NATIONAL HURRICANE CENTER TROPICAL CYCLONE REPORT

HURRICANE ELSA

(AL052021)

30 June–9 July 2021

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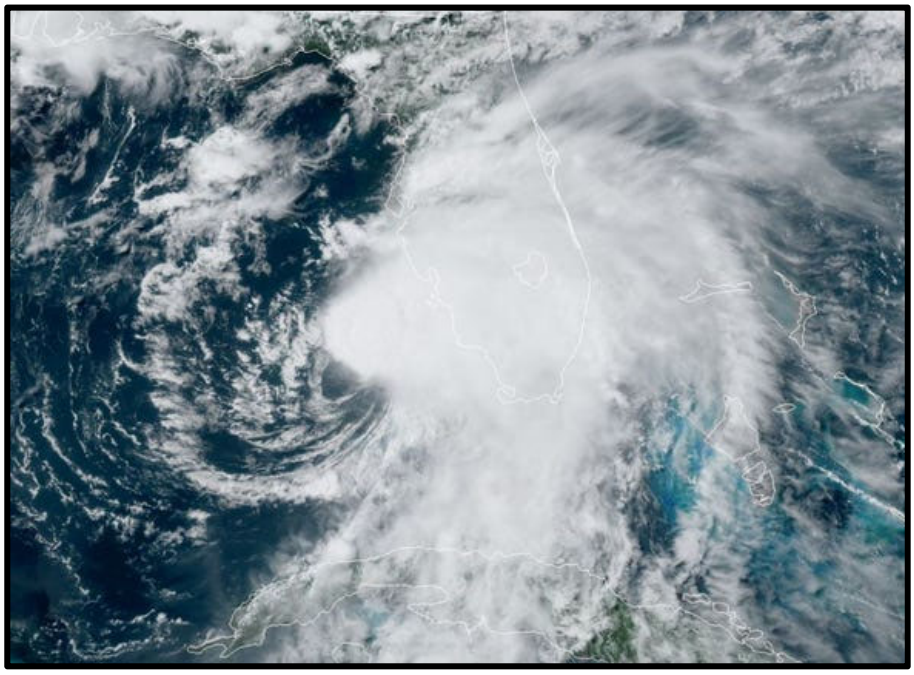

GOES-16 GEOCOLOR SATELLITE IMAGE OF ELSA AT 2100 UTC 6 JULY WHEN IT WAS LOCATED OFF THE COAST OF SOUTHWESTERN FLORIDA AS A TROPICAL STORM.

Elsa was an early season category 1 hurricane (on the Saffir-Simpson Hurricane Wind Scale) that formed over the central tropical Atlantic. Elsa affected many countries including Barbados, St. Lucia, St. Vincent and the Grenadines, Martinique, the Dominican Republic, Haiti, Cuba, and the United States. The hurricane caused around $1 billion in damage along its track and was responsible for 13 direct fatalities.

[1] Original report dated 10 February 2022. This version updates the damage total for the United States

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Hurricane Elsa

30 JUNE–9 JULY 2021

SYNOPTIC HISTORY

Elsa formed from a tropical wave that departed the west coast of Africa on 27 June with support from a convectively-coupled Kelvin wave. The low-latitude tropical wave produced disorganized showers and thunderstorms while it moved quickly westward across the eastern tropical Atlantic during the next few days. Deep convection increased along the wave axis on 30 June, and geostationary satellite, scatterometer, and microwave data indicate that a closed and well-defined low pressure system developed by 1800 UTC that day, marking the formation of a tropical depression about 1000 n mi east-southeast of Barbados. Genesis this far east in the basin is quite unusual for late June and early July. In fact, Elsa's genesis was the second farthest east in history in the month of June, behind the second tropical cyclone in 1933. However, it should be noted that reliable records over the open oceans only began when satellite images became available in the 1960s. The depression strengthened to a tropical storm 6 h later. The "best track" chart of Elsa'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].

On the south side of a strong subtropical ridge, Elsa moved rapidly westward at about 25 kt across the tropical central Atlantic on 1 July, and the storm steadily strengthened with banding features becoming more prominent around the center. By early 2 July, microwave and radar data indicate that a small inner core formed (Fig. 4a), and Elsa strengthened to a hurricane as the center moved just south of Barbados around 1200 UTC that day. The southern portion of Barbados was estimated to be within the radius of maximum wind, and hurricane-force winds were measured on the island. Elsa continued to strengthen during the next several hours, and the small hurricane passed near St. Lucia and St. Vincent in the Windward Islands around 1600 UTC, and then reached a peak intensity of 75 kt over the eastern Caribbean Sea by 1800 UTC. This concluded a 30-kt intensification over a 24-h period. The episode of rapid intensification was quite impressive given Elsa's fast forward motion, which typically hinders a rapid rate of development. However, around the time Elsa reached its peak intensity, Air Force Reserve Hurricane Hunter data suggested that the circulation at flight-level (700 mb) was not well-developed and there was a significant amount of vertical tilt in the vortex between the surface and 700 mb. This asymmetric and ragged structure was likely due to the fast low-level easterly flow (which caused Elsa's fast forward speed) and associated westerly vertical wind shear.

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[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.

Elsa's forward speed increased to near 30 kt while it moved across the eastern and central Caribbean Sea early on 3 July, and the low- and mid-level circulations decoupled further. The low-level center became exposed to the west of the main area of deep convection by 1200 UTC that day (Fig. 4b) and Elsa weakened back to a tropical storm by that time when it was located about 100 n mi south of the southern coast of the Dominican Republic. Elsa continued to lose strength later that day and early on 4 July as the center passed to the south of Haiti and then between Jamaica and eastern Cuba, and the cyclone weakened to a 50-kt tropical storm by 1200 UTC 4 July. Around that time, the forward speed of the storm slowed significantly to a more climatological 10–15 kt as Elsa neared the southwestern periphery of the ridge. Deep convection again began to form over the system's center, and the storm restrengthened slightly to 55 kt by 0000 UTC 5 July when it was located about 60 n mi south of central Cuba. Elsa held that intensity until it made landfall around 1830 UTC that day in the southwestern portion of the country in Parque Nacional Cienaga de Zapata.

Elsa weakened a little as it moved across western Cuba during the afternoon and evening hours on 5 July. Meanwhile the storm turned northwestward to north-northwestward and slowed to a forward speed of about 10 kt during that time. By early 6 July, Elsa emerged over the Florida Straits and deep convection again reformed over the center. Now moving north-northwestward within favorable atmospheric and oceanic conditions, Elsa began to strengthen once again. Doppler radar data from Key West indicated that the inner core began to redevelop as it passed near the Dry Tortugas around 1200 UTC that day, and an eye feature became apparent late on 6 July when Elsa was located off the coast of southwestern Florida (Fig. 4c). Doppler radar data from Tampa and Key West indicate that Elsa briefly regained hurricane intensity by 0000 UTC 7 July when it was centered about 50 n mi west of Englewood, Florida. However, shortly after that time, the convective pattern became ragged, likely due to an increase in shear and dry air intrusions, and Elsa began to lose strength. The system weakened back to a tropical storm 6 h later when it was located about 35 n mi west of St. Petersburg. Elsa then began to accelerate northward, and it made landfall in a remote location in Taylor County in northern Florida around 1430 UTC that day with maximum winds of about 55 kt.

After moving inland over Florida, land interaction caused the inner-core convection to decay, and Elsa weakened to an intensity of 40 kt by 0600 UTC 8 July as it turned northeastward over southeastern Georgia. Later on 8 July, Elsa turned northeastward and began moving more quickly across the U.S. southeast and Mid-Atlantic states. Although the center remained inland, the storm restrengthened slightly with the strongest winds occurring over the nearby Atlantic waters. Elsa emerged back over water off New Jersey early on 9 July and it began extratropical transition with convection shifting to the north of the center and frontal features developing (Fig 4d). The center of the storm moved over eastern Long Island and western Rhode Island during the late morning and early afternoon hours on 9 July with peak winds estimated to be around 50 kt. Elsa became extratropical by 1800 UTC that day as it moved over southeastern New England. The extratropical cyclone moved even faster in the mid-latitude flow later that day and slowly weakened. The storm dissipated over Atlantic Canada before 1200 UTC 10 July.

METEOROLOGICAL STATISTICS

Observations in Elsa (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 13 reconnaissance aircraft missions into the hurricane. This includes 9 flights of the U.S. Air Force Reserve Command's 53rd Weather Reconnaissance Squadron's WC-130 aircraft and 4 missions of the NOAA WP-3D Orion aircraft, 3 of which were operationally tasked and 1 research mission. These missions provided a total of 35 center fixes for Elsa from 2–7 July. There were also 2 synoptic surveillance flights of the NOAA G-IV aircraft that provided information on Elsa's environment on 2–3 July.

Data and imagery from NOAA polar-orbiting satellites including the Advanced Microwave Sounding Unit (AMSU), the NASA Global Precipitation Mission (GPM), the European Space Agency's Advanced Scatterometer (ASCAT), and Defense Meteorological Satellite Program (DMSP) satellites, among others, were also useful in constructing the best track of Elsa. In addition, data from radars across the Caribbean region and National Weather Service WSR-88D radars across Florida and much of the U.S. east coast were beneficial in tracking Elsa. While Elsa was near Florida, Doppler velocity data was particularly useful in estimating the system's intensity along with the extent and strength of the outer wind field.

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

Winds and Pressure

Elsa's estimated peak intensity of 75 kt at 1800 UTC 2 July is based on a combination of flight-level, SFMR, and dropsonde data from a NOAA Hurricane Hunter aircraft. The maximum SFMR wind reported was 73 kt at 1905 UTC 2 July and dropsonde data from a couple of hours earlier at 1633 UTC revealed peak mean boundary layer winds and average winds in the lowest 150 m of the atmosphere that supported 76 kt at the surface. The peak flight-level wind was 78 kt at 700 mb, which reduces to about a 70-kt intensity at the surface. The estimated minimum pressure of 991 mb is based on dropsonde data from the NOAA Hurricane Hunter aircraft.

Caribbean Islands

Elsa brought sustained hurricane-force winds to Barbados on 2 July when the center of the compact storm moved just south of the island. The Barbados airport recorded maximum 10-minute sustained winds of 65 kt at 1122 UTC 2 July and a peak wind gust of 78 kt. Elsa later moved through the Windward Islands and over the Caribbean Sea, spreading tropical-storm-force

winds across the Windward Islands and the southern Leeward Islands. NOAA buoy 42059 in the eastern Caribbean recorded sustained winds of 41 kt and a gust of 45 kt at 0754 UTC on 3 July. Later that day, squalls associated with Elsa affected Hispaniola and scatterometer data showed tropical-storm-force winds near the southern coast of the island. On 4 and 5 July, Elsa affected Jamaica, the Cayman Islands and Cuba, bringing squalls and tropical-storm-force winds to portions of that region.

United States

Florida

Elsa affected the Florida Keys and paralleled the west coast of Florida before making landfall in the Big Bend region on 6 and 7 July. In the Florida Keys, the Smith Shoal Light marine station reported maximum winds of 53 kt and a wind gust to 58 kt at 1408 UTC 6 July. On land, Key West International airport (KEYW) recorded sustained winds of 45 kt and gust of 61 kt at 1550 UTC 6 July. Near the point of landfall in north Florida, Horseshoe Beach reported sustained winds of 54 kt and a wind gust to 62 kt at 1440 UTC 7 July, which was the highest wind recorded during Elsa in Florida. Cedar Key observed sustained winds of 40 kt and wind gusts to 50 kt at 1042 UTC 7 July.

Georgia and the Carolinas

After the Florida landfall, Elsa turned toward the northeast and accelerated ahead of a frontal boundary, producing tropical-storm-force winds over a large portion of the U.S. eastern seaboard. In Georgia, a station in Tybee Island recorded sustained winds of 55 kt and a wind gust to 65 kt at 0303 UTC 8 July, but this was likely associated with a strong squall to the east of the center and not representative of Elsa's true intensity at the time. Nearby in South Carolina, a Weatherflow station in Calibogue Sound recorded sustained winds of 47 kt and a gust to 70 kt at 0328 UTC 8 July in a similar squall. The elevated Frying Pan Tower located southeast of Cape Fear, North Carolina recorded sustained winds of 43 kt and a gust to 50 kt at 1400 UTC 8 July. In North Carolina, the highest winds were recorded in the Outer Banks by a Weatherflow station at Kites Resort that reported sustained winds of 46 kt and a wind gust to 55 kt at 0155 UTC 9 July.

Mid-Atlantic and eastern New England

Most of the wind impacts associated with Elsa in the Mid-Atlantic and northeastern U.S. occurred over the eastern portion of the circulation as the system interacted with an approaching frontal boundary. An elevated site in Tangier Island, Virginia, reported sustained winds of 50 kt and a wind gust to 59 kt at 0153 UTC on 9 July, which was the highest report in the state during Elsa. Similarly, in Maryland, a Weatherflow site at Assateague Island recorded sustained winds of 46 kt and a wind gust of 59 kt at 0353 UTC on 9 July. Farther up the coast, three coastal stations in New Jersey reported wind gusts over 60 kt during the morning hours of 9 July. The highest wind recorded in New York occurred on the northern coast of Long Island, where a Weatherflow site at Eatons Neck reported sustained winds of 48 kt and gust to 52 kt at 1219 UTC on 9 July. Mount Washington recorded a peak sustained wind of 60 kt and a gust of 74 kt at

0554 UTC on 9 July. In coastal Massachusetts and Maine, wind gusts reached over 50 kt on 9 July.

Canada

Elsa reached the Atlantic provinces of Canada as an extratropical cyclone and was promptly absorbed by a larger system. Observing sites in Nova Scotia and Prince Edward Island recorded sustained winds in the 25 to 35 kt range. The highest wind gust reported was 54 kt at Cape Breton at 0815 UTC on 10 July.

Storm Surge[3]

Elsa produced storm surge inundation levels of 1 to 3 ft above normally dry ground (AGL) along portions of the west coast of Florida, with the highest water levels (2 to 3 ft) occurring along the coasts of Hernando, Citrus, Levy, Dixie, and Taylor Counties. A United States Geological Survey (USGS) gauge at the mouth of the Withlacoochee River near Yankeetown, Florida, measured a peak water level of 4.41 ft above the North American Vertical Datum of 1988 (NAVD88), which converts to 2.9 ft above Mean Higher High Water (MHHW). Other notable water levels measured in the region include 2.7 ft MHHW from the National Ocean Service (NOS) tide gauge at Cedar Key and 2.5 ft MHHW from USGS gauges near the mouths of the Homosassa and Crystal Rivers. Peak water levels recorded by gauges from the Tampa Bay region southward, as well as along Apalachee Bay, were between 1 to 2 ft MHHW. Table 3 and Figure 5 provide observations from various tide stations and water level sensors along the west coast of Florida.

Elsa produced a couple feet of storm surge above normal tide levels along some parts of the east coast of the United States, but the surge did not result in any notable coastal flooding. The highest measured storm surge was 2.65 ft above normal tide levels at Fort Pulaski, Georgia, but this surge occurred during an ebb tide and thus did not result in coastal flooding. The highest water level recorded from any NOS tide gauge along the U.S. east coast was 1.5 ft MHHW at Dahlgren, Virginia.

Rainfall and Flooding

Elsa produced a swath of heavy rain along its path across the eastern U.S. (Fig. 6). In Florida, a large area of 3–7 inches of rain fell across the west coast of the state. The highest

[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).

rainfall total was in Punta Gorda, Florida, where 11.04 inches accumulated. Several sites across southwest Florida recorded amounts of 8–11 inches. Rainfall amounts of 3–7 inches were observed in the Lower Florida Keys, with the highest accumulation occurring in Key West. Significant flooding occurred in the Old Town and Mid-Town areas of Key West as a heavy rainband set up over the island.

A widespread area of 3–5 inches of rain occurred across coastal Georgia through southeastern Virginia, with isolated pockets of 5–8 inches. The highest rainfall total in Georgia was 8.20 inches in Skidaway Island in the Savannah area. The heavy rainfall flooded several roads in the Savannah area with 13 people needing rescuing from their vehicles. In South Carolina, flooding was also reported in Charleston, necessitating the closing of several streets. Most of the rainfall amounts from North Carolina to the Mid-Atlantic states were between 3 and 6 inches.

A Predecessor Rain Event (PRE) affected portions of the Northeast U.S. on 8 July, resulting in heavy rainfall in the New York City area and portions of Connecticut. The rainfall in this area was enhanced by nearby frontal boundary. Elsa arrived the next day with another round of heavy rainfall. In total, the rainfall amounts were in the range of 5 to 7 inches. The heavy rainfall caused several roads and a subway station to flood in the New York City area, numerous road closures and water rescues, including the rescue of over a dozen motorists on I-87. Elsewhere in New England, especially the coastal areas, received between 3 and 5 inches of rain, with isolated spots approaching 6 inches.

Although data were sparse across the Caribbean region, rainfall amounts were lower across the Windward and Leeward Islands due to Elsa's fast forward motion over those islands. However, heavier rains and associated flooding occurred over portions of Hispaniola and Cuba.

Tornadoes

Elsa produced 17 tornadoes from northern Florida to southern New Jersey (Table 5). Among the tornadoes, 2 were reported in Florida, 2 in Georgia, 5 in South Carolina, 3 in North Carolina, 3 in Virginia, and 2 in New Jersey. The strongest and most damaging tornado was an EF-2 that passed through Camden County, Georgia on 7 July. Peak winds associated with the tornado are estimated to be around 130 mph, and these very powerful winds caused damage to residences and businesses in St. Marys, Georgia. The tornado also passed through an RV park and flipped numerous vehicles and knocked down several hardwood trees, resulting in 17 injuries. The tornado with the longest path also occurred in coastal Georgia, where an EF-1 lasted for about 1.9 miles in Effingham County. In South Carolina, all 5 tornadoes were rated as EF-1s and had maximum winds close to 100 mph.

In New Jersey, one of the tornadoes was rated an EF-1 that passed through Cape May County and caused damage to condominiums and trees. The other tornado in New Jersey and the ones that occurred in North Carolina and Virginia were weaker and caused less damage.

CASUALTY AND DAMAGE STATISTICS

There were 13 direct deaths[4] associated with Elsa, nine offshore in the Florida Straits, two in the Dominican Republic, one in Martinique, and one in the United States. See below for details on the fatalities. According to the NOAA National Centers for Environmental Information, Elsa is responsible for an estimated $1.2 billion of damage in the U.S. However, as of this writing, financial losses across the Caribbean region are unknown.

Barbados

Elsa produced significant wind damage, especially across the southern portion of the island as the northern eyewall of the compact hurricane moved directly across the area. Hurricane-force winds were reported for a brief time, which caused numerous downed trees, structural and roof damage to homes and businesses, and power outages that affected the entire island (Fig. 7). Media reports indicate that Queen Elizabeth hospital suffered major damage with sections of the roof lifted and windows blown out. There were also many reports of flooded streets. Despite the impact to the island, there were no reports of casualties. Elsa was the first hurricane strike to Barbados since Hurricane Janet in 1955.

St. Lucia, St. Vincent, and Martinique

The center of Elsa passed between St. Lucia and St. Vincent on 2 July and very strong winds moved across those islands resulting in widespread tree damage, fallen power lines, and significant damage to the banana crop. In St. Lucia, about 90% of the island's homes were out of power and in St. Vincent the main impact was tree damage and flooding. Damage was more minor in Martinique; however, one fatality was reported there. A 67-year-old man sustained head injuries and later passed away when gusty winds caused a small wind turbine to fall on his vehicle.

Dominican Republic and Haiti

Even though Elsa did not make landfall in Hispaniola, significant impacts were felt there as the storm passed just south of the island on 3 July. Two deaths were reported in the Dominican Republic. A 15-year old boy and 75-year-old woman both died in southwestern Bahoruco province due to walls collapsing from strong winds. The southern coast of Haiti also received a fair amount of damage, including numerous downed trees and power poles, and structural harm to homes and businesses. Some damage was also reported to the banana and maize crop.

[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.

Jamaica and Cayman Islands

Damage in Jamaica and the Cayman Islands was generally minor. Both countries experienced flooding, which caused some roads to be impassable. Rough seas were also reported along the coast.

Cuba

Elsa made landfall in a remote and swampy location in southwestern Cuba on 5 July, and the strongest winds likely occurred in rural areas of this portion of the island. The main impact from Elsa in Cuba was heavy rainfall and associated flash flooding and mudslides. In Cienfuegos, very heavy rainfall was reported and many streets were flooded. Some towns, including Santa Clara, Arroyo Pretiles, and Jiabacoa were cut off due to the flooding of the Jiabacoa River. Mudslides were reported in the Granma province due to heavy rains over the mountainous terrain.

Florida Straits

On 5 July a boat containing 22 people left Cuba for south Florida. Unfortunately, strong winds and high seas from Elsa caused the boat to capsize in the Florida Straits. The U.S. Coast Guard successfully rescued 13 people, but 9 others (7 men and 2 women) were not found.

United States

Elsa passed near the western Florida Keys and the Dry Tortugas early on 6 July and then moved offshore and parallel to southwestern and west-central Florida through early 7 July. Since Elsa was a relatively compact storm, the strongest winds remained offshore and wind damage was mostly minor across the Florida Keys and central and southern Florida. However, there were some reports of downed trees and flooded streets in Key West, southwestern Florida, and the Tampa Bay area. Numerous tree damage was also reported near the landfall location in Taylor County, Florida.

In northeastern Florida, southeastern Georgia, and across portions of the Carolinas, there was isolated damage caused by tornadoes associated with Elsa. A 26-year-old man died in Jacksonville, Florida, when a tree fell on him during a strong squall. In Camden County, Georgia, an EF-2 tornado ripped through an RV park; see the Tornadoes section for more details.

Elsa also caused flooding and some wind damage from New Jersey through coastal southern New England. Heavy rains in New York City caused significant flooding in some subway stations and a landslide was reported in West Haven, Connecticut. Gusty winds caused some tree and power line damage along the New Jersey coast and on Long Island, New York.

FORECAST AND WARNING CRITIQUE

Genesis

The genesis of Elsa was not well anticipated (Table 4). The potential for tropical cyclone formation was first noted in the Tropical Weather Outlook at 1200 UTC 29 June with a low (<40%) chance of development over the next five days. This provided only 30 h of lead time before development occurred. The 5-day chance of genesis was raised to the medium (40–60%) category 24 h before formation, and the high (>60%) category 12 h before development occurred. The system was assigned a low 2-day probability of formation 30 h before development and it reached the medium category 18 h before formation. However, the system became a tropical cyclone in the best track before the 2-day probabilities reached the high category. The short lead time of the NHC genesis forecasts is likely the result of mixed and inconsistent model guidance, and because the forecasters thought the fast forward motion of the system would delay genesis. Another complicating factor is that there was another low pressure system to the west of Elsa, and many of the models had difficulty with the interaction between the lows and were inconsistent in predicting which one of these disturbances would develop.

Track

A verification of NHC official track forecasts for Elsa is given in Table 6a. Official forecast track errors were slightly above the mean official errors for the previous 5-yr period at 12 and 24 h. However, the mean errors for Elsa beyond that time were below the previous 5-yr means, and more than 40% lower than the 5-yr means from 60 to 120 h. The climatology-persistence (OCD5) errors were similar to their 5-yr means, suggesting that the track forecasts for Elsa were about of average difficulty. A homogeneous comparison of the official track errors with selected guidance models is given in Table 6b and forecast skill is illustrated in Fig 8. The NHC track forecasts were very skillful and were only outperformed by the consensus models for the short lead times and by the GFS ensemble mean (AEMI) at 120 h. Among the individual models, the GFS (GFSI) and AEMI were the most skillful, and the ECMWF model (EMXI) was the poorest performer at the longer lead times. In fact, EMXI had very large errors at those forecast times, and had no skill at 120 h. Figure 9 shows the NHC forecasts and guidance from GFSI, EMXI, and HCCA from 1800 UTC 30 June to 0000 UTC 4 July. It can be seen that the NHC forecasts were quite consistent, but did have a slight right bias, while the GFSI was less consistent but exhibited little bias. However, there was a notable right bias in the EMXI and HCCA forecasts during that time period.

Intensity

A verification of NHC official intensity forecasts for Elsa is given in Table 7a. The NHC intensity forecast errors were at or lower than the previous 5-yr means at all forecast times, and about 50% smaller than average from 60 to 120 h. The OCD5 errors were close to their long-term means, indicating that the low official intensity errors were quite skillful. Figure 10 shows the NHC intensity forecasts from 1800 UTC 30 June to 0000 UTC 7 July. It can be seen that the forecasts were fairly accurate, but they did not quite capture the rapid intensification that took place early

in Elsa's lifecycle. A homogeneous comparison of the official intensity errors with selected guidance models is given in Table 7b and forecast skill is illustrated in Figure 11. Although some of the consensus models and GFSI had slightly lower errors than the NHC forecasts for the short lead times, NHC outperformed all of the models beyond 48 h. Among the individual models, GFSI, DSHP, and LGEM generally performed better than the hurricane regional models HMNI and HWFI from 12 to 72 h. Most of the models had similar errors at 96 and 120 h. In terms of biases, the NHC forecasts and the bulk of the models had a slight low bias, but HWFI had a notable high bias for the middle forecast times (not shown).

Watches and Warnings

Wind watches and warnings associated with Elsa are given in Table 8 and displayed in Fig. 12. In the Florida Keys and southwestern Florida, tropical storm watches provided 48 to 60 h of lead time and tropical storm warnings provided 36 to 48 h of lead time before those conditions began. In west-central and northwestern Florida, a Hurricane Warning was issued, but Elsa weakened to a tropical storm before it affected that area. The watches and warnings in this area provided approximately 48 h and 36 h of lead time, respectively, before tropical storm conditions began. Tropical storm conditions started by early 8 July along the Georgia and Carolina coastlines, and the lead time for watches and warnings were roughly 42 h and 30 h, respectively, for that region. Farther north along the mid-Atlantic and northeast U.S. coastlines, tropical storm watches and warnings provided about 45 h and 30 h of lead time, respectively.

Storm surge watches and warnings associated with Elsa are given in Table 9 and indicated in Fig. 13. A Storm Surge Watch was first issued for the west coast of Florida from Bonita Beach to the Suwanee River, including Tampa Bay, at 2100 UTC 4 July, and that watch was extended northward to the Ochlocknee River at 1500 UTC 5 July. The initial peak storm surge inundation forecast was 2 to 4 ft above normally dry ground somewhere within this region. A Storm Surge Warning was issued from Bonita Beach to the Aucilla River, including Tampa Bay, at 2100 UTC 5 July, with the peak storm surge inundation forecast being increased to 3 to 5 ft above normally dry ground. There were no observations of storm surge inundation of 3 ft or greater above normally dry ground (which NHC uses as a first-cut threshold for the storm surge watch/warning). However, there is a lack of coastal water level observing sites in much of the affected area, and a storm surge simulation hindcast produced by the NHC Storm Surge Unit (not shown) suggests that some isolated areas, particularly between Cedar Key and Elsa's landfall location in Taylor County, may have experienced water levels of 3 ft or more above normally dry ground. Therefore, the Storm Surge Warning may have only verified in some isolated areas, and the peak inundation forecast range was a little high. Potential reasons are that Elsa's core remained just offshore much of the west coast of Florida, and the storm weakened before making landfall in the Florida Big Bend region, decreasing the amount of surge that was produced along the coast. However, any eastward deviation in Elsa's track closer to the Florida west coast, or an increase in the storm's size, would have produced higher inundation values along the coast.

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

NHC began communication with emergency managers on 1 July as Elsa became a tropical storm east of the Windward Islands through its landfall in Florida and final exit from the Mid-Atlantic States on 8 July. This communication included briefings with FEMA HQ and FEMA Regions 2, 3 and 4, along with the State of Florida. These decision support briefings were coordinated through the FEMA Hurricane Liaison Team, embedded at the NHC. The Tropical Analysis and Forecast Branch of NHC provided 13 live briefings from 1–7 July to U.S. Coast Guard District 7 in Miami in support of their life-saving mission.

NHC began to provide Facebook Live broadcasts for Elsa on 3 July, with additional broadcasts provided during the next day. The NHC forecast called for a strong tropical storm to produce significant wind and water impacts over much of the Florida peninsula, so a limited media pool was initiated on 5 July and continued until 7 July.

The @NHC_Atlantic Twitter account had 25.7 million impressions during the event. NHC provided 15 Facebook Live broadcasts via its Facebook page from 3 to 7 July, and experienced about 981,000 views of these videos during the event. The number of Facebook followers increased by more than 24,000 during the lifetime of the storm.

ACKNOWLEDGEMENTS

Data in Table 3 and Table 5 were compiled from post-storm reports provided by the U.S. National Weather Service, and meteorological services from Cuba and Barbados. David Roth of the NOAA Weather Prediction Center provided additional rainfall reports and Figure 6.

Table 1. Best track for Hurricane Elsa, 30 June – 9 July 2021.

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
30 / 1800	9.4	42.8	1008	30	tropical depression
01 / 0000	9.3	45.3	1007	35	tropical storm
01 / 0600	9.4	47.7	1006	35	"
01 / 1200	9.9	50.2	1005	40	"
01 / 1800	10.7	52.6	1004	45	"
02 / 0000	11.5	55.0	1002	50	"
02 / 0600	12.3	57.3	1000	55	"
02 / 1200	13.0	59.8	995	65	hurricane
02 / 1800	13.8	62.4	991	75	"
03 / 0000	14.7	65.1	995	70	"
03 / 0600	15.7	67.9	998	65	"
03 / 1200	16.6	70.3	1000	60	tropical storm
03 / 1800	17.2	72.5	1002	60	"
04 / 0000	17.6	74.4	1004	55	"
04 / 0600	18.0	75.5	1006	55	"
04 / 1200	18.5	76.5	1007	50	"
04 / 1800	19.3	77.6	1007	50	"
05 / 0000	20.1	78.6	1005	55	"
05 / 0600	20.7	79.6	1005	55	"
05 / 1200	21.3	80.7	1005	55	"
05 / 1800	22.1	81.5	1005	55	"
05 / 1830	22.2	81.6	1005	55	"
06 / 0000	22.9	82.0	1005	50	"
06 / 0600	23.7	82.4	1005	50	"
06 / 1200	24.6	82.7	1003	55	"
06 / 1800	25.5	82.9	997	60	"
07 / 0000	26.6	83.2	996	65	hurricane
07 / 0600	27.8	83.5	998	55	tropical storm
07 / 1200	29.1	83.6	999	55	"

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
07 / 1430	29.8	83.5	1000	55	"
07 / 1800	30.3	83.4	1002	45	"
08 / 0000	31.5	82.7	1005	45	"
08 / 0600	32.8	81.8	1006	40	"
08 / 1200	34.2	80.5	1006	40	"
08 / 1800	35.5	79.0	1004	45	"
09 / 0000	36.8	77.4	1003	45	"
09 / 0600	38.4	75.5	1001	50	"
09 / 1200	40.3	73.1	999	50	"
09 / 1500	40.9	72.3	999	50	“
09 / 1630	41.4	71.7	999	50	“
09 / 1800	42.0	71.0	999	45	extratropical
10 / 0000	44.0	68.3	997	40	"
10 / 0600	46.8	64.4	999	35	"
10 / 1200					dissipated
02 / 1800	13.8	62.4	991	75	minimum pressure and maximum winds
05 / 1830	22.2	81.6	1005	55	Landfall in Parque Nacional Cienaga de Zapata, Cuba
07 / 1430	29.8	83.5	1000	55	Landfall near Fish Creek, Florida
09 / 1500	40.9	72.3	999	50	Landfall near East Hampton, New York
09 / 1630	41.4	71.7	999	50	Landfall near Westerly, Rhode Island

Table 2. Selected ship reports with winds of at least 34 kt for Hurricane Elsa, 30 June–9 July 2021.

Date/Time (UTC)	Ship call sign	Latitude (°N)	Longitude (°W)	Wind dir/speed (kt)	Pressure (mb)
02 / 0100	9HA382	14.3	53.1	090 / 37	1015.0
02 / 0400	9HA382	14.7	53.5	110 / 38	1017.0
02 / 0400	9HA382	14.8	53.5	110 / 37	1017.0
02 / 1900	3FOB5	17.3	62.9	090 / 40	1015.0
03 / 0100	2IYH5	18.1	64.1	090 / 35	1019.5
03 / 1300	J8QX6	20.5	71.4	080 / 37	1016.2
03 / 1500	J8QX6	20.2	71.1	090 / 50	1015.4
05 / 0100	9V6210	17.9	75.1	130 / 40	1015.1
06 / 0000	WTEK	28.2	80.3	340 / 83	1019.0
06 / 0400	WTEK	28.3	80.5	340 / 38	1018.0
06 / 1000	WTEK	28.2	80.3	220 / 37	1018.0
06 / 1600	WTEK	28.2	80.3	250 / 36	1019.0
06 / 1800	WTEK	28.2	80.3	020 / 39	1018.0
06 / 2200	WTEK	28.2	80.3	010 / 40	1017.0
07 / 0000	WTEK	28.2	80.3	090 / 38	1017.0
07 / 0200	WTEK	28.2	80.3	300 / 44	1017.0
07 / 0300	WTEK	28.2	80.3	300 / 51	1017.0
07 / 0500	WTEK	28.2	80.3	110 / 43	1017.0
07 / 0700	WTEK	28.2	80.3	300 / 60	1016.0
07 / 0900	WTEK	28.2	80.3	330 / 57	1016.0
07 / 1100	WTEK	28.3	80.6	130 / 44	1017.0
07 / 1200	WTEK	28.3	80.6	130 / 44	1017.0
07 / 1400	WTEK	28.1	80.3	150 / 37	1018.0
07 / 1600	WTEK	28.2	80.3	310 / 48	1018.0
07 / 1700	WTEK	28.2	80.3	320 / 51	1017.0
07 / 1800	WTEK	28.3	80.4	310 / 39	1017.0
07 / 2000	WTEK	28.4	80.5	320 / 54	1016.0

Date/Time (UTC)	Ship call sign	Latitude (°N)	Longitude (°W)	Wind dir/speed (kt)	Pressure (mb)
07 / 2100	WTEK	28.4	80.5	140 / 42	1015.0
07 / 2300	WTEK	28.4	80.5	340 / 51	1016.0
08 / 0000	WTEK	28.4	80.5	140 / 42	1016.0
08 / 0200	WTEK	28.4	80.5	320 / 48	1017.0
08 / 0400	WTEK	28.4	80.5	120 / 50	1017.0
08 / 0600	WTEK	28.4	80.5	090 / 38	1016.0
08 / 1000	WTEK	28.4	80.5	320 / 47	1017.0
08 / 1100	WTEK	28.4	80.5	310 / 43	1017.0

Table 3. Selected surface observations for Hurricane Elsa, 30 June–9 July 2021.

Location	Minimum Sea Level Pressure		Maximum Surface Wind Speed			Storm surge (ft)[c]	Storm tide (ft)[d]	Estimated Inundation (ft)[e]	Total rain (in)
	Date/ time (UTC)	Press. (mb)	Date/ time (UTC)[a]	Sustained (kt)[b]	Gust (kt)				
Barbados									
Grantley Adams Airport (TBPB)	2/1100	1005.4	2/1122	65	78				3.60
Saint Lucia									
Hewanorra Airport (TLPL)			2/1400	40	69				
George F.L. Charles Airport (TLPC)			2/1600	29	66				
Saint Vincent and the Grenadines									
J.F. Mitchell Airport			2/1700	29	42				
Argyle International Airport			2/2030	24	33				1.36
South Rivers (CWSA)									2.35
Majorca (CWSA)									2.26
Martinique									
Lamentin Airport (TFFF)			2/1500	28 (3 m)	41				
Fond-Denis-Cadet			2/1645	39 (493 m ASL)	74				1.99
Vaulin			2/1600	52 (12 m ASL)	79				
Trinite			2/1617	27 (10 min, 26 m ASL)	60				
Lamentin	2/1200	1012.0	2/1400	37 (3 m ASL)	49				
Fort France Negre			2/1528	21 (10 min, 12 m ASL)	49				
Lorrain			2/1625	16 (10 min, 83 m ASL)	47				1.06
Schoelcher (ISCHLC10) (14.61N 61.09W)	2/1344	1008.8	2/1609	33 (16 m)	42				
Dominica									
Canefield Airport (TDCF) (15.34N 61.39W)			2/1500	17	40				0.26
Douglas-Charles Airport (TDPD) (15.55N 61.30W)			2/1600	20	33				0.24
Salisbury (ISALISBU48) (15.43N 61.44W)			2/1939	33 (27 m)	43				
Guadeloupe									

Location	Minimum Sea Level Pressure		Maximum Surface Wind Speed			Storm surge (ft)[c]	Storm tide (ft)[d]	Estimated Inundation (ft)[e]	Total rain (in)
	Date/ time (UTC)	Press. (mb)	Date/ time (UTC)[a]	Sustained (kt)[b]	Gust (kt)				
Pointe-à-Pitre Le Raizet Airport (TFFR), GrandeTerre (16.26N 61.52W)			2/2030	26	39				
Dominican Republic									
Barahona (MDBH)			3/1400	20	45				
Las Americas (MDSD)			3/1400	18	34				
Haiti									
Toussaint Louverture Intl Arpt (MTPP)			3/1651	29	44				
Cuba									
Guantanamo Bay (MUGM)			4/1351	39	48				
Santiago de Cuba (MUCU)			4/2340	22	35				
Offshore									
Buoy 42060 - Caribbean Valley (16.43N 63.33W)	2/2010	1013.2	2/1924	33 (4 m, 1 min)	41				
Buoy 42059 - Eastern Caribbean (15.30N 67.50W)	3/0500	1005.4	3/0754	41 (4 m, 1 min)	45				
Middle Tampa Bay (MTBF1) (27.66N 82.60W)	7/1100	1011.0	6/1548	33	44				
Buoy 42036 - West Tampa (28.51N 84.51W)	7/1010	1009.1	7/0310	31 (4 m, 1 min)	35				
Buoy 41029 - Capers Nearshore COOPS (32.81N 79.63W)	8/0953	1008.2	8/0953	16 (3 m, 8 min)	52				
Buoy 41008 - Grays Reef (31.40N 80.87W)	8/0150	1010.5	8/0250	37 (5 m, 1 min)	45				
Buoy 41033 - Fripp Nearshore COOPS (31.40N 80.87W)	8/0708	1007.6	8/0438	25 (3 m, 8 min)	43				
Buoy 41064 - Oslo Bay 30 SE (34.21N 76.95W)	8/2008	1013.1	8/1908	29	41				
Buoy 41025 - Diamond Shoals (35.01N 75.45W)	8/2300	1013.3	9/0049	35 (4 m, 1 min)	41				

Location	Minimum Sea Level Pressure		Maximum Surface Wind Speed			Storm surge (ft)[c]	Storm tide (ft)[d]	Estimated Inundation (ft)[e]	Total rain (in)
	Date/ time (UTC)	Press. (mb)	Date/ time (UTC)[a]	Sustained (kt)[b]	Gust (kt)				
Buoy 41013 - Frying Pan Shoals (33.44N 77.73W)	8/1630	1014.0	8/1629	35 (4 m, 1 min)	39				
Frying Pan Tower (Privately Owned) (33.49N 77.59W)			8/1400	43 (26 m, 2 min)	50				
Buoy 41038 - 5 SE Wrightsville Beach (34.10N 77.70W)			8/1908	31 (3 m, 8 min)	41				
Buoy 41037 - 27 SE Wrightsville Beach (33.99N 77.36W)			8/1808	29 (3 m, 8 min)	39				
Buoy 41024 - Sunset Nearshore (33.85N 78.48W)			8/1353	35 (3 m, 8 min)	51				
Buoy 44014 - Virginia Beach (36.61N 74.84W)	9/0410	1009.7	9/0245	37 (3 m, 1 min)	41				
Buoy 44042 - near Point Lookout (36.03N 76.34W)	9/0406	1003.2	9/0242	31 (3 m)	39				
Buoy 44009 - Delaware Bay (38.45N 74.68W)	9/0620	1001.5	9/0457	39 (4 m, 1 min)	47				
Buoy 44062 - Gooses Reef (38.56N 76.42W)	9/0506	1006.4	9/0630	27 (3 m)	35				
Buoy 44066 - Texas Tower #4 (39.62N 72.64W)	9/1140	1002.1	9/0905	39 (4 m, 1 min)	43				
Buoy 44065 - NY Harbor Entrance (40.37N 73.70W)	9/1210	1001.4	9/0918	33 (4 m, 1 min)	39				
Buoy 44025 - Long Island (40.25N 73.16W)	9/1310	1000.3	9/0923	39 (4 m, 1 min)	45				
Buoy 44017 - Montauk Point (40.69N 72.05W)	9/1440	1000.5	9/1108	35 (4 m, 1 min)	39				
Buoy 44008 - Nantucket (40.50N 69.26W)	9/1830	1008.6	9/1541	31 (4 m, 1 min)	39				
Buoy 44020 - Nantucket Sound (41.49N 70.28W)	9/1840	1001.1	9/1543	41 (4 m, 1 min)	49				

Buoy 44005 - Gulf of Maine (43.20N 69.13W)	9/2150	1000.5	10/0041	29 (5 m, 1 min)	35				
Buoy 44034 - Eastern Maine Shelf (44.10N 68.11W)					37				
Florida									
Weatherflow Sites									
Banana River (XCCB) (28.36N 80.65W)			6/0021	29	34				
Bellair (XBLA) (27.94N 82.80W)			7/0347	27 (21 m)	36				
Biscayne Bay Light 20 (XKBS) (25.66N 80.19W)			5/1919	27 (6 m, 1 min)	35				
Capri (XCAP) (26.04N 81.70W)			6/1933	27	37				
Carysfort Reef Light (XCFL) (25.23N 80.21W)			6/0337	42 (15 m)	46				
Charlotte Harbor YC (XCHL) (26.96N 82.08W)			7/0250	32 (10 m)	38				
Clam Bayou Nature Park (XCBN) (27.74N 82.70W)			7/0321	27 (10 m)	37				
Cocoa Beach Pier (XCCO) (28.37N 80.60W)			6/0020	30	35				
Dania Pier (XDAN) (26.05N 80.11W)			5/2000	35 (10 m)	41				
Dodge Island (XBBH) (25.77N 80.15W)			6/1832	24 (13 m)	37				
Dunedin Causeway (XDUN) (28.06N 82.81W)			7/1007	26	40				
Government Cut (XGVT) (25.74N 80.10W)			5/1940	33 (23 m)	42				
Grove City (XGRV) (26.90N 82.31W)			6/2331	26 (20 m)	37				
Hillsboro Inlet (XHBI) (26.26N 80.08W)			5/2021	30 (6 m)	39				
Huguenot Park (XHUP) (30.42N 81.41W)	7/2143	1010	7/2143	42 (12 m)	47				
Jacksonville (XJAK) (30.39N 81.48W)	7/2331	1010	7/2121	33 (10 m)	38				
Juno Beach Pier (XJUP) (26.89N 80.06W)			5/2130	34 (6 m)	43				
Key West CG (XKYW) (24.57N 81.80W)			6/1354	27	43				

New Pass Shoal Light (XLID) (27.32N 82.60W)			7/0022	37	45				
Port Everglades (XPEG) (26.08N 82.11W)			5/2004	34 (41 m)	45				
Sarasota (XSAR) (27.35N 82.52W)			7/0028	26 (20 m)	36				
Sarasota Bay Marker (XSRB) (27.34N 82.57W)			7/0245	36 (16 m)	42				
Skyway Fishing Pier (XSKY) (27.60N 82.65W)			7/0335	36	40				
Smith Shoal Light (XSMS) (24.72N 81.92W)			6/1408	53 (19 m)	58				
St. Andrew Bay (XSTA) (30.13N 85.72W)			6/1555	31	34				
Tampa Bay Cut J (XTAM) (27.77N 82.57W)			7/0436	33 (15 m)	43				
Tarpon Pt. (XTRP) (26.54N 82.00W)			7/0849	34 (10 m)	40				
Terminal Channel (XTRM) (30.34N 81.63W)	7/2211	1011	7/2113	30 (9 m)	40				
Turkey Point (XTKY) (25.43N 80.35W)			5/1824	30 (20 m)	40				
Weeki Wachee (XWKI) (28.52N 82.57W)			6/1933	31 (23 m)	40				
ICAO Sites									
Key West Intl Arpt. (KEYW) (24.56N 81.76W)	6/0853	1013.2	6/1550	45	61				
NAS Boca Chica Field (KNQX) (24.58N 81.68W)	6/0853	1013.1	6/1551	41	51				
Marathon Intl Arpt. (KMTH) (24.56N 81.76W)	6/0953	1014.2	6/1336	21	35				
Ft. Lauderdale Intl Arpt. (KFLL) (26.07N 80.15W)	7/0955	1015.1	5/2004	28	41				
Ft. Lauderdale Exec Arpt. (KFXE) (26.20N 80.17W)	7/0953	1015.4	6/1653	16	37				
Naples Municipal Arpt. (KAPF) (26.15N 81.77W)	6/2053	1012.4	5/1814	21	36				
Jacksonville Intl Arpt. (KJAX) (30.49N 81.69W)		1010.5	7/2108	24	37				

Craig Municipal Arpt. (KCRG) (30.33N 81.52W)		1011.5	7/2019	25	35				
Gainesville Rgnl Arpt. (KGNV) (29.68N 82.27W)		1012.2	7/1550	24	38				
Sarasota / Bradenton Intl (KSRQ) (27.40N 82.55W)	7/0050	1010.8	7/0251	26	47				
St. Petersburg Intl (KPIE) (27.91N 82.69W)	7/0725	1010.5	7/0455	29	40				
Punta Gorda / Charlotte CO (KPGD) (26.92N 81.99W)	6/2355	1013.2	6/2340	26	37				6.56
Ft. Myers / Page Field (KFMY) (26.58N 81.87W)	7/0805	1012.5	7/0349	28	37				
Lakeland Linder Rgnl (KLAL) (27.99N 82.02W)			7/0735	23	36				
St. Petersburg / Albert Whitted (KSPG) (27.77N 82.63W)	7/0700	1010.2	7/0420	34	45				
WeatherSTEM									
Key West High School (KWHS) (24.55N 81.78W)					36				
Marathon High School (MHS) (24.55N 81.78W)					35				
Frost Museum - Downtown Miami (25.79N 80.18W)			6/1540	17 (19 m, 2 min)	39				
Virginia Key - RSMAS (25.74N 80.16W)					44				
Community Collaborative Rain, Hail and Snow Network (CoCoRaHS) Sites									
Punta Gorda (26.90N 82.04W)									11.04
Port Charlotte 3 SW (FL-CH-41) (26.95N 82.13W)									10.88
North Port 4 N (NPOF1) (27.11N 82.20W)									10.86
North Port 5 NNE (FL-SS-15) (27.11N 82.17W)									10.08
North Port 2 NNW (FL-SS-53) (27.08N 82.21W)									9.81
Warm Mineral Springs 2 E (NPRF1) (27.05N 82.24W)									9.76

Port Charlotte 6 W (FL-CH-13) (26.98N 82.21W)									8.84
North Port 5 SW (FL-CH-40) (26.99N 82.25W)									8.45
North Port 4 ESE (FL-SS-56) (27.04N 82.14W)									8.13
North Port 3 E (FL-SS-34) (27.04N 82.14W)									7.90
Key West - Catherine Street (24.56N 81.80W)									7.54
North Port 4 NE (NTHPT) (27.10N 82.15W)									7.45
Key West - Staples Ave (24.56N 81.77W)									7.41
Ding Darling NWR (TS755) (26.44N 82.10W)									7.40
Alachua 5 SE (29.68N 82.27W)									7.20
Land O' Lake 4 NW (DREF1) (28.25N 82.51W)									7.18
Key West - Olivia Street (24.56N 81.79W)									7.08
Port Charlotte 4 WSW (FL-CH-30) (26.96N 82.17W)									6.90
Key West - Hibiscus LN (24.56N 81.80W)									6.72
Port Charlotte 3 NNE (FL-CH-38) (27.02N 82.09W)									6.71
WFO Key West (24.55N 81.79W)									6.62
Charlotte Park 7 S (9158D) (26.80N 82.04W)									6.62
Key West - Harriet Ave (24.56N 81.76W)									5.54
Gainesville 8 W (29.66N 82.46W)									6.51
Key West - Jamaica DR (24.56N 81.77W)									6.50

ONA 3 S (CLTF1) (27.45N 81.92W)									6.43
Cape Coral 4 NNW (FL-LE-59) (26.69N 82.01W)									6.36
Boys Estate 4 SW (31.28N 81.53W)									6.28
Key West - KW Yacht Club (24.56N 81.78W)									6.17
Odessa (28.13N 82.60W)									6.15
High Springs 6 S (29.74N 82.61W)									5.99
Key West - Linda DR (24.56N 81.78W)									5.98
Key West 1 E (FL-MN-62) (24.56N 81.78W)									5.94
Cape Coral 2 NNE (CPHHS) (26.61N 81.98W)									5.90
UF 3 NW (29.67N 82.39W)									5.86
Williston (EW9802) (29.34N 82.53W)									5.83
Alachua 2 WNW (29.79N 82.51W)									5.81
Cape Coral 6 NNW (CPCMR) (26.67N 82.01W)									5.77
Lake Manatee 8 E (MKHF1) (27.47N 82.21W)									5.66
Stock Island - 9th Ave (24.57N 81.74W)									5.63
Cape Coral (FW5792) (26.54N 82.01W)									5.61
Fort Myers 2 SW (FL-LE-55) (26.61N 81.88W)									5.60
Punta Gorda 2 NNW (FL-CH-23) (26.92N 82.07W)									5.59
Port Charlotte 3 NW (1307D) (27.01N 82.13W)									5.54
Key West 1.3 ENE (FL-MN-16) (24.57N 81.76W)									5.43
Englewood 2 SE (FL-CH-34) (26.94N 82.33W)									5.40

Cape Coral 2 WNW (CPCDS) (26.59N 82.02W)									5.33
Cypress Lake 1 SSW (FL-LE-65) (26.53N 81.90W)									5.31
Port Charlotte 2 WSW (1037D) (26.96N 82.13W)									5.29
Shark Key (24.61N 81.65W)									5.26
Lake Suzy 1 W (FL-DS-3) (27.04N 82.05W)									5.15
Port Charlotte 4 NE (FL-CH-37) (27.02N 82.07W)									5.14
Bonita Shores (8615D) (26.33N 81.84W)									5.06
Coastal-Marine Automated Network (C-MAN) Sites									
Sombrero Key (SMKF1) (24.63N 81.11W)	6/0850	1014.6	6/1308	31 (5 m, 1 min)	38				
Sand Key (SANF1) (24.46N 81.88W)	6/1130	1013.4	6/1338	49 (16 m, 1 min)	56				
Venice (VENF1) (27.07N 82.45W)	7/0000	1011.3	7/0430	30 (12 m, 10 min)	41				
Cedar Key (CDRF1) (29.14N 83.03W)	7/1300	1009.1	7/1200	38 (10 m, 10 min)	51				
Keaton Beach (KTNF1) (29.81N 83.59W)	7/1600	1004.7	7/1640	26 (10 m, 10 min)	38				
St. Augustine (SAUF1) (29.86N 81.26W)			7/1930	30	44				
Fowey Rocks (FWYF1) (25.59N 80.10W)	7/0900	1015.7	5/1920	34 (44 m)	54				
Keaton Beach (KTNF1) (29.82N 83.59W)	7/1600	1004.7	7/1640	26	38				
National Ocean Service (NOS) Sites									
Lake Worth Pier (LKWF1) (26.61N 80.03W)			5/2106	28	37				
Virginia Key (VAKF1) (25.73N 80.16W)			6/1830	24 (6 m)	35				
Port Everglades (PEGF1) (26.08N 80.10W)			5/2018	26 (40 m)	34				
Loxahatchee (LOHF1) (26.48N 80.43W)			6/1632	14 (6 m, 10 min)	34				
Key West (24.55N 81.81W)						0.95			

Naples (NPSF1) (26.13N 81.81W)			5/1854	19 (7 m)	36	2.10	1.36		
Fernandina Beach (FRDF1) (30.67N 81.47W)			7/2154	21	33			0.47	
St. Johns River (MYPF1) (30.39N 81.43W)			7/2012	23	33			0.57	
St. Johns River (BKBF1) (30.19N 81.69W)								0.87	
St. Johns River (DMSF1) (30.39N 81.56W)								0.90	
St. Johns River (MSBF1) (30.32N 81.66W)								0.96	
Fort Myers (FMRF1) (26.65N 81.87W)								1.47	
Port Manatee (PMAF1) (7.64N 82.56W)								1.54	
St. Petersburg (SAPF1) (27.76N 82.63W)								1.63	
Clearwater Beach (CWBF1) (27.98N 82.83W)	7/0748	1010.0	7/1036	33	41			1.65	
Old Port Tampa (OPTF1) (27.86N 82.55W)								1.75	
East Bay (EBEF1) (27.92N 82.42W)								1.83	
Suwannee (SUWF1) (29.33N 83.14W)								1.94	
Cedar Key (CKYF1) (29.14N 83.03W)	7/1112	1007.2	7/1042	40	50			2.68	
Key West (KYWF1) (24.56N 81.81W)	6/1148	1013.1	6/1348	31	39				
Citizens Weather Observer Program (CWOP) Sites									
Clearwater Beach (FW1789) (27.98N 82.82W)					51				
Lower Sugarloaf (FW5749) (24.63N 81.54W)			6/1325	27 (16 m)	40				
Cudjoe Key (CW0925) (24.65N 81.48W)			6/1623	30	43				
Other Sites									
NWS WFO Key West Rooftop (KKEY) (24.55N 81.79W)					49				
Broward EOC Plantation (BEMA3) (26.12N 80.26W)					37				

Marco Island (MRCSC) (25.92N 81.73W)					41				
Naples Pelican Bay (NPLSR) (26.21N 81.81W)					39				
Horseshoe Beach (FSWNHORSESHOE BCH) (29.44N 83.29W)	7/1445	1004.5	7/1236	40	44				
LaFayette High School (WSLAHS) (30.05N 83.17W)	7/1659	1004.7	7/1508	30	37				
Horseshoe Beach (CW8654) (29.44N 83.29W)	7/1440	1004	7/1440	54	62				
Georgia									
Weatherflow Sites									
Jekyll Island (XJEK) (31.05N 81.41W)	7/2309	1007	7/2332	42 (10 m, 4 min)	50				
Tybee Island North (XTYB) (32.02N 80.84W)			8/0307	34	46				
Tybee Island South (XTYE) (31.99N 80.85W)	8/0742	1007.8	8/0303	55 (9 m, 1 min)	65				
Sapelo Island - NERRS (SAXG1) (31.42N 81.30W)	8/0015	1010.2	8/0015	26	36				5.08
ICAO Sites									
Savannah Intl Arpt. (KSAV) (32.13N 81.20W)	8/0653	1009.3	8/0229	27	38				
Bacon County Arpt. (KAMG) (31.54N 82.50W)		1006.8	7/1559	23	37				
Malcolm McKinnon Arpt. (KSSI) (31.15N 81.38W)		1010.5	7/2345	31	44				
Valdosta / Mody AFB (KVAD) (30.97N 83.20W)	7/2141	1006.1	7/1952	26	36				
Valdosta (KVLD) (30.79N 83.28W)	7/2153	1007.1	7/1753	23	36				
Community Collaborative Rain, Hail and Snow Network (CoCoRaHS) Sites									
Skidaway Is. 1 ENE (GA-CT-17) (31.94N 81.03W)									8.20
Skidaway Is. 1 NE (GA-CT-19) (31.94N 81.04W)									8.02
Savannah 2 SSE (GA-CT-93) (32.00N 81.11W)									7.50

Savannah 10 E (GA-CT-80) (32.01N 80.97W)									6.55
Kingsland 4 WSW (30.77N 81.73W)									5.95
Elba Island (ELBS1) (32.10N 81.01W)									5.67
Savannah 8 SSE (GA-CT-40) (31.92N 81.08W)									5.65
Savannah 10 E (GA-CT-64) (32.02N 80.95W)									5.32
Midway 3 ENE (GA-LB-4) (31.82N 81.37W)									5.31
Midway 13 ESE (GA-LB-10) (31.70N 81.25W)									5.20
Savannah 8 SSE (GA-CT-89) (31.93N 81.06W)									5.04
National Ocean Service (NOS) Sites									
Fort Pulaski (FPKG1) (32.04N 80.90W)						2.65		0.63	
St. Simmons Is. Village Pier (BRNG1) (31.13N 81.40W)			7/2330	39					
Other Sites									
Valdosta (F4363) (30.87N 83.40W)			7/1930	22	35				
South Carolina									
Weatherflow Sites									
Beaufort (XBUF) (32.34N 80.59W)	8/0638	1007.7	8/0638	36 (10 m, 1 min)	44				
Calibogue Sound (XCLB) (32.11N 80.84W)	8/0638	1006.9	8/0328	47 (6 m, 5 min)	70				
Charleston (XCHA) (32.76N 79.95W)	8/0834	1007.8	8/0824	29 (10 m, 1 min)	37				
Fort Sumter (XSUM) (32.75N 79.87W)	8/0901	1006.5	8/0644	34 (12 m, 1 min)	43				
Fort Sumter (XSUM) (32.75N 79.87W)	8/0901	1007	8/0644	38 (12 m, 1 min)	43				
Georgetown (XGEO) (33.37N 79.27W)			8/0958	27 (10 m, 1 min)	36				
Isle of Palms Pier (XIOP) (32.78N 79.79W)	8/0921	1009	8/0939	36 (8 m, 1 min)	42				
Murrells Inlet (XMUR) (33.52N 79.03W)			8/1108	36 (7 m, 5 min)	43				
ICAO Sites									

Charleston Intl Aprt. (KCHS) (32.90N 80.04W)	8/0956	1009.8	8/0603	29	41				
Charleston Exec Aprt. (KJZI) (32.70N 80.01W)			8/0835	26	37				
Hilton Head Aprt. (KHXD) (32.22N 80.70W)			8/0655	26	38				
Beaufort MCAS (KNBC) (32.49N 80.70W)	8/0756	1009.1	8/0648	23	44				
Mount Pleasant Rgnl Arpt. (KLRO) (32.90N 79.78W)			8/0915	21	38				
Beaufort County Arpt. (KARW) (32.41N 80.63W)			8/0435	23	38				5.06
North Myrtle Beach / Grand Strand (KCRE) (33.81N 78.72W)	8/1653	1011.5	8/1753	32	44				
Myrtle Beach AFB (KMYR) (33.69N 78.93W)	8/1356	1011.2	8/1025	36	47				
Florence Regional (KFLO) (34.19N 79.72W)	8/1353	1008.0	8/0950	23	39				
Coastal-Marine Automated Network (C-MAN) Sites									
Folly Island (FBIS1) (32.69N 79.89W)	8/0900	1010.4	8/0850	34 (10 m, 10 min)	48				
Community Collaborative Rain, Hail and Snow Network (CoCoRaHS) Sites									
Beaufort 2 SSW (SC-BF-80) (32.41N 80.70W)									7.15
Charleston 6 WNW (SC-CR-205) (32.81N 80.09W)									6.75
Green Pond 1 S (SC-CL-14) (32.71N 80.61W)									6.74
Bluffton 6 WNW (SC-BF-10) (32.27N 80.96W)									6.64
Beaufort 4 WSW (SC-BF-93) (32.41N 80.76W)									6.64
Bluffton 7 WNW (SC-BF-86) (32.27N 80.98W)									6.39
Bluffton 7 W (SC-BF-50) (32.22N 80.98W)									6.34

Charleston 3 NNW (SC-CR-226) (32.82N 80.01W)									6.18
Bluffton 5 NW (SC-BF-15) (32.27N 80.97W)									5.92
Parris Island 2 N (SC-BF-53) (32.35N 80.69W)									5.88
Hilton Head Is. 4 N (SC-BF-2) (32.25N 80.74W)									5.85
Charleston 4 NW (SC-CR-164) (32.83N 80.04W)									5.81
Hilton Head Is. 4 NE (SC-BF-66) (32.24N 80.70W)									5.80
Charleston 3 NNE (SC-CR-87) (32.83N 79.98W)									5.75
Charleston 2 SSW (SC-CR-194) (32.76N 80.00W)									5.63
N Charleston 3 ESE (SC-CR-78) (32.89N 79.99W)									5.63
Charleston (SC-CR-138) (32.78N 79.99W)									5.61
Walterboro 3 NNW (SC-CL-3) (32.94N 80.68W)									5.60
N Charleston 4 ESE (SC-CR-63) (32.89N 79.98W)									5.60
Beaufort 5 NE (SC-BF-97) (32.47N 80.63W)									5.58
N Charleston 3 E (SC-CR-212) (32.90N 79.99W)									5.52
Hanahan 2 SE (SC-BK-85) (32.92N 79.98W)									5.50
Beaufort 6 NE (SC-BF-37) (32.49N 80.63W)									5.46
Moncks Corner 9 S (SC-BK-55) (33.07N 79.97W)									5.43
Bluffton 3 ENE (SC-BF-22) (32.25N 80.82W)									5.41

Johns Island 2 NE (SC-CR-74) (32.72N 80.01W)									5.35
Bluffton 7 NW (SC-JS-9) (32.31N 80.95W)									5.31
Charleston 4 NW (SC-CR-183) (32.83N 80.04W)									5.29
Walterboro 2 ENE (SC-CL-34) (32.92N 80.64W)									5.25
Charleston 3 W (SC-CR-178) (32.79N 80.04W)									5.24
Midway 13 ESE (SC-LB-10) (31.70N 81.25W)									5.20
Hilton Head Is. 4 NNE (SC-BF-67) (32.25N 80.82W)									5.18
Charleston 2 S (SC-CR-88) (32.76N 80.00W)									5.17
Charleston 2 W (SC-CR-242) (32.79N 80.03W)									5.11
Remote Automated Weather Stations (RAWS)									
Walterboro (WTBS1) (32.92N 80.63W)									5.14
National Ocean Service (NOS) Sites									
Charleston (CHTS1) (32.78N 79.92W)						2.07		0.46	
Springmaid Pier Horry (MROS1) (33.66N 78.92W)								0.30	
Oyster Landing (NITS1) (33.35N 79.19W)								0.03	
Other Sites									
Futch Beach (KSCNORTH183) (33.84N 78.62W)			8/1119	36	46				
North Myrtle Beach Fire Station 2 (33.83N 78.64W)					39				
North Myrtle Beach Fire Station 3 (33.80N 78.72W)					38				
North Myrtle Beach Fire Station 4 (33.81N 78.75W)					40				

North Myrtle Beach Cherry Grove Pier (33.83N 78.63W)			8/1530	36					
North Myrtle Beach Apache Pier (33.76N 78.78W)			8/1245	47					
Debordieu Colony (KSCDEBOR6) (33.36N 79.15W)				40					
North Carolina									
ICAO Sites									
New Bern (KEWN) (35.07N 77.04W)	8/2154	1010.8	8/2045	25	38				
Hatteras (KHSE) (35.22N 75.62W)	9/0051	1013.3	8/2300	27	38				
Manteo/Dare CO R (KMQI) (35.92N 75.70W)	9/0055	1010.5	9/0135	36	43				
Cherry Pt. MCAS (KNKT) (34.90N 76.88W)	8/2154	1011.5	8/2154	27	39				
Dare CO GNRY RAN (K2DP) (35.69N 75.90W)	9/0056	1011.2	8/2241	27	38				
New River / Jack (KNCA) (34.71N 77.43W)	8/1956	1011.2	8/1756	26	36				
Bogue Field MCAL (KNJM) (34.69N 77.04W)	8/2157	1012.7	8/2117	29	43				
Michael J Smith (KMRH) (34.73N 76.66W)	8/2158	1012.8	8/2058	29	38				
Wilmington (KILM) (34.28N 77.92W)	8/1953	1011.5	8/1856	30	39				
Elizabeth City USCG (KECG) (36.26N 76.17W)	9/0054	1008.0	9/0154	27	38				
Weatherflow									
Fort Macon (34.70N 76.71W)	8/2142	1010.7	8/1931	39 (10 m)	49				
Frisco Woods (35.24N 76.70W)			8/1934	34 (6 m)	41				
Buxton (35.26N 75.59W)	9/0054	1011.7	8/2320	24 (10 m)	35				
Avon Sound (35.34N 75.50W)	9/0034	1012.2	9/0210	34 (5 m)	40				
Waves (35.57N 75.49W)	9/0035	1010.8	9/0212	39 (11 m)	45				
Oregon Inlet CG (35.77N 75.53W)	9/0047	1008.5	9/0017	33 (10 m)	45				
Oregon Inlet (35.80N 75.54W)	9/0043	1008.5	9/0204	38 (10 m)	45				

Kites Resort (35.58N 75.47W)	9/0044	1009.6	9/0155	46 (16 m)	55				
Cedar Island (35.02N 76.32W)	8/2303	1014.0	8/2323	41	54				
Real Slick-Waves (35.57N 75.48W)	9/0038	1012.7	9/0158	33 (6 m)	43				
Pamlico Sound (35.42N 75.83W)	9/0247	1011.7	9/0038	43 (13 m)	50				
Ocracoke Sound (35.14N 76.00W)	9/0008	1011.3	9/0002	37 (8 m)	43				
Jennettes Pier - Nags Head (35.91N 75.59W)	9/0052	1007.0	9/0141	40 (18 m)	50				
Avon Ocean (35.35N 75.50W)	9/0020	1013.3	9/0048	37 (12 m)	50				
Alligator River Bridge (35.90N 76.01W)	8/2227	1010.5	8/2359	42 (12 m)	46				
Lockwoods Folly Inlet (33.92N 78.23W)			8/1716	26 (6 m, 1 min)	37				
Oak Island (33.91N 78.12W)			8/1312	32 (10 m, 1 min)	48				
Federal Point (33.96N 77.94W)			8/1329	36 (15 m, 1 min)	46				
National Ocean Service (NOS) Sites									
Beaufort Tide Gauge (BFTN1) (34.72N 76.67W)	8/2148	1013.2	8/2042	33	39				
Hatteras Tide Gauge (HCGN7) (35.21N 75.70W)	9/0036	1013.3	8/2212	26	34				
Oregon Inlet Tide Gauge (ORIN7) (35.78N 75.53W)	9/0042	1011.4	9/0042	35	44				
Duck Tide Gauge (DUKN7) (36.18N 75.75W)	9/0048	1008.4	9/0306	36	44				
Johnny Mercer Pier (JMPN7) (34.21N 77.79W)			8/1912	41 (8 m, 2 min)	47			0.16	
Wilmington (WLON7) (34.23N 77.95W)								0.85	
Elizabeth City (EMWN7) (36.30 76.22W)								1.87	
Edenton (EWPN7) (36.06 76.60W)								1.88	
Coastal-Marine Automated Network (C-MAN) Sites									
Cape Lookout (CLKN7) (34.60N 76.52W)	8/2200	1013.5	8/1930	29 (10 m, 10 min)	37				
Remote Automated Weather Stations (RAWS)									
Sunny Point (NSUN) (34.26N 77.87W)					37				
Other Sites									

Wilmington-Kings Grant (KNCWILMI3) (34.26N 77.87W)					35				
Sunset Beach (KNCSUNSE19) (33.88N 78.54W)			8/1149	37	49				
Bald Head Island (33.86N 78.00W)			8/1510	26	37				
Figure Eight Island (34.26N 77.76W)			8/1420	36	43				
Hampstead 2 E (KNCHAMPS27) (34.36N 77.68W)			8/1729	37	41				
Kure Beach Pier (34.00N 77.90W)			8/1935	39	46				
Holden Beach Starfish (KNCHOLDE10) (33.91N 78.31W)					44				
Cape Fear Pilots (KNCSOUTH1) (33.92N 78.02W)					47				
Elizabeth City BLM (ELRM7) (36.47N 76.28W)			9/0254	26	45				
Virginia									
Weatherflow									
Tangier Island (37.78N 75.98W)			9/0153	50 (52 m)	59				
Puquoson (37.11N 76.31W)			9/0332	39 (34 m)	48				
Plantation Flats / Cape Charles (37.26N 76.03W)			9/0110	44 (43 m)	61				
New Point Comfort (37.33N 76.27W)			8/2359	43 (42 m)	48				
3rd Island Chesapeake Bay Bridge Tunnel (37.03N 76.08W)			9/0512	42 (52 m)	60				
Sandbridge (36.71N 75.93W)			9/0216	41 (15 m)	59				
Thimble Shoals / Chesapeake Bay (37.05N 76.26W)			8/2346	40 (20 m)	45				
Hampton Flats (36.98N 76.34W)			9/0404	39 (23 m)	47				
Onancock (37.66N 75.87W)			9/0533	39 (46 m)	52				
LaFayette River / Norfolk (36.89N 76.32W)			9/0304	36 (20 m)	45				
Cape Henry (36.92N 76.01W)			8/2214	36 (75 m)	44				

Lynnhaven Pier / Virginia Beach (36.92N 76.08W)			8/2318	35 (26 m)	43				
Silver Beach (37.49N 75.97W)			8/1727	34 (25 m)	43				
Middle Ground Lighthouse (36.94N 76.39W)			8/2339	48 (65 m)	53				
Puquoson River Light (37.16N 76.38W)			9/0010	47 (22 m)	57				
Jordan Bridge / S Norfolk (36.81N 76.29W)			9/0109	42 (192 m)	49				
Wachapreague (37.60N 75.69W)			9/0203	41 (34 m)	53				
Rudee Inlet (36.83N 75.97W)			9/0030	40 (29 m)	45				
Lower Hooper Island (38.26N 76.18W)			9/0124	34 (28 m)	38				
Creeds (36.59N 76.02W)			9/0125	22 (34 m)	36				
ICAO Sites									
Norfolk Intl Arpt. (KORF) (36.91N 76.20W)	9/0251	1005.6	9/0251	25	38				
Newport News / Patrick Henry (KPHF) (37.14N 76.50W)	9/0254	1004.1	9/0250	22	35				
Wallops Island (KWAL) (37.97N 75.47W)	9/0454	1002.9	9/0308	32	45				
NAS Oceana (KNTU) (36.83N 76.03W)	9/0256	1006.5	9/0221	23	35				
Petersburg / Dinwiddie (KPTB) (37.19N 77.52W)	9/0035	1002.5	9/0015	23	35				
James City / Williamsburg (KJGG) (37.19N 77.52W)			9/0435	21	35				
Remote Automated Weather Stations (RAWS)									
Assateague Island (ASTM2) (38.08N 75.20W)	9/0540	999.7	9/0340	31	55				
Back Bay (BBYV2) (37.19N 77.52W)			9/0254	26	45				
Coastal-Marine Automated Network (C-MAN) Sites									
Cape Henry (CHYV2) (36.91N 75.78W)	9/0242	1006.0	9/0048	28 (28 m)	38				
Dominion Terminal (DOMV2) (36.96N 76.42W)	9/0224	1005.0	8/2336	33 (9 m)	44				
Rappahannock Light Tower (RPLV2) (37.54N 76.02W)	9/0406	1003.5	9/0130	42 (17 m)	50				

York River Range Light (YRKV2) (37.25N 76.33W)			8/2354	42 (17 m)	51				
South Craney Island (CRYV2) (36.89N 76.34W)	9/0206	1005.4	8/2348	32 (9 m)	40				
Willoughby Degaussing Station (36.96N 76.33W)	9/0306	1004.0	9/07406	37 (12 m)	43				
National Ocean Service (NOS) Sites									
Kiptopeke (KPTV2) (37.17N 75.98W)			9/0106	32 (7 m)	44				
Yorktown USCG Station (YKTV2) (37.23N 76.48W)	9/0242	1002.8	9/0318	30 (10 m)	39				
Lewisetta (LWTV2) (38.00N 76.47W)	9/0400	1003.9	9/0300	29 (6 m)	35				
Wachapreague (WAHV2) (37.61N 75.69W)	9/0418	1002.8	9/0118	28 (7 m)	37				
Chesapeake Bay Bridge Tunnel (CHBV2) (37.03N 76.08W)	9/0306	1004.2	9/0542	34 (5 m)	47				
Saxis (SAXV2) (37.93N 75.72W)					2.59				
Silver Beach (NSWV2) (37.48N 75.96W)					2.05				
Community Collaborative Rain, Hail and Snow Network (CoCoRaHS) Sites									
Chester 4 SW (37.32N 77.49W)									5.57
Other Sites									
Stingray Point (CBIBS) (37.55N 76.25W)	9/0630	1002.3	9/0030	31 (3 m)	45				
Maryland									
Weatherflow									
Assateague Island (38.21N 75.20W)			9/0353	46 (13 m)	59				
Crisfield (37.97N 75.88W)			9/0616	39 (21 m)	45				
Crisfield Coast Guard (37.97N 75.88W)	9/0617	1002.2	9/0622	32 (6 m)	39				
Ocean City (38.33N 75.08W)			9/0407	39 (34 m)	44				
Raccoon Point (38.14N 75.79W)			8/1831	34 (20 m)	40				
Point Lookout (38.05N 76.32W)	9/0414	1003.5	9/0724	26 (11 m)	41				
ICAO Sites									
Ocean City Arpt. (KOXB) (38.31N 75.12W)	9/0553	1002.2	9/0407	34	53				

St. Inigoes (KNUI) (38.14N 76.43W)	9/0353	1004.3	9/0238	21	37				
Patuxent River NAS (KNHK) (38.29N 76.40W)	9/0417	1004.7	9/0332	25	35				
National Ocean Service (NOS) Sites									
Bishops Head (BISM2) (38.22N 76.04W)	9/0536	1002.7	9/0730	27 (7 m)	34			1.41	
Cambridge (CAMM2) (38.57N 76.06W)	9/0448	1004.3	9/0424	28 (6 m)	34				
Ocean City Inlet (38.32N 75.09W)	9/0554	1003.1	9/0406	22 (8 m)	35				
Crisfield (CRSMS) (37.98N 75.86W)								2.49	
Piney Point (PPTM2) (38.14N 76.53W)			9/0118	29 (8 mn)	36				
Cove Point (COVM2) (38.40N 76.39W)	9/0448	1004.8	9/0542	35 (28 m)	40				
Other Sites									
Potomac Light 3 (LT3) (38.34N 76.99W)	9/0343	1006.8	9/0323	26 (8 m)	35				
Delaware									
Weatherflow Sites									
Magnolia 1 NE (39.09N 75.46W)			9/0453	37					
Long Neck 5 E (38.61N 75.06W)			9/0453	37					
Lewes 5 NW (38.82N 75.20W)			9/0515	35					
National Ocean Service (NOS) Sites									
Lewes (LWSD1) (38.79N 75.12W)	9/0254	1002.0	9/0506	30 (6 m)	34				
New Jersey									
Weatherflow Sites									
Sea Isle City 2 NNW (39.18N 74.70W)			9/0428		69				
Beach Haven 2 SW (39.55N 74.26W)			9/0731		62				
Barnegat Light 1 ENE (39.76N 74.09W)			9/0806	34					
Harvey Cedars (39.71N 74.14W)			9/0800		65				
Lanoka Harbor 4 ESE (39.85N 74.09W)			9/0819	41					
ICAO Sites									
Atlantic City (KACY) (39.46N 74.57W)	9/0854	1001.2	9/1022	23	38				
New York									
Weatherflow Sites									

Tappan Zee Light (XTPZ) (41.14N 73.87W)			9/1311	31	38				
Bayville (XBAY) (40.91N 73.63W)			9/1301	40	46				
Eatons Neck (XEAT) (40.96N 73.39W)			9/1219	48	52				
Shinnecock Light (XSHN) (40.84N 72.47W)			9/1546	38	46				
Great Gull Island (XGUL) (41.21N 72.11W)			9/1240	36	40				
Jones Beach (XJON) (40.60N 73.55W)			9/1333	36	41				
State Boat Channel (XGRS) (40.65N 73.30W)			9/1027	34	41				
Blue Point (XBLU) (40.74N 73.03W)			9/1022	34	40				
Fire Island Coast Guard (XFIR) (40.63N 73.25W)			9/1024	34	41				
Point O'Woods Yacht Club (XPOW) (40.66N 73.13W)			9/1359	33	37				
Fishers Island (XFSH) (41.26N 72.03W)			9/1243	31	35				
East Moriches Inlet Coast Guard (XMOR) (40.79N 72.74W)			9/1034	31	36				
Larchmont Harbor (XLAR) (40.92N 73.73W)			9/1211	30	36				
Napeague (XNAP) (41.01N 72.05W)			9/1134	30	38				
Sinai Harbor (XSIN) (40.97N 73.03W)			9/1401	28	35				
ICAO Sites									
Westhampton (KFOK) (40.86N 72.61W)	9/1525	1000.9	9/1515	28	39				
Shirley (KHVN) (40.83N 72.86W)	9/1356	1001.6	9/1430	23	36				
Islip (KISP) (40.80N 73.10W)	9/1425	1001.7	9/1420	31	43				
JFK International Airport (KJFK) (40.64N 73.76W)	9/1151	1003.9	9/1405	28	36				
National Ocean Service (NOS) Sites									
Kings Point (KPTN6) (40.81N 73.77W)								0.99	
Orient Harbor (ORIN6) (41.14N 72.31W)								0.99	
Riverhead (PRIN6) (40.92N 72.64W)								1.09	

Connecticut									
Weatherflow Sites									
USCG Academy (XCGA) (41.38N 72.09W)			9/1627	35	41				
Stonington Outer Breakwater 4 (XSTO) (41.32N 72.03W)			9/1645	34	40				
Norwalk Light (XNOR) (41.08N 73.38W)			9/1112	27	34				
ICAO Sites									
Sikorsky Memorial Airport (KBDR) (41.17N 73.13W)	9/1405	1003.9	9/1352	28	37				5.22
Groton (KGON) (41.33N 72.04W)	9/1605	999.7	9/1630	26	37				
National Ocean Service (NOS) Sites									
New Haven (NWHC3) (41.28N 72.91W)	9/1454	1003.8	9/1436	26	39			1.12	
Bridgeport (BRHC3) (41.18N 73.18W)	9/1254	1003.8	9/1254	22	30			1.14	
New London (NLNC3) (41.36N 72.09W)								0.91	
Stamford (STDC3) (41.04N 73.53W)								1.15	
Community Collaborative Rain, Hail and Snow Network (CoCoRaHS) Sites									
Stamford (41.02N 73.56W)									6.22
Milford (41.23N 73.06W)									5.78
Guilford (41.28N 72.68W)									5.64
Lodi (40.88N 74.08W)									5.60
Durham 3 NNW (41.51N 72.71W)									5.43
New Milford (40.93N 74.02W)									5.22
Rhode Island									
ICAO Sites									
Block Island (KBID) (41.17N 71.58W)			9/1256	29	40				
Weatherflow Sites									
Sakonnet Vineyards (XSAK) (41.53N 71.19W)					37				
Fogland (XFOG) (41.56N 71.22W)					36				
Horseneck Beach (XHOR) (41.51N 71.09W)					41				

Halfway Rock (XHLF) (41.53N 71.31W)					36				
Bristol Harbor (XCAS) (41.65N 71.29W)					35				
National Ocean Service (NOS) Sites									
Conimicut Light (CPTR1) (41.72N 71.34W)					42				
Massachusetts									
ICAO Sites									
Nantucket (KACK) (41.25N 70.06W)			9/1825	33	44				
Falmouth (KFMH) (41.66N 70.52W)			9/1655	30	40				
Martha's Vineyard Airport (KMVY) (41.39N 70.61W)			9/1710	23	36				
Cape Cod Gateway Airport (KHYA) (41.67N 70.28W)			9/1656	18	36				
New Bedford Regional Airport (KEWB) (41.68N 70.96W)			9/1337	21	35				
Provincetown Municipal Aprt (KPVC) (42.07N 70.22W)			9/2056	25	35				
Chatham Municipal Airport (KCQX) (41.69N 69.99W)			9/1905	16	34				
Weatherflow Sites									
Kalmus (XKAL) (41.63N 70.28W)					58				
West Dennis (XWDN) (41.65N 70.17W)					49				
Chapin (XCHP) (41.73N 70.23W)					47				
Chatham (41.66N 69.98W)					44				
West Falmouth (XWFL) (41.60N 70.65W)					43				
Hatch Beach (XHCH) (41.82N 70.00W)					42				
Waquoit Bay (41.56N 70.51W)					42				
Wellfleet (41.93N 69.98W)					37				
Vineyard Station (41.46N 70.59W)					41				
Nantucket Harbor (41.31N 70.06W)					47				
Duxbury (XDUX) (42.06N 70.65W)					43				

Woods Hole Passage Light (XWHL) (41.52N 70.68W)					48				
West Island (XWST) (41.58N 70.82W)					43				
Deer Island (XDER) (42.31N 70.89W)					37				
Scituate (42.20N 70.72W)					36				
Citizens Weather Observer Program (CWOP) Sites									
Provincetown (F5907) (42.07N 70.15W)					51				
Dennis (FW7612) (41.74N 70.22W)					42				
Rockport (AV086) (42.64N 70.58W)					36				
Beverly (KB1KVS) (42.54N 70.88W)					35				
Siasconset (DW0935) (41.28N 69.96W)					45				
Wareham (EW2725) (41.74N 70.73W)					36				
Woods Hole (F2970) (41.53N 70.68W)					42				
Duxbury (42.00N 70.60W)					51				
Coastal-Marine Automated Network (C-MAN) Sites									
Buzzards Bay (BUZM3) (41.40N 71.03W)	9/1700	1000.6	9/1630	37 (25 m, 10 min)	44				
Borden Flats Light (BLTM3) (41.70N 71.17W)					37				
Automated Weather and Surface Observing Systems (AWOS, ASOS) Sites									
Otis AFB (41.63N 70.52W)					40				
Provincetown AP (42.07N 70.22W)					35				
Hyannis AP (41.67N 70.27W)					37				
New Bedford AP (41.68N 70.95W)					36				
Marthas Vineyard AP (41.40N 70.62W)					38				
Nantucket AP (41.25N 70.07W)					44				
National Ocean Service (NOS) Sites									
Nantucket (41.28N 70.10W)					38				
Community Collaborative Rain, Hail and Snow Network (CoCoRaHS) Sites									
Andover 1.5 S (41.72N 72.36W)									5.67

Central Manchester 0.8 N (41.80N 72.52W)									5.13
New Hampshire									
ICAO Sites									
Mount Washington (KMWN) (44.28N 71.30W)			9/0554	60 (1909 m)	74				
Maine									
Weatherflow Sites									
Cadillac Mountain (41.40N 71.03W)					50				
National Ocean Service (NOS) Sites									
Bar Harbor (ATGM1) (44.39N 68.20W)					37				
Eastport (PSBM1) (44.91N 66.98W)					35				
Citizens Weather Observer Program (CWOP) Sites									
Brooklin School (CW6596) (44.27N 68.57W)					37				
Lamoine (FW3015) (44.50N 68.27W)					36				
Hydrometeorological Automated Data System (HADS) Sites (NWS)									
Rogers Farm Site Old Town 2 (44.93N 68.70W)									5.21
Canada									
Meteorological Service of Canada									
Halifax Stanfield Intl Aprt, NS (CYXZ) (44.88N 63.51W)			10/0506	25	44				
Yarmouth Airport, NS (CYQI) (43.83N 66.12W)			9/2332	28	41				
Brier Island, NS (CWVU) (44.25N 66.39W)			10/0100	33	42				
CFB Greenwood, NS (CYZX) (44.98N 64.92W)			10/0330	24	40				
McNabs Island, NS (CXMI) (44.62N 63.54W)			10/0600	31	42				
Tracadie, NS (CXTD) (45.63N 61.66W)			10/0800	27	42				
Beaver Island, NS (CXTD) (44.62N 63.54W)			10/0800	33	39				
Port Hawkesbury, NS (CYPD) (45.66N 61.37W)			10/0843	24	38				

Sydney Airport, NS (CYQY) (46.17N 60.05W)			10/1012	22	38				
North Mountain, NS (CXNM) (45.10N 64.75W)			10/1400	26	38				
Lunenburg, NS (CXLB) (44.38N 64.32W)			10/0500	30	38				
Grand Etang, NS (CWZQ) (46.55N 61.05W)			10/0600	27	38				
Charlottetown, PEI (CYYG) (46.55N 61.05W)			10/0509	25	34				
North Cape, PEI (CWNE) (47.06N 64.00W)			10/0800	34	41				
Cape Breton, NS (46.75N 60.90W)			10/0815	28	54				

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

Table 4. Number of hours in advance of formation associated with the first NHC Tropical Weather Outlook forecast in the indicated likelihood category. Note that the timings for the “Low” category do not include forecasts of a 0% chance of genesis.

	Hours Before Genesis	
	48-Hour Outlook	**120-Hour Outlook**
Low (<40%)	30	30
Medium (40%-60%)	18	24
High (>60%)	-	12

Table 5. Tornadoes from Hurricane Elsa in the United States

Rating	Location	NWS Forecast Office	Notes
EF-2	Saint Marys, Camden Co, GA	Jacksonville, FL	Estimated peak winds 130 mph
EF-1	Arlington, Duval Co, FL	Jacksonville, FL	
EF-0	Columbia Co, FL	Jacksonville, FL	
EF-1	Edisto Island, Charleston Co, SC	Charleston, SC	Path length 1.1183 miles, width 100 yards, estimated peak winds 95 mph
EF-1	Awendaw, Charleston Co, SC	Charleston, SC	Path length 0.8195 miles, width 150 yards, estimated peak winds 95 mph
EF-1	Parris Island, Beaufort Co, SC	Charleston, SC	Path length 0.1344 miles, width 50 yards, estimated peak winds 97 mph
EF-1	Port Royal, Beaufort Co, SC	Charleston, SC	Path length 0.6259 miles, width 75 yards, estimated peak winds 95 mph
EF-1	Stillwell, Effingham Co, GA	Charleston, SC	Path length 1.9 miles, width 100 yards, estimated peak winds 105 mph
EF-1	Woodbine, Cape May Co, NJ	Mt. Holly, NJ	Path length 0.94 miles, width 75 yards, estimated peak winds 100 mph
EF-0	Little Egg Harbor Twp, Ocean, NJ	Mt. Holly, NJ	Path length .29 miles, width 110 yards, estimated peak winds 80 mph
EF-0	New Zion, Clarendon Co, SC	Columbia SC	Path length 1.5 miles, width 40 yards, estimated peak winds of 85 mph
EF-0	Lummis, City of Suffolk, VA	Wakefield, VA	Path length 1.8 miles, width 50 yards, estimated peaks winds 60-70 mph
EF-0	Kings Fork, City of Suffolk, VA	Wakefield, VA	Path length 0.85 miles, width 40 yards, estimated peak winds 60-70 mph

Rating	Location	NWS Forecast Office	Notes
EF-0	Smithfield, Isle of Wight Co, VA	Wakefield, VA	Path length 2.84 miles, width 50 yards, estimated peak winds 60-70 mph
EF-0	Harrellsville, Hertford Co, NC	Wakefield, VA	Path length 2.9 miles, width 40 yards, estimated peak winds 60-70 mph
EF-0	Taylors Beach, Camden Co, NC	Wakefield, VA	Path length 1.3 miles, width 60 yards, estimated peak winds 60-70 mph
EF-U	Fairfield, Hyde Co, NC	Newport/ Morehead City, NC	Path length 0.75 miles, width 90 yards, estimated peak winds unknown

Table 6a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) track forecast errors (n mi) for Hurricane Elsa, 30 June–9 July 2021. 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	26.3	37.8	**40.4**	**41.9**	**48.1**	**57.0**	**72.2**	**100.6**
OCD5	48.7	103.9	162.6	215.8	272.8	329.8	411.0	491.0
Forecasts	34	32	30	28	26	24	20	16
OFCL (2016-20)	23.9	36.3	49.1	63.9	79.0	94.1	128.1	169.7
OCD5 (2016-20)	45.1	97.2	157.2	216.7	271.1	325.4	414.4	490.0

Table 6b. Homogeneous comparison of selected track forecast guidance models (in n mi) for Hurricane Elsa, 30 June–9 July 2021. 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	25.9	38.4	41.4	41.9	48.5	57.4	68.9	84.9
OCD5	47.0	101.9	157.9	211.5	260.1	352.5	487.4	497.3
GFSI	27.1	41.8	50.6	60.7	65.8	70.2	94.2	107.3
HMNI	31.7	51.2	65.2	71.8	69.9	74.4	110.7	202.1
HWFI	33.5	55.3	66.0	70.5	74.6	85.8	159.7	122.8
EMXI	**25.2**	40.6	56.2	78.1	119.2	143.5	309.4	794.5
CMCI	27.9	45.2	59.6	82.5	105.0	119.5	142.0	182.2
AEMI	28.6	44.9	53.9	54.5	57.3	62.9	74.5	**71.9**
HCCA	**24.6**	**36.5**	**41.2**	45.1	62.8	95.5	211.9	506.9
TVCX	**25.1**	**38.1**	41.8	44.4	56.5	72.2	164.6	329.6
GFEX	**23.6**	**34.7**	**37.5**	42.9	61.0	74.8	161.5	392.6
TVCA	**25.8**	**37.9**	44.5	45.8	55.1	71.8	148.1	264.3
TVDG	26.0	**38.0**	42.3	43.6	48.8	58.6	130.7	243.0
TABD	36.4	68.7	95.0	121.1	144.3	162.3	206.7	279.4
TABM	30.3	46.4	59.4	74.5	83.8	96.5	116.7	143.1
TABS	40.1	70.8	95.3	115.2	130.9	158.8	210.0	265.8
Forecasts	30	28	26	25	21	19	11	7

Table 7a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) intensity forecast errors (kt) for Hurricane Elsa, 30 June–9 July 2021. 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	5.4	8.0	**8.7**	**10.4**	**7.3**	**6.9**	**4.8**	**8.1**
OCD5	8.8	12.6	13.7	15.1	18.3	19.0	24.0	14.2
Forecasts	34	32	30	28	26	24	20	16
OFCL (2016-20)	5.4	8.0	9.6	10.9	11.5	12.1	13.3	14.5
OCD5 (2016-20)	7.0	11.0	14.3	16.8	18.3	19.7	21.7	23.0

Table 7b. Homogeneous comparison of selected intensity forecast guidance models (in kt) for Hurricane Elsa, 30 June–9 July 2021. Errors smaller than the NHC official forecast are shown in boldface type. The number of official forecasts shown here will generally be smaller than that shown in Table 7a due to the homogeneity requirement.

Model ID	Forecast Period (h)							
	12	24	36	48	60	72	96	120
OFCL	5.8	7.9	8.1	9.2	6.4	7.8	6.0	6.7
OCD5	9.1	12.4	12.7	13.8	19.6	20.3	23.7	9.0
HMNI	7.0	9.9	13.3	15.6	13.1	16.3	11.1	11.5
HWFI	6.7	9.3	11.7	15.3	16.0	14.9	9.3	6.8
DSHP	7.5	8.7	8.9	**8.9**	8.4	9.1	11.8	11.3
LGEM	8.4	10.0	9.9	10.4	9.8	8.2	12.1	12.3
IVCN	6.2	**7.8**	9.3	10.1	9.7	10.7	9.3	6.7
HCCA	6.5	**7.0**	9.6	12.2	11.8	12.1	8.8	7.3
FSSE	6.0	**7.6**	10.0	12.1	12.8	14.2	15.4	18.5
GFSI	**5.4**	7.9	8.1	**8.8**	9.3	10.1	13.2	15.0
EMXI	6.2	9.0	11.9	13.7	14.2	14.7	14.2	10.5
Forecasts	31	29	27	26	22	18	10	6

Table 8. Watch and warning summary for Hurricane Elsa, 30 June–9 July 2021.

Date/Time (UTC)	Action	Location
30 / 2100	Tropical Storm Watch issued	Barbados, St. Vincent and the Grenadines
30 / 2100	Tropical Storm Watch issued	St. Lucia
30 / 2100	Tropical Storm Watch issued	Martinique and Guadeloupe
1 / 0300	Tropical Storm Watch changed to Tropical Storm Warning	St. Lucia
1 / 0300	Tropical Storm Watch changed to a Tropical Storm Warning	Martinique
1 / 0300	Tropical Storm Watch changed to Tropical Storm Warning	Barbados
1 / 0900	Tropical Storm Watch changed to Tropical Storm Warning	St. Vincent and the Grenadines
1 / 1200	Tropical Storm Watch issued	Grenada
1 / 1800	Tropical Storm Watch discontinued	Guadeloupe
1 / 2100	Tropical Storm Watch issued	Dominican Republic southern coast to Le Mole St Nicholas
2 / 0000	Tropical Storm Watch modified to	Punta Palenque to Le Mole St Nicholas
2 / 0000	Tropical Storm Watch issued	Jamaica
2 / 0600	Tropical Storm Watch issued	Saba and Sint Eustatius
2 / 0900	Tropical Storm Watch issued	Dominica
2 / 0900	Tropical Storm Watch discontinued	Punta Palenque to Le Mole St Nicholas
2 / 0900	Tropical Storm Warning issued	Dominican Republic from Cabo Engano to border with Haiti
2 / 0900	Hurricane Watch issued	Dominican Republic south coast to Port Au Prince, Haiti
2 / 1200	Tropical Storm Warning changed to Hurricane Warning	Barbados
2 / 1200	Tropical Storm Warning changed to Hurricane Warning	St. Lucia
1 / 0300	Tropical Storm Watch changed to a Tropical Storm Warning	Dominica
2 / 1200	Tropical Storm Warning changed to Hurricane Warning	St. Vincent and the Grenadines

2 / 1500	Tropical Storm Watch changed to Tropical Storm Warning	Jamaica
2 / 1500	Hurricane Watch issued	Jamaica
2 / 1500	Hurricane Warning changed to Tropical Storm Warning	Barbados
2 / 1500	Tropical Storm Watch issued	Bahia de Manzanillo to Cabo Engano
2 / 1500	Tropical Storm Warning modified to	Cabo Engano to Punta Palenque
2 / 1500	Hurricane Watch discontinued	S.Bdr H/DR to Port Au Prince
2 / 1500	Hurricane Warning issued	Punta Palenque to Port Au Prince
2 / 1800	Hurricane Warning changed to Tropical Storm Warning	St. Vincent and the Grenadines
2 / 1800	Hurricane Warning changed to Tropical Storm Warning	St. Lucia
2 / 1800	Tropical Storm Watch issued	Cayman Brac and Little Cayman
2 / 1800	Tropical Storm Warning discontinued	Barbados
2 / 2100	Tropical Storm Warning changed to Hurricane Warning	Jamaica
2 / 2100	Tropical Storm Warning discontinued	St. Vincent and the Grenadines
2 / 2100	Tropical Storm Warning discontinued	Dominica
2 / 2100	Hurricane Watch discontinued	Jamaica
2 / 2100	Hurricane Watch issued	Cuban provinces of Camaguey to Guantanamo
3 / 0000	Tropical Storm Watch discontinued	Grenada
3 / 0000	Tropical Storm Warning discontinued	St. Lucia
3 / 0000	Tropical Storm Warning discontinued	Martinique
3 / 0300	Tropical Storm Watch discontinued	Saba and Sint Eustatius
3 / 1500	Hurricane Warning changed to Tropical Storm Warning	Jamaica
3 / 1500	Tropical Storm Watch issued	Cuban provinces Ciego de Avila to Matanzas
3 / 1500	Tropical Storm Warning issued	Cuban provinces Camaguey to Guantanamo
3 / 1800	Tropical Storm Warning changed to Tropical Storm Watch	Dominican Republic Cabo Engano to Punta Palenque
3 / 1800	Tropical Storm Watch modified to	Dominican Republic Cabo Engano to Punta Palenque

3 / 1800	Tropical Storm Warning issued	Dominican Republic Punta Palenque to southern border with Haiti
3 / 1800	Hurricane Warning modified to	Southern border with Haiti to Port Au Prince
3 / 2100	Tropical Storm Warning changed to Hurricane Watch	Cuban provinces Camaguey to Guantanamo
3 / 2100	Tropical Storm Watch modified to	Cuban provinces Havana to Matanzas
3 / 2100	Tropical Storm Watch issued	Dry Tortugas to Craig Key, Florida
3 / 2100	Tropical Storm Warning issued	Cuban provinces Villa Clara to Guantanamo
4 / 0000	Tropical Storm Watch discontinued	Dominican Republic Cabo Engano to Punta Palenque
4 / 0000	Tropical Storm Warning discontinued	Dominican Republic Punta Palenque to southern border with Haiti
4 / 0300	Tropical Storm Warning modified to	Southern coast of Dominican Republic to Port Au Prince
4 / 1500	Tropical Storm Watch changed to Tropical Storm Warning	Dry Tortugas to Craig Key
4 / 1500	Tropical Storm Watch discontinued	Cuban provinces Havana to Matanzas
4 / 1500	Tropical Storm Watch issued	Cuban provinces Artemisa
4 / 1500	Tropical Storm Watch issued	Craig Key to Ocean Reef, Florida
4 / 1500	Tropical Storm Watch issued	Flamingo to Bonita Beach, Florida
4 / 1500	Tropical Storm Warning discontinued	Southern coast of Dominican Republic to Port Au Prince
4 / 1500	Tropical Storm Warning modified to	Cuban provinces Matanzas to Guantanamo
4 / 2100	Tropical Storm Watch modified to	Flamingo to Anclote River, Florida
5 / 0000	Tropical Storm Warning discontinued	Jamaica
5 / 0000	Hurricane Watch modified to	Cuban provinces Camaguey to Granma
5 / 0300	Tropical Storm Warning discontinued	Cuban provinces Matanzas to Guantanamo
5 / 0300	Tropical Storm Warning issued	Cuban provinces Camaguey to Villa Clara
5 / 0300	Tropical Storm Warning issued	Cuban provinces Mayabeque to Havana
5 / 0300	Hurricane Warning issued	Cuban provinces Cienfuegos to Matanzas
5 / 0900	Tropical Storm Watch modified to	Englewood to Aucilla River, Florida
5 / 0900	Tropical Storm Warning issued	Flamingo to Englewood

5 / 1200	Tropical Storm Watch discontinued	Cayman Brac and Little Cayman
5 / 1500	Tropical Storm Watch changed to Tropical Storm Warning	Cuban provinces Artemisa to Ciego de Avila
5 / 1500	Tropical Storm Watch issued	Suwannee River to Indian Pass, Florida
5 / 1500	Tropical Storm Warning discontinued	Cuban provinces Camaguey to Villa Clara
5 / 1500	Tropical Storm Warning discontinued	Cuban provinces Mayabeque to Havana
5 / 1500	Tropical Storm Warning modified to	Flamingo to Suwannee River, Florida
5 / 1500	Hurricane Watch discontinued	All
5 / 1500	Hurricane Warning discontinued	All
5 / 2100	Tropical Storm Watch discontinued	Craig Key to Ocean Reef, Florida
5 / 2100	Tropical Storm Watch modified to	Ochlockonee River to Indian Pass, Florida
5 / 2100	Tropical Storm Warning modified to	Cuban provinces Artemisa to Villa Clara
5 / 2100	Tropical Storm Warning modified to	Flamingo to Ochlockonee River, Florida
6 / 0300	Tropical Storm Warning modified to	Cuban provinces Artemisa to Matanzas
6 / 0900	Tropical Storm Watch issued	FL/GA Border to South Santee River, South Carolina
6 / 0900	Hurricane Watch issued	Egmont Key to Steinhatchee River, Florida
6 / 1500	Tropical Storm Watch discontinued	Ochlockonee River to Indian Pass, Florida
6 / 1500	Tropical Storm Warning discontinued	Cuban provinces Artemisa to Matanzas
6 / 1800	Hurricane Watch changed to Hurricane Warning	Egmont Key to Steinhatchee River, Florida
6 / 1800	Tropical Storm Warning modified to	Flamingo to Egmont Key, Florida
6 / 2100	Tropical Storm Watch modified to	Altamaha Sound, Georgia to South Santee River, South Carolina
6 / 2100	Tropical Storm Warning modified to	Dry Tortugas to Seven Mile Bridge, Florida
6 / 2100	Tropical Storm Warning issued	FL/GA Border to Altamaha Sound, Georgia
7 / 0300	Tropical Storm Watch discontinued	Altamaha Sound, Georgia to South Santee River, South Carolina
7 / 0300	Tropical Storm Watch issued	Little River Inlet to Duck, North Carolina
7 / 0300	Tropical Storm Warning discontinued	Dry Tortugas, Florida

7 / 0300	Tropical Storm Warning modified to	Chokoloskee to Egmont Key, Florida
7 / 0300	Tropical Storm Warning modified to	FL/GA Border to Little River Inlet, South Carolina
7 / 0600	Tropical Storm Warning modified to	Bonita Beach to Egmont Key, Florida
7 / 0900	Tropical Storm Watch modified to	Little River Inlet to Chincoteague, Virginia
7 / 0900	Tropical Storm Warning discontinued	Bonita Beach to Egmont Key, Florida
7 / 0900	Tropical Storm Warning issued	Englewood to Chassahowitzka, Florida
7 / 0900	Hurricane Warning modified to	Chassahowitzka to Steinhatchee River, Florida
7 / 1200	Tropical Storm Warning modified to	Longboat Key to Chassahowitzka, Florida
7 / 1500	Tropical Storm Watch modified to	Little River Inlet to Sandy Hook, New Jersey
7 / 1500	Tropical Storm Warning discontinued	Longboat Key to Chassahowitzka, Florida
7 / 1500	Tropical Storm Warning modified to	Aripeka to Ochlockonee River, Florida
7 / 1500	Hurricane Warning discontinued	All
7 / 1800	Tropical Storm Warning modified to	Suwannee River to Ochlockonee River, Florida
7 / 2100	Tropical Storm Watch issued	East Rockaway Inlet to Port Jefferson Harbor, New York
7 / 2100	Tropical Storm Watch issued	New Haven, Connecticut to Sagamore Beach, Massachusetts
7 / 2100	Tropical Storm Watch issued	Block Island, Rhode Island
7 / 2100	Tropical Storm Watch issued	Martha's Vineyard
7 / 2100	Tropical Storm Watch issued	Nantucket Island, Massachusetts
7 / 2100	Tropical Storm Warning discontinued	Suwannee River to Ochlockonee River
8 / 0300	Tropical Storm Watch modified to	Great Egg Inlet to Sandy Hook, New Jersey
8 / 0300	Tropical Storm Warning discontinued	FL/GA Border to Little River Inlet, South Carolina
8 / 0300	Tropical Storm Warning issued	Altamaha Sound, Georgia to Great Egg Inlet, New Jersey
8 / 0900	Tropical Storm Watch changed to Tropical Storm Warning	East Rockaway Inlet to Port Jefferson Harbor, New York
8 / 0900	Tropical Storm Watch changed to Tropical Storm Warning	Block Island

8 / 0900	Tropical Storm Watch changed to Tropical Storm Warning	Martha's Vineyard
8 / 0900	Tropical Storm Watch changed to Tropical Storm Warning	Nantucket Island
8 / 0900	Tropical Storm Watch discontinued	All
8 / 0900	Tropical Storm Warning modified to	Altamaha Sound, Georgia to Sandy Hook, New Jersey
8 / 0900	Tropical Storm Warning issued	New Haven, Connecticut to Merrimack River, Massachusetts
8 / 1200	Tropical Storm Warning modified to	South Santee River, South Carolina to Sandy Hook, New Jersey
8 / 2100	Tropical Storm Warning modified to	Little River Inlet, South Carolina to Sandy Hook, New Jersey
9 / 0000	Tropical Storm Warning modified to	Surf City, North Carolina to Sandy Hook, New Jersey
9 / 0300	Tropical Storm Warning modified to	Ocracoke Inlet, North Carolina to Sandy Hook, New Jersey
9 / 0600	Tropical Storm Warning modified to	Fenwick Island, Delaware to Sandy Hook, New Jersey
9 / 0900	Tropical Storm Warning modified to	Little Egg Inlet to Sandy Hook, New Jersey
9 / 1200	Tropical Storm Warning discontinued	Little Egg Inlet to Sandy Hook, New Jersey
9 / 1800	Tropical Storm Warning discontinued	East Rockaway Inlet to Port Jefferson Harbor, New Yotk
9 / 1800	Tropical Storm Warning modified to	Watch Hill, Rhode Island to Merrimack River, Massachusetts
9 / 2100	Tropical Storm Warning discontinued	All

Table 9. Storm surge watch and warning summary for Hurricane Elsa.

Date/Time (UTC)	Action	Location
4 / 2100	Storm Surge Watch issued	Bonita Beach to the Suwanee River, FL, including Tampa Bay
5 / 1500	Storm Surge Watch extended	Suwanee River to Ochlockonee River, FL
5 / 2100	Storm Surge Warning issued	Bonita Beach to the Aucilla River, FL, including Tampa Bay
7 / 1200	Storm Surge Warning discontinued	South of the Middle of Longboat Key, FL
7 / 1500	Storm Surge Warning discontinued	South of Aripeka, FL
7 / 1500	Storm Surge Watch discontinued	All
7 / 1800	Storm Surge Warning discontinued	South of Suwanee River, FL
7 / 2100	Storm Surge Warning discontinued	All

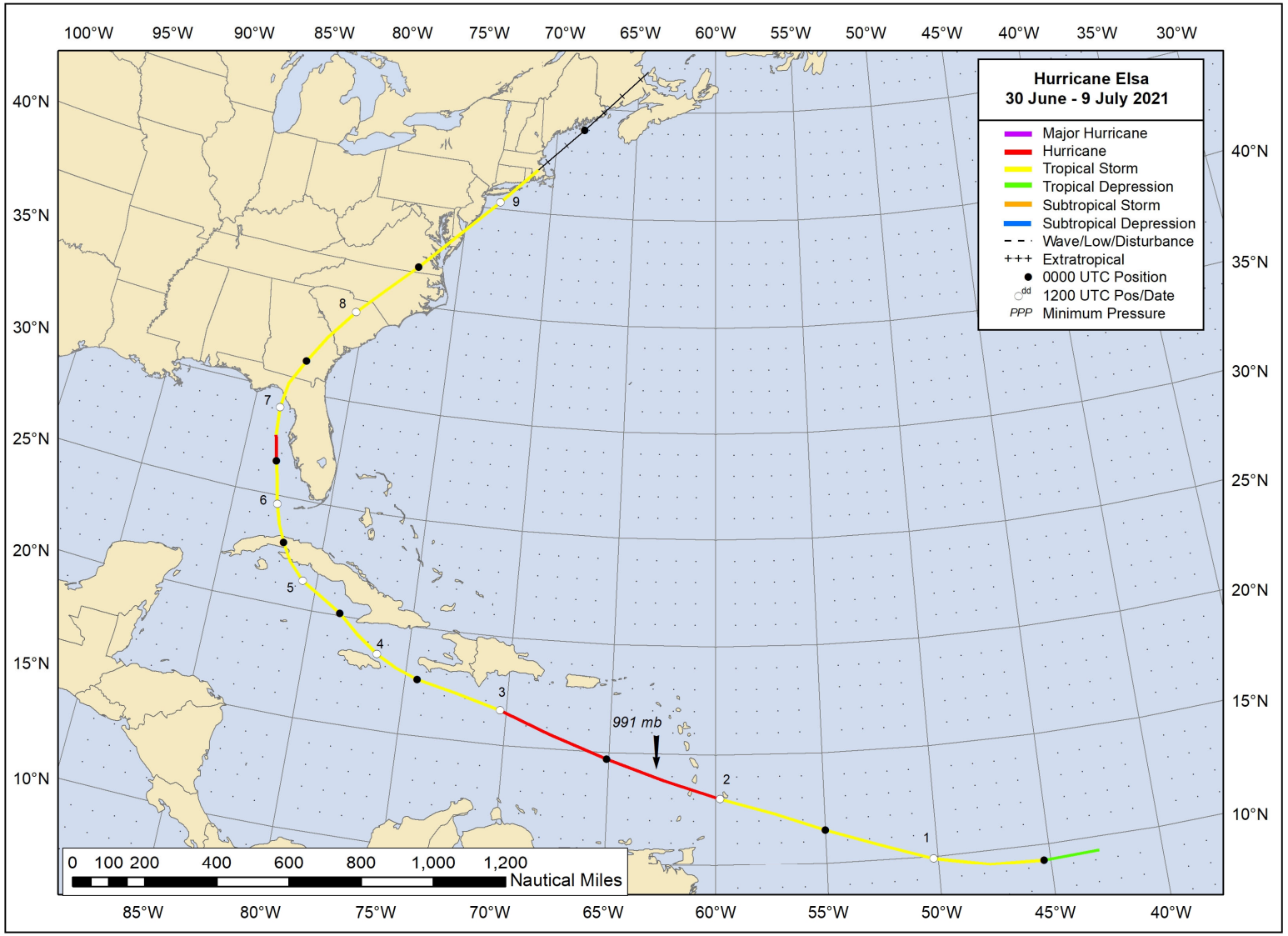

Figure 1. Best track positions for Hurricane Elsa, 30 June–9 July 2021. Track during the extratropical stage is partially based on analyses from the NOAA Ocean Prediction Center.

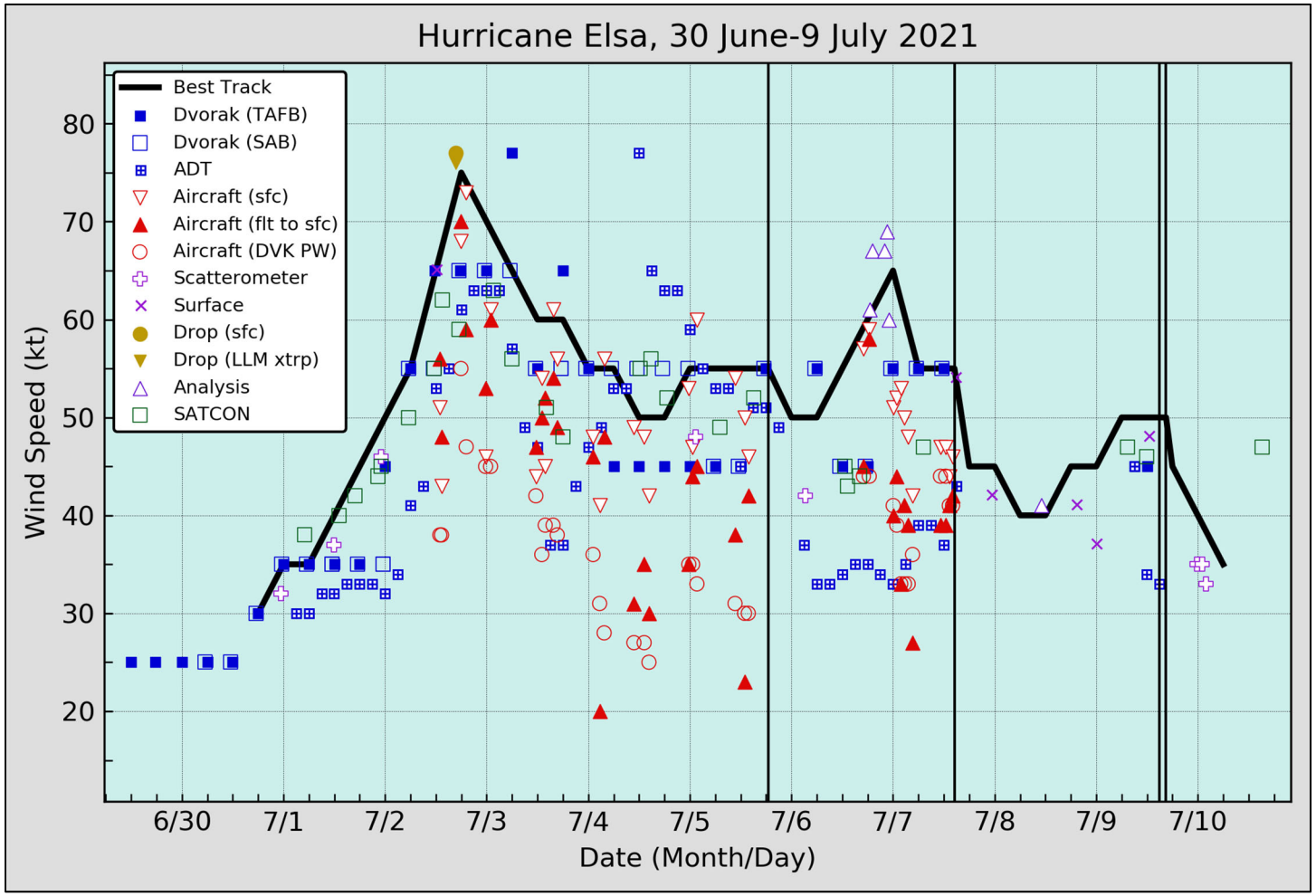

Figure 2. Selected wind observations and best track maximum sustained surface wind speed curve for Hurricane Elsa, 30 June–9 July 2021. Aircraft observations have been adjusted for elevation using 90%, 80%, and 80% adjustment factors for observations from 700 mb, 850 mb, and 1500 ft, respectively. Dropwindsonde 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.

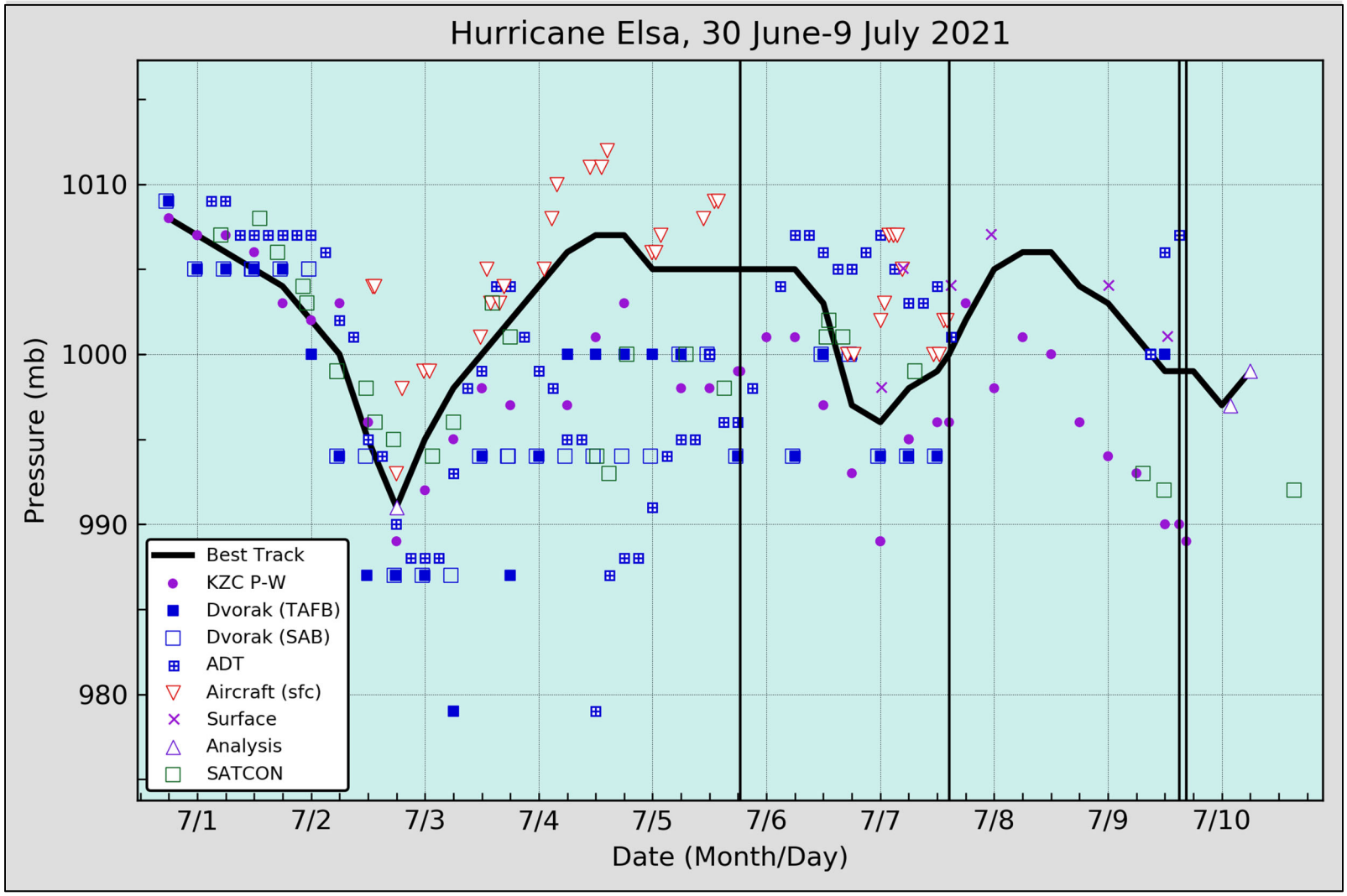

Figure 3. Selected pressure observations and best track minimum central pressure curve for Hurricane Elsa, 30 June–9 July 2021. Advanced Dvorak Technique estimates represent the Current Intensity at the nominal observation time. SATCON intensity estimates are from the Cooperative Institute for Meteorological 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.

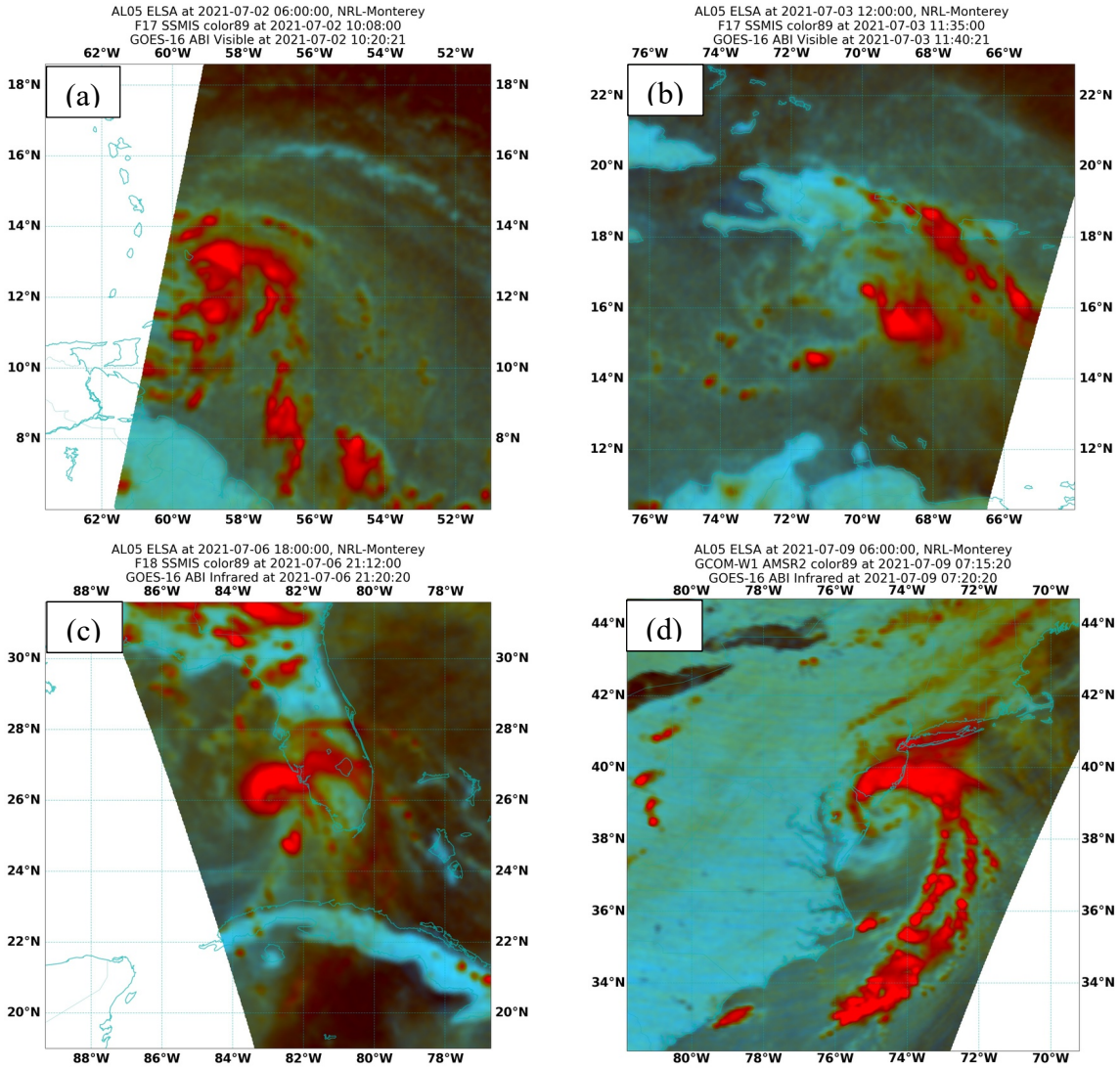

Figure 4. A series of microwave images of Elsa during its lifecycle. (a) SSMIS 89-GHz image of Elsa as a hurricane near Barbados, (b) SSMIS 89-GHz image of Elsa as a tropical storm over the central Caribbean Sea, (c) SSMIS 89-GHz image of Elsa just before it restrengthened to a hurricane off the southwestern Florida coast, (d) AMSR2 89-GHz image of Elsa as a tropical storm near southern New Jersey.

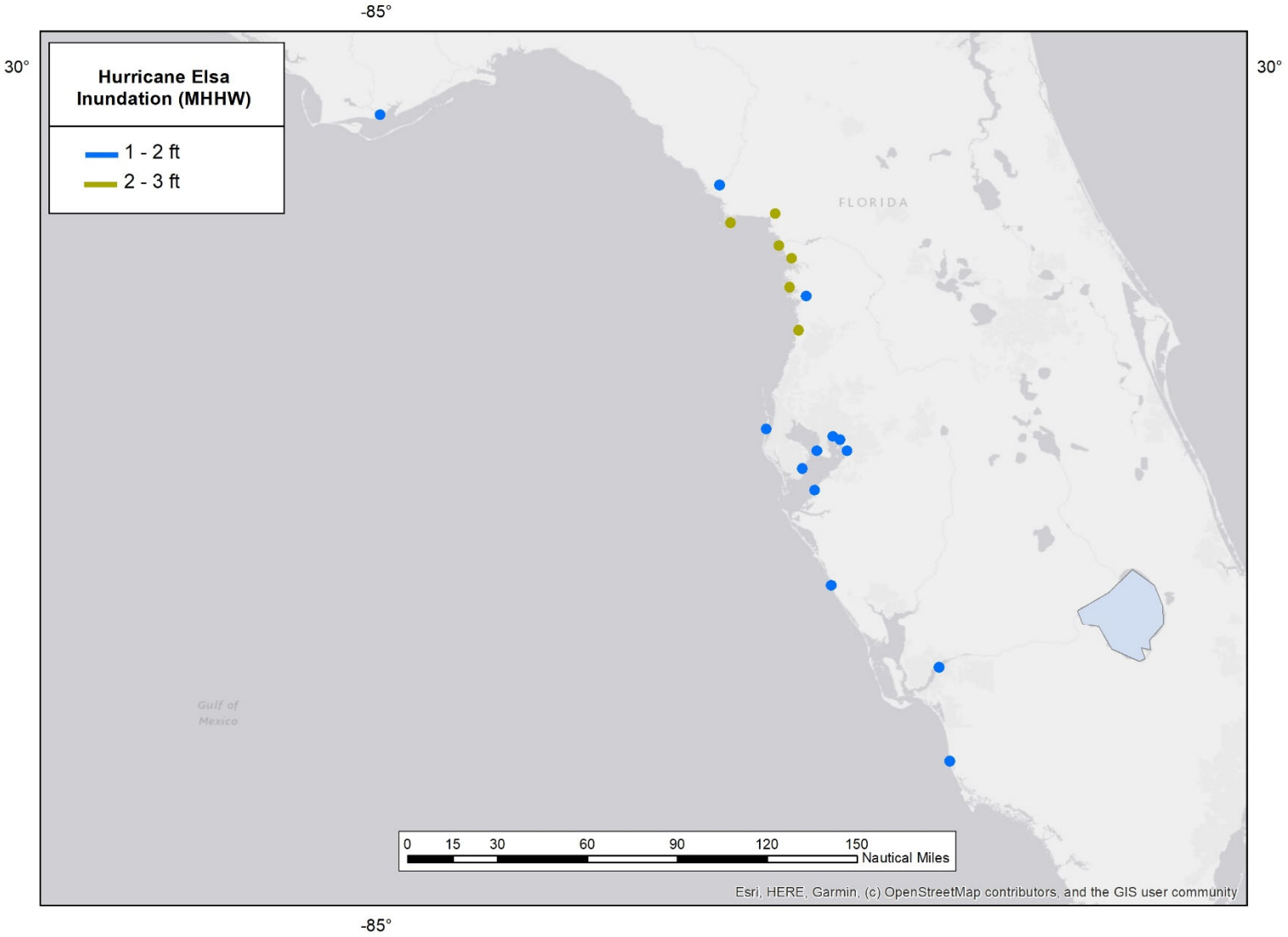

Figure 5. Maximum water levels measured from tide and stream gauges (circles) from Hurricane Elsa. Water levels are referenced as feet above Mean Higher High Water (MHHW), which is used as a proxy for inundation (above ground level) on normally dry ground along the immediate coastline.

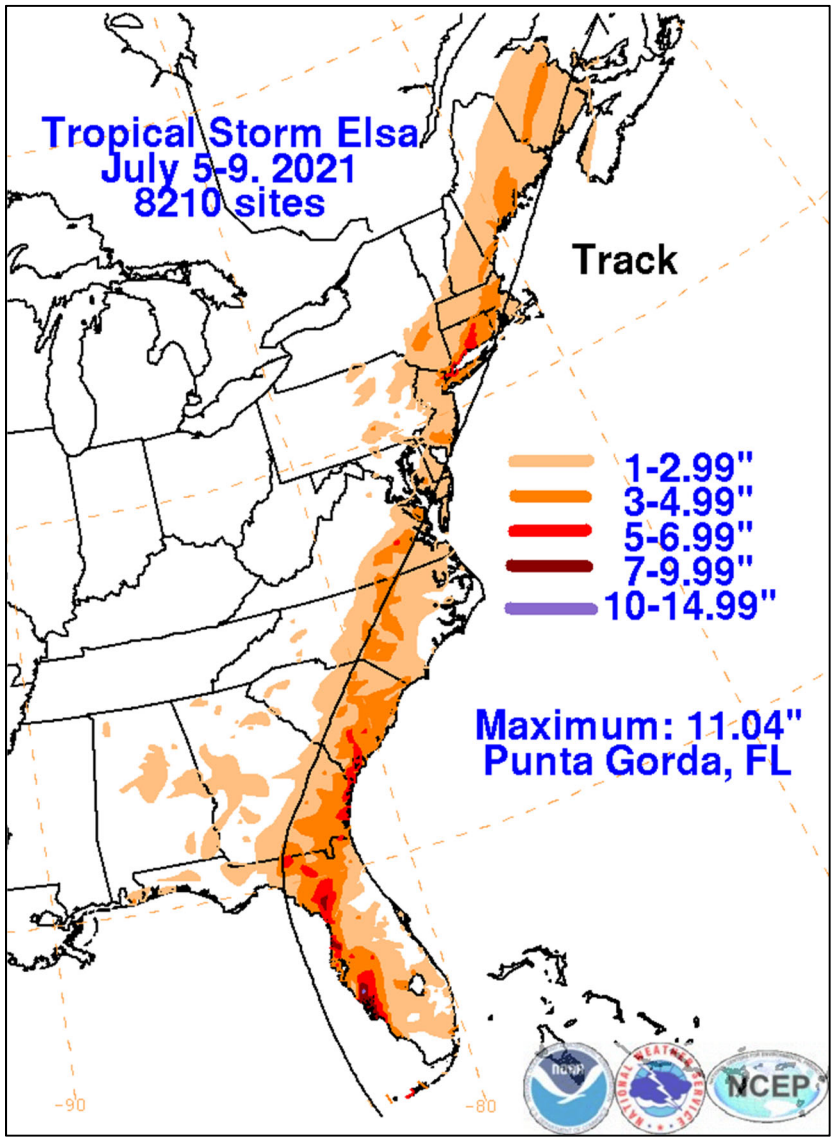

Figure 6. Total rainfall (inches) associated with Hurricane Elsa across the eastern U.S. Image courtesy of the Weather Prediction Center.

Figure 7. Example of damage caused by Elsa's hurricane-force winds in Barbados. Images courtesy of the Buzz-Caribbean news.

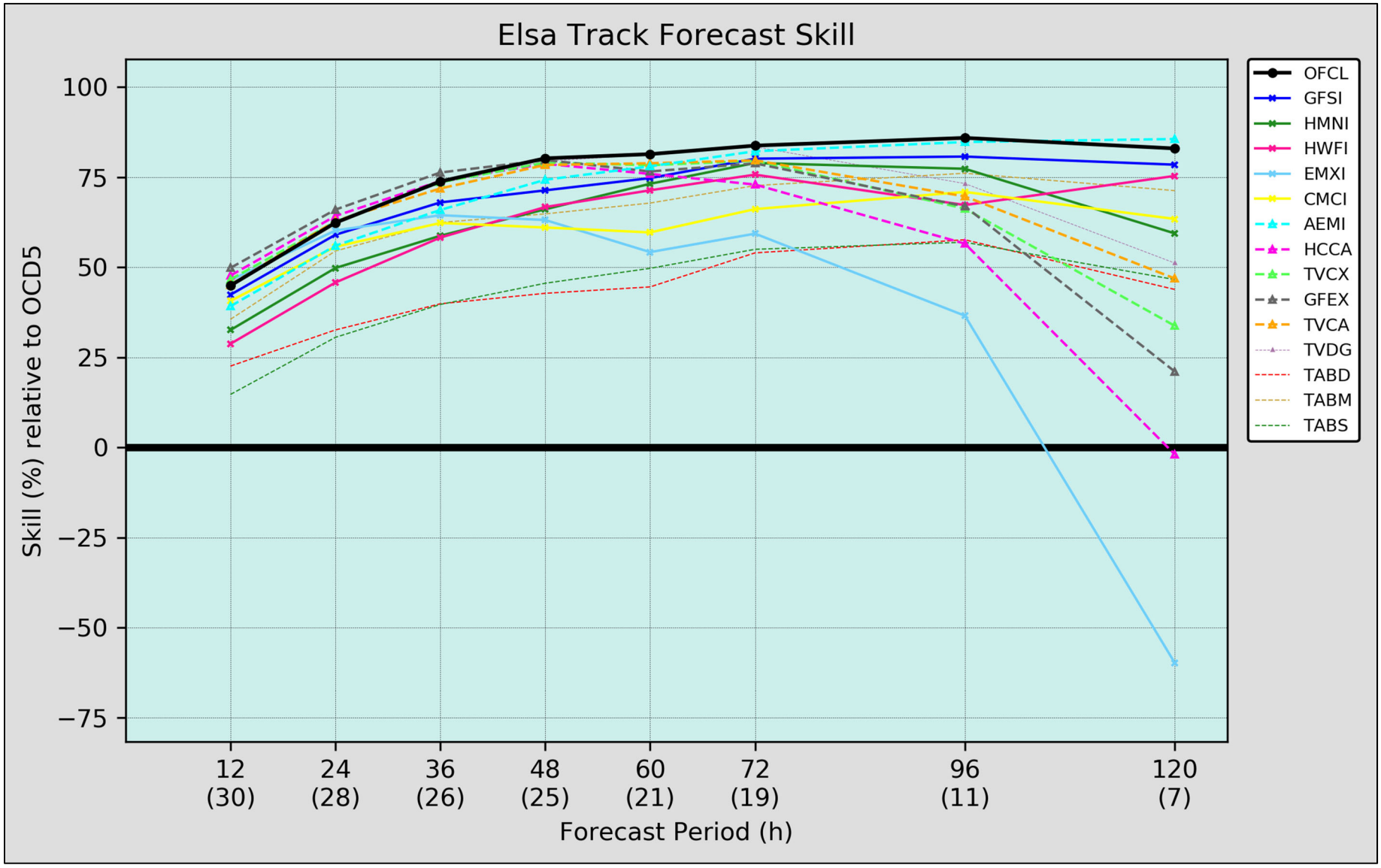

Figure 8. Track model skill for NHC (OFCL) and selected models for Hurricane Elsa, 30 June–9 July 2021.

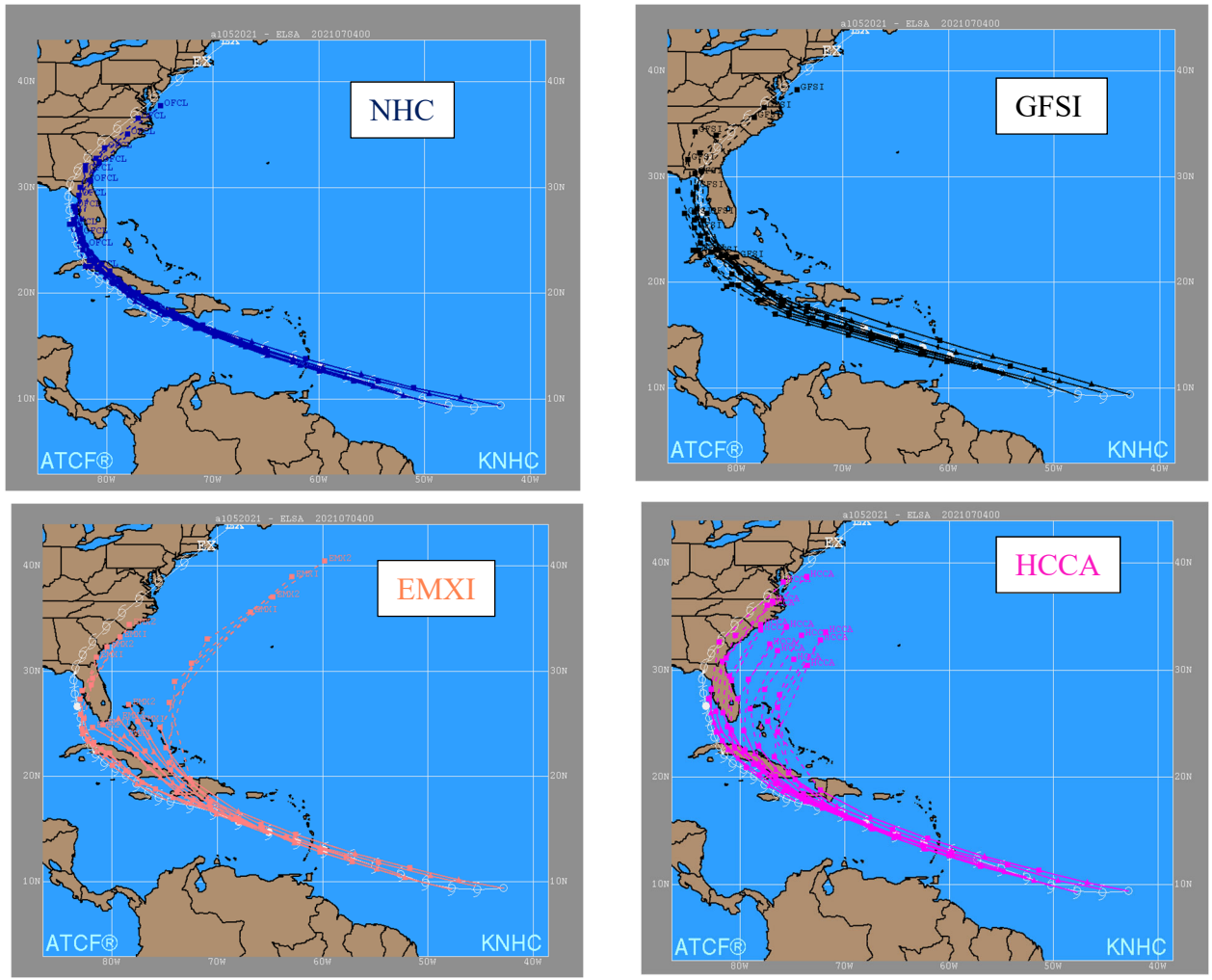

Figure 9. NHC and selected model tracks for Hurricane Elsa from 1800 UTC 30 June to 0000 UTC 4 July. Best track is shown by the white line.

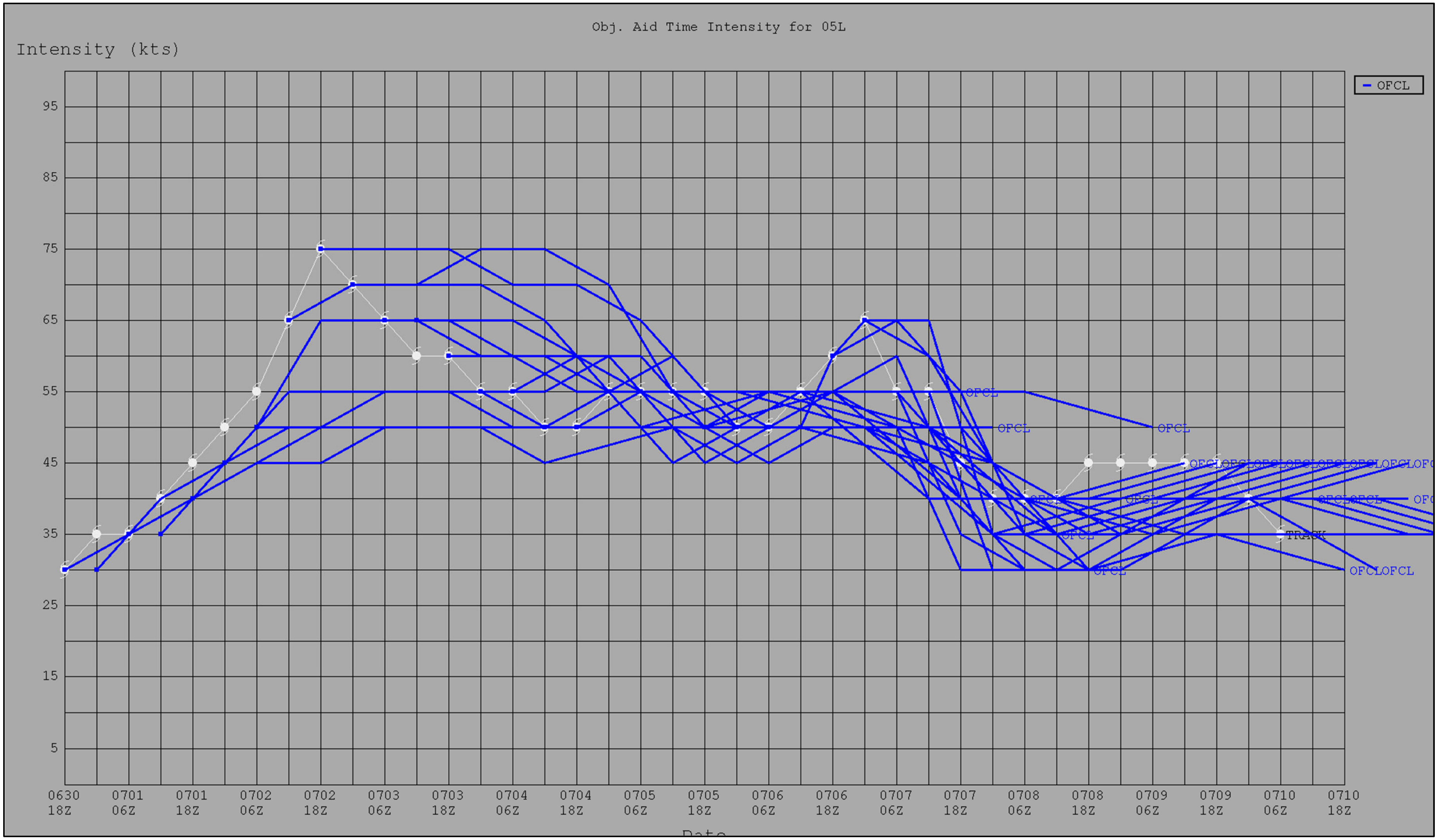

Figure 10. NHC intensity forecasts (kt) for Hurricane Elsa from 1800 UTC 30 June to 0000 UTC 7 July. Best track intensity (kt) is shown by the white line.

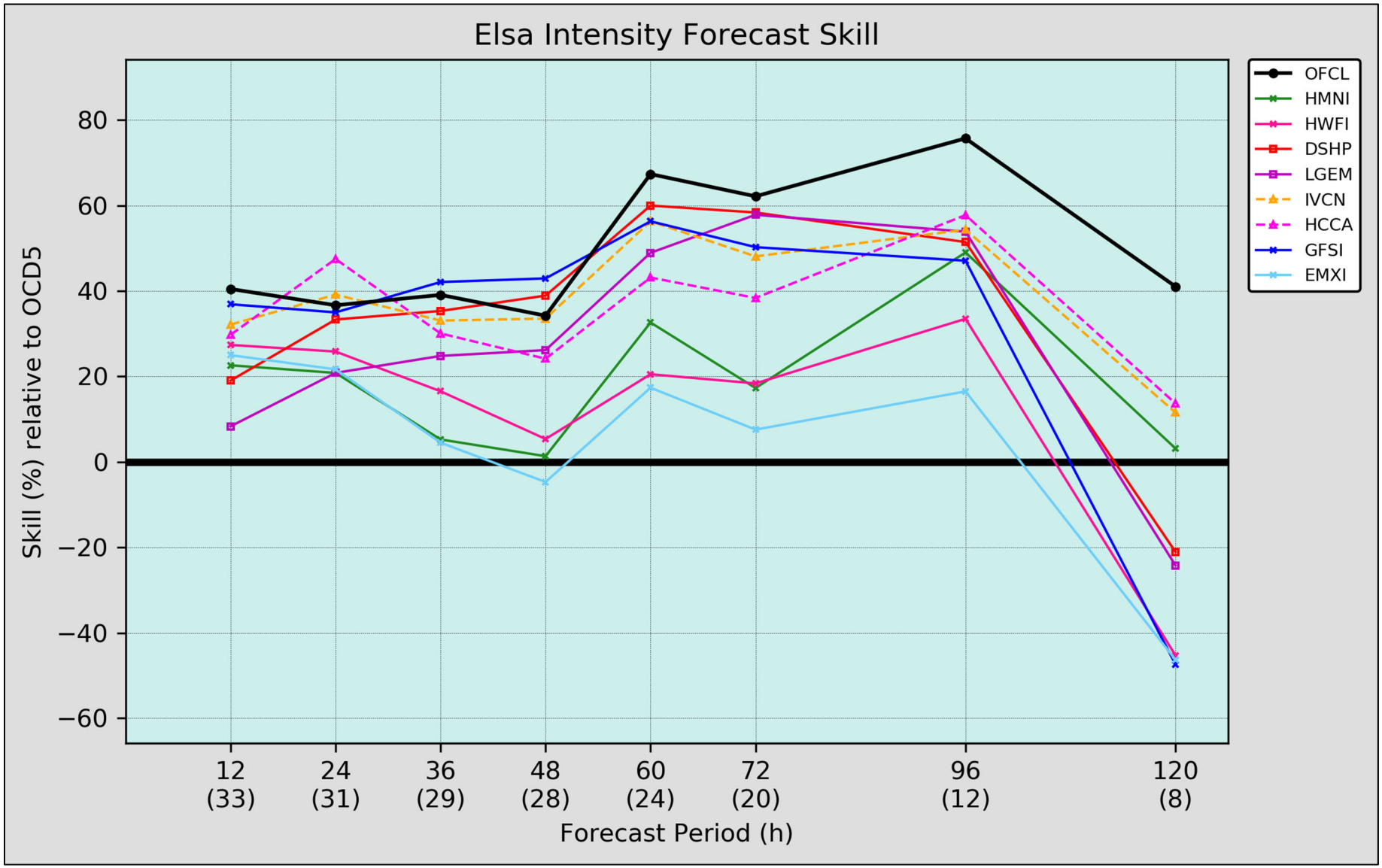

Figure 11. Intensity model skill for NHC (OFCL) and selected models for Hurricane Elsa, 30 June – 9 July 2021.

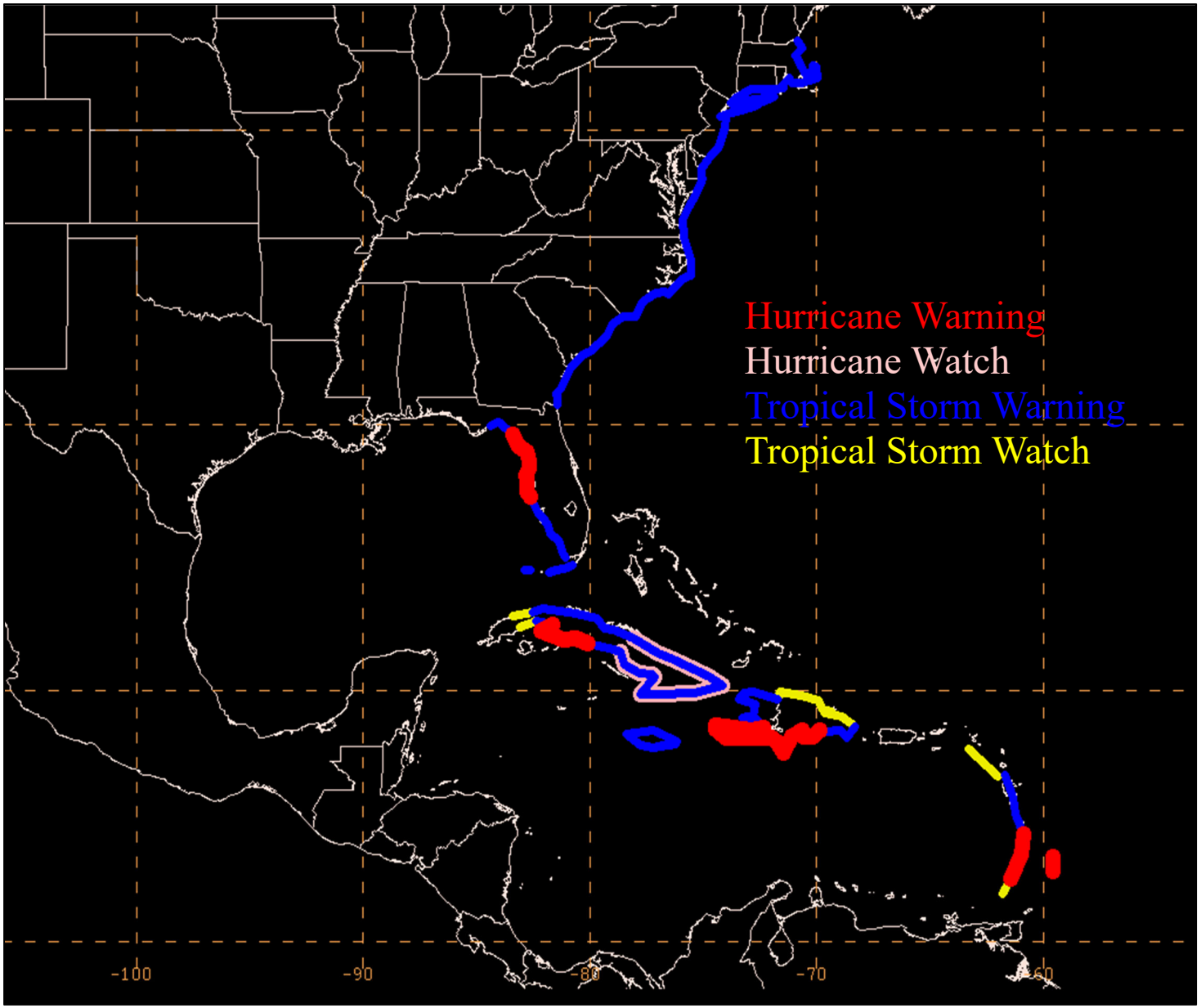

Figure 12. Wind watches and warnings issued for Hurricane Elsa.

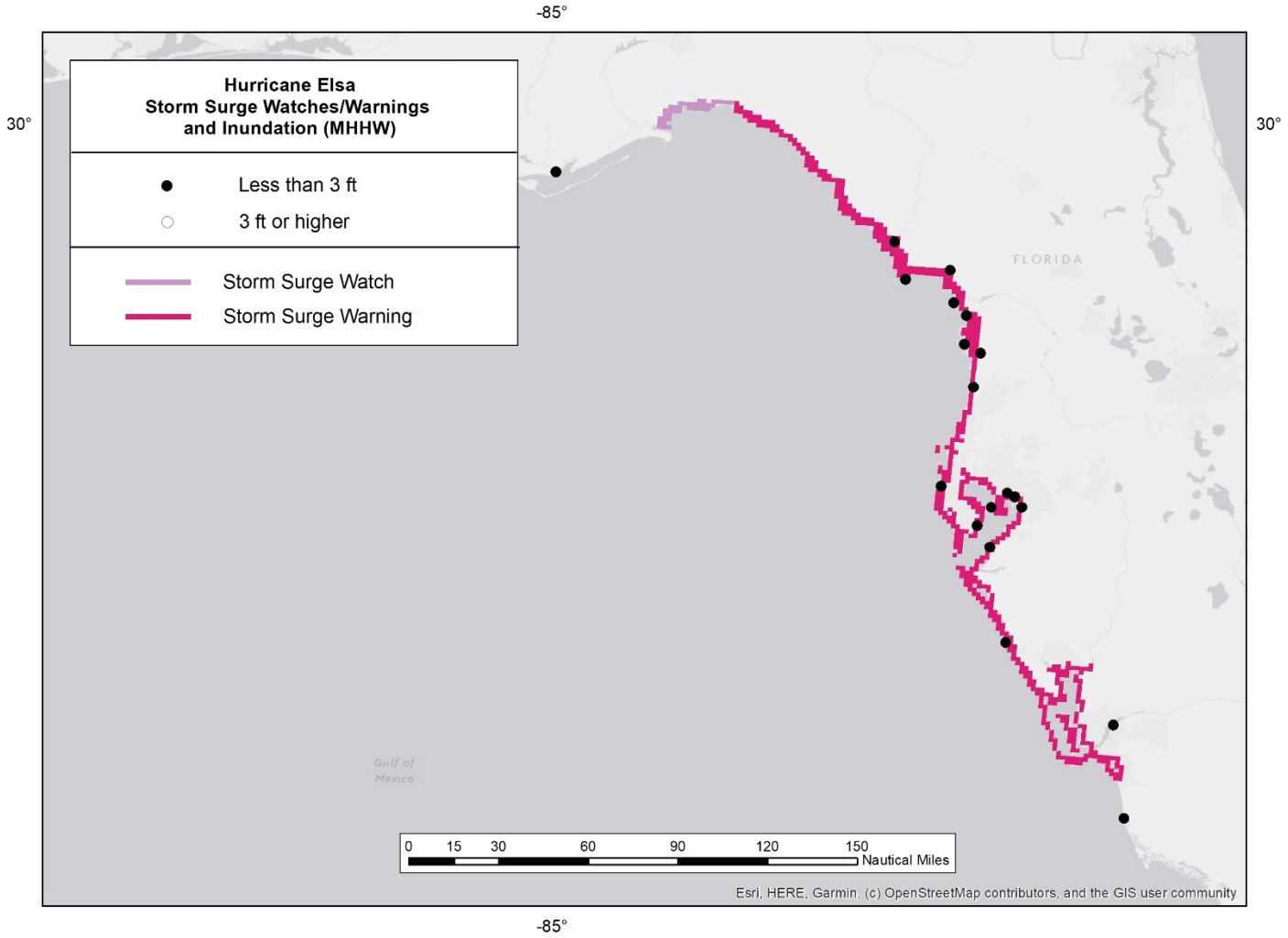

Figure 13. Maximum water levels measured during Hurricane Elsa from tide and stream gauges (circles), as well as areas covered by storm surge watches (lavender) and warnings (magenta). Water levels are referenced as feet above Mean Higher High Water (MHHW), which is used as a proxy for inundation (above ground level) on normally dry ground along the immediate coastline. Black markers denote water levels less than 3 ft above ground level, and white markers denote water levels 3 ft or higher above ground level.