NATIONAL HURRICANE CENTER TROPICAL CYCLONE REPORT

HURRICANE FRANCINE

(AL062024)

9–12 September 2024

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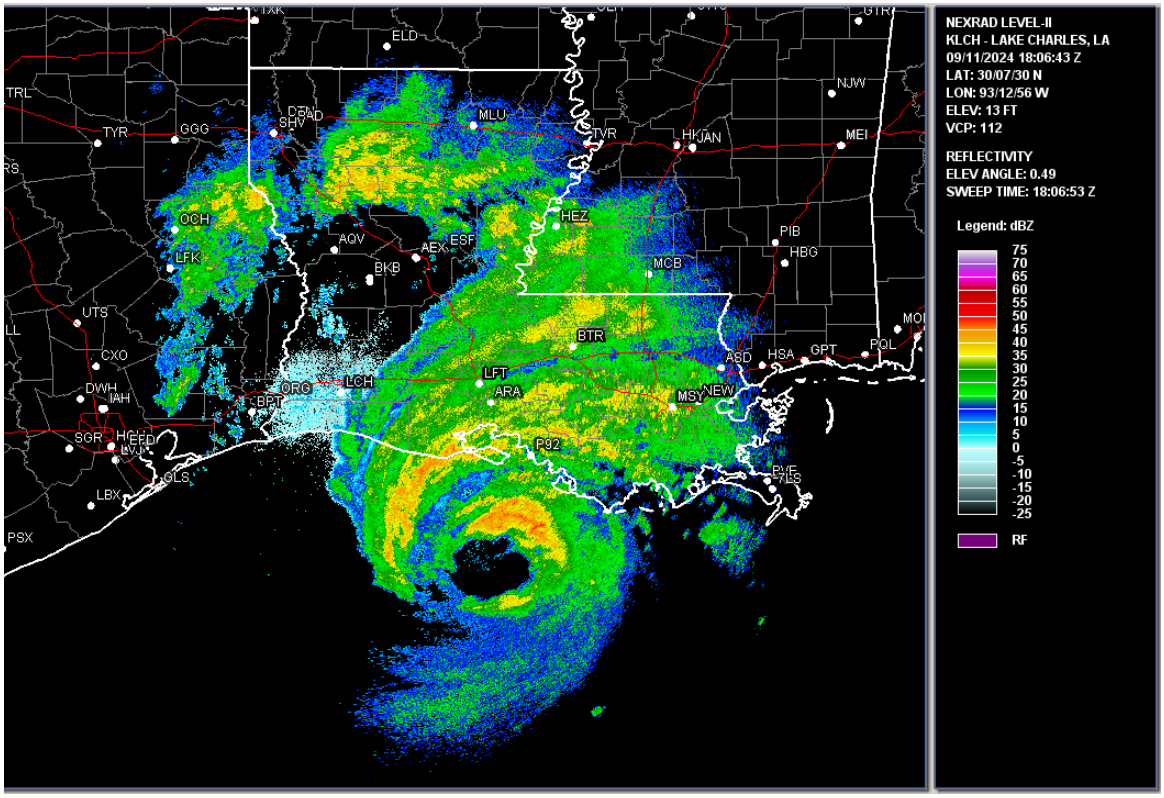

LAKE CHARLES, LOUISIANA, WSR-88D RADAR IMAGE OF HURRICANE FRANCINE WHEN IT WAS CENTERED OFF THE SOUTH-CENTRAL LOUISIANA COAST AT 1806 UTC 11 SEPTEMBER 2024. IMAGE COURTESY OF NOAA/NWS.

Hurricane Francine was a category 2 hurricane (on the Saffir-Simpson Hurricane Wind Scale) that made landfall in southeastern Louisiana. Francine produced significant flash flooding, wind, and storm surge impacts across portions of the southern United States and was responsible for over $1 billion (US) in damage in the United States.

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SYNOPTIC HISTORY

Francine's origin can be partially traced back to a tropical wave that moved off of the west coast of Africa on 25–26 August. The wave remained embedded in the monsoon trough as it moved slowly across the Atlantic for the next week, with occasional bursts of disorganized convection. The wave reached the Lesser Antilles on 2 September and its forward speed increased due to a low-level easterly jet across the Caribbean Sea. Late on 5 September, deep convection began to increase as the northern portion of the wave crossed the Yucatan Peninsula, and emerged over the Bay of Campeche early on 7 September. The tropical wave began interacting with a front associated with a non-tropical area of low pressure located over the northern Gulf of America. Based on satellite surface wind observations, a separate low pressure system with an elongated surface circulation formed by 1800 UTC 7 September over the Bay of Campeche. By 1800 UTC 8 September the surface circulation became well-defined about 310 n mi south-southeast of the mouth of the Rio Grande.

Winds near the newly-formed low quickly increased to tropical-storm-strength on 8 September, likely due to the terrain effects of the Sierra Madre Oriental Mountains and the front. By 1200 UTC 9 September, organized deep convection consolidated near the well-defined surface center, marking the formation of Tropical Storm Francine about 215 n mi southeast of the mouth of the Rio Grande. The "best track" chart of Francine'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].

A narrow mid-level ridge centered over Florida steered Francine slowly northwestward toward the coastlines of northern Mexico and southern Texas later on 9 September, bringing heavy rainfall to the region. Francine gradually strengthened and moved around the western periphery of the ridge early on 10 September. Later that day, the tropical storm turned sharply toward the northeast in the flow ahead of a shortwave trough moving across the southern United States. Around 0000 UTC 11 September, Francine intensified to a hurricane over warm waters and in an area of light vertical wind shear about 305 n mi southwest of Morgan City, Louisiana.

The hurricane continued to accelerate northeastward and strengthen as it approached the Louisiana coastline. Though strong upper-level winds imparted by the trough began to disrupt Francine's structure on satellite imagery, aircraft observations indicated that the hurricane strengthened through landfall. Ground-based radar also indicated Francine maintained a cohesive eyewall (cover photo), and it is estimated that the center of the eye crossed the

[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.

Louisiana shoreline at 2200 UTC 11 September about 25 n mi south-southwest of Morgan City with an intensity of 90 kt (Category 2 on the Saffir-Simpson Scale).

Francine continued to move northeastward early on 12 September, weakening to a tropical storm by the time it reached the western Lake Pontchartrain region at 0600 UTC. The decaying storm turned northward and moved over central Mississippi by 1200 UTC where it weakened to a tropical depression. By 1800 UTC 12 September, Francine became an extratropical low, merging with a front and moving over northern Mississippi and central Arkansas before it occluded, drifted toward the southeast, and dissipated on 14 September over southeastern Arkansas.

METEOROLOGICAL STATISTICS

Observations in Francine (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 14 aircraft reconnaissance flights (Fig. 4). The Air Force Reserve Hurricane Hunters made 8 flights into Francine and reported 17 center fixes. The NOAA Hurricane Hunters flew 4 P-3 missions into the storm with 7 center fixes, and there were 2 synoptic surveillance missions flown by the NOAA G-IV jet. 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, 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 Francine.

Ship reports of winds of tropical storm force associated with Francine are given in Table 2. Observations from select surface stations and data buoys are available for download at: www.nhc.noaa.gov/data/tcr/supplemental/francine.zip

Winds and Pressure

Francine's estimated peak intensity of 90 kt and minimum central pressure of 972 mb occurred at landfall at 2200 UTC 11 September and are based on data from an Air Force Reserve Unit reconnaissance aircraft. During the mission, the maximum 10-second averaged 700-mb flight-level winds reported in the southeastern portion of the hurricane's core were 106 kt at 2219 UTC 11 September. While the standard adjustment factor of 90% for these flight-level values would yield a peak surface wind of 95 kt, dropsonde data suggest that the standard reduction factor did not apply in this case. It should be noted that the NHC best track intensity estimates typically have an uncertainty of around ±10%.

A dropsonde released from an Air Force Reserve aircraft reported a pressure of 972 mb with a surface wind of 7 kt near 2142 UTC 11 September, and these data are the basis for the minimum pressure of 972 mb at landfall.

Louisiana

Francine made landfall in the remote coastal marshes of Louisiana where there is a very limited network of surface observation sites. The highest measured wind near the landfall location was from a National Ocean Service (NOS) station with marine exposure located north of Eugene Island that reported a peak sustained wind of 66 kt and gust of 91 kt at 2036 and 2115 UTC 11 September, respectively. A United States Geological Survey (USGS) station located at Caillou Lake (southwest of Dulac) reported a peak sustained wind of 63 kt at 2200 UTC 11 September. Hurricane-force wind gusts were recorded at the Louis Armstrong New Orleans International Airport in Kenner and at a WeatherFlow marine station along Chef Menteur Highway.

Tropical-storm-force winds spread along the coast and inland through much of eastern Louisiana. A sustained wind of 44 kt was measured at Tiger Stadium on the Louisiana State University campus in Baton Rouge at 0013 UTC September, with a gust of 48 kt at 0147 UTC.

The NOS station at North Eugene Island reported a minimum pressure of 975.7 mb at 2200 UTC 11 September. Farther inland, an in-situ pressure measurement of 978.7 mb was taken by Josh Morgerman (iCyclone) in Amelia, Louisiana, as the eye of Francine passed near that location at 2343 UTC. However, Morgerman reported that the surface structure of Francine had deteriorated at this point and conditions were quite windy despite being in portions of the radar-indicated eye.

Mississippi, Alabama, Florida and Texas

Tropical storm conditions occurred along the coast of Mississippi. A WeatherFlow station in Gulfport, Mississippi, measured a sustained wind of 34 kt at 0531 UTC 12 September with a gust of 43 kt. Tropical-storm-force gusts were also observed inland in Biloxi and Picayune, Mississippi.

While no land-based observing stations in Alabama recorded sustained tropical-storm-force winds, a couple of marine stations just offshore did report tropical storm conditions. A marine-based mesonet station operated by the National Data Buoy Center at Bon Secour, Alabama, measured a sustained wind of 38 kt at 0530 UTC 12 September.

Francine's tropical-storm-force winds reached as far east as the coast of the Florida Panhandle. A WeatherStem station in Pensacola Beach, Florida, reported a sustained wind of 38 kt at 0544 UTC 12 September with a gust of 43 kt. Farther east, a WeatherStem station at Navarre Beach measured sustained winds of 37 kt with a gust of 41 kt at 0907 UTC 12 September.

Texas had no reported sustained winds of tropical-storm-force. However, multiple stations from Brownsville northward to Galveston measured peak wind gusts of 33 kt.

Storm Surge[2]

Hurricane Francine produced a dangerous storm surge along the coastlines of Louisiana and Mississippi. Figure 5 shows the NHC storm surge analysis, which represents the maximum storm surge inundation during the event. In addition, maximum water levels referenced to Mean Higher High Water (MHHW, i.e. an approximation for inundation at the immediate coastline) from in situ sensor networks are shown in Figure 6.

Peak storm surge inundation of 5 to 8 ft above ground level (AGL) occurred just east of the landfall location in Terrebonne Parish, Louisana (Fig. 5). The highest water levels were located along the immediate coast, but storm surge penetrated inland via the various bays and lakes impacting communities such as Cocodrie and Dulac. A USGS streamgage sensor at Caillou Lake Sister Lake (southwest of Dulac) measured 5.5 ft above MHHW (Fig. 6), and a sensor at Caillou Bay southwest of Cocodrie measured 4.5 ft MHHW prior to failing to report (not shown in Fig. 6, incomplete data). Nearby, a U.S. Army Corps of Engineers (USACE) river gauge sensor at Bayou Petit Caillou at Cocodrie reached 7.8 ft NAVD88 prior to failing to report (not shown in Fig. 6, incomplete data and no conversion to MHHW). This data suggests a rapid rise in water levels near this location, and peak storm surge inundation of up to 8 ft AGL is estimated. Eyewitness accounts and videos from Cocodrie show several feet of storm surge with waves on top inundating the community (not shown; Max Olson, X).

Storm surge observations are limited between Cocodrie and Port Fourchon in remote areas of Terrebonne Bay and Lafourche Parish, but it is estimated that 3 to 5 ft of storm surge inundation occurred in these areas (Fig. 5). Elsewhere on the west bank of the Mississippi River, storm surge inundation of 2 to 4 ft above ground occurred from Barataria Bay to the Mouth of the Mississippi River. The NOS tide gauge at Grand Isle measured a storm surge of 2.11 ft above normal tide levels, however, this reading occurred during low tide; and the maximum water level at this location was 1.78 ft above MHHW. The USACE river gauge on the Barataria Waterway at Lafitte measured 3.7 ft above NAVD88 (Not shown in Fig. 6, no conversion to MHHW). In Plaquemines Parish (west bank), USGS streamgages near Grand Bayou (station CRMS0282-H01-RT) and Empire Waterway south of Empire measured 3.9 ft NAVD88 and 4.2 ft NAVD88, respectively (Not shown in Fig. 6, no conversion to MHHW).

West of the landfall location, maximum water levels in Vermilion Bay measured 2 to 4 feet AGL with that area primarily experiencing offshore winds. The NOS tide gauge at Eugene Island recorded a maximum water level of 2.78 ft above MHHW, and a USGS streamgage at Vermilion Bay Bayou Fearman near Intracoastal City measured 3.0 ft above MHHW. Water levels were also elevated along the upper Texas and western Louisiana coastline, with NOS tide gauges measuring 1 to 3 ft above MHHW.

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[2] 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).

On the East Bank of the Mississippi River, maximum storm surge inundation of 2 to 4 ft AGL occurred (Fig. 5). The NOS tide gauge at Shell Beach measured a storm surge of 3.86 ft above normal tide levels, however, it occurred during low tide; and the maximum water level at this location was 2.91 ft above MHHW. The USGS streamgage at Crooked Bayou near Delacroix measured 2.6 ft above MHHW, and various other USGS streamgage sensors show hydrograph signatures with maximum storm surge occurring during low tide (e.g., Black Bay near Snake Island, Northeast Bay Gardene near Point-a-la-Hache, Cow Bayou at American Bay).

Maximum water levels of 3 to 5 feet AGL occurred along Lake Pontchartrain and the Mississippi coastline (Fig. 5). A USACE river gauge measured 5.2 ft above MHHW at Bonnet Carre along the southwest corner of Lake Pontchartrain (Fig. 6). On the northern side of the lake, a USGS streamgage on the Tchefuncte River near Madisonville, Louisiana, measured 5.15 ft above NAVD88 (Not shown in Fig. 6, no conversion to MHHW). The NOS tide gauge at New Canal Station measured 3.6 ft above MHHW along the southern side of the lake. In Mississippi, NOS tide gauges at Waveland and Pascagoula measured 4.8 ft and 3.1 ft above MHHW, respectively (Fig. 6). In Alabama, NOS tide gauges reported maximum water levels of 1 to 3 ft above MHHW.

Rainfall and Flooding

Along the Gulf coast, Francine brought two swaths of high rainfall totals to southeastern Louisiana and the panhandle of Florida (Fig. 7). However, it is important to note that it was difficult to distinguish the rainfall totals associated with Francine from the rainfall produced by the front to Francine's north due to their proximity. It should be noted that the maxima are being reported without attempting to distinguish between the two features.

Near the core of Francine, a local rainfall maximum of 11.93 inches was observed at Covington near the Abita River in Louisiana. The area of maximum rainfall had totals around 10 to 11 inches extending south and north of Lake Pontchartrain. This rainfall caused flash flooding throughout southeastern Louisiana, inundating many structures and roadways.

Along the Florida Panhandle, Navarre, Florida, received Francine's peak rainfall total with a measurement of 14.61 inches. To the east near Apalachicola, a swath of 10 to 14 inches of rain was reported. It is likely that these totals were enhanced by the front.

Inland, Francine brought heavy rainfall to northern Alabama. Danville, Alabama, recorded 13.65 inches of rain with a relatively large area receiving over 10 inches (Fig. 7). During the cyclone's extratropical stage, western Mississippi and eastern Arkansas reported rainfall totals of 7 to 9 inches near the path of the center.

CASUALTY AND DAMAGE STATISTICS

There were no reports of casualties[3] associated with Francine. Four injuries were reported in Louisiana[4] and Mississippi (2 due to falling trees, 1 during a rescue, and one due to an unspecified cause). In Louisiana, the sheriff's department reported that multiple water rescues were conducted in Lafourche Parish[5] and one man was rescued during a live news report from a flooded vehicle in New Orleans (Fig. 8). After the storm, 18 emergency department visits were noted in the southeastern Louisiana region due to carbon monoxide exposure.[6]

The NOAA National Centers for Environmental Information (NCEI) estimated losses from Francine totaling $1.3 billion to homes, vehicles, businesses, and other infrastructure. Hundreds of structures in St. Charles and Jefferson Parishes were damaged or destroyed due to winds, flooding and falling trees (Fig. 9).[7] Downed trees also blocked many roadways and knocked out powerlines across Louisiana, Mississippi, and Alabama. Power outages peaked at approximately 500,000 residents in the tri-state area. In southern Texas, coastal flooding and heavy rainfall resulted in impassable roadways and flooding at the SpaceX's Starbase.[8] Heavy rainfall in northeastern Mexico caused flooding in many neighborhoods around Matamoros.[9] The hurricane also caused a disruption in the U.S. energy production with a reported 169 offshore gas and oil platforms evacuated because of Francine.[10]

FORECAST AND WARNING CRITIQUE

Genesis

The genesis of Francine was particularly problematic to forecast (Table 3). The wave from which Francine developed was introduced in the Tropical Weather Outlook (TWO) 324 h (13.5 days) prior to genesis with a low probability (< 40%) of formation during the next 7 days. The 7-day formation chances were first raised to the medium (40-60%) category 264 h before Francine formed and remained in this category for 5 days before the chances returned to the low category at 1800 UTC on 3 September. By 1800 UTC 6 September, the 7-day probabilities were raised to the medium category 66 h prior to formation, and then to the the high category (> 70%) 42 h prior

[3] 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.
[4] https://www.wafb.com/2024/09/12/lsp-trooper-hurt-during-hurricane-francine-response/
[5] https://www.foxweather.com/weather-news/tracking-hurricane-francine-landfall
[6]https://www.weather.gov/media/lix/TropicalEventSummary/PSHLIX_2024AL06_Francine_ImpactNarratives.pdf
[7] https://www.cnn.com/2024/09/12/us/tropical-storm-francine-louisiana-new-orleans-thursday/index.html
[8] https://www.foxweather.com/weather-news/francine-flooding-spacex-starbase-texas
[9]https://www.krgv.com/news/tracking-tropical-storm-francine-flooding-reported-in-several-matamoros-neighborhoods/
[10] https://www.eia.gov/todayinenergy/detail.php?id=63104

to genesis. The difficulty predicting the long-range genesis potential of Francine seemed to be related to both the deterministic Global Forecast System (GFS) model and the European Center for Medium Range Weather Forecast (ECMWF) ensembles showing tropical cyclone formation too early, first in the central tropical Atlantic and then in the western Caribbean.

A low probability of formation in the 2-day TWO was shown for Francine multiple times prior to formation. The first was on 0000 UTC 30 August (252 h prior to genesis) for 12 h. Then the system was introduced again at 0000 UTC 1 September (228 h prior to genesis) for 30 h. Ultimately, Francine was re-introduced with a low probability at 1800 UTC 6 September, 66 h before formation. The 2-day probabilities were raised to the medium and high categories 54 h and 30 h before genesis, respectively.

The location of Francine's genesis was also poorly forecast (Fig. 10). While Francine formed in the western portion of the Gulf of America, the 7-day TWO highlighted the majority of the Caribbean Sea as the formation area and gradually shifted the location westward. The observed genesis position was only included in 38% of the 52 7-day genesis area highlighted by NHC.

Track

A verification of NHC official track forecasts for Francine is given in Table 4a. Official track forecast errors were comparable to the mean official errors for the previous 5-yr period at the 12 h forecast lead time and lower than the 5-yr mean at all other lead times. A homogeneous comparison of the official track errors with selected guidance models is given in Table 4b and illustrated in Fig. 11. While the official forecasts did quite well relative to climatology (OCD5), several individual models and consensus aids had lower forecast errors than NHC. This is largely due to the westward bias in the early official track forecasts (Fig. 12). Of note, a few simple consensus models (TVCA, TVCX, and TVDG) had more accurate forecasts at all lead times. The HAFS-A model (HFAI) also had particularly low track errors at all forecast lead times.

Intensity

A verification of NHC official intensity forecasts for Francine is given in Table 5a and shown in Fig. 13. Official intensity forecast errors were lower than the mean official errors for the previous 5-yr period at all forecast lead times except 12 h (when it was comparable to the mean error). A homogeneous comparison of the official intensity errors with selected guidance models is given in Table 5b. Various individual, simple, and corrected consensus aids outperformed the official forecast at different lead times with the Florida State Super Ensemble aid (FSSE) having consistently lower errors through the 60-h lead time. Model and NHC intensity forecasts (Fig. 14) tended to underpredict the peak intensity of Francine.

Wind Watches and Warnings

Watches and warnings associated with Francine are given in Table 6. Potential tropical cyclone advisories were initiated at 2100 UTC 8 September on the precursor low pressure system to issue Tropical Storm Watches for the Gulf coast of northern Mexico. In subsequent advisories, the Tropical Storm Watch was extended northward along the southern Texas coastline. These watches were not upgraded to warnings, and no land-based stations in these areas reported sustained or gusts of tropical-storm-force winds.

A Hurricane Watch was issued for the Louisiana coast, including the landfall location, at 1500 UTC 9 September or 51 hours prior to landfall. The Hurricane Watch was upgraded to a Hurricane Warning at 2100 UTC 9 September, 45 hours before Francine's center crossed the coastline. Initially, the Hurricane Warning area only covered the center landfall location and the western portion of the wind field. The area where the eastern side of the storm moved was under a Tropical Storm Warning and Hurricane Watch until 1200 UTC 10 September, when the eastern portion of the Louisiana coastline was upgraded to a Hurricane Warning (30 h prior to landfall).

Storm Surge Watches and Warnings

A Storm Surge Watch was first issued at 1500 UTC 9 September from High Island, Texas, eastward to the Mississippi/Alabama Border including Vermilion Bay, Lake Maurepas, and Lake Pontchartrain (Table 7). The western portion of this watch area, from High Island to the Mouth of the Mississippi River including Vermilion Bay, was upgraded to a warning 6 h later. At this time, a Storm Surge Watch was also issued within the Morgan City levee to signify the threat of overtopping, but this watch was never upgraded to a Storm Surge Warning during the event. The eastern portion of the watch area, from the Mouth of the Mississippi River to the Mississippi/Alabama Border including Lake Maurepas and Lake Pontchartrain, was upgraded to a warning at 1500 UTC 10 September. At this same time a Storm Surge Watch was issued from the Mississippi/Alabama Border to the Florida/Alabama Border including Mobile Bay. This portion of the watch was never upgraded to a storm surge warning; a Coastal Flood Warning was issued for these areas at 1500 UTC 11 September to signal significant coastal flooding below the level of life-threatening storm surge inundation.

Starting at 2100 UTC 10 September, the Storm Surge Warning was modified as the threat area shifted eastward. At this time, the warning was discontinued west of Sabine Pass, Texas. Six hours later (0300 UTC 11 September) the warning was discontinued west of Cameron, Louisiana. At 2100 UTC 11 September, just prior to the landfall, the warning was discontinued west of the Vermilion/Cameron Parish Line. The remainder of the warning was removed incrementally as the dangerous water levels receded.

Figure 6 shows the Storm Surge Watch and Warning in effect at 2100 UTC 11 September, the advisory time prior to landfall, along with the storm surge observations greater than 3 ft above MHHW (shown in blue), a first cut threshold to verify the storm surge warning. Based on the timing of when tropical-storm-force winds first reached the coast (e.g., 1800 UTC 11 September in Terrebonne Parish), the lead time of the Storm Surge Watch and Warning was 51 h and 45 h, respectively (Storm Surge Watch 1500 UTC 9 Sept; Storm Surge Warning 2100 UTC Sept 9).

The initial peak storm surge forecast, issued with the first Storm Surge Watch (1500 UTC 9 September), was for 5 to 10 feet of inundation AGL to occur somewhere between Cameron, Louisiana and Port Fourchon, Louisiana. The western edge of this area was gradually trimmed, and at the advisory prior to landfall (2100 UTC 11 September) the peak storm surge inundation of 5 to 10 ft AGL was forecast to occur somewhere between Burns Point, Louisiana and Port Fourchon. The NHC post-storm analysis of 5 to 8 ft AGL falls within this area.

In Lake Pontchartrain and coastal Mississippi, the initial peak storm surge forecast was for 2 to 4 ft AGL at the time of the initial watch issuance (1500 UTC 9 September). The forecast was increased to 3 to 5 ft AGL when the Storm Surge Warning was issued (1500 UTC

10 September) and then increased again to 4 to 6 ft AGL the morning of the landfall (0900 UTC 11 September). The NHC storm surge analysis for this area falls within the final forecast range.

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

The NHC began communication with emergency managers on Monday, 9 September as Francine was forming in the western Gulf of America. Ten decision support briefings were provided to emergency managers and coordinated through the FEMA Hurricane Liaison Team embedded at the NHC. The briefings included video-teleconferences with FEMA Headquarters, FEMA Region 6, FEMA Region 4, and the state of Louisiana. These briefings continued through Thursday, 12 September, as Francine moved inland over the southern U.S. NHC also provided four live briefings to U.S. Coast Guard District 8 beginning on 8 September in support of their life-saving mission.

The NHC television media pool was activated for two days beginning at 6:00 AM CDT 10 September through 10:00 PM CDT 11 September. During this period, 49 interviews were conducted with national networks and local affiliates in Texas, Louisiana, and Mississippi. A total of 6 live streams were conducted for this event beginning on 9 September. The live streams were announced on NHC social media accounts. A total of two shorter content videos in the form of “reels” were created and posted on the three platforms. This is the fourth time NHC has provided shorter content on social media platforms, and these videos received 376K views.

ACKNOWLEDGEMENTS

The data from this report came from the Post Tropical Cyclone (PSH) Reports issued by NWS Weather Forecast Offices (WFOs) in Slidell, Lake Charles, Mobile, Jackson, Houston, Corpus Christi, and Brownsville. Data were also provided by the NOAA National Data Buoy Center and the NOS Center for Operational Oceanographic Products and Services. David Roth of the NOAA Weather Prediction Center provided the rainfall graphic and data. Dr. Philippe Papin provided the genesis figure. Michael Spagnolo of FEMA and Maria Torres contributed the IDSS and public communication summaries.

Table 1. Best track for Hurricane Francine, 9–12 September 2024.

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
08 / 1800	21.4	94.5	1003	45	low
09 / 0000	22.0	94.8	1003	45	"
09 / 0600	22.7	95.1	1003	45	"
09 / 1200	23.2	95.5	1002	45	tropical storm
09 / 1800	23.7	95.9	996	50	"
10 / 0000	23.9	96.1	992	55	"
10 / 0600	24.1	96.2	992	55	"
10 / 1200	24.5	95.8	990	55	"
10 / 1800	25.3	95.3	987	55	"
11 / 0000	26.0	94.7	982	65	hurricane
11 / 0600	26.6	94.1	977	80	"
11 / 1200	27.5	93.2	976	80	"
11 / 1800	28.6	92.1	974	85	"
11 / 2200	29.3	91.3	972	90	"
12 / 0000	29.6	90.9	980	70	"
12 / 0600	30.5	90.3	988	45	tropical storm
12 / 1200	31.8	90.1	995	30	tropical depression
12 / 1800	33.4	89.7	996	25	extratropical
13 / 0000	34.7	90.5	998	25	"
13 / 0600	35.4	90.9	1001	20	"
13 / 1200	35.9	91.5	1005	15	"
13 / 1800	35.7	92.0	1009	15	"

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
14 / 0000	34.9	91.7	1009	15	"
14 / 0600					dissipated
11 / 2200	29.3	91.3	972	90	minimum pressure, maximum wind, and Landfall in Terrebone Parish, Louisiana

Table 2. Selected ship reports with winds of at least 34 kt for Hurricane Francine, 9–12 September 2024.

Date/Time (UTC)	Ship call sign	Latitude (°N)	Longitude (°W)	Wind dir/ speed (kt)	Pressure (mb)
10 / 1700	V7PQ5	28.4	94.7	090 / 40	1007.0
12 / 0900	WLMQ	29.2	87.5	210 / 35	1003.9
12 / 1500	WLMQ	29.4	87.8	240 / 36	1007.3

Table 3. Number of hours in advance of formation associated with the first NHC Tropical Weather Outlook forecast in the indicated likelihood category. Note that the timings for the “Low” category do not include forecasts of a 0% chance of genesis. Parentheses indicate the time before genesis that category was introduced a second time, with brackets indicating a third time.

	Hours Before Genesis	
	48-Hour Outlook	**168-Hour Outlook**
Low (<40%)	252 (228) [66]	324
Medium (40%-60%)	54	264 (66)
High (>60%)	30	42

Table 4a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) track forecast errors (n mi) for Francine. 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	**22.8**	**25.9**	**32.0**	**52.2**	**71.9**	**47.2**		
OCD5	55.1	104.2	189.0	320.3	376.1	361.8		
Forecasts	11	9	7	5	3	1		
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 4b. Homogeneous comparison of selected track forecast guidance models (in n mi) for Francine. Errors smaller than the NHC official forecast are shown in boldface type. The number of official forecasts shown here will generally be smaller than that shown in Table 4a due to the homogeneity requirement.

Model ID	Forecast Period (h)							
	12	24	36	48	60	72	96	120
OFCL	21.2	26.1	33.3	56.7	73.8			
OCD5	54.1	113.5	209.7	362.2	418.1			
GFSI	**20.4**	**24.7**	**28.3**	58.9	95.8			
HWFI	**19.0**	31.4	47.5	69.0	91.7			
HMNI	**15.0**	28.2	39.9	73.8	116.3			
HFAI	**18.5**	**26.0**	**24.3**	**29.6**	**40.2**			
HFBI	23.6	33.3	42.0	**41.3**	**53.3**			
EGRI	21.7	**25.9**	38.9	**50.2**	79.5			
EMXI	**20.0**	40.9	50.5	81.9	85.5			
NVGI	27.5	40.7	64.3	78.1	81.7			
CMCI	25.2	46.8	76.8	116.9	122.9			
CTCI	23.0	35.8	74.0	99.7	111.0			
TVCA	**18.1**	**23.4**	**30.8**	**53.8**	**70.5**			
TVCX	**18.7**	**23.8**	**30.0**	**54.4**	**70.2**			
GFEX	**18.3**	30.5	33.5	60.8	78.3			
TVDG	**18.5**	**23.8**	**31.1**	**51.2**	**71.1**			
HCCA	**18.8**	**25.8**	37.1	57.1	**60.9**			
FSSE	**19.3**	28.1	36.2	65.4	**63.8**			
AEMI	**19.2**	**24.3**	**33.0**	62.9	111.1			
TABS	65.0	152.0	238.0	320.0	377.7			
TABM	34.6	49.3	62.0	83.9	83.5			
TABD	39.5	66.4	104.3	154.9	201.7			
Forecasts	10	8	6	4	2			

Table 5a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) intensity forecast errors (kt) for Francine. 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	7.7	**7.2**	**5.7**	**5.0**	**5.0**	**5.0**		
OCD5	9.5	14.7	13.7	22.8	8.0	30.0		
Forecasts	11	9	7	5	3	1		
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 5b. Homogeneous comparison of selected intensity forecast guidance models (in kt) for Francine. 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	7.7	7.2	5.7	5.0	5.0	5.0		
OCD5	9.5	14.7	13.7	22.8	8.0	30.0		
HWFI	**6.6**	7.6	11.9	15.2	5.3	15.0		
HMNI	8.8	**6.7**	9.9	11.0	6.3	**4.0**		
HFAI	**5.8**	**6.0**	7.1	6.4	8.3	9.0		
HFBI	**5.3**	7.9	10.7	8.6	6.7	5.0		
DSHP	8.5	13.1	6.4	**4.8**	7.3	10.0		
LGEM	8.5	12.2	**5.6**	**3.8**	7.3	10.0		
ICON	**6.7**	8.9	7.6	6.6	6.7	8.0		
IVCN	**5.7**	7.6	6.3	6.2	6.0	6.0		
IVDR	**5.5**	**7.0**	6.9	7.4	6.0	6.0		
CTCI	**4.6**	**7.1**	10.6	10.6	8.7	**2.0**		
GFSI	**7.5**	11.1	13.4	13.8	10.3	**4.0**		
EMXI	8.2	11.7	16.1	10.8	11.7	8.0		
HCCA	**4.1**	**5.4**	**5.6**	5.6	5.0	**4.0**		
FSSE	**5.4**	**5.8**	**5.3**	**1.8**	**4.7**	9.0		
Forecasts	11	9	7	5	3	1		

Table 6. Coastal wind watch and warning summary for Hurricane Francine, 9–12 September 2024.

Date/Time (UTC)	Action	Location
8 / 2100	Tropical Storm Watch issued	Barra del Tordo to TX/MEX Border
9 / 0300	Tropical Storm Watch modified	Barra del Tordo to Port Mansfield
9 / 1500	Tropical Storm Watch issued	High Island to Cameron
9 / 1500	Tropical Storm Watch issued	Grand Isle to Pearl River
9 / 1500	Hurricane Watch issued	Cameron to Grand Isle
9 / 2100	Tropical Storm Watch modified	Barra del Tordo to High Island
9 / 2100	Tropical Storm Warning issued	Morgan City to Grand Isle
9 / 2100	Tropical Storm Warning issued	High Island to Sabine Pass
9 / 2100	Hurricane Watch modified	Morgan City to Grand Isle
9 / 2100	Hurricane Warning issued	Sabine Pass to Morgan City
10 / 0000	Tropical Storm Watch modified	Barra del Tordo to La Pesca
10 / 0000	Tropical Storm Warning issued	La Pesca to Port Mansfield
10 / 1200	Tropical Storm Watch changed to Tropical Storm Warning	Grand Isle to Pearl River
10 / 1200	Tropical Storm Warning modified	Grand Isle to Pearl River
10 / 1200	Hurricane Watch discontinued	All
10 / 1200	Hurricane Warning modified	Sabine Pass to Grand Isle
10 / 1500	Tropical Storm Watch issued	AL/MS Border to AL/FL Border
10 / 1500	Tropical Storm Warning modified	Grand Isle to AL/MS Border
10 / 1800	Tropical Storm Watch discontinued	Barra del Tordo to La Pesca
10 / 1800	Tropical Storm Watch modified	Matagorda to High Island
10 / 1800	Tropical Storm Warning discontinued	La Pesca to Port Mansfield
10 / 2100	Tropical Storm Watch discontinued	All
10 / 2100	Tropical Storm Warning modified	High Island to Cameron

Date/Time (UTC)	Action	Location
10 / 2100	Tropical Storm Warning modified	Grand Isle to AL/FL Border
10 / 2100	Hurricane Watch issued	Lake Maurepas, Lake Pontchartrain, and metropolitan New Orleans
10 / 2100	Hurricane Warning modified	Cameron to Grand Isle
11 / 0300	Tropical Storm Warning discontinued	High Island to Cameron
11 / 0300	Tropical Storm Warning issued	Sabine Pass to Vermillion/Cameron PL
11 / 0300	Hurricane Warning modified	Vermillion/Cameron PL to Grand Isle
11 / 1800	Tropical Storm Warning modified	Cameron to Vermillion/Cameron PL
12 / 0300	Tropical Storm Warning discontinued	Cameron to Vermillion/Cameron PL
12 / 0300	Tropical Storm Warning modified	Intracoastal City to AL/FL Border
12 / 0300	Hurricane Watch discontinued	All
12 / 0300	Hurricane Warning discontinued	All
12 / 0600	Tropical Storm Warning modified	Morgan City to AL/FL Border
12 / 0900	Tropical Storm Warning modified	Grand Isle to AL/FL Border
12 / 1200	Tropical Storm Warning discontinued	All

Table 7. Storm surge watch and warning summary for Hurricane Francine, 9–12 September 2024.

Date/Time (UTC)	Action	Location
9 / 1500	Storm Surge Watch issued	High Island to the Mississippi/Alabama Border, (including Vermilion Bay, Lake Maurepas, and Lake Pontchartrain)
9 / 2100	Storm Surge Warning issued	High Island to Mouth of the Mississippi River (including Vermilion Bay)
10 / 1500	Storm Surge Warning modified	High Island to the Mississippi/Alabama Border
10 / 1500	Storm Surge Watch issued	Mississippi/Alabama Border to the Alabama/Florida Border (including Mobile Bay)
10 / 2100	Storm Surge Warning modified	Sabine Pass to Mississippi/Alabama Border
11 / 0300	Storm Surge Warning modified	Cameron to Mississippi/Alabama Border
11 / 1500	Storm Surge Watch discontinued	Mississippi/Alabama Border to the Alabama/Florida Border
12 / 0300	Storm Surge Warning modified	Avery Island to Mississippi/Alabama Border
12 / 0900	Storm Surge Warning modified	Grand Isle to Mississippi/Alabama Border
12 / 1200	Storm Surge Warning modified	Pearl River to Mississippi/Alabama Border
12 / 1500	Storm Surge Warning discontinued	All

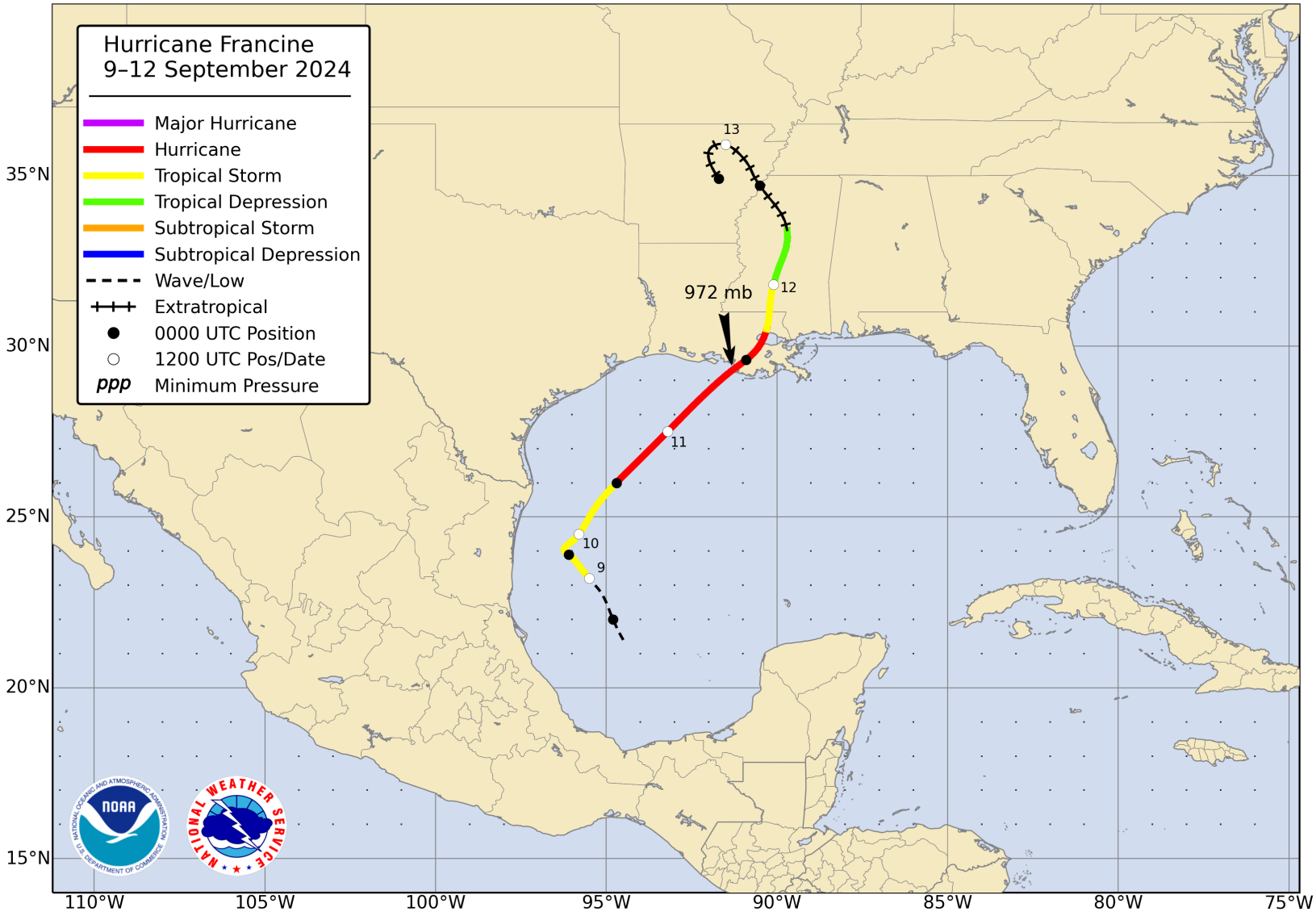

Figure 1. Best track positions for Hurricane Francine, 9–12 September 2024. Tracks over the United States and during the extratropical stage are partially based on analyses from the NOAA Weather Prediction Center.

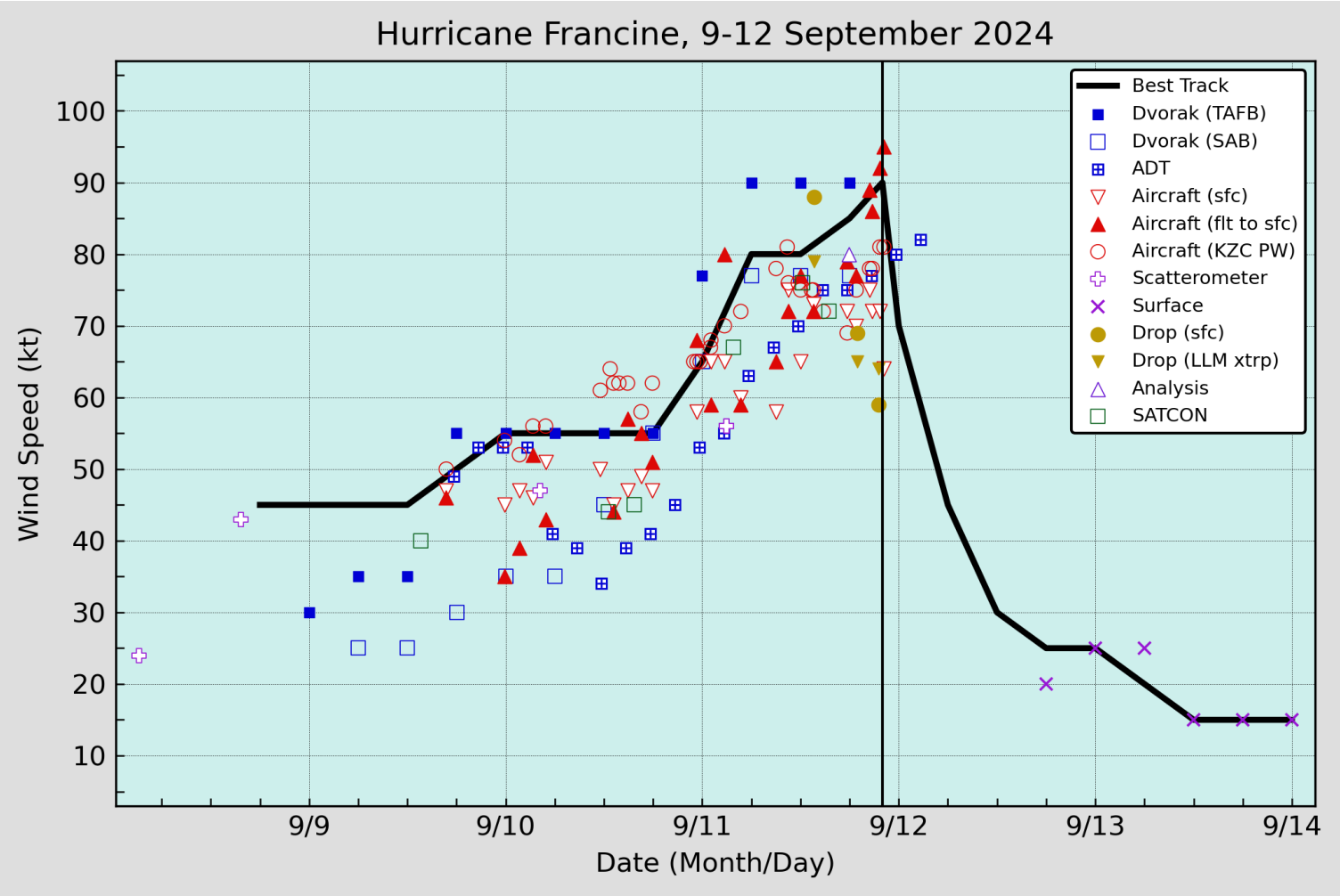

Figure 2. Selected wind observations and best track maximum sustained surface wind speed curve for Hurricane Francine, 9–12 September. Aircraft observations have been adjusted for elevation using 90%, 80%, and 75% adjustment factors for observations from 700 mb, 850 mb, and 925 mb, respectively. Dropwindsonde 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.

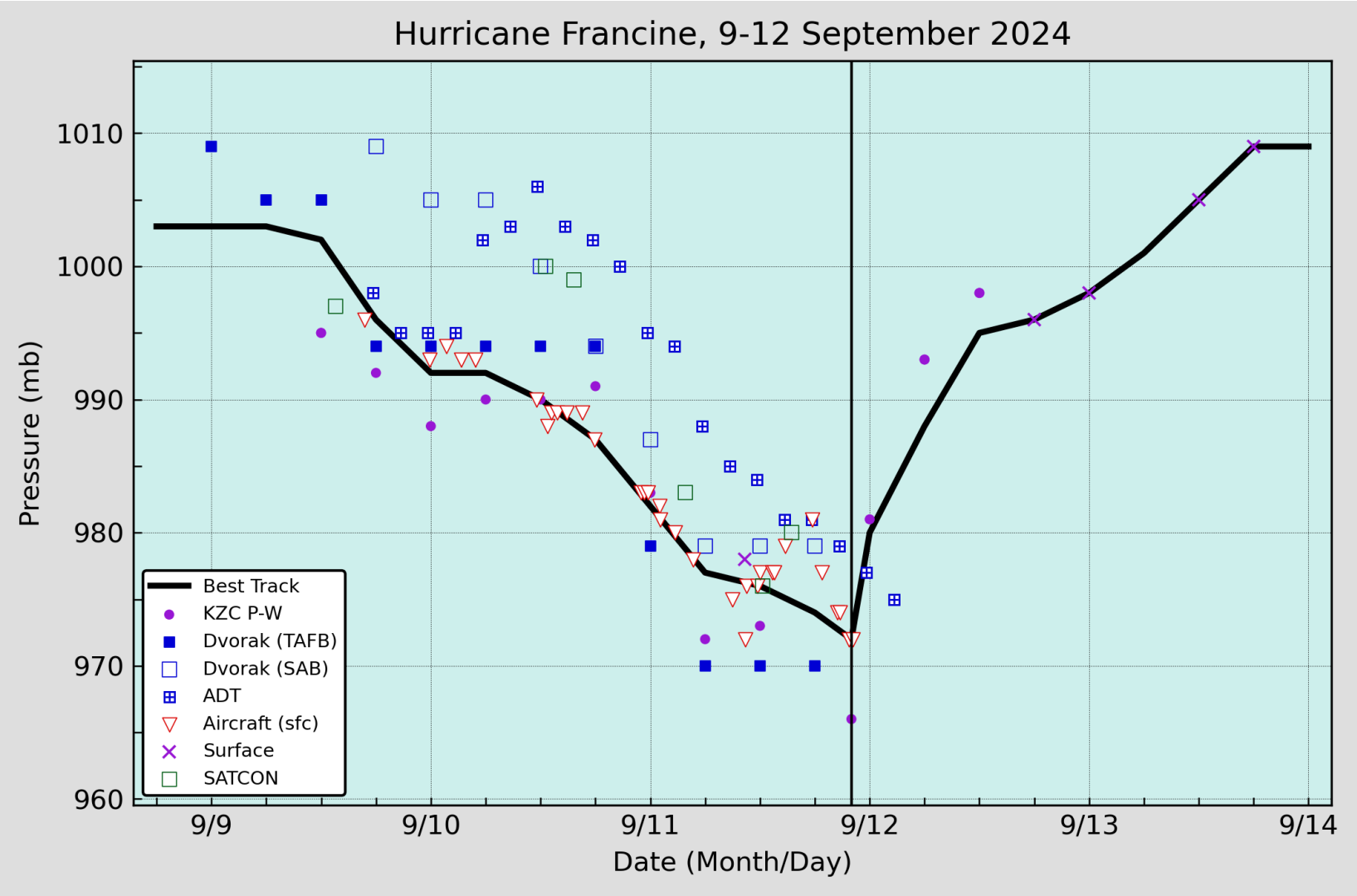

Figure 3. Selected pressure observations and best track minimum central pressure curve for Hurricane Francine, 9–12 September 2024. Advanced Dvorak Technique estimates represent the Current Intensity at the nominal observation time. SATCON intensity estimates are from the Cooperative Institute for Meteorological 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.

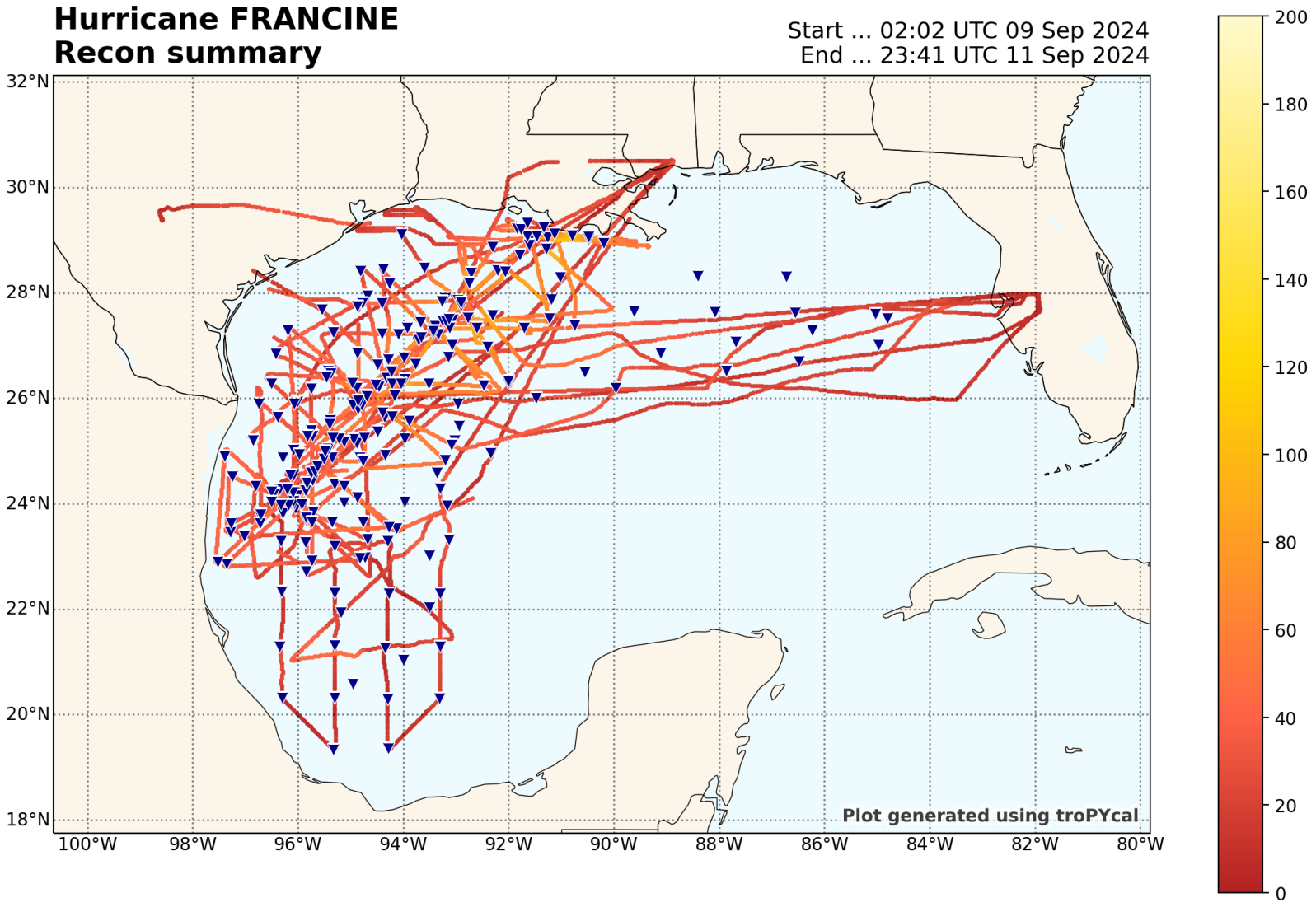

Figure 4. Air Force Reserve and NOAA Hurricane Hunter aircraft flight tracks (colored lines) from reconnaissance missions into Francine from 9–11 September 2024. The blue triangles indicate dropsonde locations. The color of the flight track represents the observed flight-level wind speed in knots at that location (see legend). Dropsondes with no flight tracks are from the NOAA G-IV aircraft.

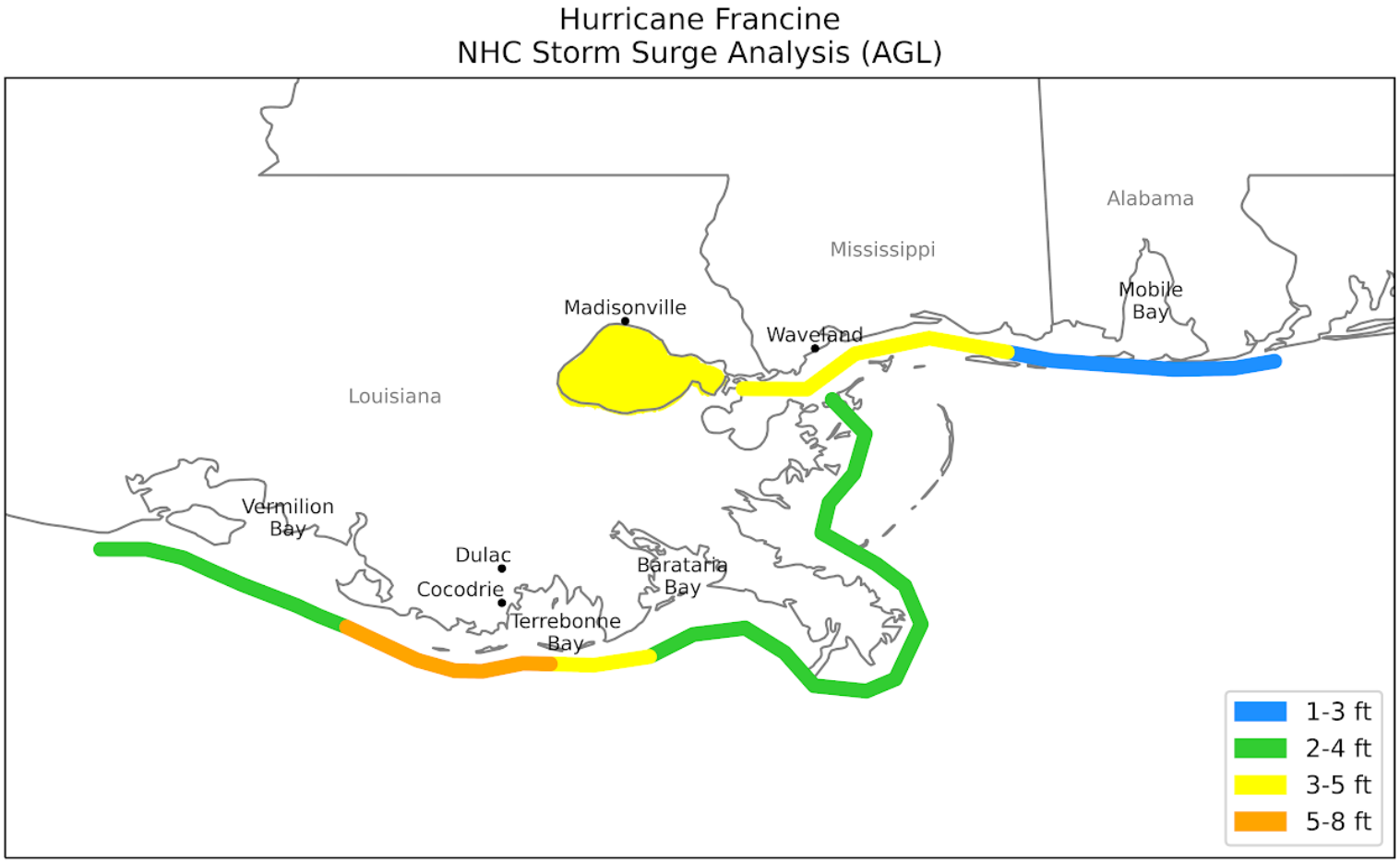

Figure 5. Analyzed storm surge inundation (feet above ground level) along the coasts of Louisiana, Mississippi, and Alabama from Hurricane Francine.

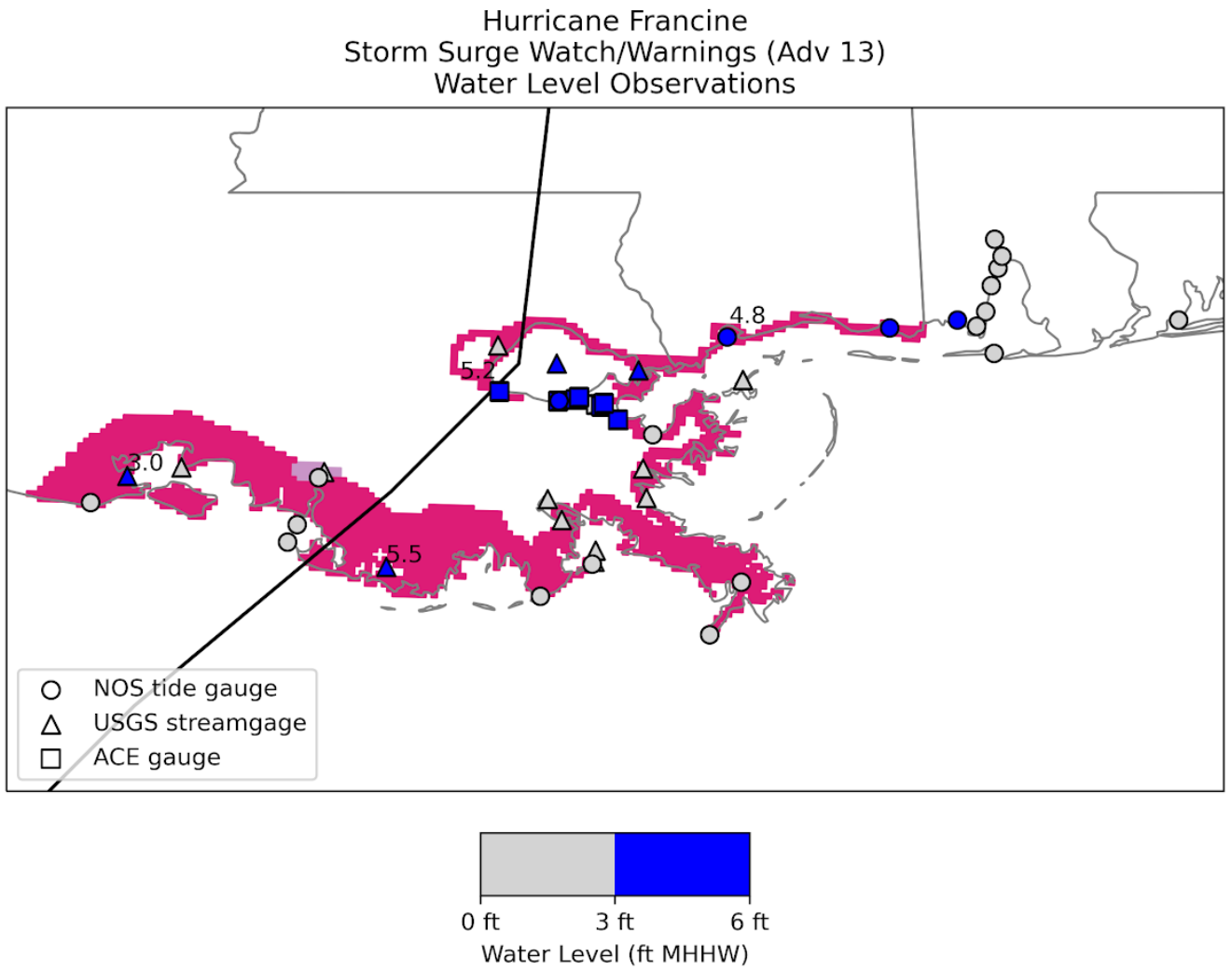

Figure 6. Maximum water levels (ft above MHHW) during Hurricane Francine measured by NOS tide gauges, USGS streamgages, and USACE gauge networks, overlaid on the storm surge watch (lavender) and warning (magenta) in effect at 2100 UTC 11 September. Francine's track is overlaid (black line).

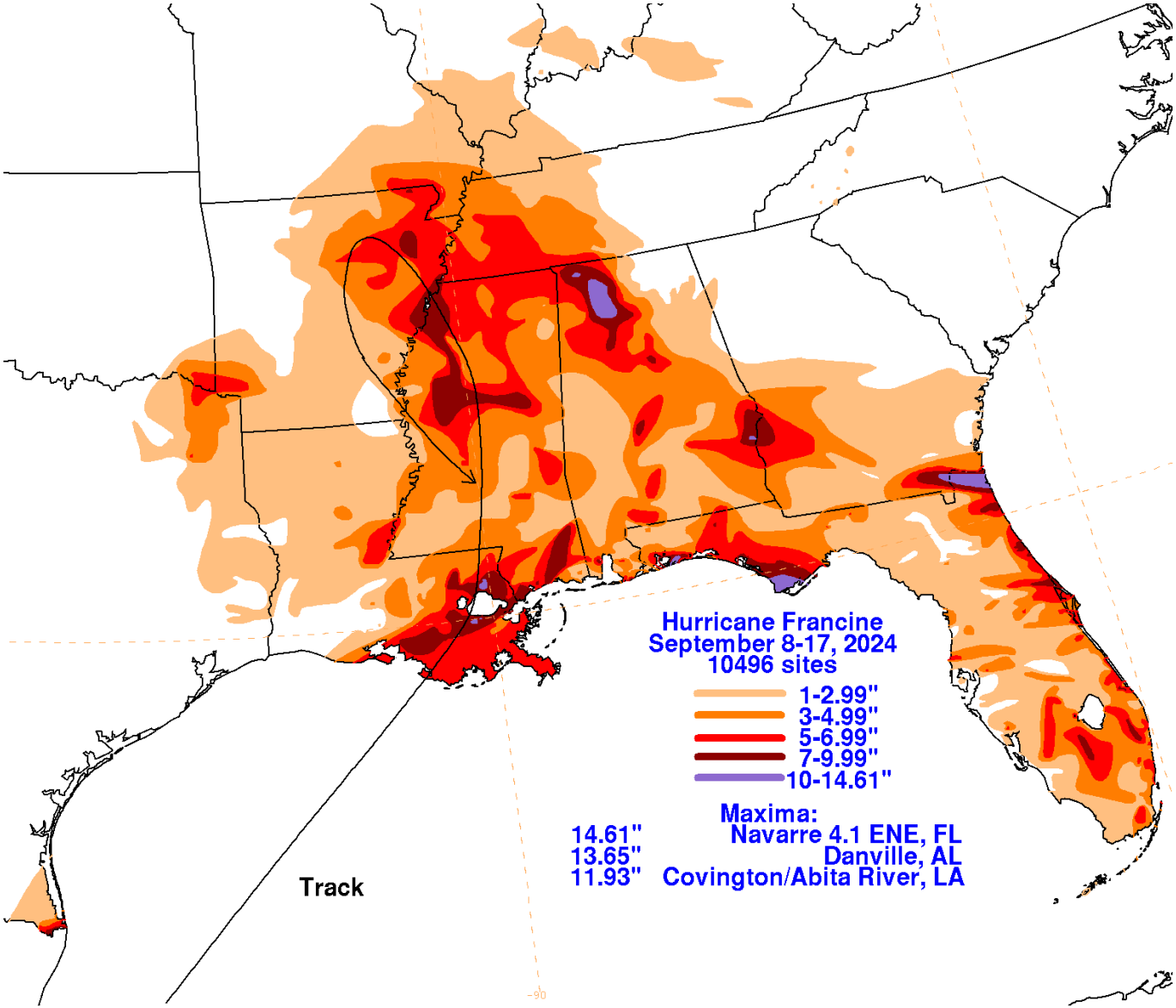

Figure 7. Storm total rainfall amounts (inches) in the United States from 8–17 September. The track is based on the NHC operational assessment. Image courtesy of David Roth (NOAA Weather Prediction Center).

Figure 8. Bystander rescuing passenger of a partially submerged pickup truck in the rainfall floodwaters of New Orleans, Louisiana during Hurricane Francine on 11 September. Credit: WDSU/CNN affiliate

Figure 9. The damaged remains of a residence in Bayou Dularge on 12 September 2024, one day after Hurricane Francine made landfall in Terrebonne Parish. Credit: Wes Muller/Louisiana Illuminator

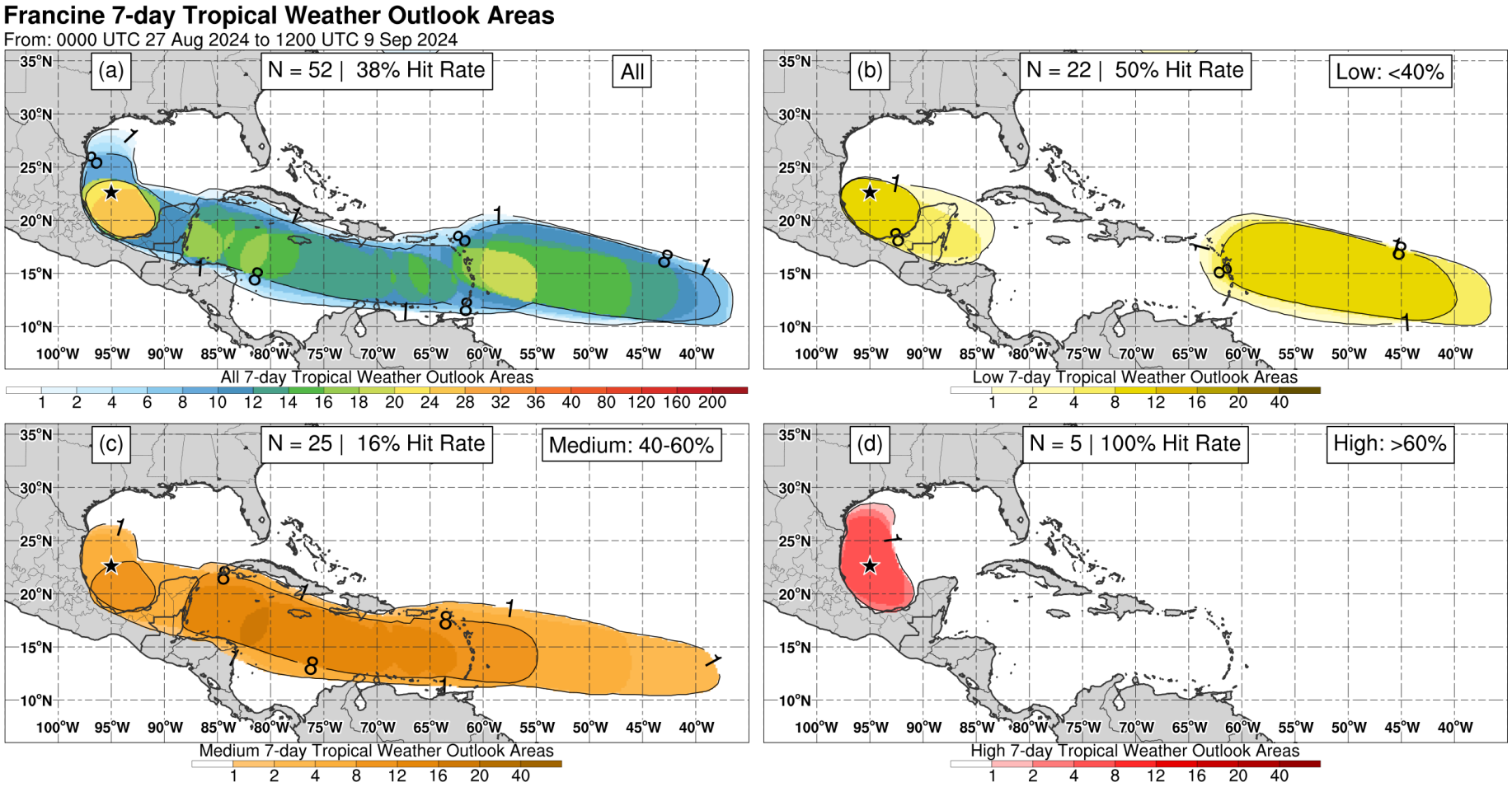

Figure 10. Composites of 7-day tropical cyclone genesis areas depicted in NHC's Tropical Weather Outlooks prior to the formation of Francine for (a) all probabilistic genesis categories, (b) the low (<40%) category, (c) medium (40–60%) category, and (d) high (>60%) category. The location of genesis is indicated by the black star.

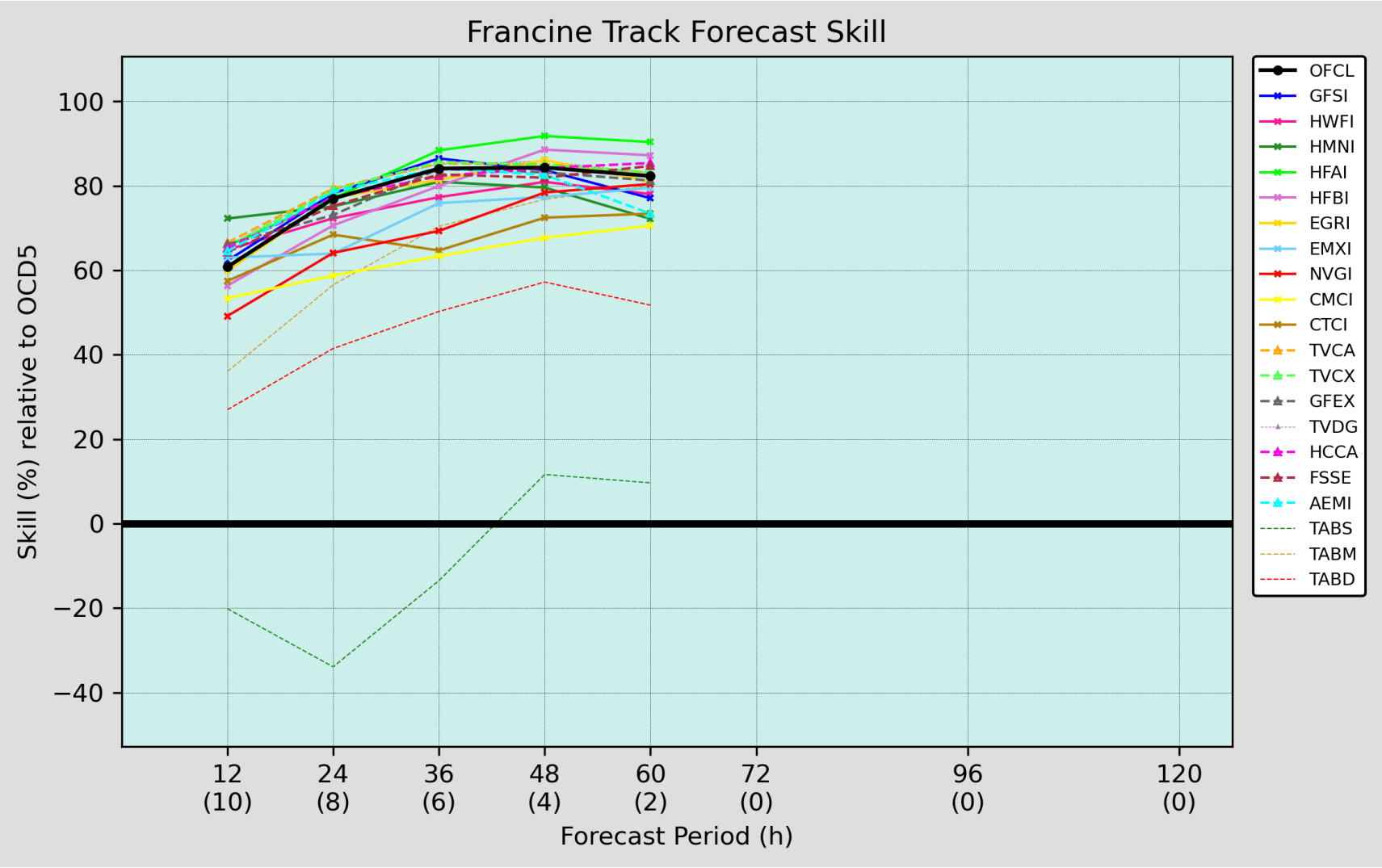

Figure 11. NHC official forecast and selected model forecast track skill (relative to climatology-persistence, OCD5) for Hurricane Francine, 9–12 September 2024.

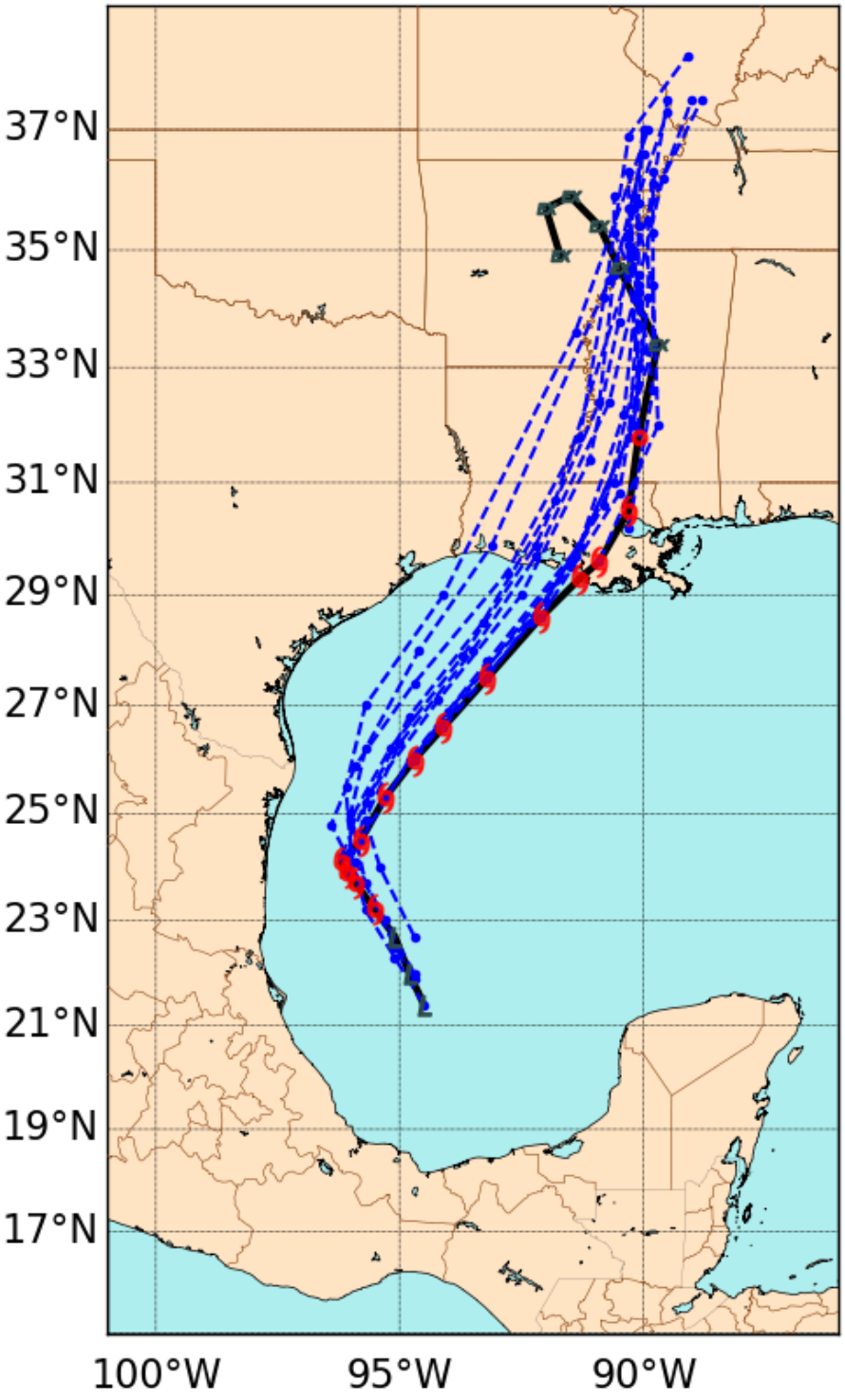

Figure 12. NHC official track forecasts (dashed blue lines) for Francine from 1800 UTC 8 September to 1200 UTC 12 September. The best track is given by the solid black line with red position symbols (TS, HU) and gray position symbols (LO) at 6-h intervals.

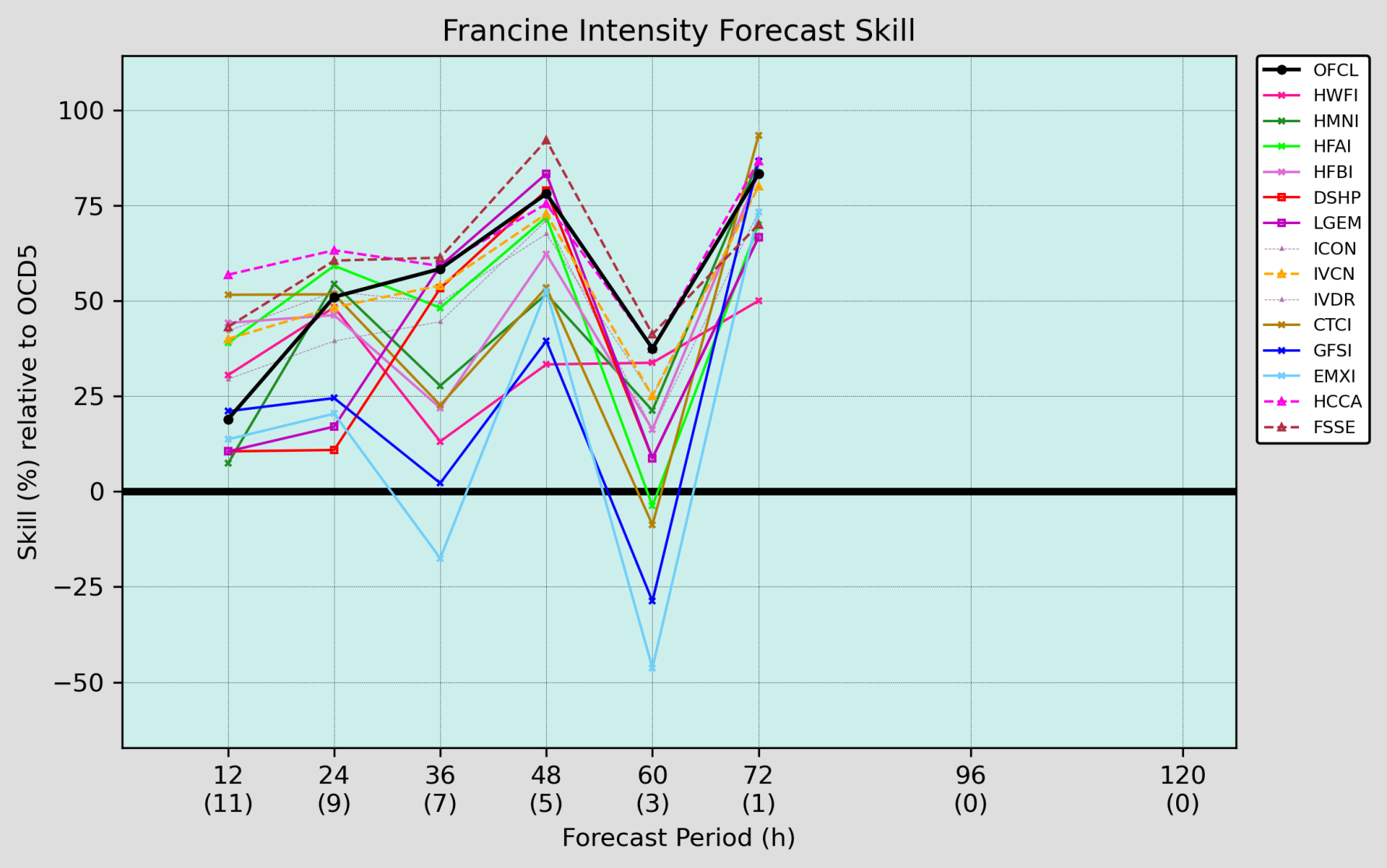

Figure 13. NHC official forecast and selected model intensity track skill (relative to climatology-persistence, OCD5) for Hurricane Francine, 9–12 September 2024.

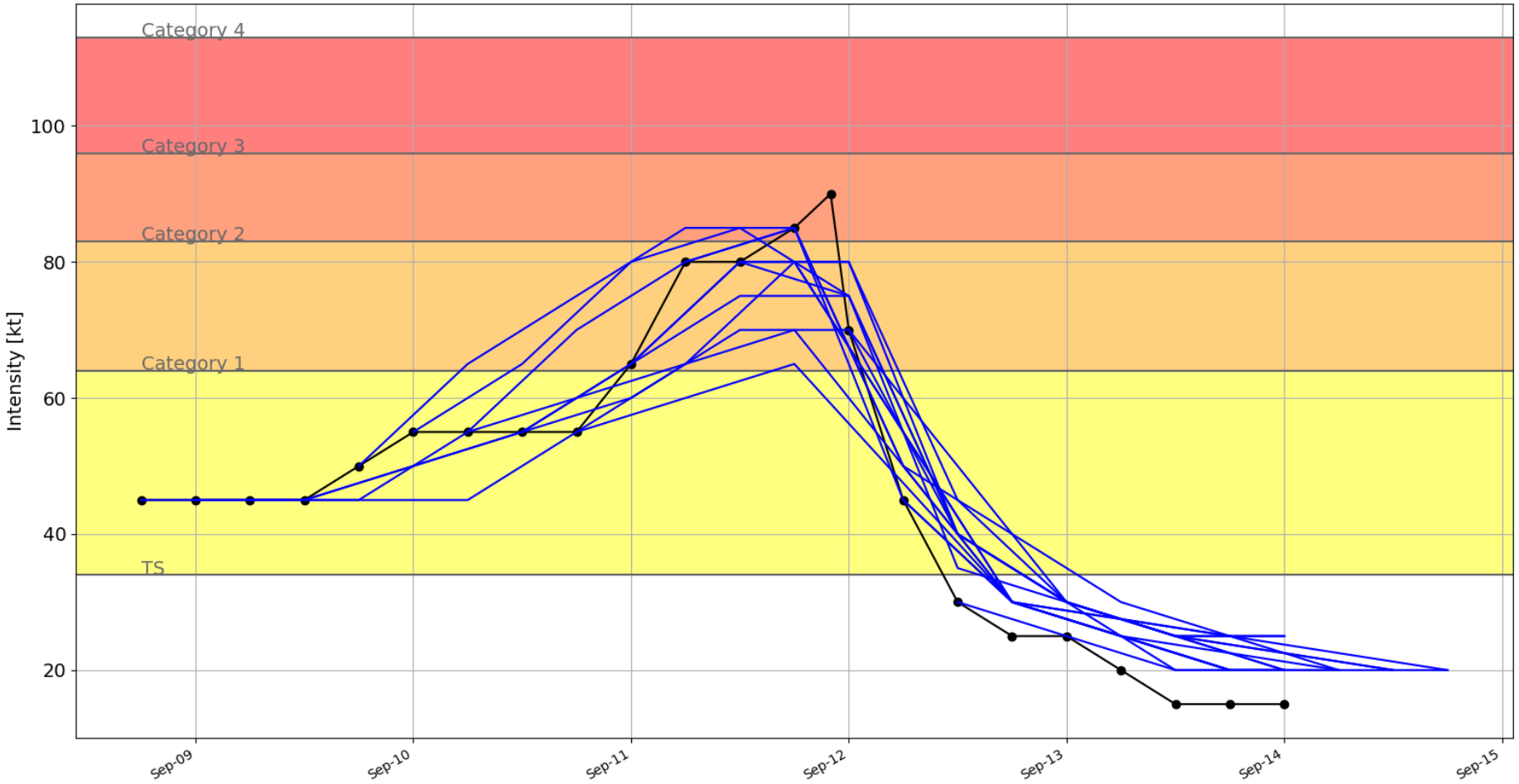

Figure 14. Selected official intensity forecasts (blue lines) for Hurricane Francine, 9–12 September 2024. The best track is given by the solid black line with intensities given at 6 h intervals.