NATIONAL HURRICANE CENTER TROPICAL CYCLONE REPORT

HURRICANE DEBBY

(AL042024)

3–8 August 2024

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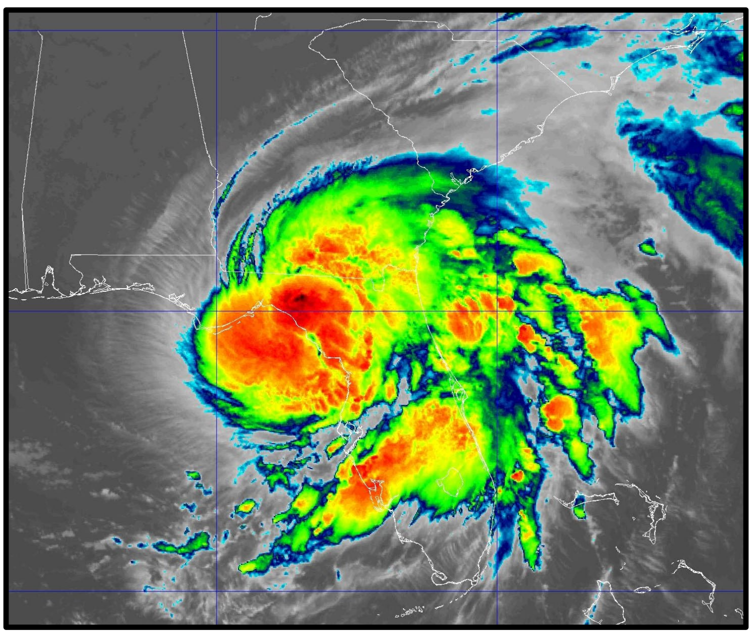

GOES-EAST INFRARED SATELLITE IMAGE OF HURRICANE DEBBY MAKING LANDFALL IN THE BIG BEND REGION OF FLORIDA AT 1100 UTC 5 AUGUST 2024. IMAGE COURTESY NOAA/NESDIS/STAR.

Debby was a category 1 hurricane (on the Saffir-Simpson Hurricane Wind Scale) that made landfall along the Florida Big Bend. After emerging over the southwestern Atlantic Ocean, Debby transitioned to a subtropical storm and made a second landfall in South Carolina. Debby produced devastating flash and river flooding impacts across portions of the southeastern United States and was responsible for 18 fatalities (12 direct) and over $4 billion (USD) in damage in the United States and Canada.

[1] Original report date 23 January 2025. This version includes updates to the tornado section, Figure 12, and the supplemental data file.

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SYNOPTIC HISTORY

A tropical wave emerged off of the west coast of Africa on 25–26 July. The wave moved quickly westward across the eastern and central tropical Atlantic during the next several days, but shower activity was limited due to dry air in the surrounding environment. The wave crossed 50°W on 30 July, and showers and thunderstorms began increasing ahead of the wave axis before it moved over the Lesser Antilles on 31 July. Shower and thunderstorm activity continued to increase but remained disorganized on 1 August while the wave moved west-northwestward across Puerto Rico and Hispaniola. Scatterometer data that day showed a sharp wind shift across the wave axis, but the disturbance lacked a closed surface circulation. Showers and thunderstorms began showing increased signs of organization on 2 August while the wave moved across eastern Cuba and late that day, surface observations and radar data from Cuba indicated the system had acquired a well-defined circulation. It is estimated that a tropical depression formed by 0000 UTC 3 August, about 65 n mi west-southwest of Camaguey, Cuba. 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[2].

The depression moved west-northwestward across western Cuba on the morning of 3 August and then emerged over the southeastern Gulf of Mexico, where it strengthened into Tropical Storm Debby by 1800 UTC that day. The storm gradually turned northwestward and northward on 4 August while moving around the western periphery of a subtropical ridge over the western Atlantic. Despite some intrusions of dry air over the southwestern part of the circulation early on 4 August, Debby rapidly intensified that day over the eastern Gulf of Mexico within an environment of weak vertical wind shear over extremely warm sea-surface temperatures of 30.5–31.5°C. Debby developed an inner core and exhibited a ragged mid-level eye in passive microwave images late on 4 August (Fig. 4a). Flight-level winds and Tail Doppler Radar velocity data from reconnaissance aircraft suggest Debby became a 70-kt hurricane by 0000 UTC 5 August when it was centered about 90 n mi west-northwest of Tampa, Florida.

The hurricane continued northward and then gradually turned north-northeastward overnight ahead of a deep-layer trough over the eastern United States. This trough began to impart some westerly shear on the hurricane, which brought dry air over the western portion of the circulation and resulted in Debby becoming vertically tilted on its approach to the coast. However, Debby maintained a cohesive eyewall in radar data and passive microwave images

[2] 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.

(Fig. 4b), and it is estimated to have made landfall as a 70-kt hurricane just west of Steinhatchee, Florida, at 1100 UTC 5 August (cover image and Fig. 5).

Debby quickly weakened to a tropical storm after landfall, moving northeastward over the Florida Panhandle and crossing into southeastern Georgia that night. The center of the storm moved slowly northeastward on 6 August and passed near Savannah, Georgia, around 1800 UTC that day, then turned eastward and moved offshore the coasts of Georgia and South Carolina that evening. During this time, Debby began to exhibit characteristics more suggestive of a subtropical cyclone. The central convection of the storm collapsed due to significant intrusions of dry air resulting from the upper-level trough interaction (Fig. 6). Debby also had a large radius of maximum winds (RMW) and an asymmetric wind field after emerging over the southwestern Atlantic. Therefore, Debby is best classified as a subtropical storm beginning near 0000 UTC 7 August, when it was located about 30 n mi east of Savannah. Debby meandered offshore within weak steering currents on 7 August. Aircraft data indicate it reached a secondary peak intensity of 50 kt at 1200 UTC that day, when it was located about 50 n mi southeast of Charleston, South Carolina. The strongest winds during this period occurred offshore within broken convective bands displaced well away from the center. Soon after, weakening commenced as Debby was unable to regenerate organized convection closer to its center. The system's circulation became increasingly elongated as it approached the coast, and it is estimated that Debby made landfall as a 40-kt subtropical storm around Bulls Bay, South Carolina, near 0600 UTC 8 August.

After landfall, Debby moved across eastern South Carolina and into central North Carolina, where the system merged with a front and became extratropical by 0000 UTC 9 August. The low accelerated northeastward across the Mid-Atlantic and northeastern United States that day, then moved across portions of southern Quebec and over the Gulf of St. Lawrence on 10 August. By 0000 UTC 11 August, the extratropical low became absorbed along a frontal system that was associated with a new area of low pressure over the northern Atlantic.

METEOROLOGICAL STATISTICS

Observations in Debby (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), 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 10 aircraft missions into Debby and its precursor disturbance from 2–8 August (Fig. 7). This includes 6 flights of the U.S. Air Force Reserve Command's 53rd Weather Reconnaissance Squadron's WC-130 aircraft and 4 flights of the NOAA WP-3D Orion aircraft. These missions provided a total of 24 center fixes for Debby. 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), the Defense Meteorological Satellite Program (DMSP) satellites, and the Time-Resolved Observations of Precipitation structure and storm Intensity with a Constellation of Smallsats (TROPICS) satellites, among others, were also useful in constructing the best track of Debby.

Ship reports of winds of tropical storm force associated with Debby are given in Table 2, and selected surface observations from land stations and data buoys are given in Table 3.

Winds and Pressure

The 70-kt peak intensity of Debby on 5 August is based primarily on aircraft data. The Air Force Reserve Hurricane Hunters reported peak 700-mb flight-level winds of 77 kt at 0040 UTC 5 August in convection to the east of the center, which corresponds to a surface intensity estimate of about 70 kt using the standard 90% adjustment factor. The NOAA Hurricane Hunters recorded 82–91-kt flight-level winds at a height of 750 mb roughly one hour later, and NOAA Tail Doppler Radar data showed a peak 2.0-km wind speed of almost 81 kt in the same area to the east of the center. A blend of these datasets supports the 70-kt peak intensity estimate.

It is estimated that Debby made landfall as a 70-kt hurricane at 1100 UTC 5 August, although this estimate is somewhat uncertain given the remote location where Debby moved ashore. The Air Force Reserve Hurricane Hunters recorded peak 700-mb flight-level winds of 71 kt shortly before landfall at 1005 UTC, but the flight leg lengths were constrained by Debby's proximity to land. Despite the lower flight-level winds, the higher satellite intensity estimates and falling central pressure overnight suggest Debby likely maintained its intensity before it reached the coast.

The estimated minimum central pressure of 979 mb at landfall is based on aircraft data. A 0906 UTC 5 August center dropsonde measured a 979-mb surface pressure with 13-kt surface winds, and a subsequent dropsonde at 1013 UTC reported a 980-mb surface pressure with 7-kt near-surface winds. An in-situ pressure measurement of 982.2 mb was taken by Josh Morgerman (iCyclone) in Steinhatchee, Florida, as the eye of Debby passed near that location.

The estimated landfall intensity of 40 kt in South Carolina near 0600 UTC 8 August is based on aircraft data. An Air Force Reserve Hurricane Hunter flight into Debby shortly before landfall measured 925-mb flight-level winds of 50–55 kt, which reduces to a surface intensity of about 40 kt using the standard 75% adjustment factor from that level. There were no observations at the landfall location, but the estimated South Carolina landfall pressure is 995 mb. The Florence Regional Airport (KFLO) reported a pressure of 995.7 mb a few hours after landfall (0953 UTC) as the center of Debby passed near the location.

Florida

Debby made landfall in a remote part of Florida with limited surface observation sites. Thus, there were no direct measurements of sustained hurricane-force winds. The highest measured wind near the landfall location was from a National Ocean Service (NOS) station at Cedar Key, which reported a sustained wind of 45 kt at 1006 UTC 5 August and a gust of 58 kt. Wind gusts of 61 kt and 56 kt were measured at WeatherSTEM sites in the Florida Panhandle at Lafayette High School (Mayo) and Madison County High School (Madison), respectively.

Debby brought tropical storm conditions to portions of the Florida Keys early on 4 August while it moved across the southeastern Gulf of Mexico. A Coastal-Marine Automated Network (C-MAN) site at Sand Key (SANF1) reported a sustained wind of 46 kt at 1001 UTC and a gust of 50 kt. Tropical storm conditions spread across much of the west coast of Florida on 4–5 August while Debby passed offshore of the peninsula, with some of the highest wind reports coming from the Tampa Bay region. A WeatherFlow station at Egmont Channel (XEGM) measured a sustained wind of 47 kt at 0114 UTC 5 August and a gust of 56 kt. The Sarasota-Bradenton International Airport (KSRQ) reported a sustained wind of 40 kt at 0529 UTC 5 August and a gust of 56 kt. A wind gust of 61 kt occurred at the Skyway Fishing Pier (XSKY), and 55-kt wind gusts were reported at a C-MAN station in Venice (VENF1) and a NOS station in Clearwater Beach (CWBF1). Elsewhere, Debby's large wind field resulted in tropical-storm-force gusts at numerous inland locations across the Florida Peninsula, including Orlando and Gainesville. There were also reports of sustained tropical-storm-force winds along the northeast coast of Florida after Debby made landfall, including a sustained wind of 36 kt at 1500 UTC 5 August and a gust of 44 kt in St. Augustine Beach (SAUF1).

Georgia

Tropical storm conditions occurred across portions of southeastern Georgia later on 5 August as Debby moved inland. The Valdosta Regional Airport (KVLD) reported a sustained wind of 38 kt at 2014 UTC 5 August with a gust of 50 kt. Later, a WeatherFlow station at Jekyll Island (XJEK) measured a sustained wind of 40 kt at 2327 UTC and a gust of 49 kt. The lowest reported pressure in Georgia was 996.7 mb at 2251 UTC 6 August by a WeatherFlow station at Tybee South (XTYE) after the center of Debby had moved offshore.

South Carolina and North Carolina

Debby brought tropical storm conditions to parts of coastal South Carolina beginning early on 6 August while it was still inland. A WeatherFlow station (XCHA) in Charleston, South Carolina, reported sustained winds of 36 kt at 0415 UTC 6 August and a peak gust of 52 kt. There were additional reports of tropical-storm-force winds along the coasts of North and South Carolina on 8 August near and after the time of Debby's second landfall. A NOS station (JMPN7) in Wrightsville Beach, North Carolina, measured a sustained wind of 36 kt at 0718 UTC 8 August and a peak gust of 45 kt. Later that day, a C-MAN station (CLKN7) in Cape Lookout, North Carolina, recorded a sustained wind of 39 kt and a gust of 51 kt.

Storm Surge[3]

In situ water level measurements suggest Debby produced peak storm surge inundation levels of 4 to 5 ft above ground level (AGL) along the coast of the Florida Big Bend region from

[3] 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).

Steinhatchee eastward to Cedar Key (Figs. 8 and 9). The NOS tide gauge located at Cedar Key recorded the highest storm surge value of 6.11 ft above the normal tide level. With the timing of the peak storm surge occurring between high tide cycles, however, the resulting storm tide was recorded as 4.65 ft above Mean Higher High Water (MHHW). Additionally, the United States Geological Survey (USGS) streamgage located east of the landfall location at Steinhatchee measured peak water levels of 3.8 ft above MHHW, approximately two miles upstream from the mouth of the river. Unfortunately, with much of the area near the landfall location being remote natural wetlands/evergreen forest and a lack of in situ data near the RMW along the coast, the peak storm surge was likely not captured with tide gauges or high-water mark surveys. Therefore, to more accurately determine the storm surge inundation along the immediate coast, a hindcast produced by the NHC Storm Surge Unit (SSU) was used to augment the available data. From the hindcast, it could be deduced that a peak storm surge inundation level of up to 6 ft AGL occurred between Keaton Beach and Cedar Key. This is reflected in the final storm surge analysis illustrated in Fig. 8.

Elsewhere, the large extent of the tropical-storm-force winds caused more than ~300 n mi of the west coast of Florida to experience elevated water levels. In particular, storm surge inundation of up to 4 ft AGL occurred from Cedar Key to the Anclote River. The USGS streamgages located on the Crystal River near Shell Island and on the Withlacoochee River at Chambers recorded peak water levels of 4.1 ft and 3.9 ft above MHHW, respectively. Farther down the west coast of Florida, peak water levels of 2 to 3 ft AGL were observed as far south as Naples. In Tampa Bay, a USGS streamgage located at the mouth of the Hillsborough River observed a storm tide of 3.0 ft above MHHW. Nearby NOS tide gauges at Old Port Tampa and at East Bay both recorded water levels of 2.97 ft above MHHW. The tide stations located at Fort Myers and Naples observed peak water levels of 3.27 ft and 3.11 ft above MHHW, respectively.

Areas west of Debby's landfall location also experienced storm surge inundation. Specifically, peak water levels of 2 to 4 ft AGL extended from Keaton Beach westward to the Aucilla River as suggested by the NHC SSU hindcast (not shown). Also, 1 to 2 ft AGL inundation occurred from the Aucilla River westward to Apalachicola. A USGS streamgage at Spring Creek, FL, measured a peak water level of 2.3 ft above MHHW, and a nearby NOS tide gauge at Apalachicola observed a peak water level of 1.96 ft above MHHW.

On the U.S. East Coast, storm surge inundation of 1 to 2 feet AGL occurred along the Georgia, South Carolina, and North Carolina coastlines. The NOS tide station at Fort Pulaski, Georgia, recorded a maximum storm surge of 3.28 ft above the normal tide level. However, this occurred at low tide, resulting in a storm tide of 1.67 ft above MHHW. In South Carolina, NOS tide gauges at Charleston and Springmaid Pier reported 1.05 ft and 0.95 ft above MHHW, respectively. In North Carolina, a USGS streamgage on the Pamlico River near Washington reported 2.6 ft above MHHW.

Rainfall and Flooding

In Florida, Debby produced a large swath of 5–10 inches of rainfall that extended from west-central Florida northward to the Florida Big Bend (Fig. 10). Locally higher amounts of 10–15 inches occurred near and to the south of the Tampa Bay region, with the highest total in the state (16.98 inches) reported in Sarasota. Isolated totals greater than 12 inches were reported in northern Florida near and to the east of the track of the center. Debby also produced a large swath of 10–15 inches of rainfall across eastern portions of Georgia and South Carolina and southeastern North Carolina. Higher amounts of 15–20 inches were reported over the southeastern part of South Carolina, with a storm-total maximum of 22.02 inches near Moncks Corner.

Maximum reported storm-total rainfall by state:

Florida: 16.98 inches in Sarasota (HUD-2 Arlington St., Sarasota County)
Georgia: 14.85 inches in Oliver (Oliver 1.4 ESE, Effingham County)
South Carolina: 22.02 inches in Moncks Corner (Moncks Corner 6.6 SW, Berkeley County)
North Carolina: 15.75 inches in Leland (Brunswick County)

In the southeastern United States, this heavy rainfall caused flash flooding as well as significant, long-duration river flooding. Water levels at 14 river gage locations crested above major flood stage from Florida to North Carolina, and three sites crested at record levels (Fig. 11): Manatee River at Rye Bridge in Florida (RYEF1), Canoochee River near Claxton, Georgia (CNOG1), and Ogeechee River near Rocky Ford, Georgia (RFDG1).

As an extratropical cyclone, Debby brought 1–3 inches of rainfall to much of the Mid-Atlantic and northeastern United States, with 3–5 inches and locally higher amounts near the low track over portions of Virginia, Maryland, Pennsylvania, and New York. Extratropical Debby also contributed to heavy rainfall in portions of Canada, with 3–7 inches (80–180 mm) falling over southern Quebec (Fig. 10). A storm-total maximum of 8.70 inches (221 mm) of rain was reported in Lanoraie. The cities of Dorval (6.06 inches; 154 mm) and Montreal (5.55 inches; 141 mm) received all-time daily record rainfall amounts on 9 August.

Tornadoes

Debby produced 26 tornadoes as a tropical cyclone from 4–8 August – 10 in North Carolina, 8 in South Carolina, 5 in Florida, 2 in Virginia, and 1 in Delaware. These include 1 EF-3 and 2 EF-2 tornadoes, with the remaining tornadoes rated EF-0 or EF-1. Another 4 tornadoes occurred on 9 August after Debby transitioned to an extratropical cyclone – 1 each in Virginia, West Virginia, Pennsylvania, and New York. Figure 12 shows the locations of all of the tornadoes associated with Debby.

Some of the most damaging tornadoes occurred in North Carolina within the outer rainbands of Debby on 7–8 August. In Lucama, an EF-3 tornado destroyed several homes and severely damaged a middle school (Fig. 13). Elsewhere, several homes and an assisted living facility were severely damaged by an EF-2 tornado near Harrells. Another EF-2 tornado in Snow Hill damaged multiple homes, barns, trees, wooden power poles, and rolled a medium sized pickup truck. In South Carolina, multiple EF-1 tornadoes occurred from 4–6 August, including one that damaged about 29 homes in Charleston County. Other EF-1 tornadoes caused significant structural damage to a few homes in the Edisto Beach area and damaged some restaurants near Moncks Corner. After Debby became extratropical, an EF-1 tornado on 9 August in Harrisburg, Pennsylvania, caused roof damage to multiple homes and businesses and uprooted trees.

CASUALTY AND DAMAGE STATISTICS

Debby is responsible for 18 fatalities during its time as a tropical, subtropical, and extratropical cyclone – 17 in the United States and 1 in Canada. Of the 17 U.S. fatalities, 11 were directly[4] caused by the storm. This includes 5 fatalities related to wind, 4 caused by freshwater flooding, and 1 each attributed to a marine incident and a tornado. There was also one direct fatality in Canada due to freshwater flooding. There were 6 indirect fatalities in the U.S., including 4 that were related to vehicle accidents on wet roads (3 in Florida and 1 in North Carolina).

Five direct fatalities occurred in Florida. Downed trees on homes killed a 13-year-old male in Levy County and a 59-year-old male in Dixie County. A 48-year-old male was found deceased aboard a submerged sailboat in Boca Ciega Bay near Gulfport. A 67-year-old man in Sarasota drowned after his vehicle was swept away by floodwaters near Philippi Creek. In Bradford County, a 75-year-old male drowned after his vehicle left the roadway and was submerged in a flooded ditch. Elsewhere, a 19-year-old male died in Moultrie, Georgia, after a tree fell on a home.

In North Carolina, a 78-year-old female died after a tree fell on her home in Browns Summit, and a 60-year-old male died after a tornado near Lucama caused the second floor of a home to collapse. A woman drowned in Robeson County, North Carolina, after her vehicle was swept off the road and submerged by lingering floodwaters.

A few direct fatalities occurred after Debby became an extratropical cyclone. A 36-year-old female near Harpers Ferry, West Virginia, was killed after a large oak tree was uprooted and fell on a home. On 9 August, a 65-year-old male in Tioga County, Pennsylvania, was swept away by rising floodwaters along Troups Creek. In Canada, one direct fatality occurred in the Mauricie region of Quebec near Notre-Dame-de-Montauban after a roadway collapse caused an 83-year-old man to fall into the Batiscan River and be swept away by floodwaters.

Debby produced an estimated $2.5 billion (USD) in damage according to the NOAA National Centers for Environmental Information (NCEI).[5] Based on estimates from Catastrophe Indices and Quantification Inc. (CatIQ) shared by the Insurance Bureau of Canada[6], Debby caused 2.5 billion (CAD), or about $1.75 billion (USD), in damage mostly due to flooding as an extratropical cyclone in Canada.

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[4] 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.

[5] NOAA National Centers for Environmental Information (NCEI) U.S. Billion-Dollar Weather and Climate Disasters (2024). https://www.ncei.noaa.gov/access/billions/

[6] The costliest severe weather event in Quebec's history – August flooding caused nearly $2.5 billion in insured damage (2024). https://www.ibc.ca/news-insights/news/the-costliest-severe-weather-event-in-quebec-s-history-august-flooding-caused-nearly-2-5-billion-in-insured-damage

Florida

Major to historic flash and river flooding occurred as a result of Debby's heavy rainfall. Some of the hardest-hit locations were in Manatee and Sarasota Counties in west-central Florida (Fig. 14), where floodwaters inundated homes, submerged vehicles, and flooded roadways. In Sarasota County, officials estimated $57.9 million (USD) in total damage to over 1,000 structures. Over 500 high-water rescues were performed in Sarasota County along the Myakka River and in the Pinecraft and Philippi Creek neighborhoods. More than 160 buildings in Manatee County suffered major damage, and officials estimated over $55 million (USD) in total damage in the county. Over 200 high-water rescues were reported in Manatee County due to flooding in Parrish and other communities.

Significant flood damage also occurred in parts of north Florida near the landfall location and along Debby's track. A Flash Flood Emergency was issued for Live Oak and surrounding communities in Suwannee County, where emergency management officials reported widespread flash flooding with nearly every road closed in the city. Many businesses and structures were inundated, and extensive damage was reported. Widespread flash and river flooding occurred in Madison County, where numerous homes and several businesses were flooded and some water rescues were necessary. The flooding in southeastern Madison County corresponded with a 500-year flood event, and portions of that area remained inundated for weeks following the storm. In Columbia County, floodwaters submerged a vehicle and washed out State Road 240 in Lake City. There were also reports of flooded homes in parts of Alachua County including Gainesville, High Springs, Newberry, and Alachua.

Strong winds downed trees and power lines across a swath of north Florida, primarily focused near and to the east of Debby's center. Many trees were downed in Dixie, Levy, and Suwannee Counties. Downed trees and power lines blocked roadways in Alachua County, and several homes were struck by fallen trees. A home in Columbia County suffered major roof damage. There were also reports of damaging winds in Union, Putnam, Clay, and Duval Counties, including fallen trees that struck homes or vehicles. More than 245,000 power outages were reported across the state.

Georgia

Significant flash and river flooding across southern and eastern portions of Georgia resulted in hundreds of road closures, numerous wash outs, and some dam breaches. In Bulloch County alone, about 100 roads were damaged, and several dams were breached. Floodwaters entered numerous homes, boat houses, and other structures along the banks of Lake Cypress. Emergency management officials in Evans County reported that about 30 homes were destroyed and another 18 suffered major damage from flooding along the Canoochee River, Anderson Pond Creek, and Bull Creek. In Pierce County, College Avenue near Blackshear washed out and collapsed, stranding about 200 residents in a nearby subdivision. Flooding in Savannah resulted in dozens of street closures, and several homes were inundated in the Tremont Park neighborhood. In Brunswick, water entered some homes in the College Park neighborhood. Two swift-water rescues were performed in Jeff Davis County.

Gusty winds from Debby downed trees and power lines across portions of south Georgia, resulting in some road closures and power outages that affected at least 69,000 customers. There were scattered reports of roof damage and trees falling onto homes, one of which resulted in a fatality in Colquitt County. Debby also resulted in significant agricultural losses, damaging hundreds of pecan trees and over half of the state's tobacco crops.

South Carolina

South Carolina experienced significant damage and impacts from flooding, particularly across the southern and eastern portions of the state (Fig. 15). Hundreds of roads were closed or made impassable by flooding, including a portion of eastbound Interstate 26 in Berkeley County. Some road washouts were reported, and numerous vehicles were disabled by rising floodwaters. About 30 water rescues were performed near Moncks Corner. Multiple water rescues were performed in Florence County, with a few others reported in Beaufort County and one in Jasper County. Floodwaters entered some buildings in downtown Charleston, and primary road access into the city was closed. Significant flooding resulted in water entering many homes in Beaufort County, including Bluffton and Hilton Head Island. Long-duration river flooding caused additional damage, with floodwaters inundating some homes and structures along the Edisto River in Colleton and Dorchester Counties. Some ground-level homes were flooded along French Quarter Creek in Berkeley County, and a few homes and businesses were flooded along Ireland Creek in Colleton County. The Ashley River in Dorchester County inundated surrounding roads and neighborhoods for about one week after the storm.

In addition to the previously described tornado damage, gusty winds over the saturated ground downed many trees in Beaufort and Colleton Counties and several trees along the Interstate 95 corridor in Jasper County. A downed tree caused major damage to a house in Dillon County. Media reports indicate tens of thousands of power outages occurred across the state. According to the South Carolina Emergency Management Division, at least 70 homes suffered major damage from Debby's impacts.

North Carolina

Numerous homes and structures suffered serious damage as a result of strong tornadoes that touched down in Lucama, Harrells, and Snow Hill (see Tornadoes section). In addition, heavy rainfall caused flash and river flooding impacts across eastern portions of the state. Many roads were inundated or washed out in Robeson County, and some neighborhoods and cars were flooded near the Lumber River. Carteret County reported several flooded or washed out roads. In Bladen County, some water rescues were performed, and floodwaters entered some businesses. Several rivers reached moderate or major flood stage, including the Lumber River in Robeson County and the Haw River in Alamance and Chatham Counties. Otherwise, generally minor wind damage was reported in eastern portions of North Carolina. Downed trees and power lines resulted in power outages that affected about 520,000 customers.

Mid-Atlantic and Northeastern United States

As an extratropical cyclone, Debby brought flooding rains and strong winds to portions of the Mid-Atlantic and northeastern United States. Downtown Annapolis, Maryland, was inundated with water due to the combined effects of high tide and strong onshore flow from the system. At City Dock, water levels rose 4 feet above normal levels, resulting in Annapolis' eighth highest flooding event on record. Over a dozen businesses were impacted near City Dock, and some flooding also occurred at the U.S. Naval Academy.

Heavy rainfall in mountainous areas of northern Pennsylvania resulted in significant flash and river flooding. A Flash Flood Emergency was issued for Westfield in Tioga County, where some people were stranded on roofs and about 100 people were rescued.

In New York, flooding required some high-water and helicopter rescues in areas south of the Finger Lakes. Water rescues were reported in Allegany County as well. There were also some flash flooding impacts in Vermont, which had previously received flooding rains from the remnants of Hurricane Beryl.

Strong winds impacted areas across the Mid-Atlantic, Northeast, and New England states. Wind gusts greater than 50 kt were reported in New York and Vermont with 35–45-kt gusts across areas from Pennsylvania northward into Massachusetts. This led to an estimated 167,000 customers losing power across Pennsylvania, New York, and Vermont.

Canada

Heavy rainfall from extratropical Debby caused significant flooding in portions of southern Quebec. In Montreal, media reports indicate there were widespread road and highway closures, along with many damaged homes due to flooding and sewer backups. According to the Insurance Bureau of Canada[7], the damage caused by Debby made it the costliest weather event in the history of Quebec. Hundreds of thousands of customers lost power during the event.

FORECAST AND WARNING CRITIQUE

Genesis

The genesis of Debby was well forecast at long range, but its near-term development was not as well anticipated (Table 4). The disturbance from which Debby developed was introduced in the Tropical Weather Outlook (TWO) over 7 days (174 h) prior to genesis and raised to the medium category 6 days (144 h) before formation. A low 2-day chance of formation was introduced into the outlook 42 h before genesis, and the near-term probabilities were raised to the medium category 24 h before formation. However, the 7-day and 2-day probabilities were raised to the high category only 30 h and 6 h before genesis, respectively.

While forecasters correctly recognized long-range model signals that favored tropical cyclone formation, pinpointing the exact timing of genesis proved challenging. This was the result of inconsistent global model guidance that made it difficult to anticipate where Debby would form. Although a majority (64%) of the Graphical TWOs issued by NHC correctly captured the location where genesis occurred (Fig. 16), the success rate was actually lower for the medium and high category areas. Less-than-ideal environmental conditions limited development of the wave while it crossed the tropical Atlantic. Later, there were inconsistent signals in the global models

[7] https://www.lapresse.ca/actualites/2024-09-13/vestiges-de-l-ouragan-debby/l-evenement-climatique-le-plus-couteux-de-l-histoire-du-quebec.php

regarding where low-level vorticity consolidation would occur along the broad wave axis. In fact, there was a period on 30 July when much of the guidance (and the NHC Graphical TWO forecasts) shifted the focus for development to the east of the Florida peninsula over the southwestern Atlantic. Ultimately, Debby formed along the southern portion of the wave axis over the northwestern Caribbean Sea, near the southern coast of Cuba.

Track

A verification of NHC official track forecasts (OFCL) for Debby is given in Table 5a. Official track forecast errors were lower than the mean official errors for the previous 5-yr period at all forecast times. A homogeneous comparison of the official track errors with selected guidance models is given in Table 5b and illustrated in Fig. 17. Note that the UKMET model and the Florida State Superensemble have been excluded from this comparison due to limited sample sizes. The NHC track forecasts verified extremely well and were quite skillful, outperforming almost all of the available track guidance including the consensus aids. The only models with slightly lower track errors for a majority of forecast times were the ECMWF (EMXI) and COAMPS-TC (CTCI) models. Overall, the NHC forecasts (Fig. 18) were consistent in showing Debby making landfall in the Florida Big Bend region, reemerging over the southwestern Atlantic Ocean, and meandering offshore before making a second landfall in South Carolina.

Intensity

A verification of NHC official intensity forecasts (OFCL) for Debby is given in Table 6a. Official intensity forecast errors were comparable to or lower than the mean official errors for the previous 5-yr period at all forecast times. A homogeneous comparison of the official intensity errors with selected guidance models is given in Table 6b and illustrated in Fig. 19. Note that the Florida State Superensemble has been excluded from this comparison due to limited sample size. The best performing models were the HFIP corrected consensus approach (HCCA) and the double-weighted regional model variable consensus (IVDR) aids, which had slightly lower errors than OFCL at most forecast times. Of the individual models, HAFS-A (HFAI) was the best performer with lower or comparable intensity errors to OFCL from 36–120 h.

The NHC forecasts consistently called for Debby to strengthen over the eastern Gulf of Mexico, but rapid intensification was not explicitly forecast until early on 4 August. As a result, some early NHC intensity forecasts were too low. Later NHC intensity forecasts had a high bias, since Debby transitioned to a subtropical cyclone (which was never explicitly forecast by NHC) and weakened on 8 August after failing to regenerate central convection.

Wind Watches and Warnings

Coastal wind watches and warnings associated with Debby are given in Table 7 and Fig. 20. Notably, land-based U.S. wind warnings were in effect for Debby's entire lifetime, from the first potential tropical cyclone advisory until the final NHC advisory was issued. A verification of select coastal watches and warnings is provided below.

Potential tropical cyclone advisories were initiated at 1500 UTC 2 August on the precursor disturbance to issue Tropical Storm Watches and Warnings for portions of the Florida Keys and the west coast of Florida. This included a Tropical Storm Watch for the west coast of Florida from north of Bonita Beach to Aripeka, which was extended northward to the mouth of the Suwannee

River at 2100 UTC 2 August. Most of this coastline (Boca Grande to south of Yankeetown) was upgraded to a Tropical Storm Warning at 0900 UTC 3 August. Surface observations suggest that tropical storm conditions began reaching this portion of the coast by 2100 UTC 4 August, yielding watch and warning lead times of 54 h and 36 h, respectively.

Closer to the landfall location, a Hurricane Watch was issued for the Florida Gulf Coast from the Aucilla River to Yankeetown at 0900 UTC 3 August. A Hurricane Warning was issued at 2100 UTC that day for the Florida Gulf Coast from the Suwannee River to the Ochlockonee River. Tropical storm conditions began spreading across the coast by 0000 UTC 5 August, which means these watches and warnings provided about 39 h and 27 h of lead time, respectively.

On the U.S. East Coast, a Tropical Storm Watch was issued for coastal Georgia from the Mouth of St. Mary's River to Altamaha Sound at 0900 UTC 4 August. The watch was extended northward along the coasts of Georgia and South Carolina to the South Santee River at 1200 UTC that day. A Tropical Storm Warning was issued at 2100 UTC 4 August for the northeastern Florida and Georgia coasts from Ponte Vedra Beach, Florida, northward to the Savannah River. The watch for the South Carolina coast to the South Santee River was upgraded to a Tropical Storm Warning at 0300 UTC 5 August. Surface observations show sustained tropical-storm-force winds began along the Georgia coast near 2100 UTC 5 August, so the watches and warnings provided about 36 h and 24 h of lead time, respectively. Along the South Carolina coast, tropical-storm-force winds began near 0300 UTC 6 August, indicating watch (warning) lead times of 39 h (24 h).

Storm Surge Watches and Warnings

On the Florida Gulf coast, a Storm Surge Watch was first issued at 2100 UTC 2 August from Bonita Beach northward to the Mouth of the Suwannee River, including Tampa Bay. The Storm Surge Watch was extended westward to the Aucilla River at 0900 UTC 3 August. A Storm Surge Warning was first issued at 1500 UTC 3 August from Aripeka northward to the Aucilla River. Simultaneously, a Storm Surge Watch was issued from the Aucilla River westward to Indian Pass. This portion of the Storm Surge Watch was upgraded to a warning at 2100 UTC 3 August. The Storm Surge Warning was later extended southward from Aripeka to the middle of Longboat Key, including Tampa Bay, at 1500 UTC 4 August (Fig. 21).

Storm surge observations indicate that more than 3 ft of inundation (a first-cut threshold for storm surge watches/warnings) occurred east of the Aucilla River and south to the Anclote River. Based on the timing of when tropical-storm-force winds first reached the coast near the landfall location (0000 UTC 5 August), the lead time for the storm surge watch and warning in these areas was 51 h and 33 h, respectively.

In regards to the peak storm surge forecast, the initial forecast was 3 to 5 ft AGL from the Aucilla River southward to Aripeka (0900 UTC 3 August). The forecast was increased to 4 to 7 ft AGL (2100 UTC 3 August) and later to 6 to 10 ft AGL (0300 UTC 4 August) as the intensity forecast increased to 75 kt. The forecast 12 h later called for the peak intensity to reach 80 kt before landfall and further reinforced a peak storm surge forecast of 6 to 10 ft AGL. Based on in situ observations and a post-storm hindcast, the highest storm surge inundation levels were up to 6 ft AGL in these areas. The observed storm surge inundation levels are shown to be on the lower end of the predicted range, primarily due to the peak storm surge occurring between high tide cycles and the maximum intensity at landfall (70 kt) being lower than predicted.

On the U.S. East Coast, a Storm Surge Watch was issued along the Georgia coast from the Mouth of the St. Marys River to Altamaha Sound at 0900 UTC 4 August. The Storm Surge Watch was extended northward to the South Santee River, South Carolina, three hours later (Fig. 21). The entire area was upgraded to a warning at 2100 UTC 4 August. The peak storm surge forecast for this area was steady at 2 to 4 ft AGL. However, the observed storm surge inundation levels are shown to be on the lower end of the predicted range.

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

The NHC began communication with emergency managers on 2 August as Debby was developing near Cuba. In total, 19 decision support briefings were provided to emergency managers and coordinated through the FEMA Hurricane Liaison Team embedded at the NHC. These briefings included video-teleconferences with FEMA HQ, FEMA Regions 1, 2, 3, and 4, and the states of Florida, Georgia, South Carolina, and North Carolina. Briefing support continued through 8 August as Debby moved inland over the southeastern United States.

The NHC conducted 15 live stream broadcasts from 1–8 August that were promoted on NHC Facebook, Instagram, and X accounts. The media pool was activated from 4–6 August, and a total of 94 interviews (media pool and virtual; English and Spanish) were provided during the event. Key messages for Debby were included in NHC tropical cyclone discussions and on the NHC website from 2–9 August, beginning with the issuance of potential tropical cyclone advisories and continuing through Debby’s transition to an extratropical cyclone.

Beginning on 1 August, the Tropical Analysis and Forecast Branch (TAFB) of NHC provided a total of 14 live briefings on Debby to Districts 7 and 8 of the U.S. Coast Guard (USCG) in support of their life-saving mission. In addition, TAFB provided spot forecast support to USCG District 7 for a rescue mission of two adrift boaters aboard a disabled vessel offshore of Boca Grande, FL.[8]

[8] Coast Guard rescues 2 adrift boaters off Boca Grande during Tropical Storm Debby. *United States Coast Guard News*. 4 August 2024. https://www.news.uscg.mil/Press-Releases/article/3860964/coast-guard-rescues-2-adrift-boaters-off-boca-grande-during-tropical-storm-debby/

ACKNOWLEDGEMENTS

Data in Table 3 and damage summaries were compiled from Post Tropical Cyclone Reports issued by National Weather Service (NWS) Forecast Offices in Jacksonville, Key West, Melbourne, Miami, Tallahassee, and Tampa Bay, Florida; Peachtree City, Georgia; Charleston, South Carolina; Morehead City and Wilmington, North Carolina; and Wakefield, Virginia. Data from the National Data Buoy Center, NOS Center for Operational Oceanographic Products and Services, NOAA Weather Prediction Center, NOAA Storm Prediction Center, NWS Southeast River Forecast Center, and Environment and Climate Change Canada were also used in this report. David Roth (WPC) provided the U.S. rainfall graphic. Dr. Lisa Bucci (NHC) created the aircraft reconnaissance summary graphic, and Dr. Philippe Papin (NHC) created the Debby water vapor images and the Graphical TWO verification image. Nicole Rockwell (NWS Southeast River Forecast Center) compiled the data used to create the river flooding map. Michael Spagnolo (FEMA), Maria Torres (NHC Public Affairs), and Christina Rivero (NOAA Lapenta Intern) contributed to the IDSS and Public Communication section.

Table 1. Best track for Hurricane Debby, 3–8 August 2024.

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
02 / 1200	20.4	75.8	1012	25	disturbance
02 / 1800	20.6	77.5	1011	25	"
03 / 0000	20.9	78.9	1010	25	tropical depression
03 / 0600	21.5	80.2	1009	25	"
03 / 1200	22.2	81.5	1008	30	"
03 / 1800	23.1	82.6	1006	35	tropical storm
04 / 0000	23.9	83.2	1003	35	"
04 / 0600	25.0	83.8	1000	40	"
04 / 1200	26.2	84.3	994	50	"
04 / 1800	27.3	84.3	989	60	"
05 / 0000	28.3	84.1	986	70	hurricane
05 / 0600	29.1	83.9	980	70	"
05 / 1100	29.7	83.5	979	70	"
05 / 1200	29.9	83.4	982	65	"
05 / 1800	30.4	83.0	992	50	tropical storm
06 / 0000	30.8	82.3	996	45	"
06 / 0600	31.3	81.8	999	45	"
06 / 1200	31.8	81.4	999	40	"
06 / 1800	32.0	81.1	999	40	"
07 / 0000	31.9	80.4	997	40	subtropical storm
07 / 0600	31.8	79.7	995	45	"
07 / 1200	32.2	79.3	994	50	"

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
07 / 1800	32.5	79.2	994	50	"
08 / 0000	32.7	79.4	995	45	"
08 / 0600	33.0	79.6	995	40	"
08 / 1200	33.7	80.0	995	40	"
08 / 1800	34.6	80.3	997	40	"
09 / 0000	35.5	80.1	1000	30	extratropical
09 / 0600	37.0	79.7	1003	30	"
09 / 1200	40.3	78.9	1003	30	"
09 / 1800	42.8	76.5	998	30	"
10 / 0000	45.3	73.0	996	30	"
10 / 0600	47.8	69.1	998	30	"
10 / 1200	49.4	64.7	998	35	"
10 / 1800	50.0	59.5	999	35	"
11 / 0000					absorbed into frontal system
05 / 1100	29.7	83.5	979	70	maximum winds, minimum pressure, and landfall near Steinhatchee, FL
08 / 0600	33.0	79.6	995	40	Landfall near Bulls Bay, SC

Table 2. Selected ship reports with winds of at least 34 kt for Hurricane Debby. Note that the observation heights vary, and some reports may not be from the standard 10-meter height used to assess the maximum sustained wind speed.

Date/Time (UTC)	Ship call sign	Latitude (°N)	Longitude (°W)	Wind dir/ speed (kt)	Pressure (mb)
03 / 1400	C6PZ8	24.0	81.0	140 / 38	1010.2
04 / 0000	WABS	24.5	80.5	180 / 39	1011.5
04 / 0000	9HA567	25.2	79.5	120 / 35	
04 / 0200	BFUGCQ	25.9	78.0	130 / 35	1017.0
04 / 0400	C6ZJ3	24.5	80.7	160 / 50	1010.8
04 / 0400	WABS	25.3	79.9	150 / 36	1015.2
04 / 0500	C6ZJ3	24.9	80.2	230 / 40	1011.8
04 / 0900	C6PT7	23.9	80.7	180 / 40	1016.7
04 / 1000	C6PT7	23.8	81.0	140 / 40	1009.7
04 / 1200	C6PT7	23.5	81.6	140 / 38	1011.7
05 / 1200	C6XN6	29.2	78.1	170 / 35	1015.4
05 / 1400	WABS	29.8	80.3	140 / 36	1014.0
05 / 1800	WABS	29.8	80.3	170 / 41	1012.3
05 / 2100	WABS	29.6	80.3	170 / 41	1009.9
05 / 2300	WABS	29.5	80.3	180 / 50	1009.4
06 / 0000	WABS	29.4	80.3	160 / 41	1009.2
06 / 0400	WABS	29.2	80.2	280 / 40	1011.2
06 / 0400	5LRUZ9	30.8	78.3	140 / 36	1013.0
06 / 0600	C6CL6	32.6	78.2	140 / 35	1012.7
06 / 0900	C6CL6	32.6	77.7	130 / 35	1011.2
06 / 1500	WABS	29.2	80.0	200 / 35	1010.7
06 / 1500	C6CL6	32.5	76.6	130 / 35	1011.8
06 / 2000	C6CL6	32.6	75.8	150 / 35	1010.8
07 / 0900	C6CL6	31.6	75.2	170 / 39	1006.7
07 / 1000	C6CL6	31.5	75.2	160 / 42	1006.3
07 / 1100	C6CL6	31.4	75.2	140 / 40	1006.8
07 / 1500	C6CL6	31.1	75.2	180 / 35	1008.1

Table 3. Selected surface observations for Hurricane Debby, 3–8 August 2024. A more detailed list of observations from Debby can be found at: https://www.nhc.noaa.gov/data/tcr/supplemental/debby.zip

Location	Minimum Sea Level Pressure		Maximum Surface Wind Speed			Storm surge (ft)[b]	Storm tide (ft)[c]	Estimated Inundation (ft)[d]	Total rain (in)
	Date/ time (UTC)	Press. (mb)	Date/ time (UTC)[a]	Sustained (kt)	Gust (kt)				
Florida									
International Civil Aviation Organization (ICAO) Sites									
Sarasota – Bradenton Intl. Airport (KSRQ) (27.40N 82.56W)	04/2154	1005.4	05/0529	40 (10 m, 2 min)	56				11.73 [I]
St. Petersburg – Albert Whitted Airport (KSPG) (27.76N 82.63W)	04/2253	1003.8	05/0232	39 (8 m, 2 min)	55				4.00 [I]
Perry-Foley AP (KFPY) (30.07N 83.58W)	05/1255	985.4	05/1055	38 (10 m, 2 min)	54				
St. Pete – Clearwater Intl. Airport (KPIE) (27.91N 82.69W)	05/0034	1004.4	05/0143	35 (10 m, 2 min)	52				7.78
Venice Municipal AP (KVNC) (27.07N 82.44W)			04/2215	35 (10 m, 2 min)	45				
Key West NAS (KNQX) (24.58N 81.68W)			04/0936	34 (10 m, 2 min)	48				
Naples Municipal AP (KAPF) (26.15N 81.77W)			04/1038	32 (10 m, 2 min)	43				4.17
Key West Intl. Airport (KEYW) (24.56N 81.76W)			04/0325	32 (10 m, 2 min)	48				
Orlando Intl. Airport (KMCO) (28.43N 81.31W)			04/1613	30 (10 m, 2 min)	44				1.52
Gainesville Reg. AP (KGNV) (29.69N 82.28W)	05/1953	1003.5	05/0853	29 (10 m, 2 min)	46				6.96
Jacksonville NAS (KNIP) (30.23N 81.67W)	05/2253	1001.3	05/1253	29 (10 m, 2 min)	50				3.98
Jacksonville – Mayport Naval Station (KNRB) (30.40N 81.42W)	05/2352	1002.4	05/1452	28 (10 m, 2 min)	52				
Jacksonville Intl. AP (KJAX) (30.49N 81.69W)	05/2256	1000.4	05/2331	27 (10 m, 2 min)	50				5.27
Coastal-Marine Automated Network (C-MAN) Sites									
Sand Key (SANF1) (24.46N 81.88W)	03/2250	1006.9	04/1001	46 (15 m)	50				
Venice (VENF1) (27.07N 82.45W)	04/2200	1006.7	04/2350	41 (12 m)	55				
St. Augustine (SAUF1) (29.86N 81.27W)	07/2200	1002.3	05/1500	36 (8 m)	44				
National Ocean Service (NOS) Sites									
Cedar Key (CKYF1) (29.13N 83.03W)	05/0918	996.7	05/1006	45 (4 m, 2 min)	58	6.11	6.19	4.65	

Location	Minimum Sea Level Pressure		Maximum Surface Wind Speed			Storm surge (ft)[b]	Storm tide (ft)[c]	Estimated Inundation (ft)[d]	Total rain (in)
	Date/ time (UTC)	Press. (mb)	Date/ time (UTC)[a]	Sustained (kt)	Gust (kt)				
Clearwater Beach (CWBF1) (27.98N 82.83W)	05/0012	1002.7	05/0306	40 (7 m, 2 min)	55	3.41	3.41	2.46	
Middle Tampa Bay (MTBF1) (27.66N 82.60W)	04/2248	1004.3	05/0642	38 (7 m, 8 min)	48				
St. Petersburg (SAPF1) (27.76N 82.63W)	04/2318	1005.4	05/0348	37 (7 m, 2 min)	47	3.75	3.4	2.62	
TPA Cruise Terminal 2 (TPAF1) (27.94N 82.44W)			05/0912	35 (23 m, 2 min)	53				
Old Port Tampa (OPTF1) (27.86N 82.55W)	04/2312	1005.3	05/0536	34 (7 m, 2 min)	44	4.22	3.76	2.97	
Key West (KYWF1) (24.55N 81.81W)	04/0000	1008.5	04/0800	30 (17 m)	43	0.88	1.09	1.05	
Fort Myers (FMRF1) (26.65N 81.87W)	04/1024	1009.1	04/1636	24 (8 m)	36	3.06	3.54	3.27	
Apalachicola (APCF1) (29.72N 84.98W)	05/0812	1003.9	05/0554	23 (9 m)	31	2.09	2.82	1.96	
North Naples Bay (NBNF1) (26.14N 81.79W)						3.3	3.8	3.11	
East Bay (EBEF1) (27.92N 82.42W)						4.4	3.82	2.97	
Port Manatee (PMAF1) (27.64N 82.56W)						3.38	3.0	2.42	
WeatherFlow Sites									
Egmont Channel (XEGM) (27.61N 82.76W)	04/2134	1002.0	05/0114	47 (12 m, 1 min)	56				
Alligator Reef Light (XALG) (24.85N 80.62W)			04/2045	42 (7.5 m, 5 min)	52				
Skyway Fishing Pier (XSKY) (27.60N 82.65W)	04/2236	1006.0	04/2331	40 (16 m, 1 min)	61				
Jax Beach Pier (XJAX) (30.29N 81.39W)	06/0221	999.9	05/1531	37 (12 m, 1 min)	46				
Sarasota Bay Marker 17 (XSRB) (27.34N 82.57W)	04/2340	1006	05/0120	36 (5 m, 1 min)	49				
Clam Bayou Nature Park (XCBN) (27.74N 82.69W)	04/2233	1004	04/2358	36 (10 m, 1 min)	50				
Dunedin Causeway (XDUN) (28.05N 82.81W)	05/0023	1004	05/0123	36 (6 m, 1 min)	47				
Jacksonville (XJAK) (30.39N 81.48W)	05/2358	999.7	05/1523	34 (10 m, 1 min)	44				
WeatherSTEM Sites									
Mayo – Lafayette HS (30.05N 83.17W)			05/1351	(15 m)	61				
Madison – Madison Co. HS (30.48N 83.45W)			05/1247		56				
United States Geological Survey (USGS) Streamgages									

Location	Minimum Sea Level Pressure		Maximum Surface Wind Speed			Storm surge (ft)[b]	Storm tide (ft)[c]	Estimated Inundation (ft)[d]	Total rain (in)
	Date/ time (UTC)	Press. (mb)	Date/ time (UTC)[a]	Sustained (kt)	Gust (kt)				
Crystal River (SISF1) (28.93N 82.69W)							5.4	4.05	
Homosassa River at Shell Island (2310712) (28.77N 82.69W)							4.9	3.9	
Steinhatchee River (STIF1) (29.67N 83.38W)							5.38	3.76	
Crystal River (CKBF1) (28.89N 82.60W)							4.9	3.75	
Chassahowitzka River (CHMF1) (28.69N 82.64W)							4.74	3.41	
Spring Creek (SBIF1) (30.07N 84.33W)							3.9	2.26	
Public/Other									
Steinhatchee (iCyclone) (29.67N 83.37W)	05/1044	982.2							
Other Sites									
HUD-2 Arlington St (530, Sarasota Co.) (27.32N 82.53W)									16.98
Manatee River at Rye (RYEF1) (27.51N 82.37W)									15.84
PH-14 BoB (416, Sarasota Co.) (27.35N 82.40W)									15.09
PH-1 Hidden Forest (410, Sarasota Co.) (27.37N 82.49W)									14.91
Lake Manatee at Verna Bethany Rd (MCRG43) (27.47N 82.27W)									14.81
Georgia									
International Civil Aviation Organization (ICAO) Sites									
Valdosta Reg. AP (KVLD) (30.78N 83.27W)	05/1855	999.3	05/2014	38 (10 m, 2 min)	50				
St. Simons Island AP (KSSI) (31.15N 81.39W)			05/2315	32 (10 m, 2 min)	45				
Savannah – Hilton Head Intl. AP (KSAV) (32.13N 81.20W)	06/2053	999.2	05/2325	31 (10 m, 2 min)	48				10.69
National Ocean Service (NOS) Sites									
Fort Pulaski (FPKG1) (32.03N 80.90W)	06/2106	998.7	05/2254	36 (6.5 m, 8 min)	46	3.29	5.12	1.67	

Location	Minimum Sea Level Pressure		Maximum Surface Wind Speed			Storm surge (ft)[b]	Storm tide (ft)[c]	Estimated Inundation (ft)[d]	Total rain (in)
	Date/ time (UTC)	Press. (mb)	Date/ time (UTC)[a]	Sustained (kt)	Gust (kt)				
Kings Bay (KBMG1) (30.78N 81.49W)								0.64	
WeatherFlow Sites									
Jekyll Island (XJEK) (31.05N 81.41W)	06/0607	999.1	05/2327	40 (10 m, 1 min)	49				
Tybee South (XTYE) (31.99N 80.85W)	06/2251	996.7	05/2031	39 (9 m, 1 min)	48				
Tybee North (XTYB) (32.02N 80.84W)	06/2111	997.0	05/2026	31 (10 m, 1 min)	44				
Other Sites									
Oliver 1.4 ESE (GA-JK-5) (32.51N 81.51W)									14.85
Glennville (UGA88) (31.98N 81.92W)									13.76
Rincon 5.3 NNE (GA-EF-18) (32.36N 81.21W)									13.72
Rocky Ford 4 SE (RCFG1) (32.63N 81.77W)									13.38
Bellville 2.8 N (GA-EV-1) (32.19N 81.97W)									12.36
South Carolina									
International Civil Aviation Organization (ICAO) Sites									
North Myrtle Beach - Grand Strand AP (KCRE) (33.82N 78.72W)	08/0953	997.3	08/1827	26 (10 m, 2 min)	42				8.78
Beaufort MCAS (KNBC) (32.48N 80.72W)	07/2156	998.9	06/0523	23 (10 m, 2 min)	42				9.17
Charleston (KCHS) (32.90N 80.04W)	07/2256	996.3	06/1005	22 (10 m, 2 min)	45				12.84
National Ocean Service (NOS) Sites									
Springmaid Pier (MROS1) (33.66N 78.92W)	08/0948	996.2	08/2048	37 (7 m, 8 min)	43	2.15	3.4	0.95	
Charleston – Cooper River Entrance (CHTS1) (32.77N 79.92W)	07/2236	996.4	06/0948	36 (16 m)	41	1.9	3.68	1.05	
WeatherFlow Sites									
Charleston (XCHA) (32.76N 79.95W)	07/2235	994.6	06/0415	36 (10 m, 1 min)	52				
Winyah Bay (XWIN) (33.19N 79.18W)	07/2243	994.5	06/1010	35 (15 m, 1 min)	46				
Isle of Palms Pier (XIOP) (32.78N 79.79W)	07/2229	994.4	06/0434	35 (8 m, 1 min)	48				

Location	Minimum Sea Level Pressure		Maximum Surface Wind Speed			Storm surge (ft)[b]	Storm tide (ft)[c]	Estimated Inundation (ft)[d]	Total rain (in)
	Date/ time (UTC)	Press. (mb)	Date/ time (UTC)[a]	Sustained (kt)	Gust (kt)				
Fort Sumter Range Front Light (XSUM) (32.75N 79.87W)	07/2232	994.7	06/0947	34 (12 m, 1 min)	41				
Shutes Folly (XSHF) (32.77N 79.91W)	07/2106	994.0	06/0951	34 (13 m, 1 min)	45				
Murrells Inlet (XMUR) (33.52N 79.03W)	08/0938	994.6	06/1008	33 (7 m, 1 min)	41				
Georgetown (XGEO) (33.37N 79.27W)	07/2137	993.5	06/1227	23 (10 m, 1 min)	37				
Other Sites									
Moncks Corner 6.6 SW (SC-BK-109) (33.14N 80.09W)									22.02
Saint George (G4000) (33.18N 80.56W)									19.51
North Charleston (G4091) (32.91N 80.10W)									19.06
Waccamaw River (ACWS1) (33.85N 78.90W)									19.03
Ridgeville 3.2 WSW (SC-DC-69) (33.07N 80.36W)									18.86
North Carolina									
International Civil Aviation Organization (ICAO) Sites									
Lumberton Mun. AP (KLBT) (34.61N 79.06W)	08/0956	997.8	08/0219	27 (10 m, 2 min)	40				5.71
Wilmington Intl. AP (KILM) (34.27N 77.90W)	08/0753	1001.1	08/1057	26 (10 m, 2 min)	44				9.24
Coastal-Marine Automated Network (C-MAN) Sites									
Cape Lookout (CLKN7) (34.62N 76.52W)	08/0800	1005.8	08/1730	39 (10 m, 10 min)	51				
Masonboro Island (MBIN7) (34.09N 77.87W)	08/0836	999.3	08/0700	32 (3 m)	44				
National Ocean Service (NOS) Sites									
Wrightsville Beach (JMPN7) (34.21N 77.79W)	08/0900	1000.6	08/0718	36 (8 m, 8 min)	45	1.66	2.72	0.99	
Beaufort (BFTN7) (34.72N 76.67W)	08/0736	1004.9	08/1242	29 (7 m, 8 min)	43	1.51	2.55	1.09	
Wilmington (WLON7) (34.23N 77.95W)						2.38	3.65	1.56	
Oregon Inlet Marina (ORIN7) (35.79N 75.55W)						1.54	1.6	1.12	
WeatherFlow Sites									

Location	Minimum Sea Level Pressure		Maximum Surface Wind Speed			Storm surge (ft)[b]	Storm tide (ft)[c]	Estimated Inundation (ft)[d]	Total rain (in)
	Date/ time (UTC)	Press. (mb)	Date/ time (UTC)[a]	Sustained (kt)	Gust (kt)				
Oak Island (XOKI) (33.91N 78.12W)	08/0603	997.8	08/1908	31 (10 m, 1 min)	38				
Lockwoods Folly Inlet (XLOC) (33.92N 78.22W)	08/0744	998.2	08/0259	30 (8 m, 1 min)	38				
United States Geological Survey (USGS) Streamgages									
Pamlico River at Washington (2084472) (35.54N 77.06W)							2.72	2.6	
Other Sites									
Leland (GW2239) (34.24N 77.99W)									15.75
Shallotte Fire Station (33.97N 78.38W)									15.27
Lumber River State Park (LRPN7) (34.39N 79.00W)									14.60
Leland 5.7 WSW (NC-BR-2) (34.20N 78.09W)									13.92
Calabash 1.9 NNE (NC-BR-1) (33.92N 78.57W)									13.87
Offshore									
NOAA Buoys									
42036 – West Tampa (28.50N 84.52W)	05/0140	997.3	05/0111	44 (3.8 m, 1 min)	53				
41004 – Edisto (32.50N 79.10W)	07/2220	994.8	06/0533	44 (3.7 m, 1 min)	51				
41008 – Grays Reef (31.40N 80.87W)	06/2340	998.1	06/0406	39 (3.4 m, 1 min)	45				
41013 – Frying Pan Shoals (33.44N 77.76W)	07/2220	999.6	06/1349	35 (3.8 m, 1 min)	40				
USF Coastal Ocean Monitoring and Prediction System (COMPS) Buoys									
42013 – C10 Central Buoy (27.17N 82.92W)	04/2235	1004.6	04/1405	39 (3 m)	54				
42023 – C13 South Buoy (26.01N 83.09W)	04/1035	1003.2	04/1035	37 (3 m)	49				
42026 – C22 Loop Current (25.17N 83.48W)	04/0735	1000.5	04/1635	25 (3 m)	37				
UNC-W Coastal Ocean Research and Monitoring Program (CORMP) Buoys									
41066 – Charleston (32.54N 79.66W)	07/2308	995.3	06/0408	33 (3 m, 8 min)	45				

Location	Minimum Sea Level Pressure		Maximum Surface Wind Speed			Storm surge (ft)[b]	Storm tide (ft)[c]	Estimated Inundation (ft)[d]	Total rain (in)
	Date/ time (UTC)	Press. (mb)	Date/ time (UTC)[a]	Sustained (kt)	Gust (kt)				
41029 – Capers Nearshore (32.80N 79.62W)	07/2208	995.1	06/0908	29 (3 m, 8 min)	39				
41033 – Fripp Nearshore (32.28N 80.41W)	08/0308	996.8	06/0208	29 (3 m, 8 min)	43				
41024 – Sunset Nearshore (33.84N 78.48W)	08/1108	997.2	07/1408	29 (3 m, 8 min)	41				

[a] Date/time is for sustained wind when both sustained and gust are listed.
[b] Storm surge is water height above normal astronomical tide level.
[c] For most locations, storm tide is water height above the North American Vertical Datum of 1988 (NAVD88). Storm tide is water height above Mean Lower Low Water (MLLW) for NOS stations in Puerto Rico, the U.S. Virgin Islands, and Barbados.
[d] Estimated inundation is the maximum height of water above ground. For some USGS storm tide pressure sensors, inundation is estimated by subtracting the elevation of the sensor from the recorded storm tide. For other USGS storm tide sensors and USGS high-water marks, inundation is estimated by subtracting the elevation of the land derived from a Digital Elevation Model (DEM) from the recorded and measured storm tide. For NOS tide gauges, the height of the water above Mean Higher High Water (MHHW) is used as a proxy for inundation.
[I] Incomplete

Table 4. Number of hours in advance of formation of Debby 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%)	42	174
Medium (40%-60%)	24	144
High (>60%)	6	30

Table 5a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) track forecast errors (n mi) for Hurricane Debby, 3–8 August 2024. 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	**17.9**	**19.8**	**28.7**	**35.8**	**46.6**	**54.1**	**64.0**	**51.1**
OCD5	43.0	95.9	160.2	229.7	298.3	351.8	386.8	405.9
Forecasts	22	20	18	16	14	12	8	4
OFCL (2019-23)	23.9	36.5	49.3	63.4	79.2	93.4	132.9	190.4
OCD5 (2019-23)	45.7	97.1	153.0	205.4	254.9	297.8	372.7	439.1

Table 5b. Homogeneous comparison of selected track forecast guidance models (in n mi) for Hurricane Debby, 3–8 August 2024. Errors smaller than the NHC official forecast are shown in boldface type. The number of official forecasts shown here will generally be smaller than that shown in Table 5a due to the homogeneity requirement.

Model ID	Forecast Period (h)							
	12	24	36	48	60	72	96	120
OFCL	17.6	18.6	28.8	37.6	50.2	58.1	69.4	66.1
OCD5	42.9	94.3	156.2	221.8	286.6	335.1	347.5	328.2
GFSI	20.4	39.9	55.3	72.9	92.2	104.9	123.9	112.4
HWFI	20.1	31.6	59.5	96.8	143.5	197.9	278.7	270.4
HMNI	22.2	26.1	34.2	38.2	53.6	60.9	76.3	82.2
HFAI	23.6	38.1	55.6	72.0	91.5	114.1	145.8	82.7
HFBI	22.8	33.7	48.7	68.0	89.7	110.8	152.9	98.8
EMXI	**14.5**	**17.0**	**23.3**	**29.6**	**41.7**	**46.5**	**69.0**	96.1
NVGI	20.8	30.5	43.3	61.5	78.0	92.2	117.7	**44.0**
CMCI	19.0	29.8	46.2	61.2	84.4	107.9	160.9	126.3
CTCI	**15.5**	19.2	**27.2**	**32.3**	**42.9**	**48.4**	**62.0**	136.9
TVCA	17.9	22.9	32.6	43.6	60.1	71.9	86.8	**53.8**
TVCX	**17.0**	21.3	30.7	40.8	56.6	67.9	81.6	**55.9**
GFEX	**16.8**	25.5	33.7	44.3	56.5	63.9	78.1	100.6
TVDG	**17.4**	22.7	32.0	43.0	56.8	65.0	73.9	**57.9**
HCCA	**16.4**	19.8	31.8	42.7	59.7	71.8	91.4	72.1
AEMI	22.7	36.8	47.7	60.6	77.8	85.7	116.5	129.8
TABS	32.9	64.8	96.1	127.3	160.4	193.1	188.2	117.8
TABM	29.3	45.4	69.7	95.8	131.0	164.0	153.2	112.7
TABD	25.7	30.9	38.9	45.3	62.9	79.0	95.1	201.4
Forecasts	21	19	17	15	13	11	7	3

Table 6a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) intensity forecast errors (kt) for Hurricane Debby, 3–8 August 2024. 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	5.0	**6.0**	**8.1**	**6.9**	**4.6**	**5.4**	**4.4**	**12.5**
OCD5	7.4	10.9	12.5	14.7	11.4	12.8	14.1	9.8
Forecasts	22	20	18	16	14	12	8	4
OFCL (2019-23)	5.0	7.3	8.5	9.7	10.4	10.9	12.9	15.5
OCD5 (2019-23)	6.6	10.2	13.1	15.6	17.2	18.6	21.8	22.6

Table 6b. Homogeneous comparison of selected intensity forecast guidance models (in kt) for Hurricane Debby, 3–8 August 2024. 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 6a due to the homogeneity requirement.

Model ID	Forecast Period (h)							
	12	24	36	48	60	72	96	120
OFCL	5.2	6.3	8.2	6.3	4.6	5.5	4.3	13.3
OCD5	7.7	11.4	12.8	14.1	11.4	12.8	13.0	**10.7**
HWFI	5.8	6.4	**7.9**	8.0	7.4	8.3	7.1	**9.7**
HMNI	7.3	8.9	10.9	8.9	7.1	8.0	11.9	**4.0**
HFAI	5.8	6.7	**6.4**	**5.5**	**4.5**	**4.3**	**4.1**	**4.0**
HFBI	**5.0**	6.8	**6.8**	6.7	5.1	5.7	6.4	**2.3**
DSHP	6.1	**5.7**	9.6	8.1	8.6	11.5	15.1	**9.3**
LGEM	6.9	7.1	11.6	10.1	8.2	9.8	7.7	**5.3**
ICON	5.8	**5.9**	**8.1**	8.2	7.5	8.2	9.7	**3.3**
IVCN	5.2	**5.2**	**6.5**	**5.9**	**4.4**	5.7	7.0	**1.0**
IVDR	5.2	**5.6**	**6.6**	**5.7**	**3.7**	**5.0**	5.9	**0.7**
CTCI	**5.1**	7.1	8.4	8.2	4.9	**4.5**	**3.3**	**8.3**
GFSI	5.4	7.3	**8.0**	7.6	5.8	6.5	4.7	**9.7**
EMXI	8.1	11.0	12.5	10.0	7.3	7.0	**2.9**	**7.3**
HCCA	**4.6**	**3.7**	**5.4**	**5.0**	**4.0**	**5.1**	**3.7**	**8.0**
Forecasts	21	19	17	15	13	11	7	3

Table 7. Watch and warning summary for Hurricane Debby, including those issued with potential tropical cyclone advisories before Debby formed.

Date/Time (UTC)	Action	Location
2 / 1500	Tropical Storm Watch issued	Aripeka to Bonita Beach, FL
2 / 1500	Tropical Storm Watch issued	East Cape Sable to Card Sound Bridge, FL
2 / 1500	Tropical Storm Watch issued	Florida Keys south of Card Sound Bridge, including Dry Tortugas
2 / 1500	Tropical Storm Warning issued	Bonita Beach to East Cape Sable, FL
2 / 2100	Tropical Storm Watch modified to	Suwannee River to Boca Grande, FL
2 / 2100	Tropical Storm Warning modified to	Boca Grande to East Cape Sable, FL
3 / 0300	Tropical Storm Warning issued	Dry Tortugas
3 / 0900	Tropical Storm Watch discontinued	Florida Keys north of the Channel 5 Bridge
3 / 0900	Tropical Storm Watch discontinued	East Cape Sable to Card Sound Bridge, FL
3 / 0900	Tropical Storm Watch modified to	Key West to Channel 5 Bridge
3 / 0900	Tropical Storm Watch issued	Ochlockonee River to Aucilla River, FL
3 / 0900	Tropical Storm Warning modified to	Yankeetown to East Cape Sable, FL
3 / 0900	Hurricane Watch issued	Aucilla River to Yankeetown, FL
3 / 1500	Hurricane Watch modified to	Indian Pass to Yankeetown, FL
3 / 1800	Tropical Storm Warning issued	Florida Keys west of the Seven Mile Bridge
3 / 2100	Tropical Storm Watch issued	Mexico Beach to Indian Pass, FL
3 / 2100	Tropical Storm Warning modified to	Suwannee River to East Cape Sable, FL
3 / 2100	Tropical Storm Warning issued	Indian Pass to Ochlockonee River, FL
3 / 2100	Hurricane Warning issued	Ochlockonee River to Suwannee River, FL
4 / 0900	Tropical Storm Watch issued	FL/GA Border to Altamaha Sound, GA
4 / 1200	Tropical Storm Watch modified to	FL/GA Border to South Santee River, SC

Date/Time (UTC)	Action	Location
4 / 1500	Tropical Storm Warning and Tropical Storm Watch discontinued	Florida Keys
4 / 2100	Tropical Storm Watch changed to Tropical Storm Warning	Mexico Beach to Indian Pass
4 / 2100	Tropical Storm Warning modified to	Suwannee River to Bonita Beach, FL
4 / 2100	Tropical Storm Warning discontinued	Dry Tortugas
4 / 2100	Tropical Storm Warning issued	Ponte Vedra Beach, FL to Savannah River, GA
4 / 2100	Hurricane Warning modified to	Indian Pass to Suwannee River, FL
5 / 0300	Tropical Storm Warning modified to	Yankeetown to Boca Grande, FL
5 / 0300	Tropical Storm Warning modified to	Ponte Vedra Beach, FL to South Santee River, SC
5 / 0300	Hurricane Warning modified to	Indian Pass to Yankeetown, FL
5 / 1500	Tropical Storm Warning modified to	Indian Pass to Longboat Key, FL
5 / 1500	Hurricane Warning discontinued	Indian Pass to Yankeetown, FL
5 / 1800	Tropical Storm Warning modified to	Indian Pass to Aripeka, FL
5 / 2100	Tropical Storm Watch issued	South Santee River, SC to Cape Fear, NC
5 / 2100	Tropical Storm Warning discontinued	Indian Pass to Aripeka, FL
6 / 0300	Tropical Storm Watch modified to	Little River Inlet, SC to Cape Fear, NC
6 / 0300	Tropical Storm Warning modified to	Ponte Vedra Beach, FL to Little River Inlet, SC
6 / 0900	Tropical Storm Watch modified to	Little River Inlet, SC to Surf City, NC
6 / 1200	Tropical Storm Warning modified to	Altamaha Sound, GA to Little River Inlet, SC
6 / 1500	Tropical Storm Watch modified to	Surf City to Beaufort Inlet, NC
6 / 1500	Tropical Storm Warning modified to	Altamaha Sound, GA to Surf City, NC
7 / 0300	Tropical Storm Warning modified to	Savannah River, GA to Surf City, NC
8 / 0300	Tropical Storm Warning modified to	Edisto Beach, SC to Surf City, NC

Date/Time (UTC)	Action	Location
8 / 0900	Tropical Storm Warning modified to	South Santee River, SC to Ocracoke Inlet, NC
8 / 1500	Tropical Storm Warning modified to	Murrells Inlet, SC to Ocracoke Inlet, NC
8 / 1800	Tropical Storm Warning modified to	Surf City to Ocracoke Inlet, NC
8 / 2100	Tropical Storm Warning discontinued	All

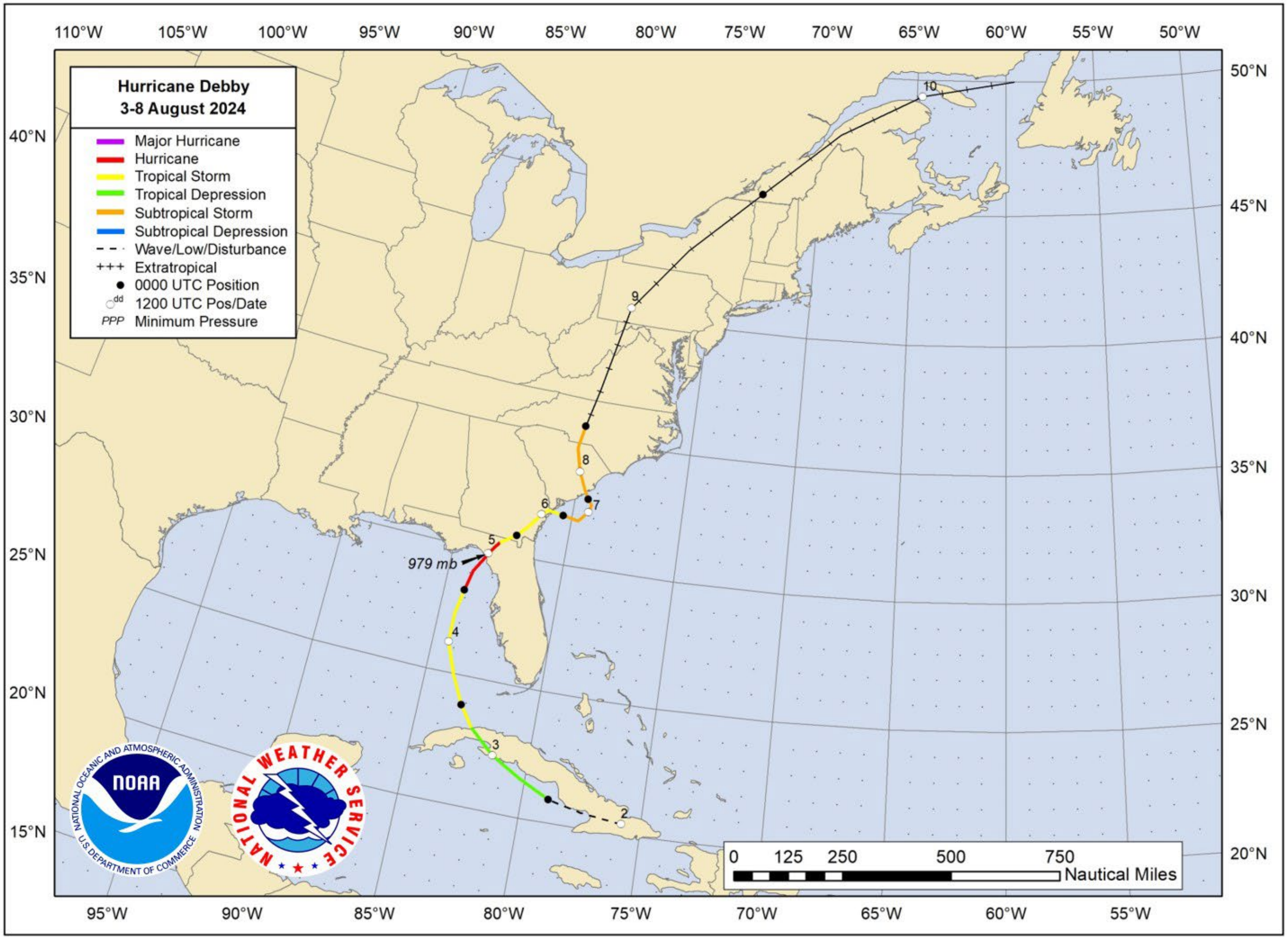

Figure 1. Best track positions for Hurricane Debby, 3–8 August 2024. Tracks over the United States and during the extratropical stage are partially based on analyses from the NOAA Weather Prediction Center and the NOAA Ocean Prediction Center.

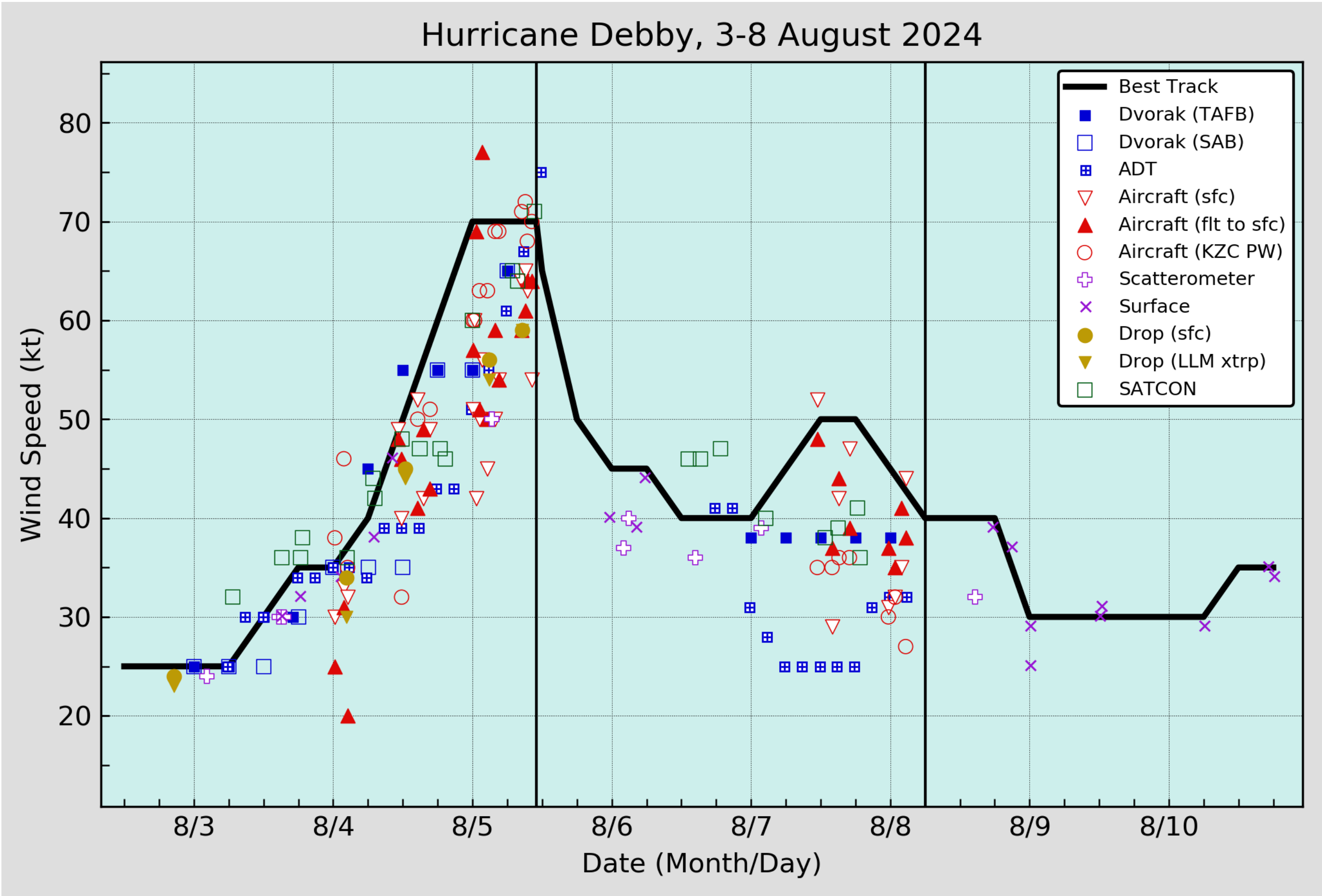

Figure 2. Selected wind observations and best track maximum sustained surface wind speed curve for Hurricane Debby, 3–8 August 2024. Aircraft observations have been adjusted for elevation using 90%, 80%, and 75% adjustment factors for observations from 700 mb, 850 mb, and 925 mb, respectively. Dropwindsonde observations include actual 10 m winds (sfc), as well as surface estimates derived from the mean wind over the lowest 150 m of the wind sounding (LLM). 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.

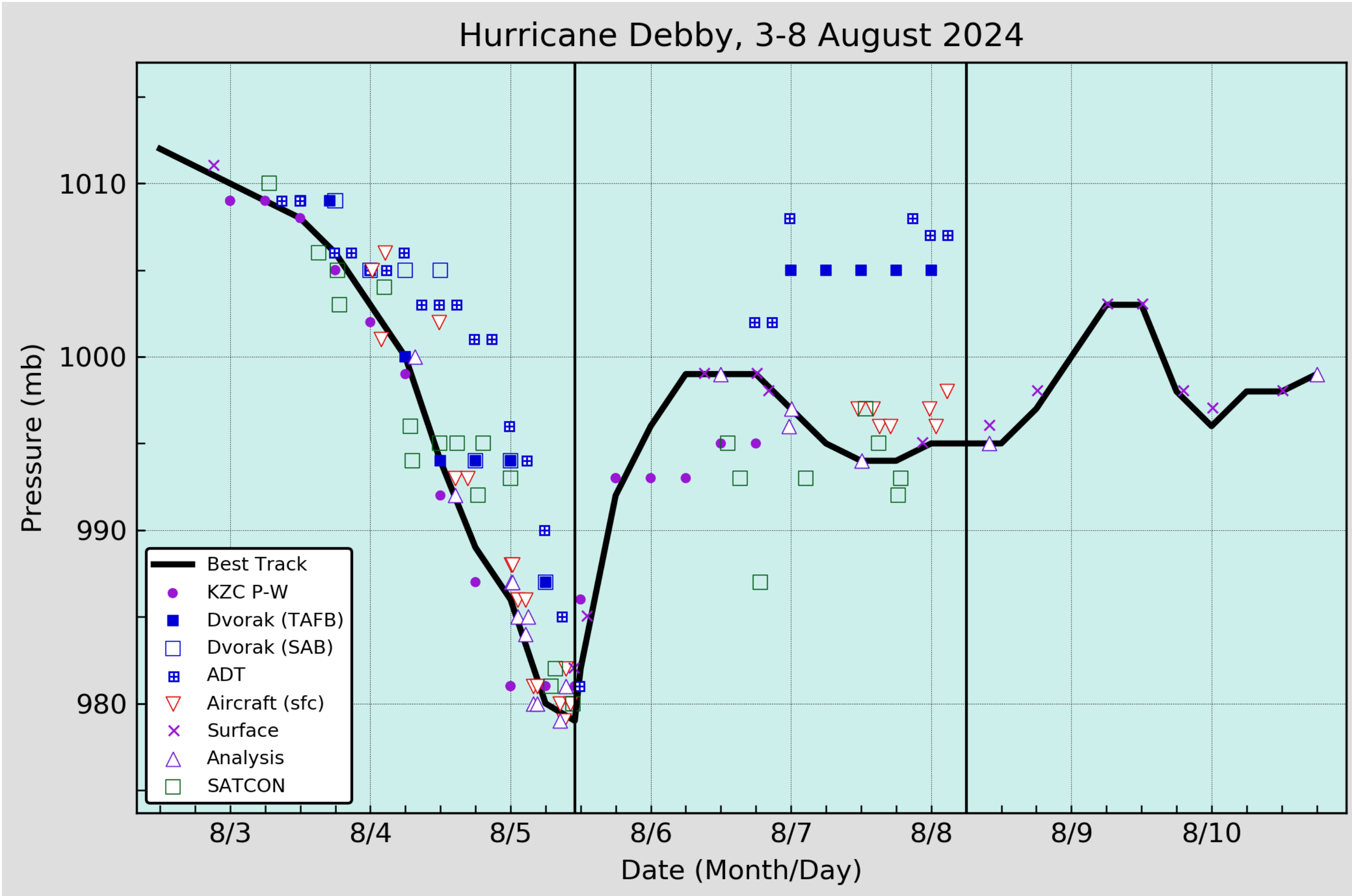

Figure 3. Selected pressure observations and best track minimum central pressure curve for Hurricane Debby, 3–8 August 2024. Advanced Dvorak Technique estimates represent the Current Intensity at the nominal observation time. SATCON intensity estimates are from the Cooperative Institute for Meteorological 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.

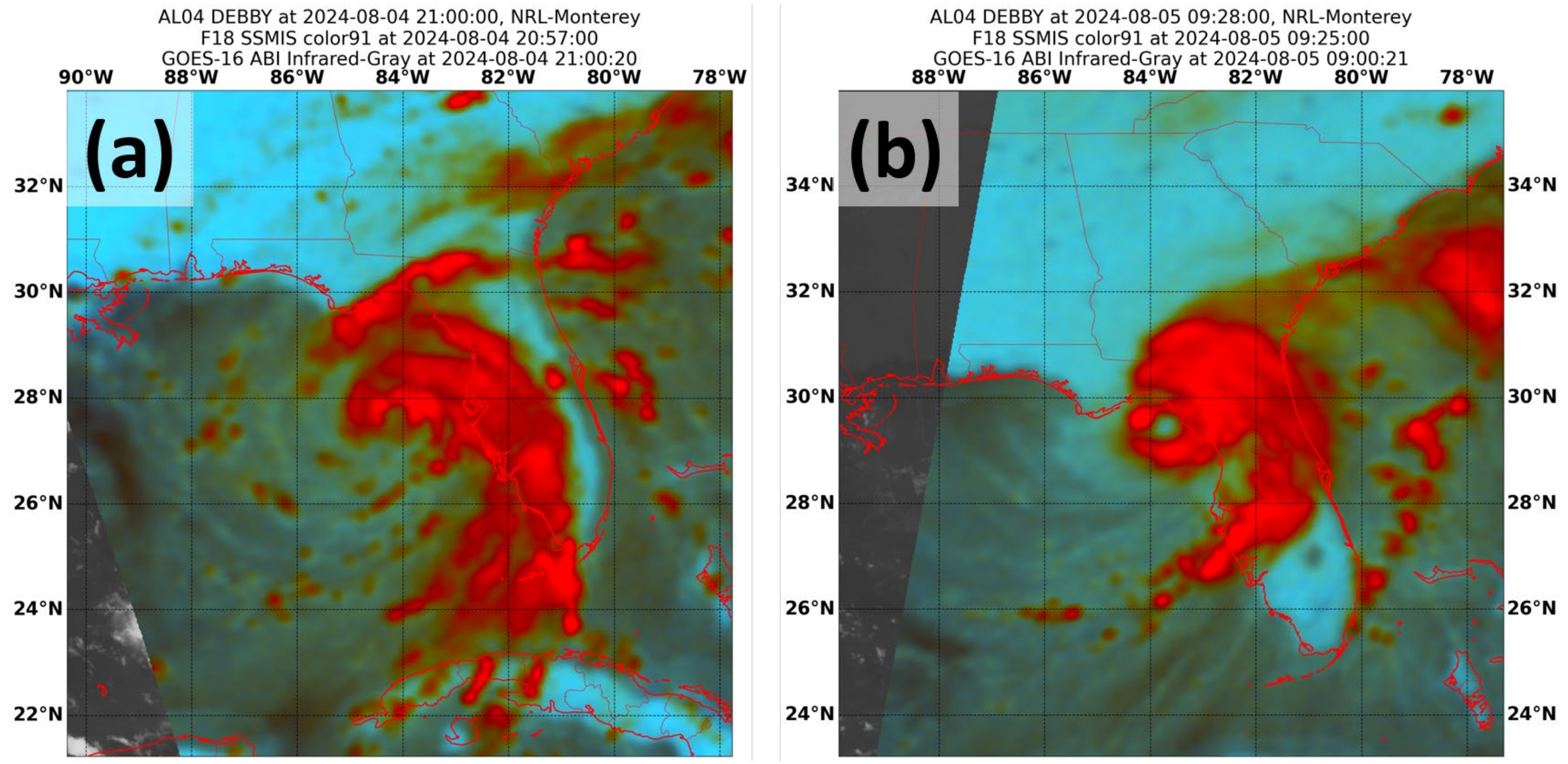

Figure 4. (a) SSMIS 91-GHz color composite image of Tropical Storm Debby at 2057 UTC 4 August, showing a formative mid-level eye feature. (b) SSMIS 91-GHz color composite image of Hurricane Debby at 0925 UTC 5 August, shortly before it made landfall near Steinhatchee along the Florida Gulf Coast.

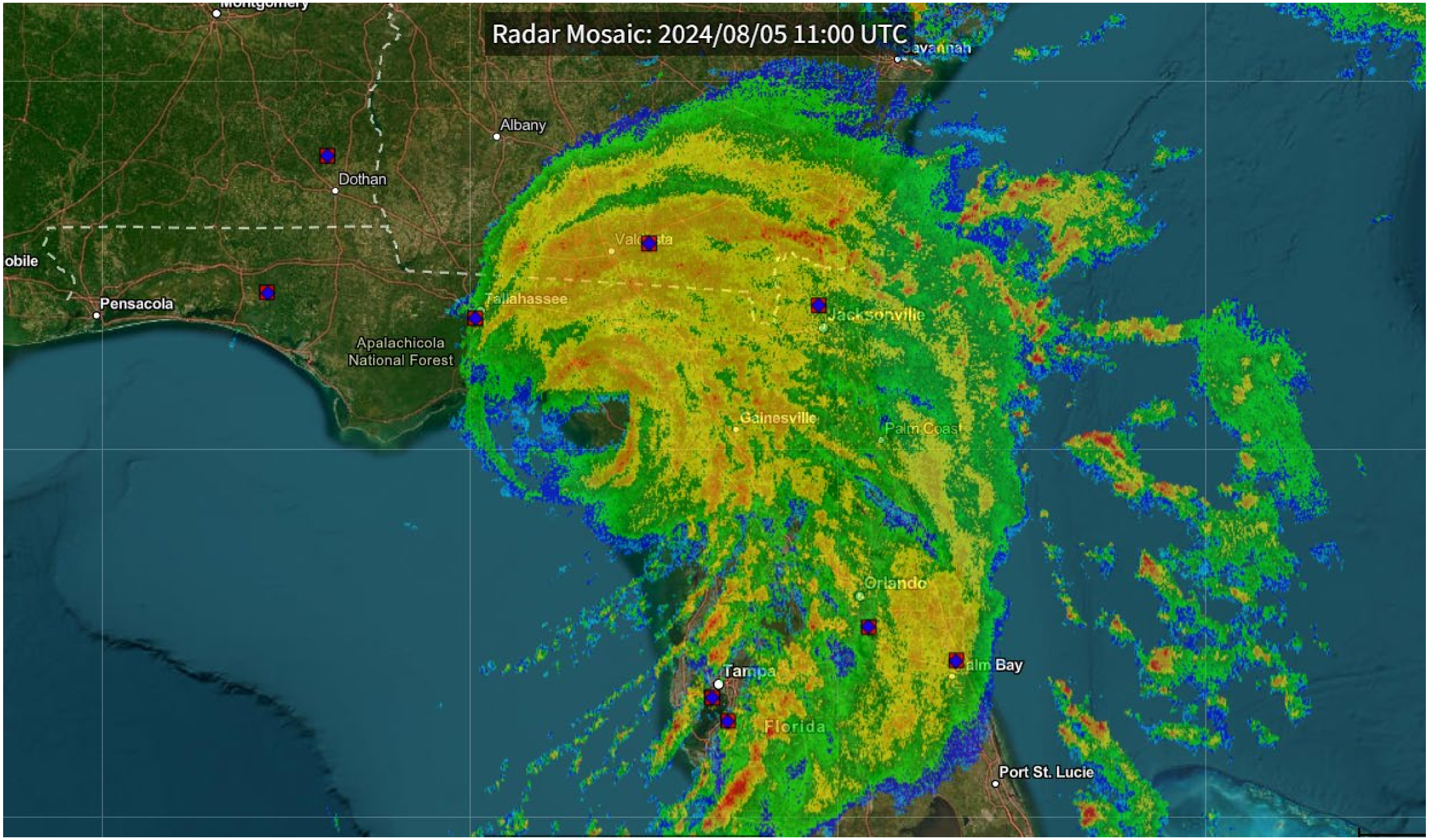

Figure 5. National radar reflectivity mosaic of Hurricane Debby at 1100 UTC 5 August, near the time of landfall in the Florida Big Bend. Image courtesy of NOAA/NCEI radar data page (https://www.ncei.noaa.gov/maps/radar/).

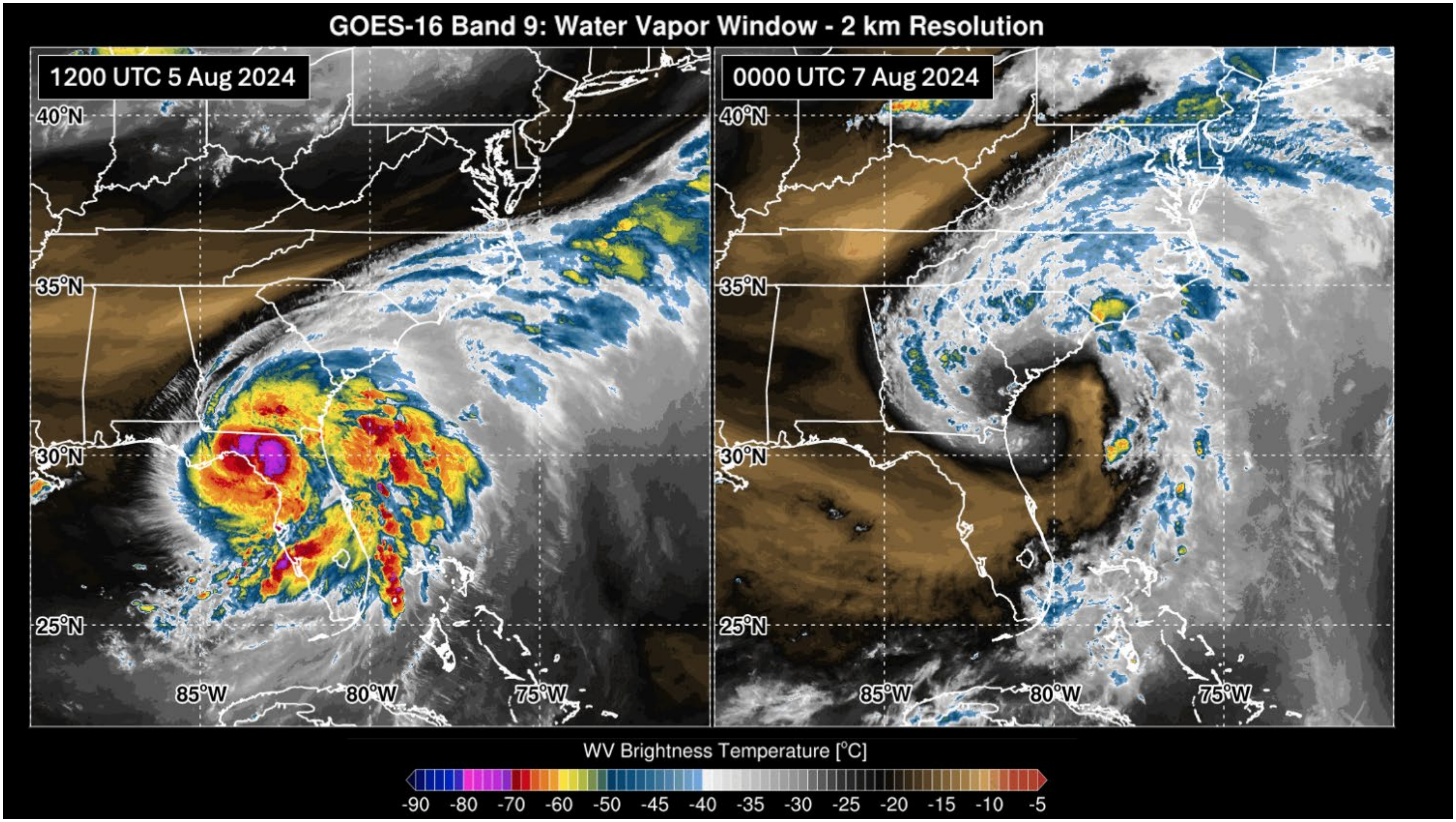

Figure 6. (Left) GOES-East water vapor image of Hurricane Debby at 1200 UTC 5 August 2024, shortly after landfall in the Florida Big Bend. (Right) Water vapor image of Subtropical Storm Debby at 0000 UTC 7 August 2024, showing a lack of central convection with a pronounced dry slot wrapping around the center of the storm.

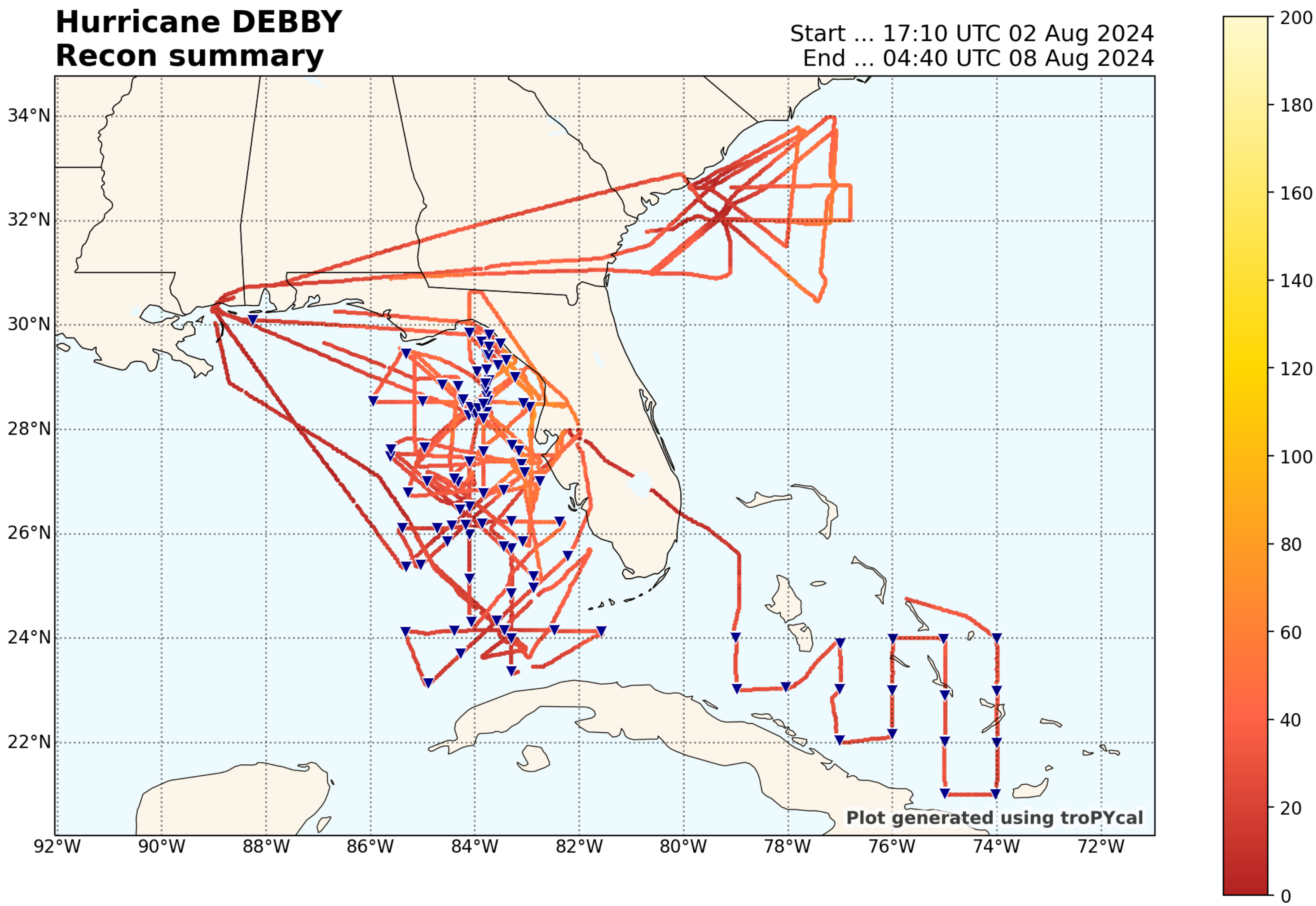

Figure 7. Air Force Reserve and NOAA Hurricane Hunter aircraft flight tracks (colored lines) from reconnaissance missions into Debby from 2–8 August 2024. The blue triangles indicate dropsonde locations. The color of the flight track represents the observed flight-level wind speed in knots at that location (see legend).

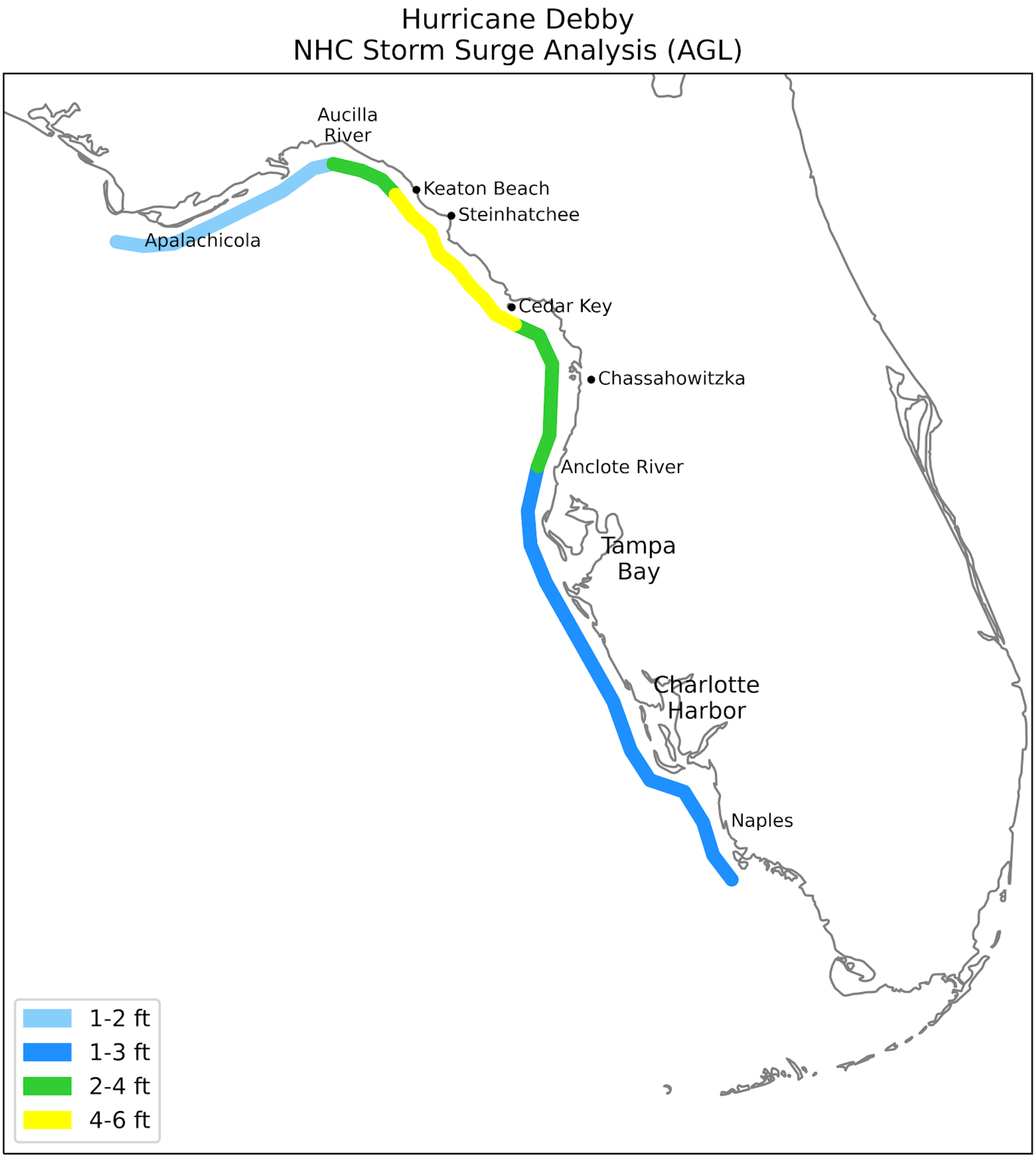

Figure 8. Analyzed storm surge inundation (feet above ground level) along the Florida Gulf coast from Hurricane Debby.

Figure 9. Storm surge from Hurricane Debby on 5 August in Cedar Key, Florida. Photo credit: Joe Raedle/Getty Images.

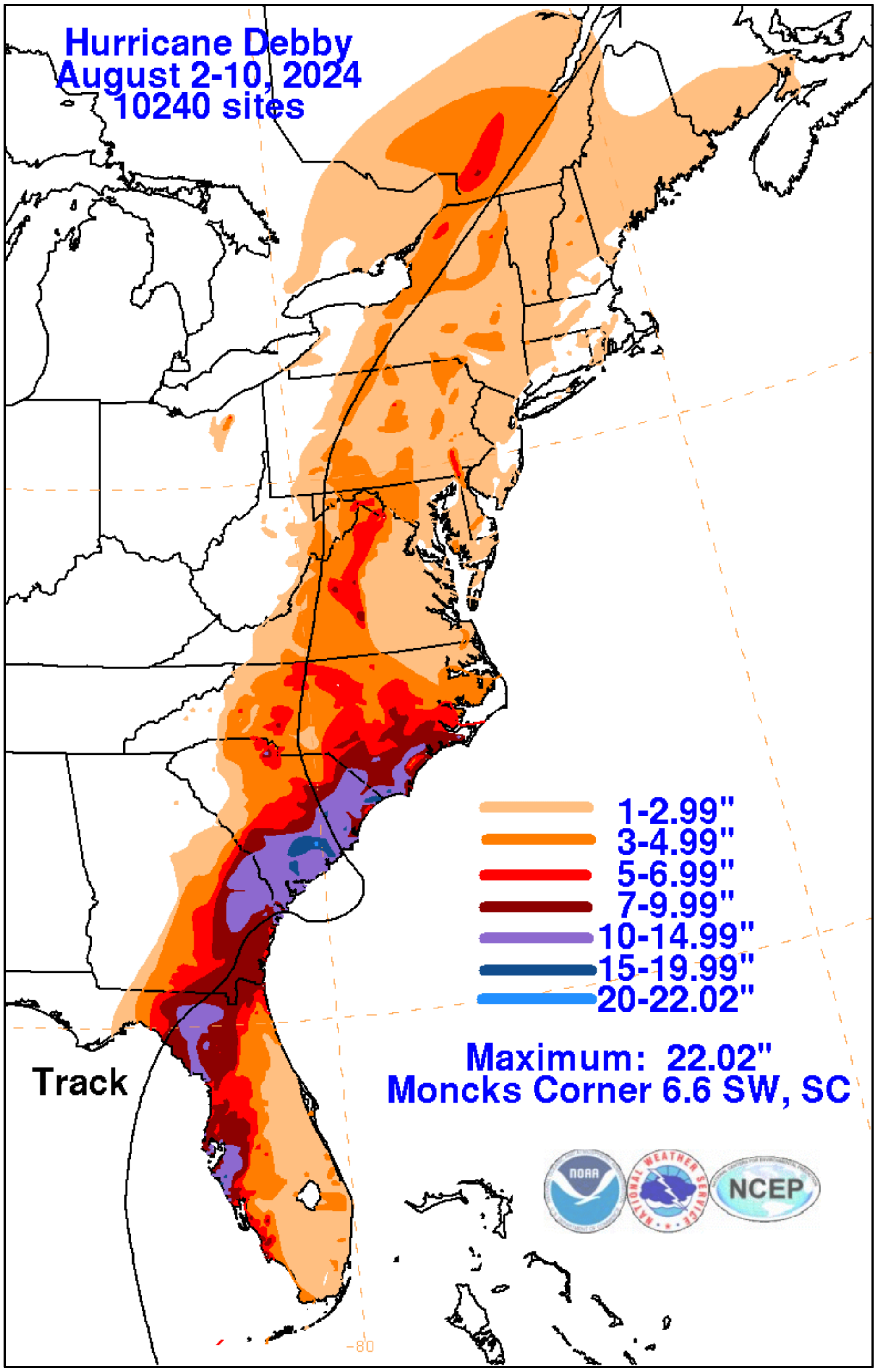

Figure 10. Storm total rainfall amounts (inches) in the United States and Canada from 2–10 August. The track is based on the NHC operational assessment. Image courtesy of David Roth (NOAA Weather Prediction Center).

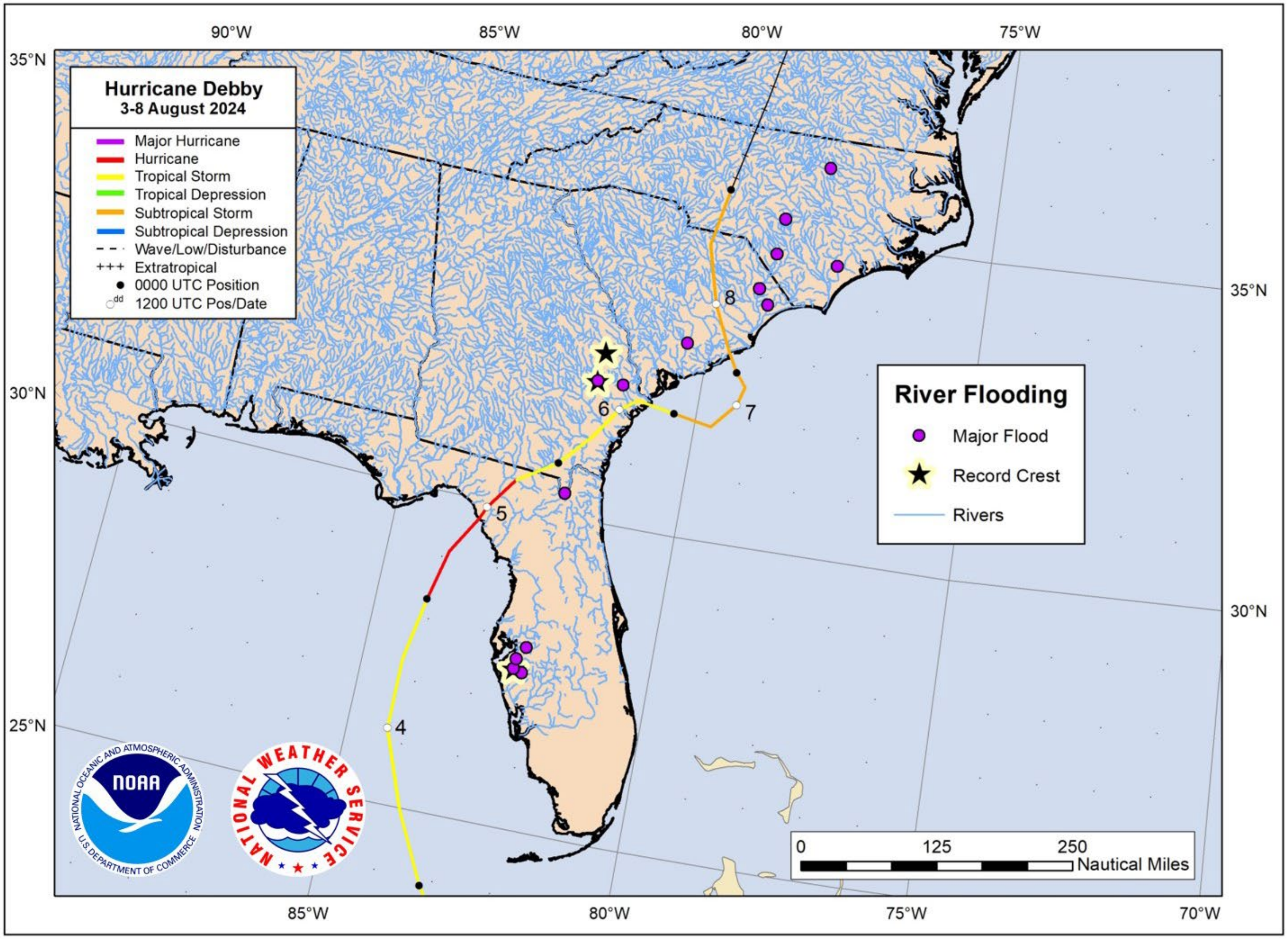

Figure 11. A map of river gage locations that exceeded major flood stage (purple circles) and crested above record levels (black stars) as a result of heavy rainfall from Debby. Data courtesy of Nicole Rockwell (NWS Southeast River Forecast Center).

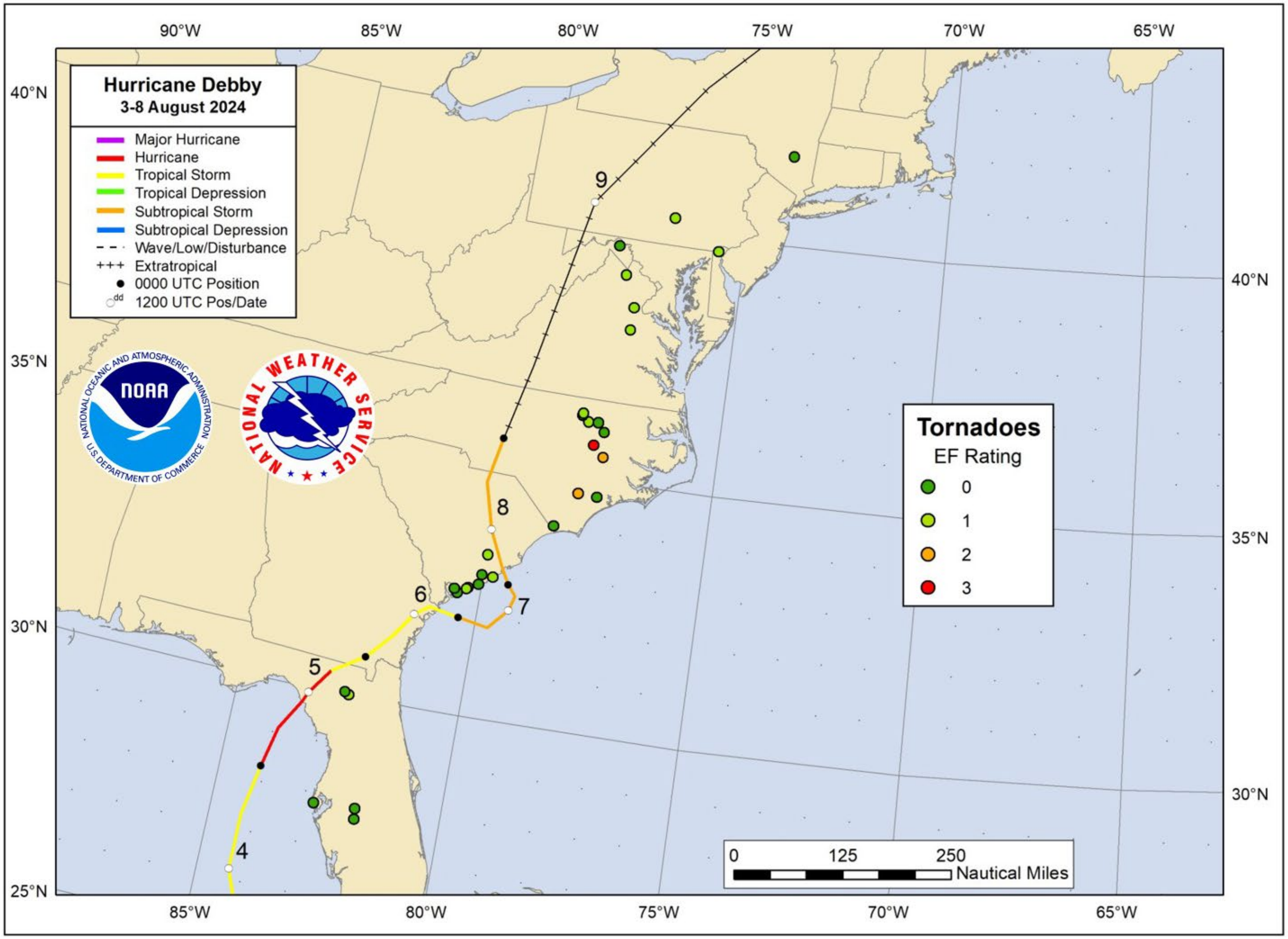

Figure 12. A map of tornadoes associated with Debby from 4–9 August 2024, including the extratropical stage. Data courtesy of the NOAA Storm Prediction Center.

Figure 13. A home was destroyed by an EF-3 tornado near Lucama, North Carolina. Photo credit: Travis Long, The News & Observer.

Figure 14. Aerial view of the long-duration flooding that occurred in the Laurel Lakes community in Sarasota County, Florida, as a result of heavy rainfall from Debby. Photo credit: Thomas Bender/Sarasota Herald-Tribune.

Figure 15. Significant flooding from Debby in Ridgeland, South Carolina. Photo credit: Miguel J Rodríguez Carrillo/Getty Images.

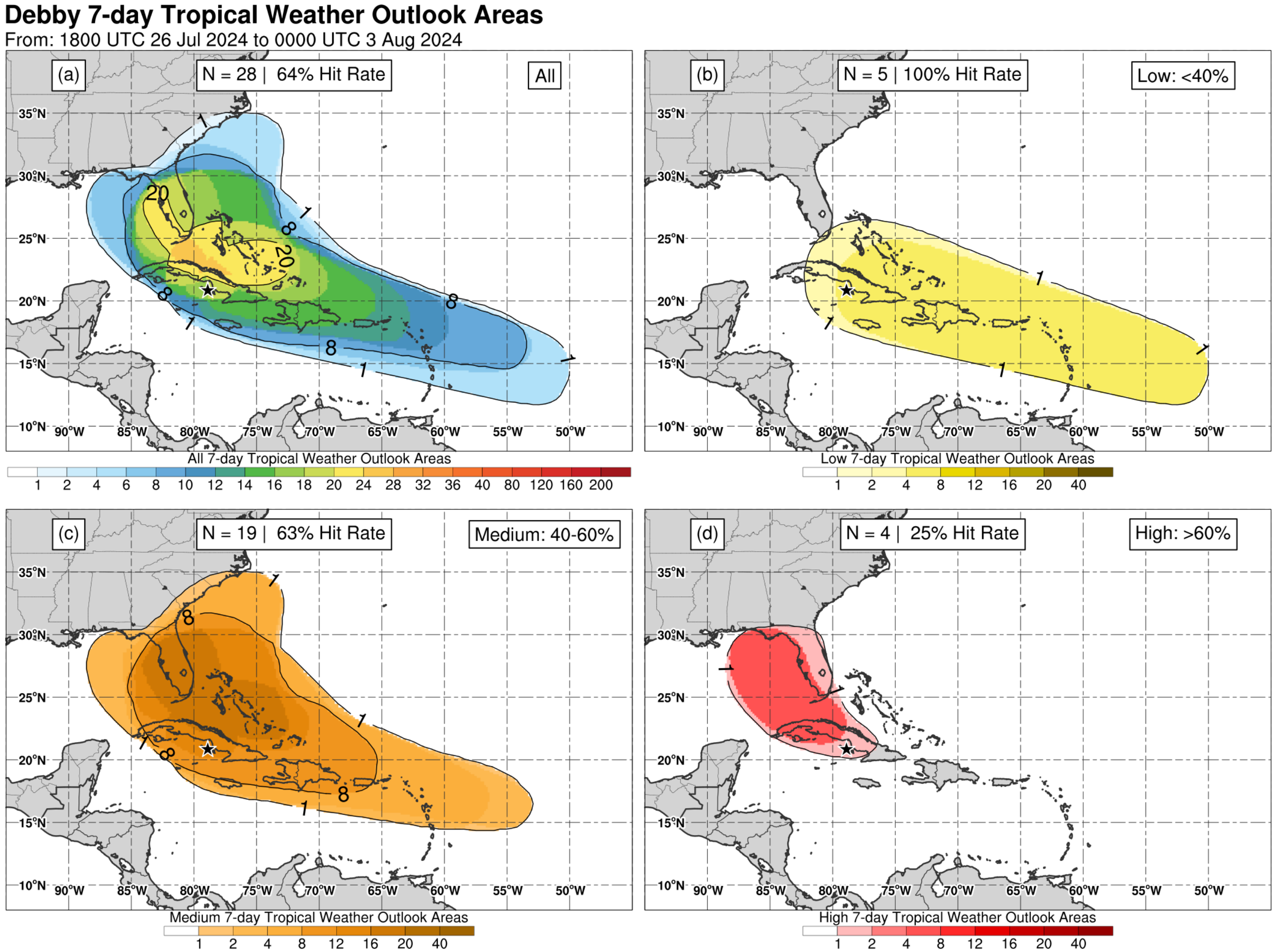

Figure 16. Composites of 7-day tropical cyclone genesis areas depicted in NHC's Tropical Weather Outlooks prior to the formation of Debby for (a) all probabilistic genesis categories, (b) the low (<40%) category, (c) medium (40–60%) category, and (d) high (>60%) category. The location of genesis is indicated by the black star.

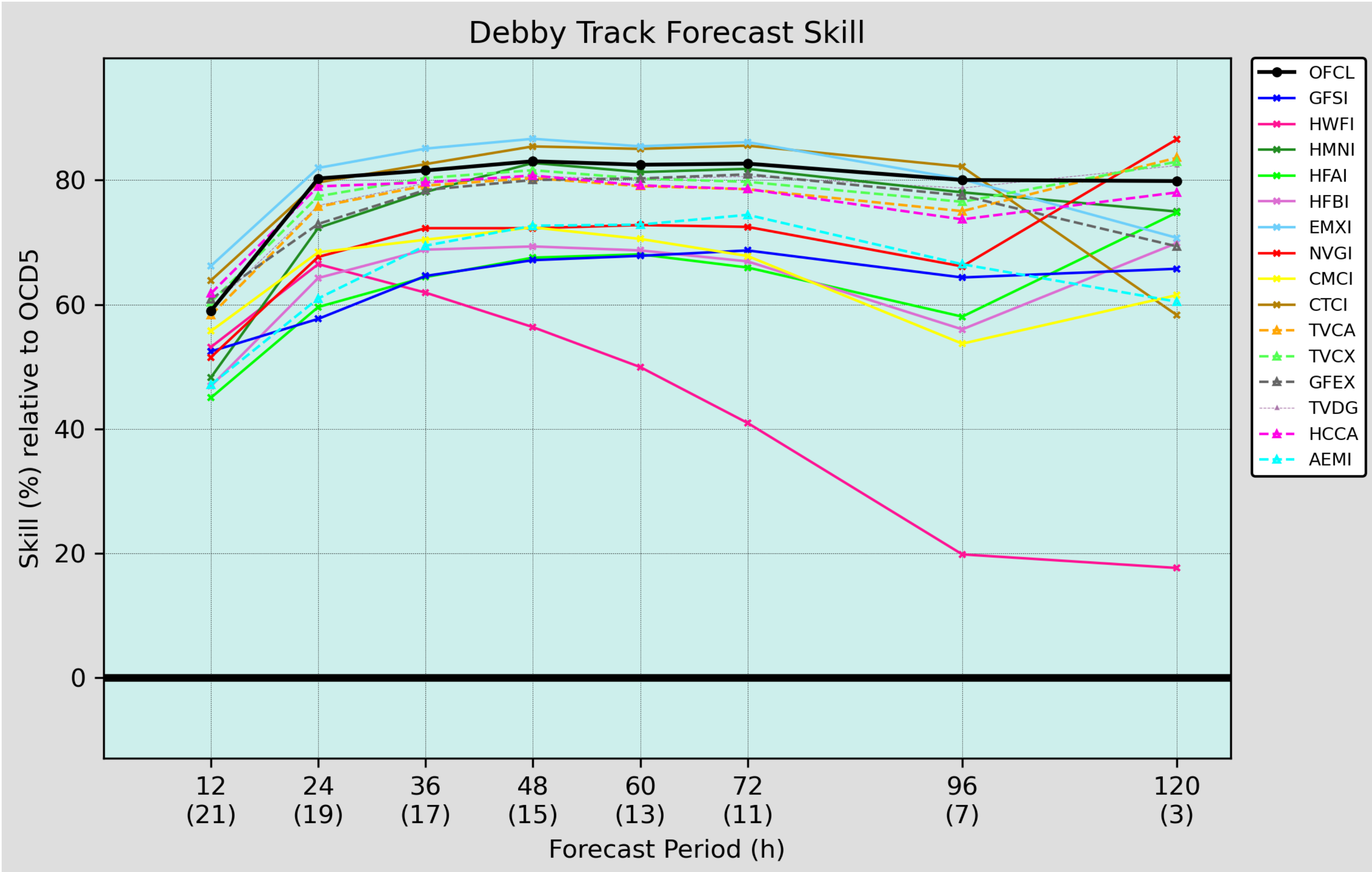

Figure 17. NHC official forecast and selected model forecast track skill (relative to climatology-persistence, OCD5) for Hurricane Debby, 3–8 August 2024.

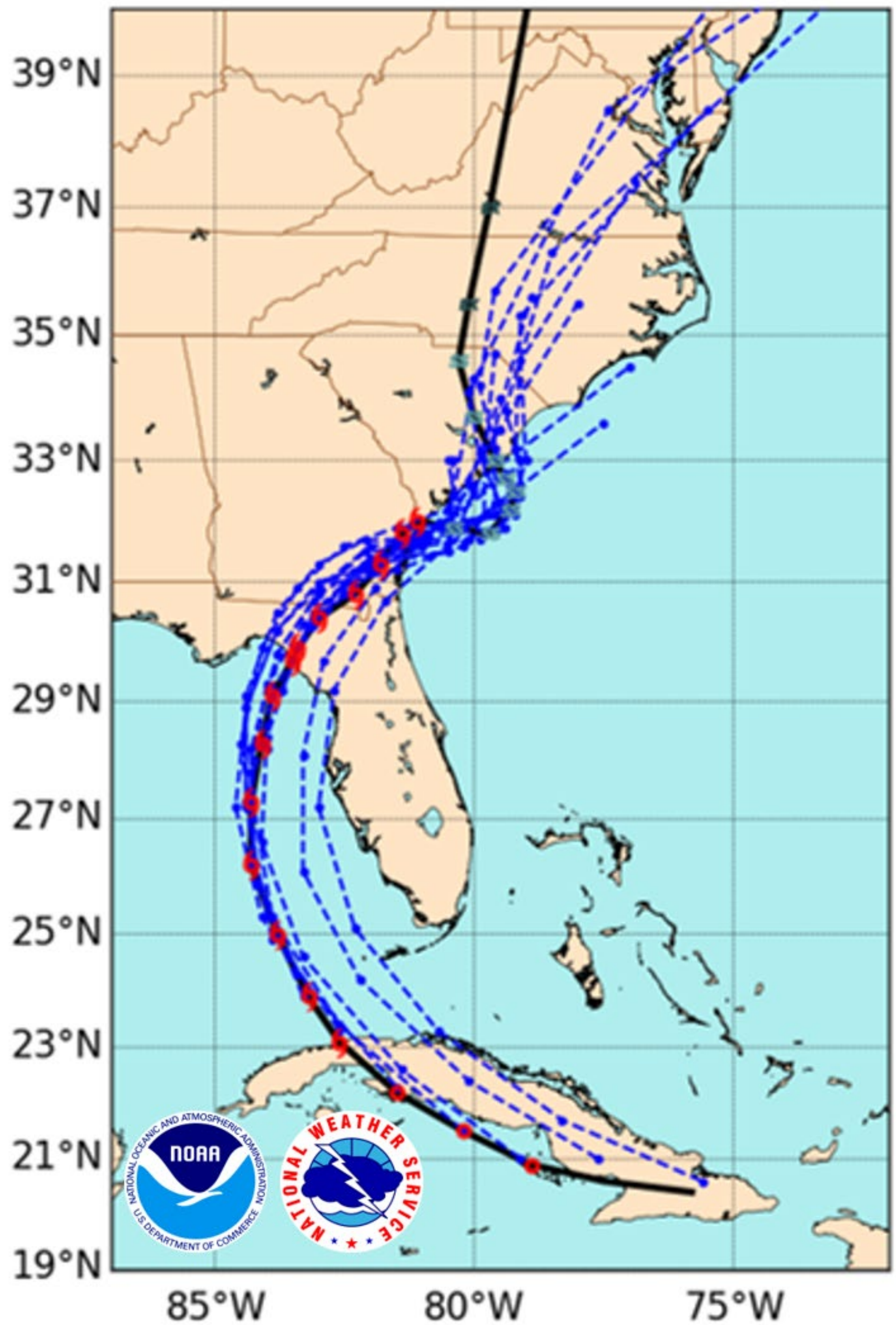

Figure 18. NHC official track forecasts (dashed blue lines) for Debby from 1200 UTC 2 August to 1200 UTC 6 August. The best track is given by the solid black line with red position symbols at 6-h intervals.

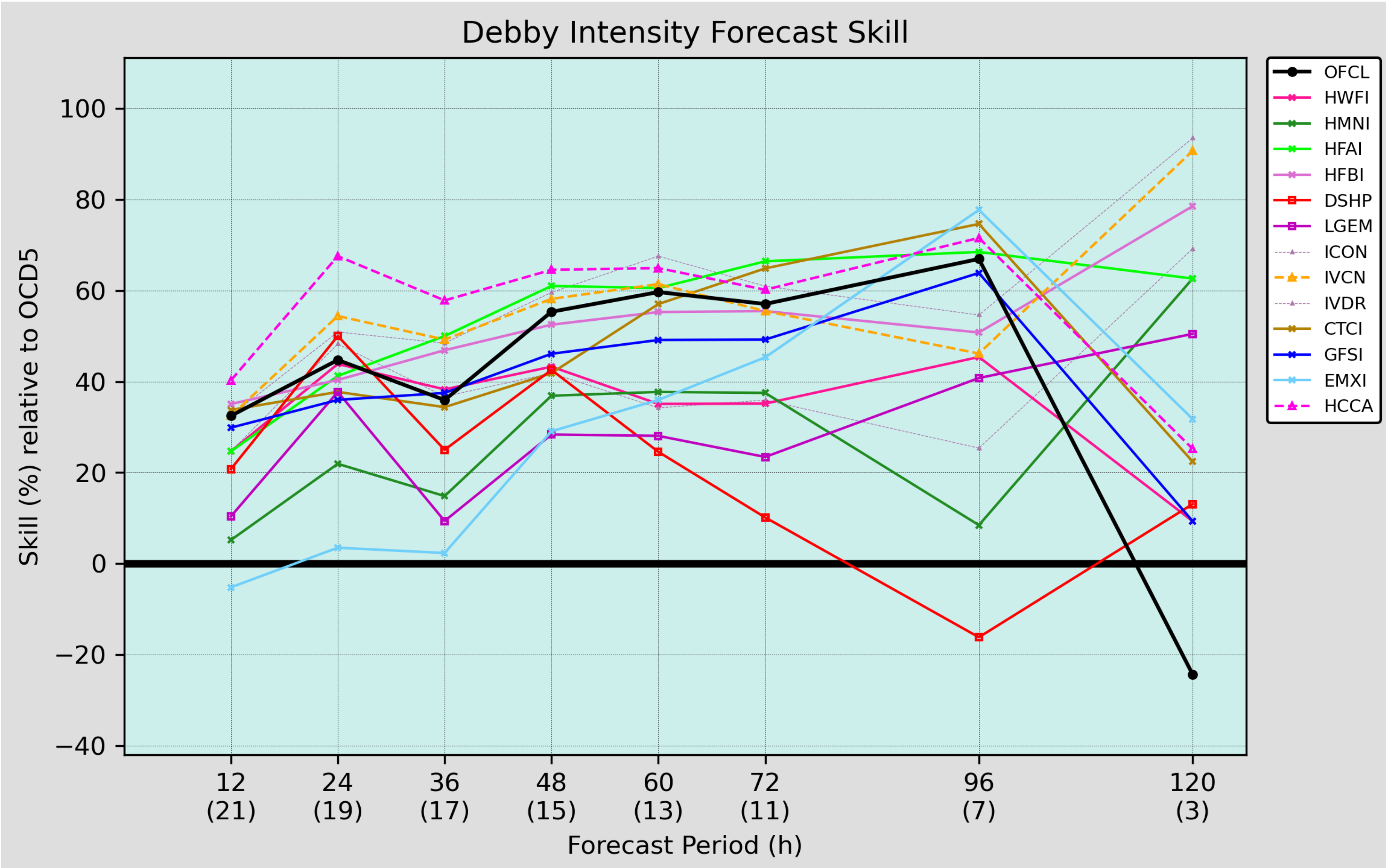

Figure 19. NHC official forecast and selected model forecast intensity skill (relative to climatology-persistence, OCD5) for Hurricane Debby, 3–8 August 2024.

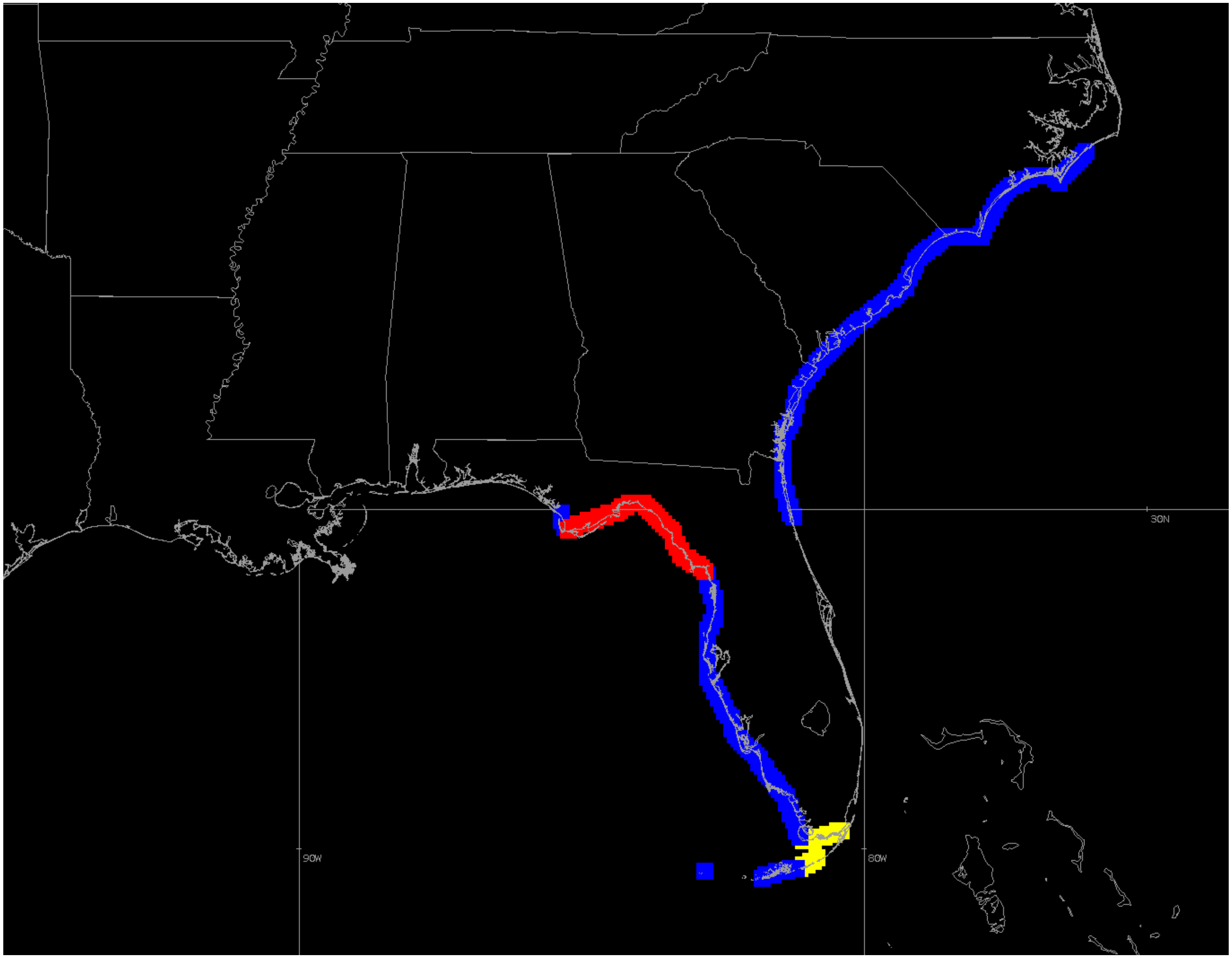

Figure 20. Coastal tropical wind watches and warnings (only highest severity shown) for Hurricane Debby.

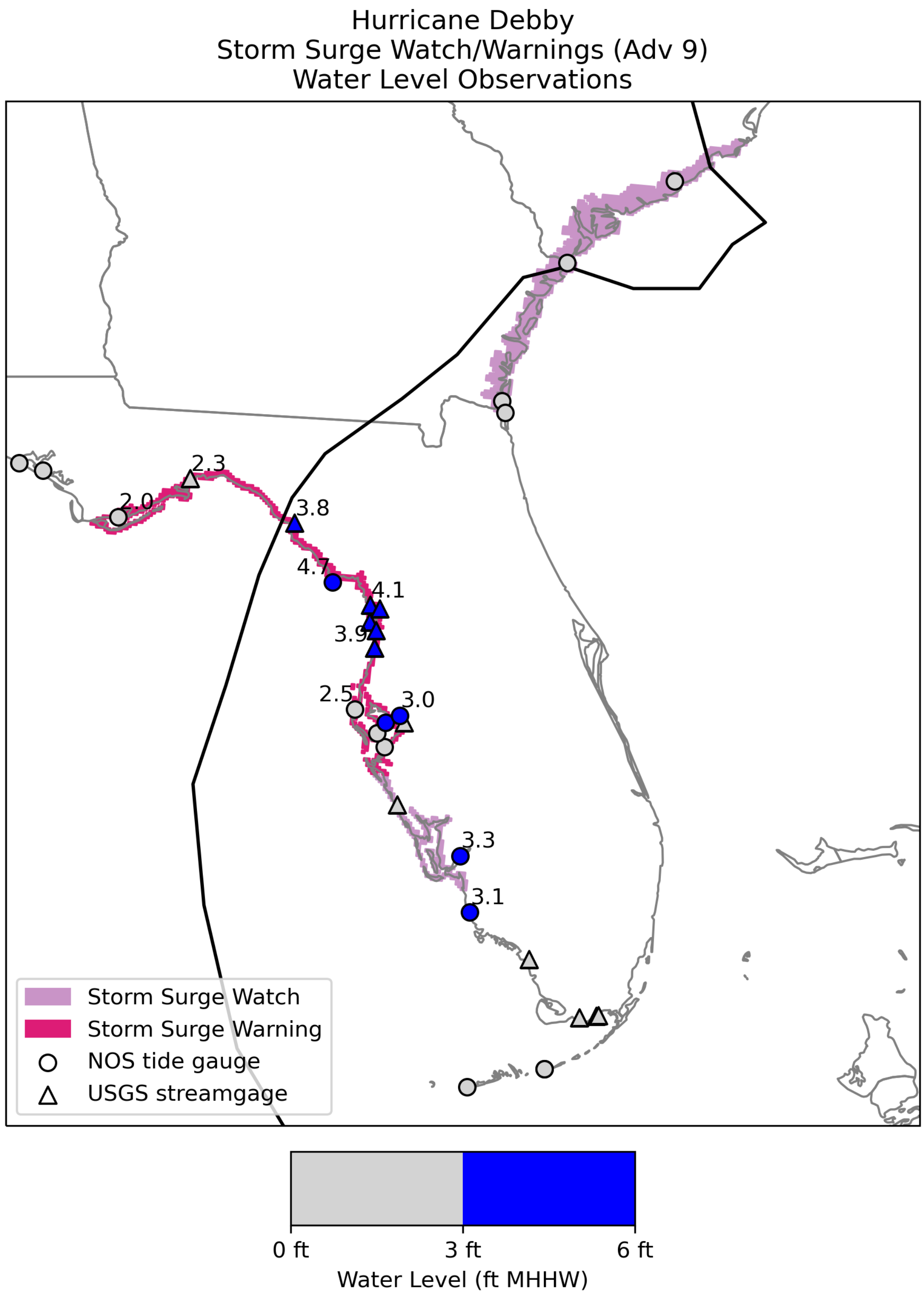

Figure 21. Storm Surge Watches (lavender) and Warnings (magenta) from 1500 UTC 4 August (Advisory 9) and maximum water levels measured during Hurricane Debby from select NOS tide gauges (circles) and USGS streamgages (triangles). Water levels are referenced as feet above Mean Higher High Water (MHHW), used as a proxy for inundation (above ground level) on normally dry ground along the immediate coastline.