304		40				
NOS Sites									
Mackinaw City (MACM4) (45.78N 84.73W)			10/1412		41				
C-MAN Sites									
Stannard Rock (STDM4) (47.18N 87.22W)			10/1500	36 (35 m)	41				
Limno Tech Buoys									
Holland (45029) (42.90N 86.27W)			10/0450		47				
Ontario									
ICAO Sites									
Kapuskasing (CYYU) (49.42N 82.47W)			10/2000		40				
Quebec									
ICAO Sites									
Umiujaq (CYMU) (56.53N 76.52W)			11/1400	46	57				
Offshore									
NOAA Buoys									
Mid Gulf (42001) (25.94N 89.66W)	6/2320	993.5	6/0950	37 (4 m, 1 min)	43				
East Gulf (42003) (25.93N 85.62W)	6/2220	1007.0	7/0544	34 (4 m, 1 min)	39				
Orange Beach (42012) (30.06N 87.55W)	7/2250	1001.7	7/2307	43 (4 m, 1 min)	49				

Location	Minimum Sea Level Pressure		Maximum Surface Wind Speed			Storm surge (ft)[c]	Storm tide (ft)[d]	Estimated Inundation (ft)[e]	Total rain (in)
	Date/ time (UTC)	Press. (mb)	Date/ time (UTC)[a]	Sustained (kt)[b]	Gust (kt)				
Luke Offshore Test Platform (42040) (29.21N 88.23W)	7/2100	998.2	7/1452	39 (4 m, 1 min)	45				
Pensacola (42039) (28.79N 86.01W)	7/0950	1006.3	7/0258	31 (4 m, 1 min)	36				
Yucatan Basin (42056) (19.82N 84.95W)	5/1840	1007.7	5/1510	29 (4 m, 1 min)	39				
Oil Platforms									
Viosca Knoll 786 / Petronius (Chevron) (KVOA) (29.23N 87.78W)	7/2035	999.7	7/1515	50 (160 m, 2 min)	56				
MP 140B AWOS (Apache Corp) (KMIS) (29.30N 88.84W)			8/0815	39 (85 m, 2 min)	48				
Green Canyon 787 / Atlantis (BP) (KATP) (27.20N 90.03W)	7/0740	993.2	6/1620	39 (230 m, 2 min)	43				
Main Pass 289C (Apache Corp) (KVKY) (29.25N 88.44W)			8/0255	38 (115 m, 2 min)	46				
Mississippi Canyon (KDSF) (28.35N 88.27W)	7/1315	996.9	6/1715	37 (130 m, 2 min)	42				
Louisiana Offshore Oil Port (LOPL1) (28.89N 90.03W)	7/1117	995.1	7/0732	36 (58 m, 2 min)	42				
Shell Alcyone Buoy (42395) (26.40N 90.79W)	7/0840	996.1	6/1400	36 (3 m)	52				
Eugene Island 215 (McMoRan Oil & Gas) (KEIR) (28.63N 91.49W)	7/1035	999.0	7/1455	34 (25 m)	40				

[a] Date/time is for sustained wind when both sustained and gust are listed.
[b] Except as noted, sustained wind averaging periods for C-MAN and land-based reports are 2 min; buoy averaging periods are 8 min.
[c] Storm surge is water height above normal astronomical tide level.
[d] For most locations, storm tide is water height above the North American Vertical Datum of 1988 (NAVD88).
[e] Estimated inundation is the maximum height of water above ground. For NOS tide gauges, the height of the water above Mean Higher High Water (MHHW) is used as a proxy for inundation.
[l] Incomplete

Table 4. Select rainfall totals in Central America and southeastern Mexico over a multi-day period from Tropical Storm Amanda, Atlantic Tropical Storm Cristobal, and a Central American gyre.

Location	Amanda Rainfall (in) (on or before 31 May)	Cristobal Rainfall (in) (on or after 1 June)	Total Rainfall (in)
Mexico[a]			
Ocotepec, Chiapas (OCOCP) (17.22N 93.15W)	10.71	24.09	34.80
Sayula, Chiapas (SAYCP) (17.43N 93.38W)	14.38	16.51	30.89
Xpujil, Campeche (XPJCA) (18.50N 89.40W)	13.11	16.81	29.92
Oxkutzcab, Yucatan (OXKYC) (20.29N 89.39W)	4.27	23.17	27.44
Tantaquin, Yucatan (TANYC) (20.03N 89.05W)	4.92	21.92	26.84
Bolonchén, Campeche (BOLCA) (20.00N 89.74W)	5.53	21.08	26.61
Emiliano Zapata, Yucatan (EZAYC) (20.98N 89.58W)	6.49	19.18	25.67
Observatorio de Valladolid, Yucatan (VALYC) (20.69N 88.20W)	0.75	24.54	25.29
Juan de Grijalva, Chiapas (JDGCP) (17.36N 93.38W)	13.36	11.91	25.27
Becanchén, Yucatan (BECYC) (19.88N 89.22W)	7.60	17.52	25.12
Sierra Morena CFE, Chiapas (SMORENACFE) (16.15N 93.59W)	1.77	23.21	24.98
Ticul, Yucatan (TICYC) (20.40N 89.56W)	2.94	21.54	24.48
Hopelchén, Campeche (HPOCA) (19.75N 89.85W)	2.13	22.32	24.45
Mocochá, Yucatan (MOCYC) (21.11N 89.44W)	2.46	21.72	24.18
Tapachula Malpaso, Chiapas (TAMCP) (14.99N 92.24W)	9.65	14.39	24.04
Boca del Cerro, Tabasco (BDCTB) (17.43N 91.48W)	7.90	16.02	23.92
Finca la Paz, Chiapas (FPZCP) (15.35N 92.48W)	3.07	19.98	23.05
Observatorio de Mérida, Yucatan (MEOYC) (20.95N 89.65W)	4.44	18.48	22.92
Escárcega, Campeche (ESCCA) (18.60N 90.74W)	1.69	21.17	22.86
San Joaquin, Chiapas (SJOCP) (17.56N 93.09W)	15.68	7.01	22.69

Location	Amanda Rainfall (in) (on or before 31 May)	Cristobal Rainfall (in) (on or after 1 June)	Total Rainfall (in)
Observatorio de Progreso, Yucatan (PROYC) (21.28N 89.65W)	6.06	16.56	22.62
Organismo de Cuenca Peninsula de Yucatan, Yucatan (GARYC) (20.98N 89.66W)	3.98	18.23	22.21
Muná, Yucatan (MUNYC) (20.49N 89.71W)	3.66	18.15	21.81
Puyacatengo, Tabasco (PUYTB) (17.57N 92.94W)	12.58	9.04	21.62
El Refugio, Chiapas (REFUGIOCP) (17.41N 93.03W)	9.79	11.78	21.57
Motul, Yucatan (MTOYC) (21.09N 89.29W)	3.10	18.45	21.55
Finca Hamburgo, Chiapas (FHACP) (15.17N 92.33W)	2.07	19.41	21.48
El Carmen, Campeche (CARCA) (18.65N 91.76W)	1.76	19.28	21.04
Tizimín, Yucatan (TIZYC) (21.16N 88.17W)	0.72	19.97	20.69
San José del Carmen, Veracruz (JOCVC) (17.87N 94.09W)	10.25	10.35	20.60
Cantamayec, Yucatan (CANYC) (20.46N 89.08W)	1.48	19.00	20.48
Abalá, Yucatan (ABAYC) (20.65N 89.68W)	2.22	18.10	20.32
Pueblo Nuevo, Tabasco (PNVTB) (17.85N 92.88W)	10.65	9.54	20.19
Planta de Bombeo 3 de La Cangrejera, Veracruz (PB3VC) (18.10N 94.38W)	9.06	11.01	20.07
Escuintla, Chiapas (ESCCP) (15.32N 92.67W)	5.18	14.82	20.00
El Salvador[b]			
Volcán Conchagua	22.70	20.10	42.80
Volcán de San Miguel	20.43	18.14	38.57
Panchimalco	19.12	13.83	32.95
Nuevo Cuscatlán	18.13	13.93	32.06
Aeropuerto de Ilopango	19.60	11.77	31.37
Finca Los Andes	18.65	12.30	30.95
Izalco	16.09	14.22	30.31
Acajutla	12.05	17.76	29.81

Location	Amanda Rainfall (in) (on or before 31 May)	Cristobal Rainfall (in) (on or after 1 June)	Total Rainfall (in)
Los Naranjos	11.50	18.08	29.58
San Vicente	18.47	10.80	29.27
Chilama	15.20	13.93	29.13
Santiago de María	14.28	14.52	28.80
La Canoa	9.54	19.03	28.57
Conchagua	12.21	15.50	27.71
Chiltuipán	15.78	11.58	27.36
El Naranjo	10.31	16.75	27.06
Apaneca	10.96	15.78	26.74
Santa Cruz Porrillo	14.06	12.56	26.62
El Piro	16.20	10.38	26.58
La Piedra	11.71	14.79	26.50
Tepetitan	16.52	9.87	26.39
Cara Sucia	10.59	15.77	26.36
Santa Cruz Porrillo	16.85	9.37	26.22
Puente Cuscatlán	16.84	8.36	25.20
Tepezontes	13.02	11.70	24.72
Huizucar	12.68	12.03	24.71
Hda Melara	12.62	11.70	24.32
La Union	10.74	13.38	24.12
Puerto Parada	12.65	11.35	24.00
Picacho	16.16	7.53	23.69
Zoológico Nacional	13.86	9.78	23.64
Guatemala[c]			
Jutiapa	11.80	14.68	26.48
Puerto San José (Aeropuerto)	5.86	10.66	16.52
San Marcos	1.63	14.63	16.26
Santa Teresa	7.35	8.57	15.92
La Reforma	0.69	14.27	14.95
Ixchiguan	0.84	12.50	13.34
Sábana Grande	3.34	9.87	13.21

Location	Amanda Rainfall (in) (on or before 31 May)	Cristobal Rainfall (in) (on or after 1 June)	Total Rainfall (in)
Todos Santos Cuchumatán	1.95	10.95	12.90
Quezada	7.54	5.13	12.67
Santa Rosa	5.55	7.02	12.57
Yepocapa	4.09	8.16	12.25
Catarina	0.18	11.77	11.94
Pochuta	3.20	8.68	11.88
La Máquina	4.28	7.50	11.77
Escuintla (La Giralda)	4.38	7.37	11.75
Siquinalá	2.64	9.02	11.65
Los Esclavos	5.27	6.35	11.62
San Andrés	1.77	9.70	11.48
Escuintla (Ing. Concepción)	3.09	7.72	10.81
San Marcos (Alamo)	4.37	6.10	10.47
San Rafael	3.06	7.20	10.26
Santa Lucía Cotzumalguapa	2.81	7.38	10.19
Jalapa	7.34	2.65	9.98
Lorena	2.25	7.61	9.87
Concepción	2.56	7.05	9.61
Potrero Carrillo	7.50	2.11	9.61
Mazatenango	1.19	8.30	9.49
Escuintla (Petén Oficina)	2.52	6.78	9.30
El Platanar	2.30	6.98	9.28
Amatitlán	3.09	6.11	9.20
Lo de Coy	2.56	6.54	9.10
Escuintla (Amazonas)	4.27	4.77	9.04
Volcán de Fuego	0.68	8.35	9.03
Escuintla (Costa Brava)	2.93	6.06	8.99
Asunción Mita	5.58	3.29	8.87
Plan de Avila	2.60	6.18	8.78
Escuintla (Tehuantepec)	2.43	6.22	8.65
Volcán de Agua	4.11	4.43	8.54
Champerico	0.73	7.74	8.47

Location	Amanda Rainfall (in) (on or before 31 May)	Cristobal Rainfall (in) (on or after 1 June)	Total Rainfall (in)
Chiquirines	0.27	8.00	8.27
Retalhuleu (Xoluta)	1.70	6.52	8.22
El Porvenir	2.75	5.46	8.21
Escuintla (Cengicaña)	1.79	6.27	8.06
Honduras[b]			
Sabana Grande	2.71	11.02	13.73
Caridad	2.95	9.79	12.74
Erandique	4.06	8.65	12.72
El Carrizo	3.93	6.82	10.74
Nacaome	0.59	9.83	10.43
Maraita	0.60	6.97	7.57
La Esperanza	1.23	5.77	7.00
Belize[b]			
Yo Chen	3.70	10.19	13.89
Hershey	11.78	1.14	12.92
Yo Creek	5.83	7.04	12.87
Belmopan	11.82	0.88	12.70
August Pine	7.85	4.37	12.22
Middlesex	10.03	2.06	12.09
Libertad	2.56	8.59	11.15
Douglas	3.72	6.75	10.47
Tower Hill	4.14	6.20	10.34
Ranchito	2.19	7.53	9.72
San Estevan	2.87	6.74	9.61
Little Belize	2.16	7.29	9.45
Shipyard	6.01	3.20	9.21
Chunox	1.62	6.75	8.37
Blue Creek	8.15	0.00	8.15

[a] Rainfall totals in Mexico cover the period from 28 May to 6 June 2020.
[b] Rainfall totals in El Salvador, Honduras, and Belize cover the period from 29 May to 7 June 2020.
[c] Rainfall totals in Guatemala cover the period from 30 May to 5 June 2020.

Table 5. Tornadoes documented during Tropical Storm Cristobal, 1–9 June 2020.

County	Begin Location	End Location	EF Scale	Begin Date/Time	Length (miles)	Width (yards)	Deaths	Injuries	Damage
Florida									
Sumter	1 E Linden	1 E Linden	0	6/2153	0.25	75	0	0	0
Pinellas	1 W Clearwater	1 NW Clearwater	0	6/2159	0.91	75	0	0	30K
Orange	3 SE Orlovista	3 SE Orlovista	0	6/2207	0.01	10	0	0	0
Sumter	3 W Oxford	3 W Oxford	0	6/2220	0.51	75	0	0	40K
Orange	2 WNW Sky Lake	2 WNW Sky Lake	0	6/2240	0.01	20	0	0	0
Orange	Belle Isle	1 SE Orlando	1	6/2320	5.12	500	0	0	956K
Volusia	1 SSE Lake Monroe	1 ESE Enterprise	0	7/0027	2.0	200	0	0	0
Columbia	2 ESE Bass	2 E Bass	0	7/1930	1.43	100	0	0	0
Lake	3 NW Orange Bend	3 NW Orange Bend	0	7/1940	0.01	25	0	0	0
Union	2 SSE Duke	2 SSE Duke	0	7/2005	0.01	25	0	0	0
Lake	1 ESE Tavares	1 E Tavares	0	7/2241	0.5	20	0	0	0
Illinois									
Ford	4 SSE Piper City	4 SE Piper City	Unknown	9/2324	1.7	75	0	0	0
Iroquois	3 W Ridgeville	2 NNW Ridgeville	Unknown	9/2326	2.66	75	0	0	0

Table 6. 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%)	36	42
Medium (40%-60%)	30	30
High (>60%)	6	12

Table 7a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) track forecast errors (n mi) for Tropical Storm Cristobal, 1–9 June 2020. 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	60	72	96	120
OFCL	**19.5**	**30.7**	**44.7**	**57.4**	**65.6**	**70.9**	**102.0**	**145.2**
OCD5	48.4	113.3	181.1	234.0	282.0	325.5	372.6	387.1
Forecasts	28	28	27	25	23	21	17	13
OFCL (2015-19)	24.1	36.9	49.6	65.1	80.7	96.3	133.2	171.6
OCD5 (2015-19)	44.7	96.1	156.3	217.4	273.9	330.3	431.5	511.9

Table 7b. Homogeneous comparison of selected track forecast guidance models (in n mi) for Tropical Storm Cristobal, 1–9 June 2020. 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 7a due to the homogeneity requirement.

Model ID	Forecast Period (h)							
	12	24	36	48	60	72	96	120
OFCL	19.8	33.1	44.5	53.4	55.5	58.0	85.7	151.8
OCD5	46.8	104.8	167.5	209.5	248.8	291.4	387.2	439.6
GFSI	22.7	37.8	**43.4**	**42.9**	**47.3**	**42.3**	**76.9**	164.7
EMXI	27.3	44.4	62.6	76.3	81.6	88.3	106.7	155.0
CMCI	32.4	44.2	47.8	**53.2**	59.5	81.4	90.8	164.9
NVGI	25.9	41.5	54.3	68.0	88.2	125.0	218.4	332.9
HWFI	24.5	47.7	65.8	83.9	108.1	127.0	160.2	**143.2**
HMNI	23.1	42.8	54.9	70.9	87.7	103.5	120.4	**149.9**
HCCA	**19.0**	**28.8**	**37.8**	**47.7**	57.0	58.7	**53.7**	**98.3**
FSSE	21.6	34.2	47.9	56.6	**54.6**	**56.5**	**63.9**	**67.5**
AEMI	20.8	37.2	46.2	59.6	73.0	90.2	135.2	214.9
GFEX	**19.4**	**30.5**	**39.8**	**46.2**	**53.5**	**55.0**	**83.4**	157.5
TVCA	**19.3**	**30.2**	**41.4**	**50.6**	**55.2**	58.4	**74.4**	**127.0**
TVCX	**19.4**	**30.3**	**42.3**	**50.8**	**55.1**	**57.5**	**72.3**	**127.6**
TVDG	**18.8**	**28.8**	**38.1**	**45.0**	**49.9**	**52.0**	**74.1**	**133.8**
TABS	50.8	91.7	119.5	144.0	174.8	200.1	192.3	165.0
TABM	40.6	73.8	107.2	137.6	165.4	179.9	151.4	155.1
TABD	36.1	60.0	87.3	112.2	139.3	163.8	196.4	221.1
Forecasts	23	23	23	21	19	17	11	7

Table 8a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) intensity forecast errors (kt) for Tropical Storm Cristobal, 1–9 June 2020. 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	60	72	96	120
OFCL	**4.5**	**5.5**	**4.8**	**4.6**	**5.0**	**6.7**	**5.6**	**8.8**
OCD5	5.7	8.6	10.4	10.6	8.9	7.3	9.5	13.9
Forecasts	28	28	27	25	23	21	17	13
OFCL (2015-19)	5.2	7.7	9.4	10.7	11.9	13.0	14.4	15.5
OCD5 (2015-19)	6.8	10.8	14.1	17.0	18.8	20.6	22.5	24.6

Table 8b. Homogeneous comparison of selected intensity forecast guidance models (in kt) for Tropical Storm Cristobal, 1–9 June 2020. 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 8a due to the homogeneity requirement.

Model ID	Forecast Period (h)							
	12	24	36	48	60	72	96	120
OFCL	4.3	5.2	4.6	4.0	3.4	5.6	6.7	8.1
OCD5	5.7	8.2	10.2	10.7	9.5	8.6	7.2	11.0
HWFI	4.6	**4.7**	5.5	6.0	6.9	6.0	**3.8**	**6.0**
HMNI	5.3	5.5	**4.1**	4.3	4.1	**4.2**	**2.9**	**6.0**
DSHP	5.3	6.6	6.3	5.7	4.9	**4.7**	**5.5**	**4.0**
LGEM	5.5	6.7	7.8	6.9	5.4	**5.0**	**5.4**	**5.1**
ICON	4.6	**5.1**	5.2	4.2	3.5	**3.1**	**3.2**	**4.5**
IVCN	**4.1**	**4.4**	**4.1**	**3.0**	**2.6**	**2.2**	**3.2**	**4.4**
HCCA	**4.1**	**4.3**	**4.0**	**3.4**	**3.0**	**2.4**	**4.6**	**6.9**
FSSE	**3.7**	**4.7**	6.4	5.7	5.1	6.6	12.2	14.5
GFSI	4.6	**4.8**	**4.5**	**3.9**	4.7	5.6	7.3	9.6
EMXI	5.7	5.6	5.7	4.5	4.3	**3.9**	**3.9**	**3.2**
Forecasts	23	23	23	21	19	17	12	8

Table 9a. Tropical cyclone wind watch and warning summary for Tropical Storm Cristobal, 1–9 June 2020.

Date/Time (UTC)	Action	Location
1 / 2100	Tropical Storm Warning issued	Campeche to Puerto de Veracruz
3 / 1500	Tropical Storm Warning modified to	Campeche to Coatzacoalcos
4 / 1500	Tropical Storm Warning discontinued	All
5 / 1200	Tropical Storm Watch issued	Punta Herrero to Rio Lagartos
5 / 1500	Tropical Storm Watch issued	Intracoastal City LA to AL/FL Border
5 / 1800	Tropical Storm Watch changed to Tropical Storm Warning	Punta Herrero to Rio Lagartos
5 / 2100	Tropical Storm Watch modified to	Intracoastal City LA to Morgan City LA
5 / 2100	Tropical Storm Warning issued	Morgan City LA to Okaloosa/Walton County FL Line
6 / 0300	Tropical Storm Warning discontinued	Punta Herrero to Rio Lagartos
6 / 1500	Tropical Storm Warning modified to	Intracoastal City LA to Okaloosa/Walton County FL Line
8 / 0000	Tropical Storm Warning modified to	Morgan City LA to Okaloosa/Walton County FL Line
8 / 0900	Tropical Storm Warning discontinued	All

Table 9b. Storm surge watch and warning summary for Tropical Storm Cristobal, 1–9 June 2020.

Date/Time (UTC)	Action	Location
5 / 1500	Storm Surge Watch issued	Grand Isle LA to Ocean Springs MS, including Lake Borgne
5 / 1500	Storm Surge Watch issued	Indian Pass FL to Arepika FL
5 / 2100	Storm Surge Warning issued	Mouth of the Mississippi River LA to Ocean Springs MS, including Lake Borgne
5 / 2100	Storm Surge Watch modified	East of Morgan City LA to the Mouth of the Mississippi River LA
6 / 1500	Storm Surge Watch discontinued	Indian Pass FL to Arepika FL
8 / 0000	Storm Surge Watch discontinued	East of Morgan City LA to the Mouth of the Mississippi River LA
8 / 1200	Storm Surge Warning discontinued	All

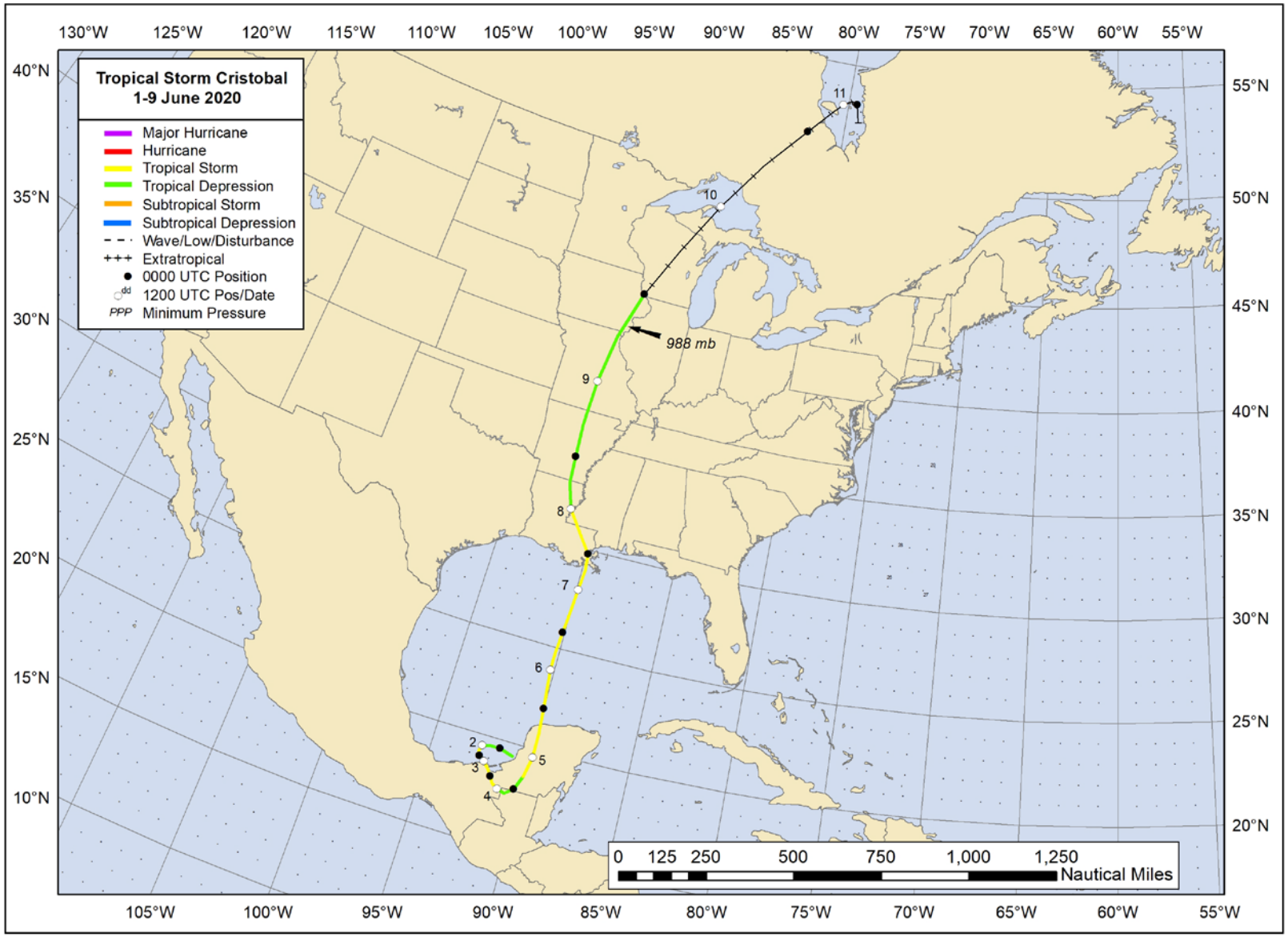

Figure 1. Best track positions for Tropical Storm Cristobal, 1–9 June 2020. The track over the United States and Canada is partially based on analyses from the NOAA Weather Prediction Center.

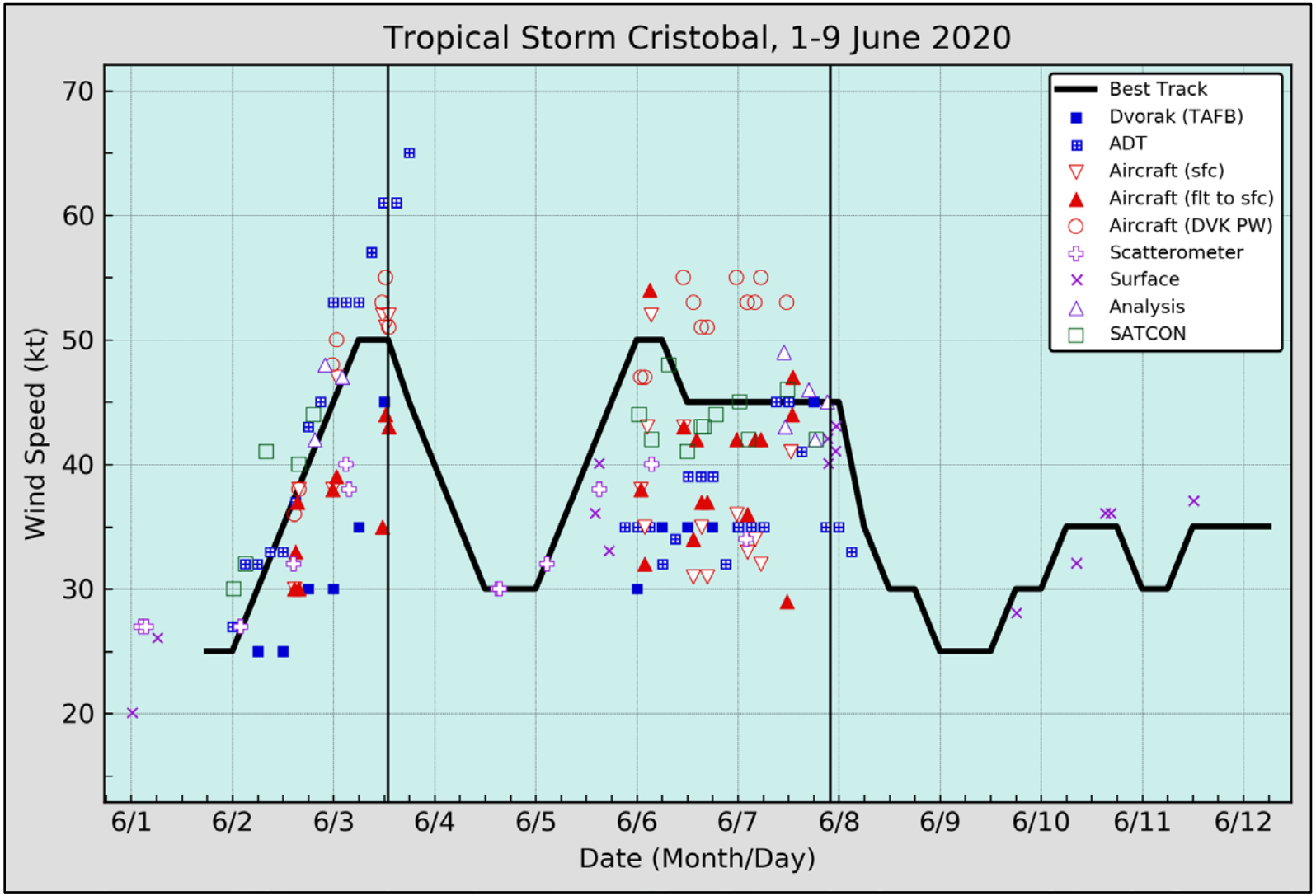

Figure 2. Selected wind observations and best track maximum sustained surface wind speed curve for Tropical Storm Cristobal, 1–9 June 2020. Aircraft observations have been adjusted for elevation using 80% and 75% adjustment factors for observations from 850 mb and 1500 ft, respectively. Advanced Dvorak Technique estimates represent the Current Intensity at the nominal observation time. SATCON intensity estimates are from the Cooperative Institute for Meteorological Satellite Studies. Dashed vertical lines correspond to 0000 UTC, and solid vertical lines correspond to landfalls.

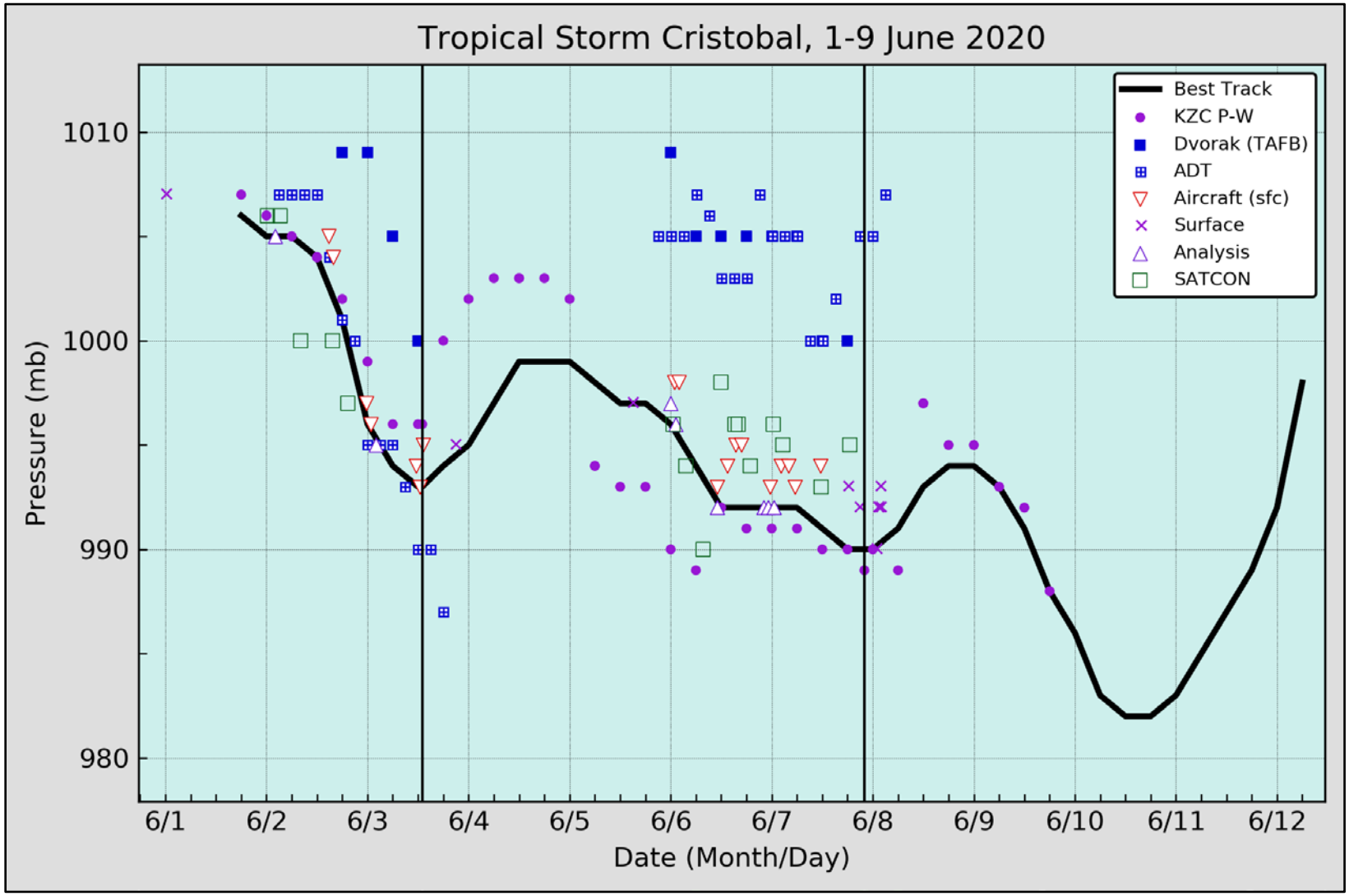

Figure 3. Selected pressure observations and best track minimum central pressure curve for Tropical Storm Cristobal, 1–9 June 2020. Advanced Dvorak Technique estimates represent the Current Intensity at the nominal observation time. SATCON intensity estimates are from the Cooperative Institute for Meteorological Satellite Studies. KZC P-W refers to pressure estimates derived using the Knaff-Zehr-Courtney pressure-wind relationship. Dashed vertical lines correspond to 0000 UTC, and solid vertical lines correspond to landfalls.

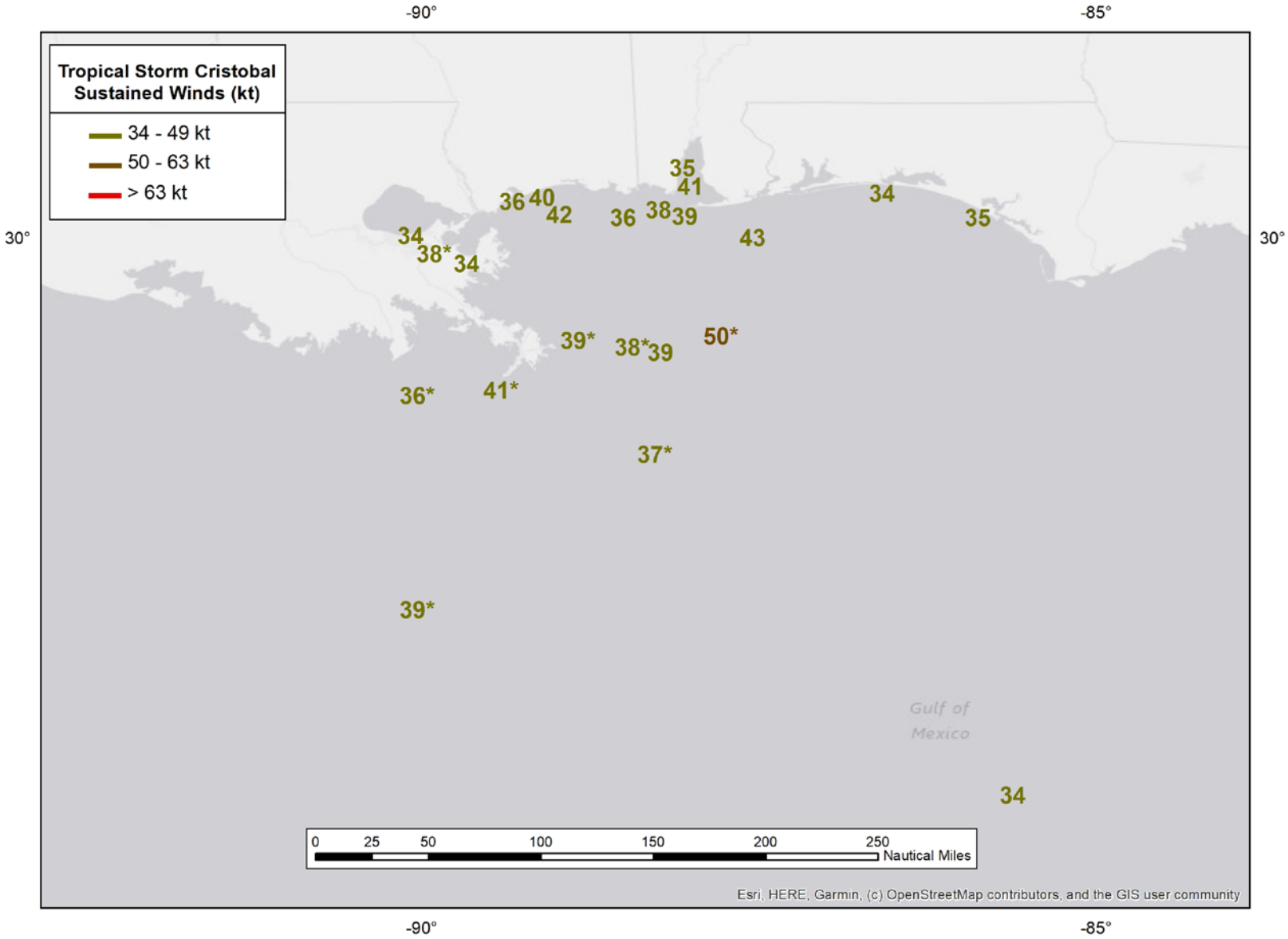

Figure 4. Selected peak sustained winds (kt) reported during Tropical Storm Cristobal. An asterisk denotes observations that were elevated more than 20 m above the surface.

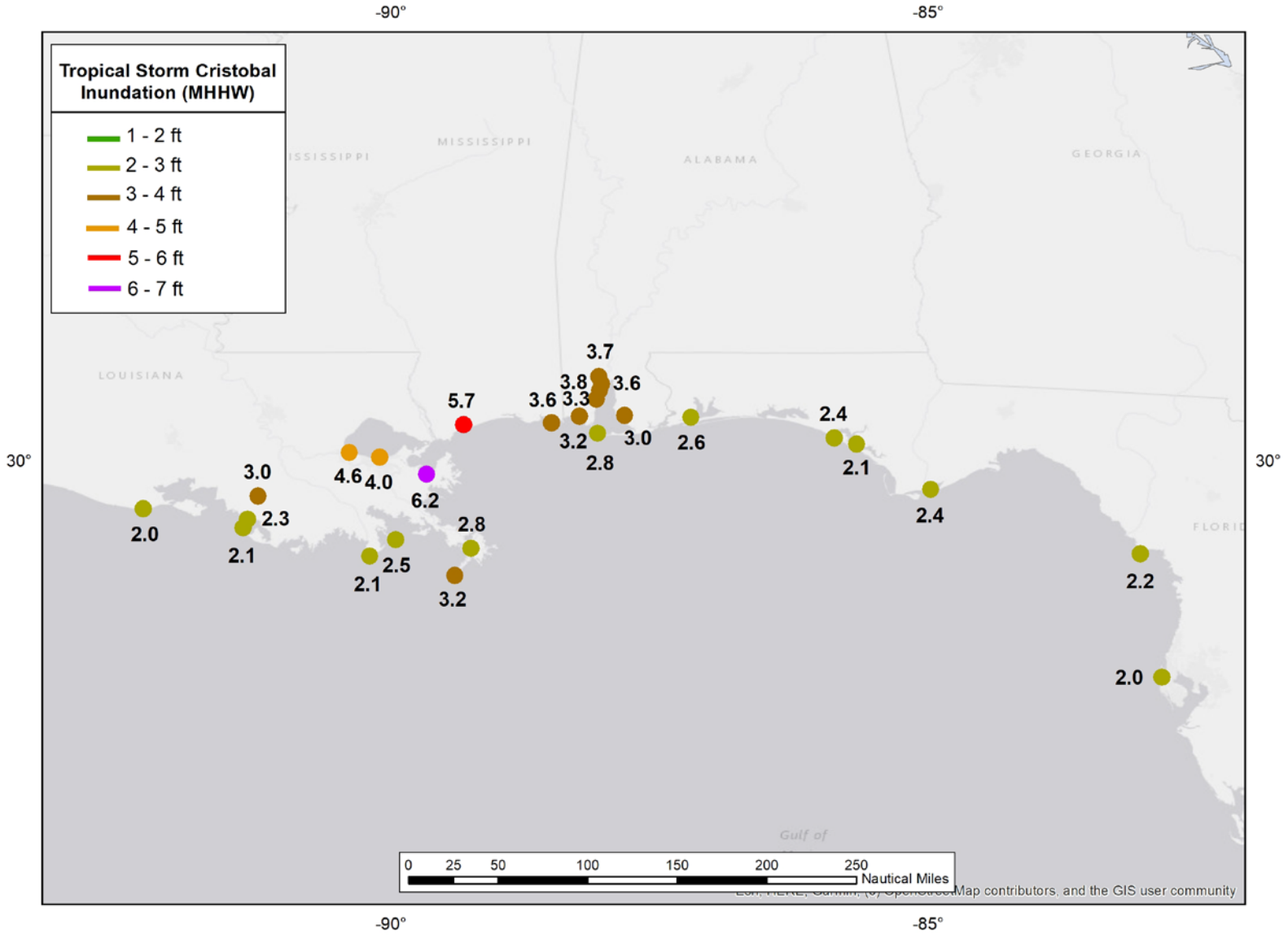

Figure 5. Maximum water levels measured from tide gauges during Tropical Storm Cristobal. Water levels are referenced as feet above Mean Higher High Water (MHHW), which is used as a proxy for inundation (above ground level) on normally dry ground along the immediate coastline.

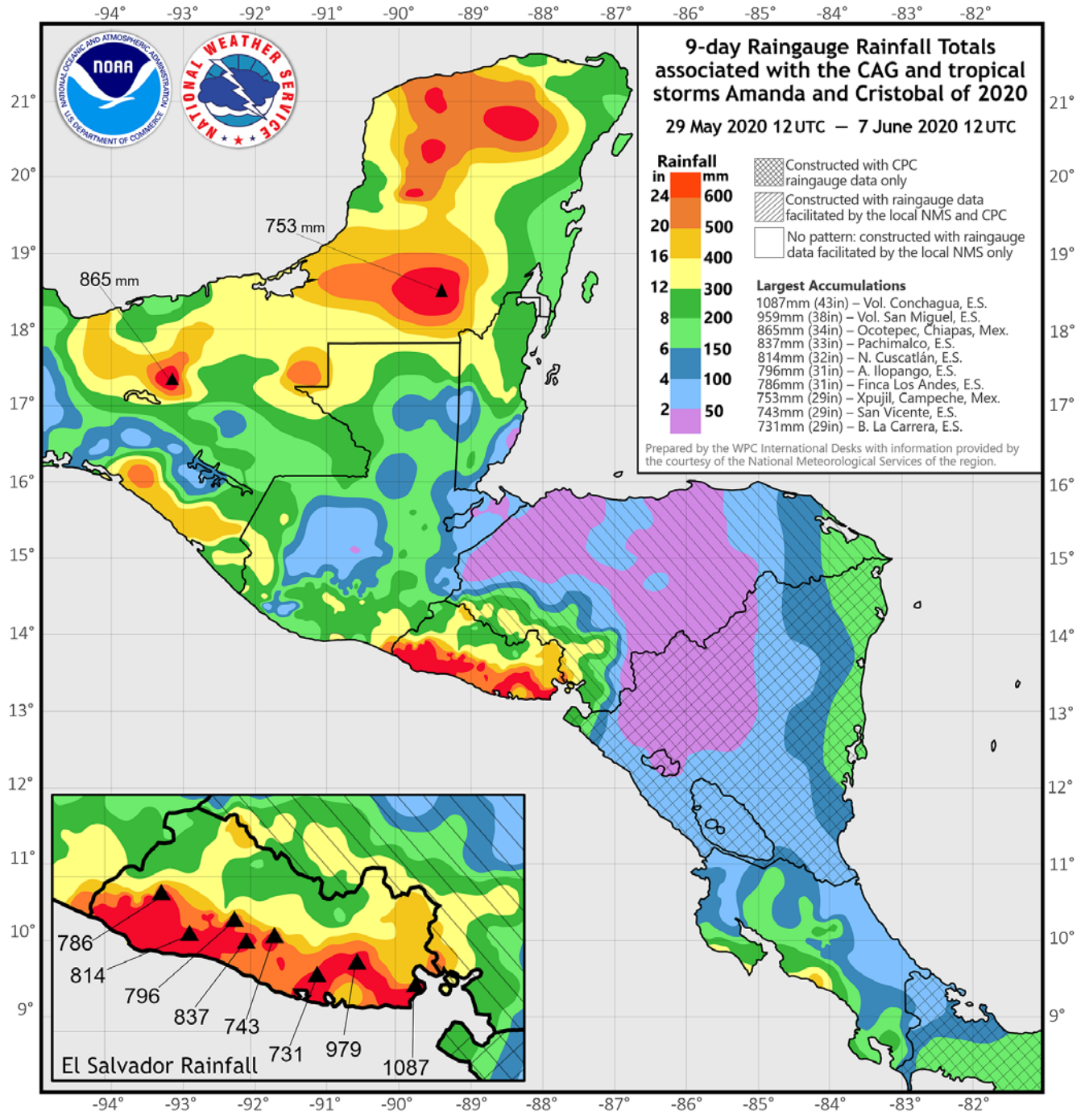

Figure 6. Nine-day rainfall accumulations (mm) in Central America and southeastern Mexico from 29 May to 7 June 2020, covering the period that the region was affected by Tropical Storm Amanda, Tropical Storm Cristobal, and a Central American gyre (CAG). Analysis and image courtesy of the NOAA Weather Prediction Center International Desk and the national meteorological services of the region.

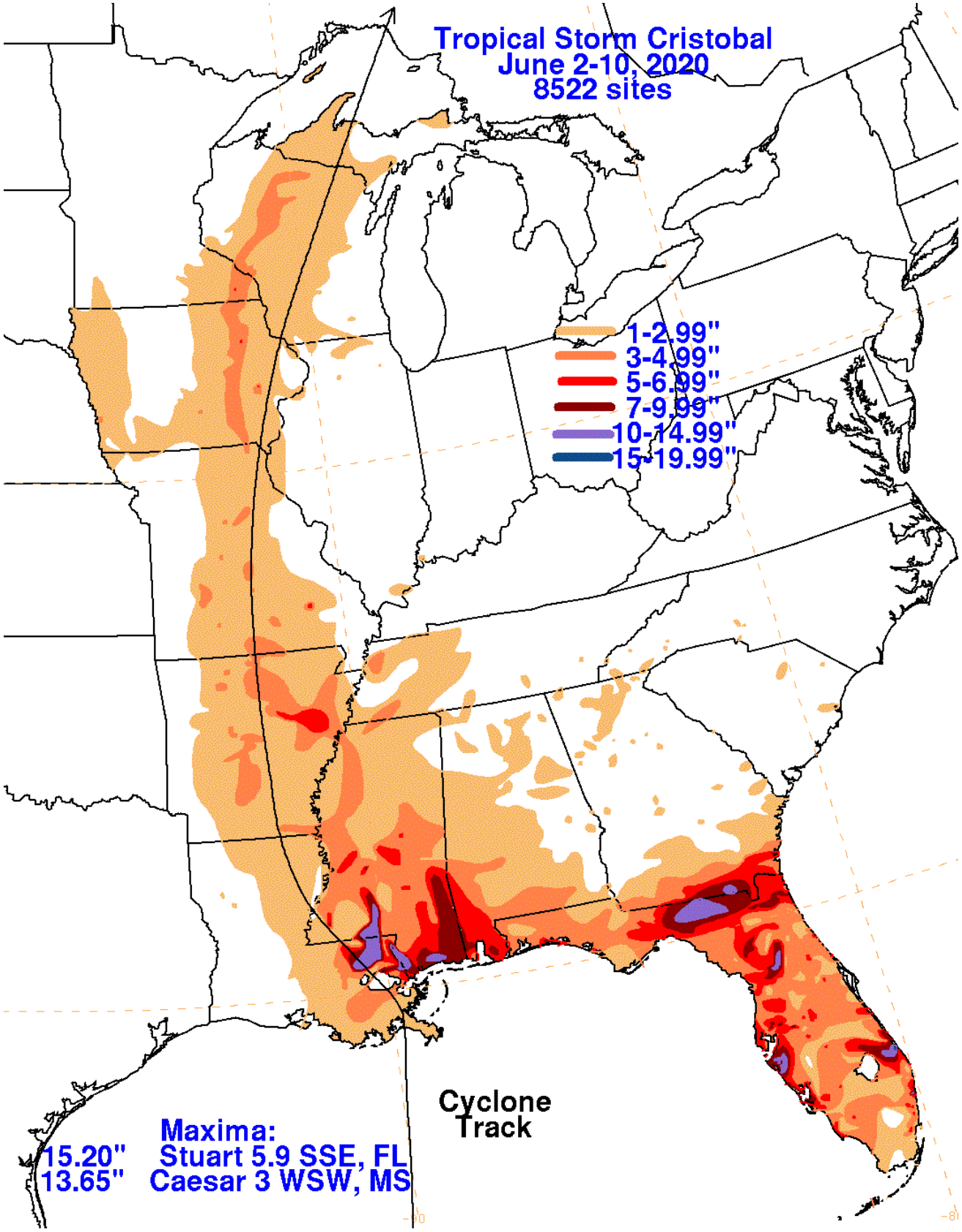

Figure 7. Rainfall accumulations (inches) from Tropical Storm Cristobal. Image courtesy of David Roth at the NOAA Weather Prediction Center.

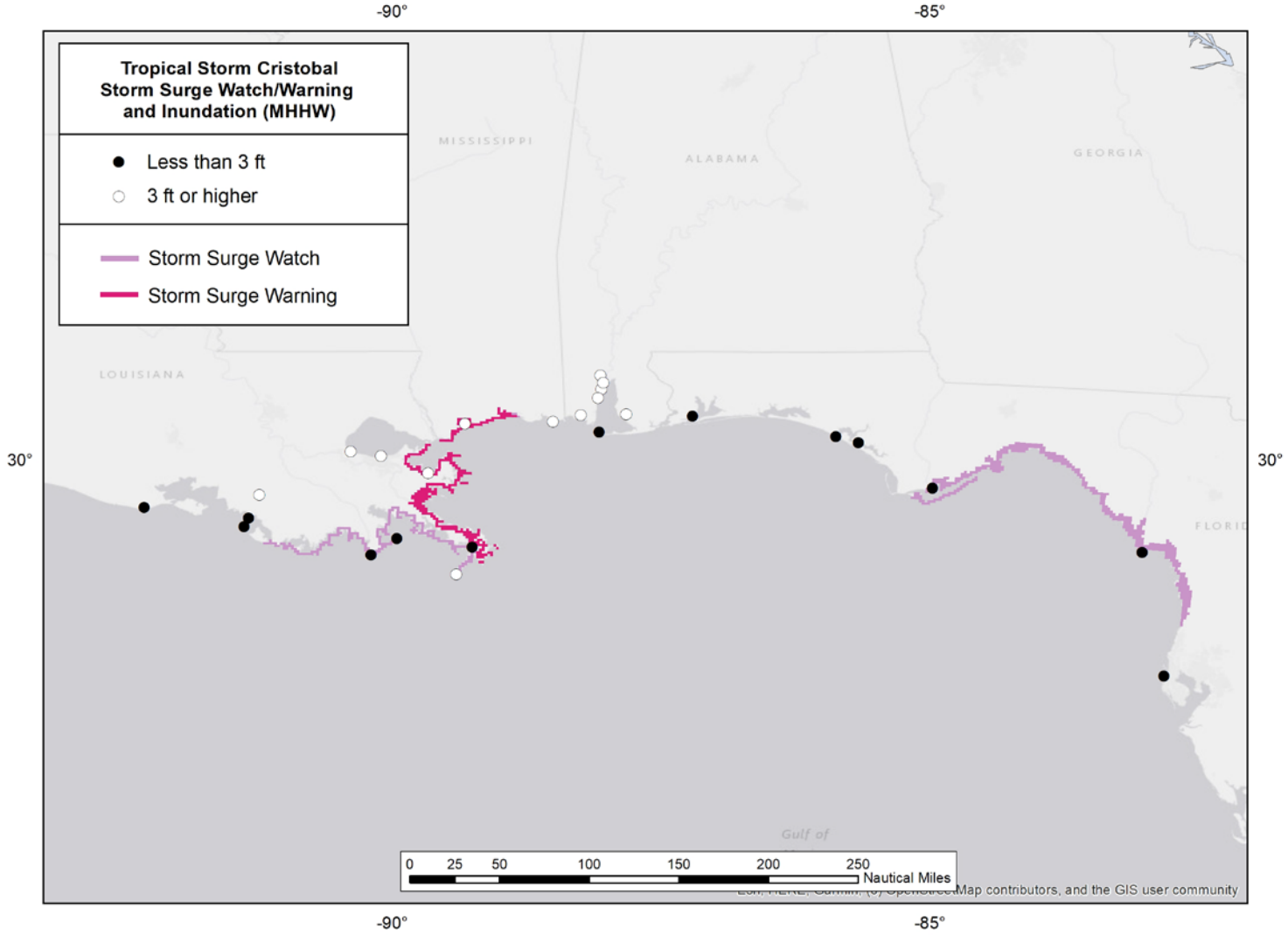

Figure 8. Maximum water levels measured from tide gauges (circles) during Tropical Storm Cristobal and areas covered by storm surge watches (lavender) and warnings (magenta). Water levels are referenced as feet above Mean Higher High Water (MHHW), which is used as a proxy for inundation (above ground level) on normally dry ground along the immediate coastline. Black markers denote water levels less than 3 ft above ground level, and white markers denote water levels 3 ft or higher above ground level.