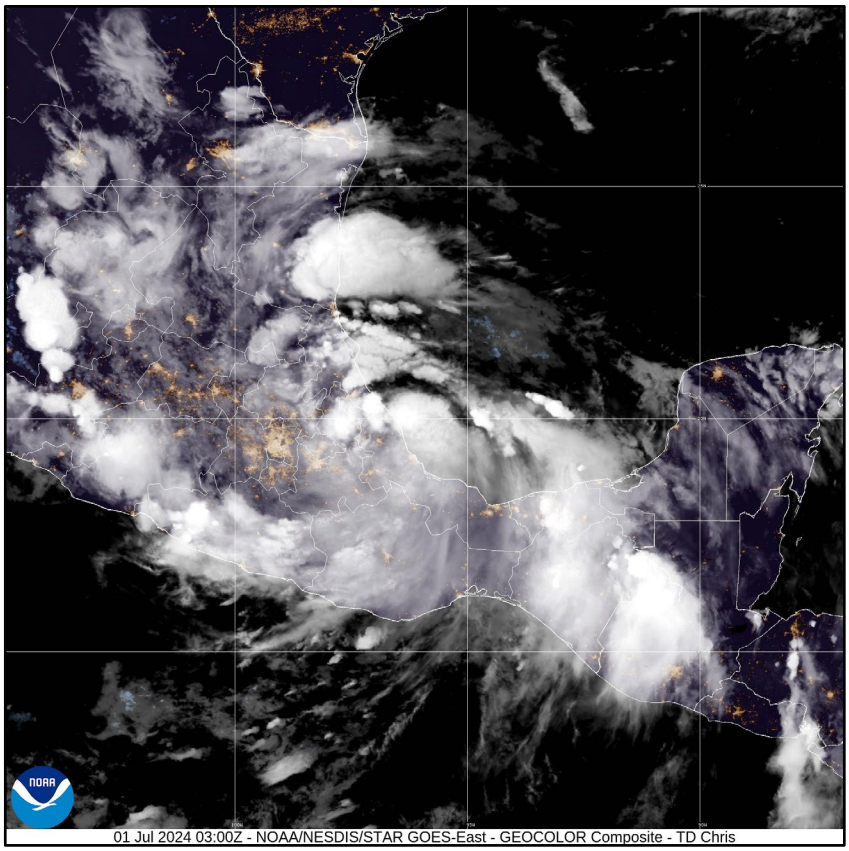
NATIONAL HURRICANE CENTER
TROPICAL CYCLONE REPORT

TROPICAL STORM CHRIS

(AL032024)

30 June–1 July 2024

Robbie Berg
National Hurricane Center
13 August 2024



GOES-EAST GEOCOLOR IMAGE OF TROPICAL STORM CHRIS AT 0300 UTC 1 JULY AT THE TIME OF ITS LANDFALL ON THE COAST OF VERACRUZ, MEXICO (IMAGE COURTESY OF NOAA/NESDIS/STAR)

Chris was a short-lived tropical storm that formed over the Bay of Campeche and made landfall in the Mexican state of Veracruz. Heavy rains caused flooding and mudslides which directly took the lives of five people.

Tropical Storm Chris

30 JUNE–1 JULY 2024

SYNOPTIC HISTORY

Chris originated from a tropical wave that moved off the west coast of Africa on 20 June. The low-latitude wave moved quickly westward at 20 to 25 kt across the tropical Atlantic Ocean during the next several days, reaching the Windward Islands early on 25 June and then transiting across the Caribbean Sea from 25–28 June. The wave produced disorganized shower and thunderstorm activity during this entire nine-day period, but it did not show signs of development due to its fast forward motion and the influence of strong deep-layer westerly shear. Once the wave reached the northwestern Caribbean Sea on 28 June, its slower motion and a decrease in shear allowed the formation of a broad area of low pressure, which then moved inland over the Yucatan Peninsula early on 29 June. The broad low continued westward and emerged over the Bay of Campeche early on 30 June.

The system's deep convection gradually increased in organization over the Bay of Campeche, and based on ASCAT data, a well-defined—albeit slightly elongated—circulation developed around midday on 30 June. A tropical depression is estimated to have formed by 1800 UTC that day about 55 n mi northeast of Veracruz, Mexico, and it strengthened into a tropical storm 6 h later. The "best track" chart of Chris'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]. Sea surface temperatures over the Bay of Campeche were about 29°C, and Chris strengthened slightly while it approached the coast of Mexico. Chris made landfall around 0300 UTC 1 July in the Alto Lucero municipality of the state of Veracruz, with estimated maximum sustained winds of 40 kt. The storm quickly weakened while moving westward over the mountainous terrain of eastern Mexico, and the circulation dissipated by 1200 UTC 1 July.

METEOROLOGICAL STATISTICS

Observations in Chris (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. Observations also include flight-level, stepped frequency microwave radiometer (SFMR), and dropwindsonde observations from two flights of the 53rd Weather Reconnaissance Squadron of

[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.

the U.S. Air Force Reserve Command. 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 Chris.

There were no ship reports of winds of tropical storm force associated with Chris.

Winds and Pressure

Chris's estimated peak and landfall intensity of 40 kt at 0300 UTC 1 July is based on a combination of aircraft data and objective satellite intensity estimates. Although the second Air Force Reserve reconnaissance flight could not reach Chris's center or fly at a lower altitude due to flight restrictions near the coast of Mexico, the plane did report a peak 700-mb wind of 49 kt at 0308 UTC and credible SFMR readings (with relatively low rain rates) around 40 kt just before 0300 UTC. In addition, objective ADT satellite estimates reached as high as T2.8/39 kt around the time of landfall. Chris's estimated minimum pressure of 1005 mb at landfall is based on an extrapolated pressure of 1005.7 mb from the reconnaissance aircraft at 0259 UTC.

Chris made landfall in a data-sparse region of the state of Veracruz between the cities of Veracruz and Tuxpan, and since it was a relatively small storm, there were no sustained tropical-storm-force winds reported in the area. A gust to 35 kt was measured in Perote, Veracruz, in the mountains at an elevation of 7,941 feet at 0930 UTC 1 July.

Rainfall and Flooding

Chris produced more than five inches (~125 mm) of rain across portions of the Mexican states of Tamaulipas, Veracruz, San Luis Potosí, Querétero, and Puebla during the period from 29 June to 1 July (Fig. 4). The highest rainfall amounts reported were 14.21 inches (361 mm) at Acatlán, Veracruz; 12.52 inches (318.1 mm) at Ballesmi, San Luis Potosí; and 12.28 inches (312 mm) at Naolinco, Veracruz. These rains caused flooding and mudslides across portions of eastern and southeastern Mexico.

CASUALTY AND DAMAGE STATISTICS

Chris caused five direct fatalities[2] in Mexico. Four police officers from Tepetlán, Veracruz, died when their vehicle was swept away by the flooded Río Seco while conducting patrols after

[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.

the storm.[3] A 67-year-old man died after a mud and rockslide buried his house in Tlanchinol in the state of Hidalgo.[4] One indirect death was reported when an elderly woman died by electrocution while sweeping a puddle on her balcony in southern Tampico.[5]

Chris's heavy rains caused flooding and landslides in the states of Veracruz, Chiapas, San Luis Potosí, Hidalgo, and Morelos. About 2,000 homes were damaged in Huilopan, Veracruz, and the state's Civil Protection set up nine temporary shelters for 86 people.[6] In Yahualica, Hidalgo, the army evacuated 200 families by helicopter due to a flooded river, and in nearby Xochiatipan, more than 20,000 residents were affected and lost some property.

FORECAST AND WARNING CRITIQUE

Although the potential for development was highlighted for several days, confidence was never very high that Chris would actually form (Table 2). The wave from which Chris developed was introduced in the Tropical Weather Outlook 144 h (6 days) prior to genesis and given a low (<40%) chance of formation during the next seven days. The system was given a low chance of formation during the next two days 120 h before genesis. Both the 2- and 7-day probabilities were raised to the medium (40-60%) category only 42 h before formation, and the chances for genesis only reached the high category at the time Chris is estimated to have formed. The location of genesis was well forecast and fell within all potential genesis areas depicted in NHC's Graphical Tropical Weather Outlook (Fig. 5).

Only one NHC official forecast verified at 12 h due to the cyclone's short existence. That forecast had a track error of 25.6 n mi and an intensity error of 5 kt, which are both near the mean official errors for the previous 5-yr period. A homogeneous comparison of the official track and intensity errors with selected guidance models is not shown due to the small sample size of forecasts.

Coastal watches and warnings associated with Chris are given in Table 3.

[3] Mueran cuatro policías arrastrados por un río tras paso de la tormenta tropical "Chris" en Veracruz. *El Imparcial*. 3 July 2024. https://www.elimparcial.com/mexico/2024/07/04/mueren-cuatro-policias-arrastrados-por-un-rio-tras-paso-de-la-tormenta-tropical-chris-en-veracruz/

[4] Reportan un muerto y 200 personas evacuadas por 'Chris' en Hidalgo. *Expreso*. 2 July 2024. https://www.expreso.com.mx/amp/noticias/mexico/tormenta-tropical-chris-deja-un-muerto-y-multiples-danos/211540

[5] Cientos de personas incomunicadas tras 12 horas de Lluvia en Tamaulipas. *La Jornada*. 1 July 2024. https://www.jornada.com.mx/noticia/2024/07/01/estados/cientos-de-personas-incomunicadas-tras-12-horas-de-lluvia-en-tamaulipas-8952

[6] Latin America & the Caribbean 2024 Atlantic Hurricane Season – Snapshot #1. Reliefweb. 2 July 2024. https://reliefweb.int/report/grenada/latin-america-caribbean-2024-atlantic-hurricane-season-snapshot-1-2-july-2024

ACKNOWLEDGEMENTS

Rainfall data in Fig. 4 were provided by CONAGUA, the national meteorological service of Mexico.

Table 1. Best track for Tropical Storm Chris, 30 June–1 July 2024.

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
30 / 1800	19.7	95.4	1007	30	tropical depression
01 / 0000	19.9	96.0	1006	35	tropical storm
01 / 0300	19.9	96.5	1005	40	"
01 / 0600	19.8	97.0	1007	30	tropical depression
01 / 1200					dissipated
01 / 0300	19.9	96.5	1005	40	maximum winds and minimum pressure
01 / 0300	19.9	96.5	1005	40	landfall in Alto Lucero municipality, Veracruz

Table 2. 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	**168-Hour Outlook**
Low (<40%)	120	144
Medium (40%-60%)	42	42
High (>60%)	0	0

Table 3. Watch and warning summary for Tropical Storm Chris, 30 June–1 July 2024.

Date/Time (UTC)	**Action**	**Location**
30 / 2100	Tropical Storm Warning issued	Cabo Rojo to Puerto Veracruz, Mexico
1 / 1200	Tropical Storm Warning discontinued	All

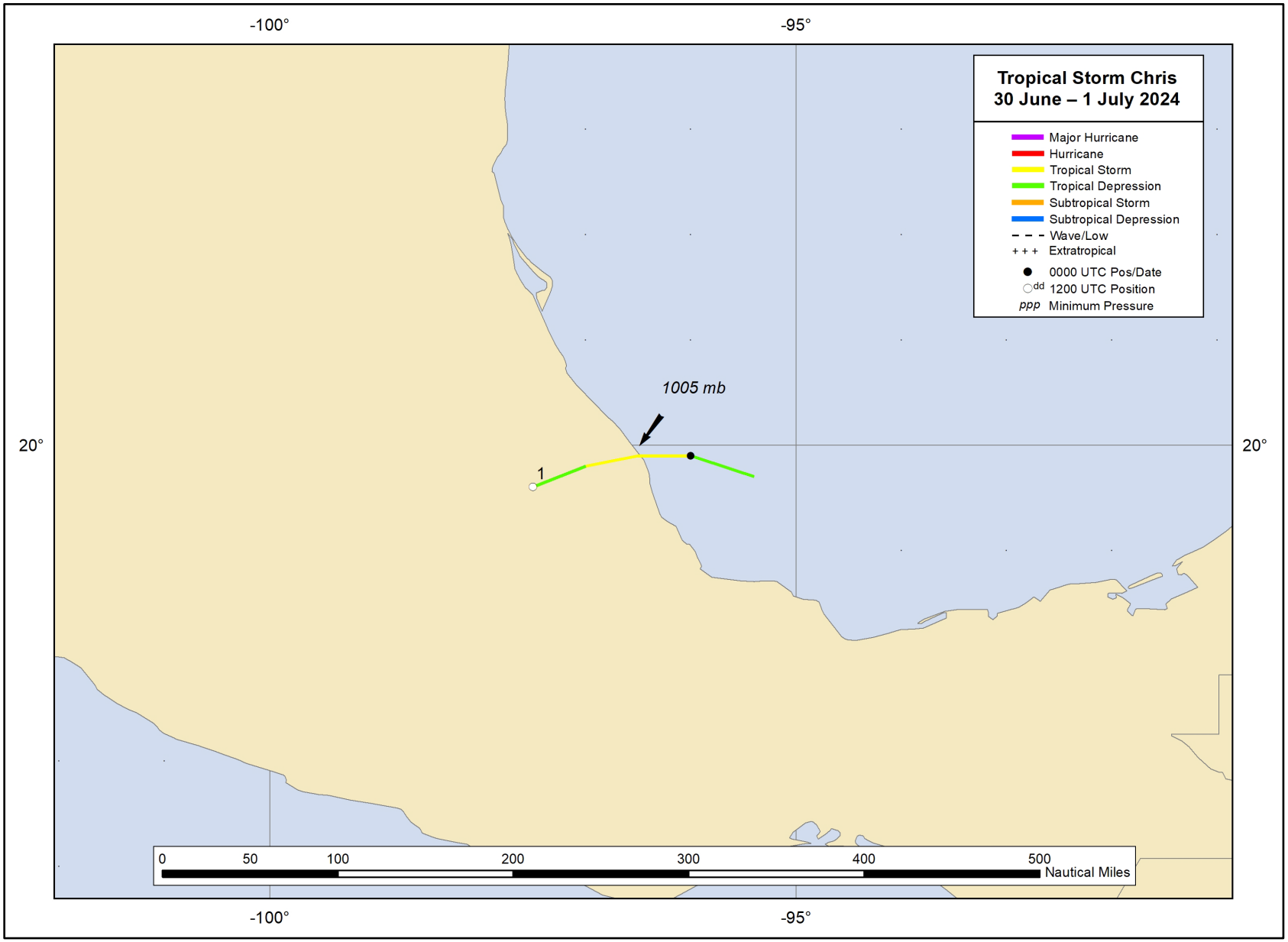


Figure 1. Best track positions for Tropical Storm Chris, 30 June–1 July 2024.

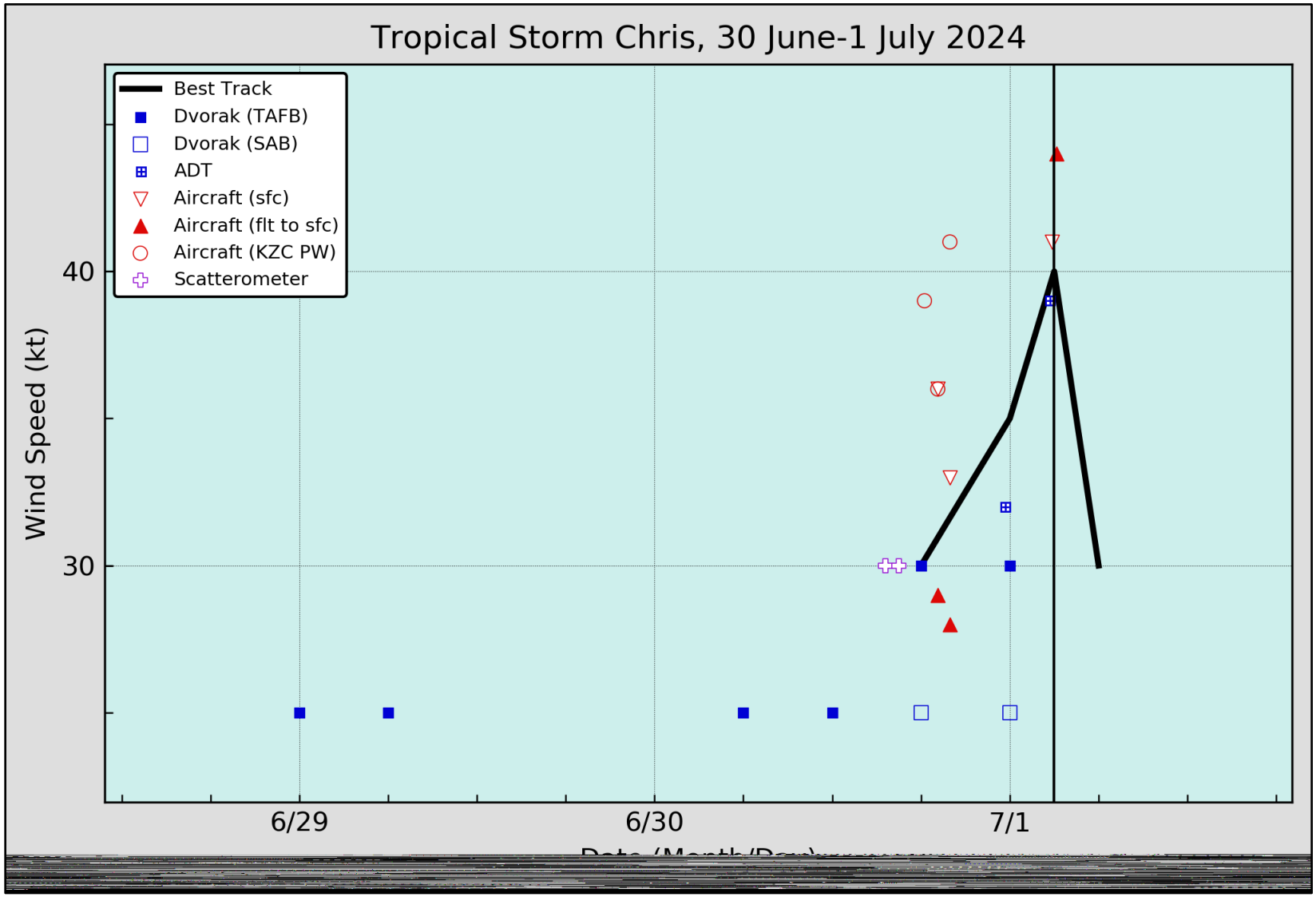


Figure 2. Selected wind observations and best track maximum sustained surface wind speed curve for Tropical Storm Chris, 30 June–1 July 2024. Aircraft observations have been adjusted for elevation using 90% and 75% adjustment factors for observations from 700 mb and 925 mb, respectively. Advanced Dvorak Technique estimates represent the Current Intensity at the nominal observation time. Dashed vertical lines correspond to 0000 UTC, and solid vertical lines correspond to landfalls.

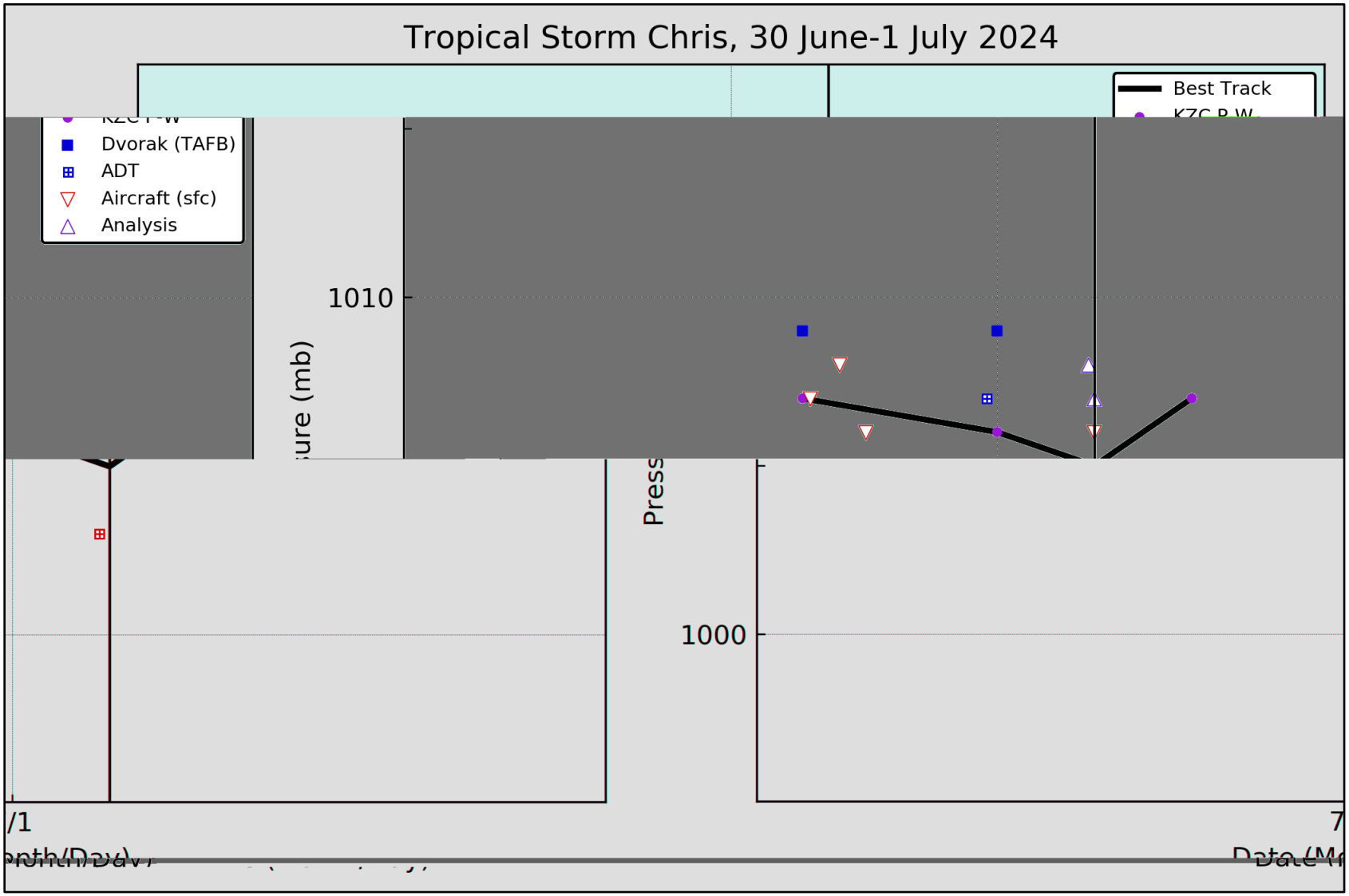


Figure 3. Selected pressure observations and best track minimum central pressure curve for Tropical Storm Chris, 30 June–1 July 2024. Advanced Dvorak Technique estimates represent the Current Intensity at the nominal observation time. KZC P-W refers to pressure estimates derived using the Knaff-Zehr-Courtney pressure-wind relationship. Dashed vertical lines correspond to 0000 UTC, and solid vertical lines correspond to landfalls.

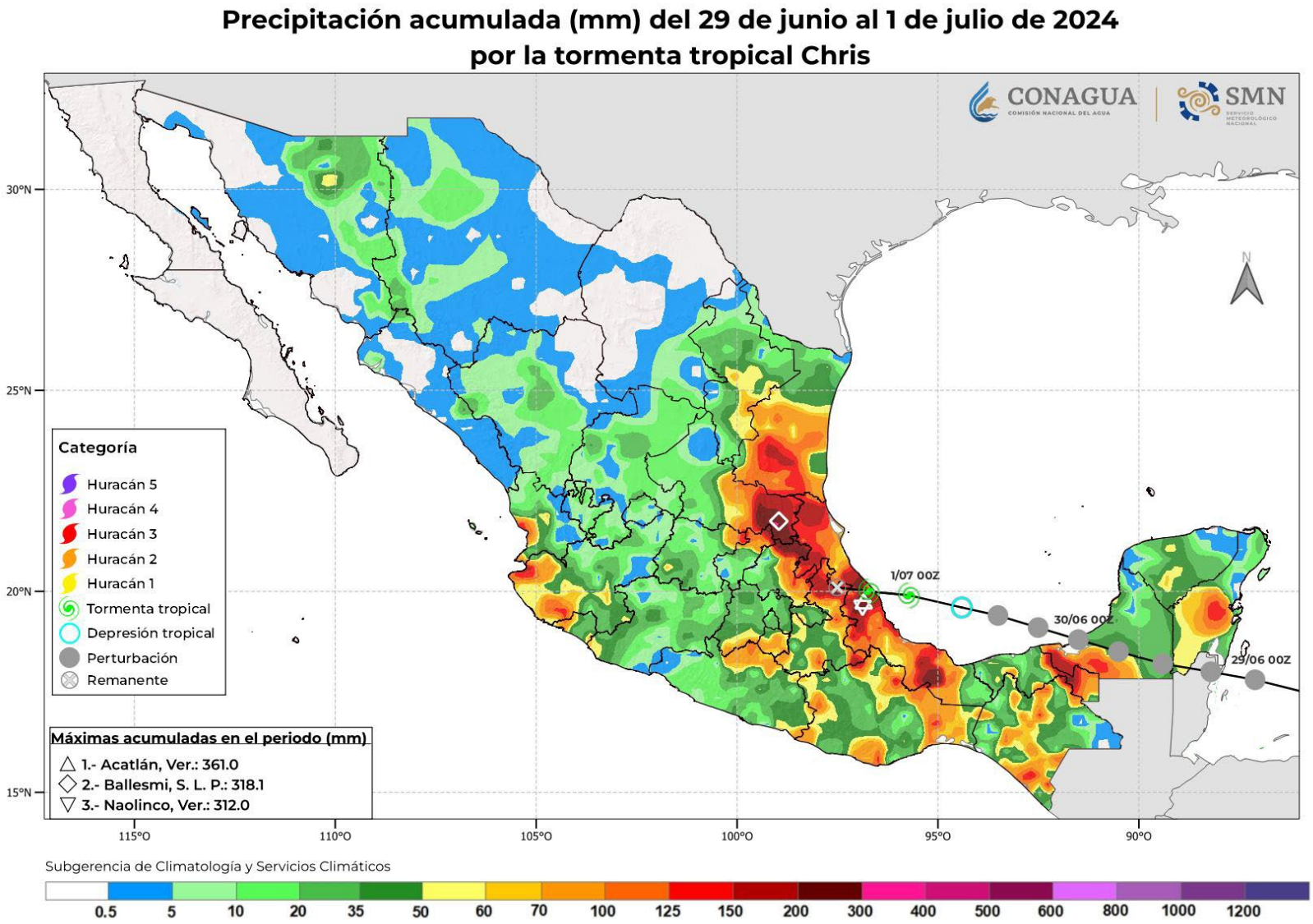


Figure 4. Rainfall accumulations (mm) in Mexico from 29 June to 1 July 2024, including the effects of Tropical Storm Chris. Chris's track is based on operational location and intensity estimates. Image courtesy of CONAGUA, the national meteorological service of Mexico.

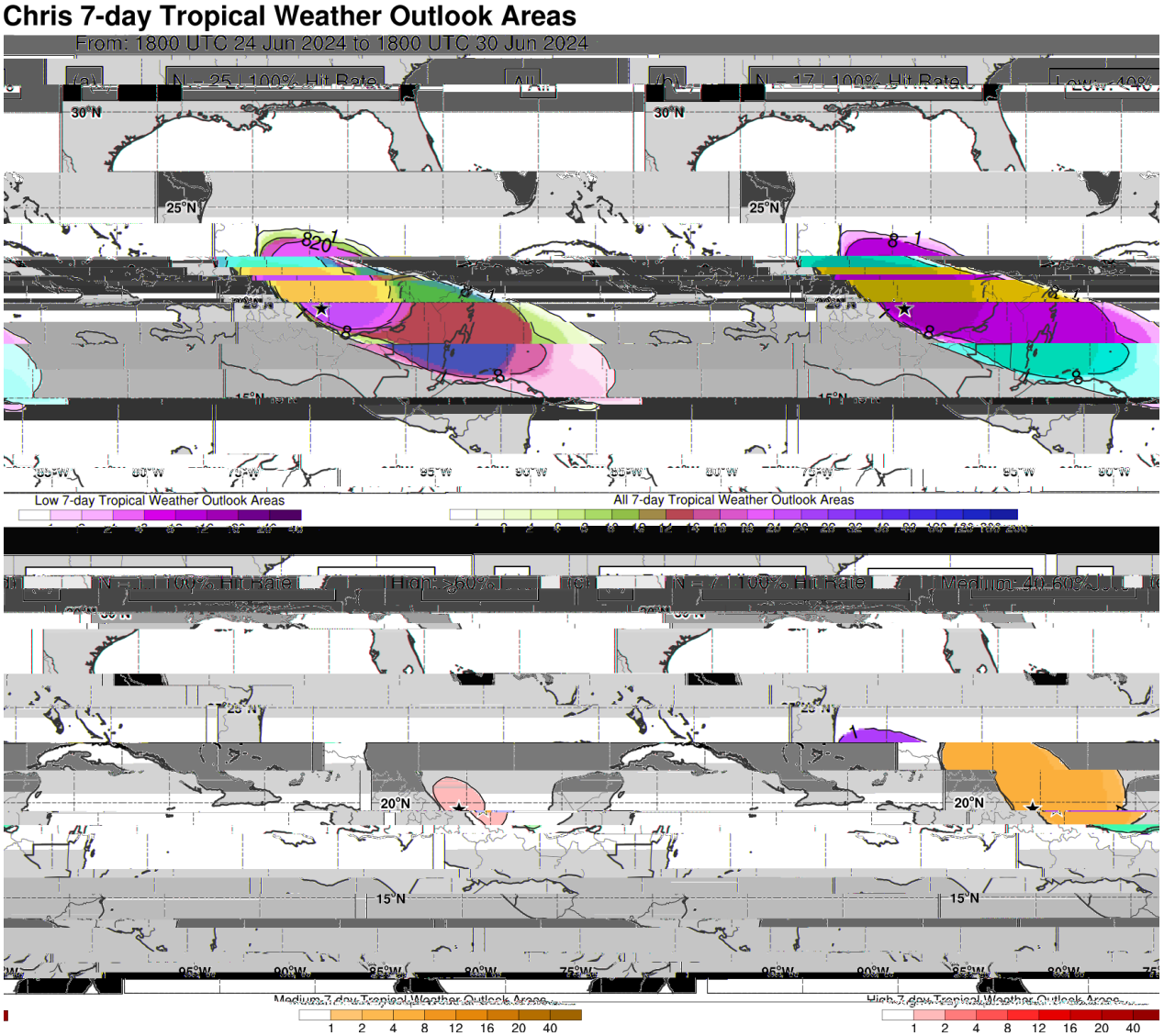


Figure 5. Composites of 7-day tropical cyclone genesis areas depicted in NHC's Tropical Weather Outlooks prior to the formation of Tropical Storm Chris for (a) all probabilistic genesis categories, (b) the low (<40%) category, (c) medium (40–60%) category, and (d) high (>60%) category. The location of genesis is indicated by the black star. Note that the single genesis forecast in the high category (panel d) was issued at the time Chris is analyzed to have become a tropical cyclone.