NATIONAL HURRICANE CENTER TROPICAL CYCLONE REPORT

HURRICANE DORIAN

(AL052019)

24 August – 7 September 2019

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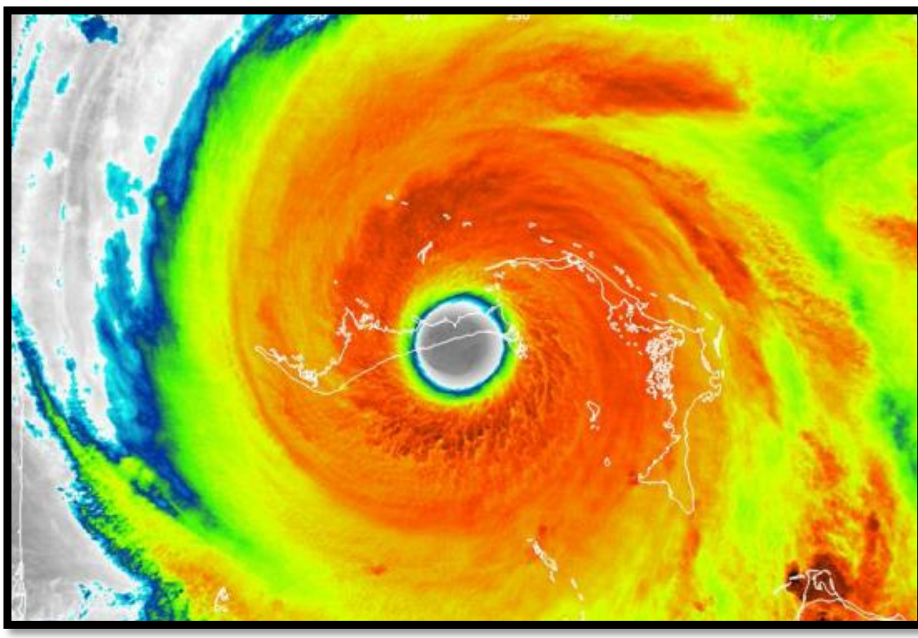

VIIRS-S-NPP SATELLITE IMAGE OF HURRICANE DORIAN AT 0703 UTC 2 SEPTEMBER 2019 SHOWING THE WELL-DEFINED EYE OF THE CATEGORY 5 HURRICANE OVER EASTERN GRAND BAHAMA ISLAND.

Dorian was the strongest hurricane to hit the northwestern Bahamas in modern records, resulting in numerous deaths and causing devastation on Great Abaco and Grand Bahama Islands. Dorian also affected a large portion of the United States eastern seaboard as a hurricane and reached Nova Scotia as a very strong post-tropical cyclone.

Hurricane Dorian

24 AUGUST – 7 SEPTEMBER 2019

SYNOPTIC HISTORY

A large tropical wave moved off the west coast of Africa on 19 August. The wave moved westward across the tropical Atlantic while losing most of its associated thunderstorm activity. On 22 August, however, a small area of convection with some signs of organization developed near the axis of the wave along 40°W. Visible satellite animations during the day showed a cyclonic circulation in the low clouds, suggesting that a small low pressure area had developed. The low moved toward the west at about 10 kt, gaining convective organization despite the influence of southeasterly deep tropospheric vertical wind shear of about 15 kt. It is estimated that the disturbance became a tropical depression at 0600 UTC 24 August while centered about 700 n mi east-southeast of Barbados in the Windward Islands. The "best track" chart of the tropical cyclone's path is given in Fig. 1, with the wind and pressure histories shown in Figs. 2 and 3, respectively. The best track positions and intensities are listed in Table 1[1].

Once the system became a tropical depression the cloud pattern became better organized. Microwave data showed the development of a curved convective band wrapping around an eye-like feature in the mid-levels, and the system became Tropical Storm Dorian at 1800 UTC 24 August. After a few hours of that upward trend, the cyclone became surrounded by dry air, and the cloud pattern changed very little in organization during the next 24 h. On 25 August, the cloud pattern gained some organization and developed a central dense overcast (CDO), but by the time Dorian reached the Windward Islands early on 27 August, an Air Force reconnaissance plane investigating the cyclone found that Dorian was not a very well-organized cyclone, having peak winds of 45 kt. Continuous intrusions of dry air might have contributed to the ragged structure of the cyclone during that period.

Dorian made landfall over Barbados as a very compact cyclone around 0130 UTC 27 August with 45-kt winds. It then moved across the remainder of the Windward Islands, with its center passing directly over St. Lucia around 1100 UTC that day. The high mountains of that island disrupted the organization of the cyclone's low-level circulation, and the center then re-formed to the north. The re-formation process was noted in radar data from Martinique and Guadeloupe. After the re-formation, the system continued to move toward the west-northwest and northwest at about 10 kt. While convective banding features became established in the northern half of the circulation, the central surface pressure gradually dropped, and a partial eyewall formed. Dorian was on an upward intensity trend and developed an inner core, becoming a 65-kt hurricane while its center moved over the eastern tip of St. Croix in the U.S. Virgin Islands around 1530 UTC. The center of the hurricane then moved across the western tip of St. Thomas

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[1] A digital record of the complete best track, including wind radii, can be found on line at ftp://ftp.nhc.noaa.gov/atcf. Data for the current year's storms are located in the *btk* directory, while previous years' data are located in the *archive* directory.

in the U.S. Virgin Islands with 70-kt winds at 1800 UTC that day, and an eye was observed then on satellite imagery.

A strengthening Dorian then moved into the Atlantic, away from the Virgin Islands and Puerto Rico, propelled northwestward by the flow between an upper-level low over the Straits of Florida and the Atlantic subtropical ridge. As the upper-low dropped southward and the subtropical ridge expanded westward, the resulting steering flow forced Dorian to take a west-northwest to west path through a region of low shear, abundant atmospheric moisture and over a very warm ocean. These conditions favored significant strengthening, and Dorian became a category 3 hurricane on the Saffir-Simpson Hurricane Wind Scale at 1800 UTC 30 August while centered about 385 n mi east of the northwestern Bahamas. After that time, the eye became quite impressive in satellite images, surrounded by a ring of very deep convection, with the estimated surface winds reaching 115 kt at 0000 UTC 31 August. The rapid intensification process continued, and the eye of 12 n mi in diameter became even more distinct, displaying a "stadium effect" sometimes observed in intense hurricanes. Dorian became a category 5 hurricane and then made landfall at Elbow Cay, Great Abaco, in the northwestern Bahamas (Fig. 4), at 1640 UTC 1 September with estimated winds of 160 kt and a minimum central pressure of 910 mb. Dorian was the strongest hurricane in modern records to make landfall in the Bahamas.

As the high pressure to the north of Dorian weakened, the steering currents collapsed, and the hurricane moved very slowly westward, pounding Great Abaco for several hours with its greatest fury. In fact, the island experienced at least tropical-storm-force winds for about 3 days. The hurricane's forward speed decreased even more, and Dorian began to crawl westward and west-northwestward toward Grand Bahama Island. The eye made landfall near South Riding Point on Grand Bahama near 0215 UTC 2 September with 155-kt winds. It exited along the north coast of the island 6 h later (cover figure). By then, the eye became larger, and the winds had decreased to 140 kt, likely due to the interaction with land and ocean cooling beneath the intense hurricane.

A large mid-level trough over the eastern United States swung eastward, and contributed to a flow pattern that favored Dorian turning north-northwestward and northward at about 5 to 10 kt. This kept the intense core of the hurricane east of Florida during the period from 3–5 September. The hurricane then weakened as it moved northward toward an environment of high shear and cooler waters. But, as its core moved over the Gulf Stream, Dorian re-strengthened back to category 3 status offshore of the coasts of Georgia and South Carolina. Dorian's large eye passed directly over a NOAA buoy just offshore of the coast of South Carolina around 1600 UTC 5 September where a pressure of 959.2 mb was recorded (Fig. 5). Dorian continued its northeastward motion, its eye passing near the Outer Banks of North Carolina for several hours and making landfall over Cape Hatteras at 1230 UTC 6 September (Fig. 6) with 85-kt winds. These category 2 winds occurred mostly over water in the eastern semicircle, and it is analyzed that North Carolina experienced category 1 winds. After clearing the Outer Banks, the hurricane accelerated northeastward, embedded within the mid-latitude flow.

Dorian became a strong post-tropical cyclone at 1800 UTC 7 September before it reached Nova Scotia, Canada. The cyclone's winds increased, and the circulation expanded due to baroclinic effects. The broad central circulation of the post-tropical cyclone moved rapidly across Sambro Creek, Nova Scotia, around 2200 UTC 7 September, bringing hurricane-force wind gusts to a large portion of Atlantic Canada. Dorian then became fully extratropical over the Gulf of St.

Lawrence at 0600 UTC 8 September and was finally absorbed by a larger extratropical low by 0600 UTC 9 September over the far northern Atlantic Ocean.

METEOROLOGICAL STATISTICS

Observations in Dorian (Figs. 2 and 3) included subjective satellite-based Dvorak technique intensity estimates from NOAA's Tropical Analysis and Forecast Branch (TAFB) and the Satellite Analysis Branch (SAB), and objective Advanced Dvorak Technique (ADT) estimates from the Cooperative Institute for Meteorological Satellite Studies/University of Wisconsin-Madison. 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 Dorian. Aircraft observations include flight-level, stepped frequency microwave radiometer (SFMR), and dropwindsonde observations from 23 flights (including 103 center fixes) of the 53rd Weather Reconnaissance Squadron of the U.S. Air Force Reserve Command and 16 missions (including 30 center fixes) from the NOAA Hurricane Hunters of the NOAA Aircraft Operations Center (AOC). In addition, the NOAA AOC G-IV aircraft flew nine synoptic surveillance flights around Dorian, collecting valuable data on the surrounding steering currents and other environmental conditions.

Data from Météo-France radars on Guadeloupe and Martinique, international radars on the Bahamas and other Caribbean islands, NOAA-National Weather Service WSR-88D radars from San Juan, Puerto Rico, and along the United States east coast were extremely beneficial in tracking Dorian. While Dorian was near the U.S. east coast, Doppler velocity data was useful in estimating the hurricane's intensity along with the extent and strength of the outer wind field. Surface observations from the Caribbean weather stations and data received from HAM radio operators and local observers were included in the analysis of Dorian.

Ship reports of tropical-storm-force winds associated with Dorian are given in Table 2, and selected surface observations along the entire track of Dorian from land stations, data buoys, tide gauges, barometric storm tide sensors, and high water marks are given in Table 3.

Winds and Pressure

The Bahamas

Dorian's estimated peak intensity of 160 kt at 1640 UTC 1 September, which is also the landfall intensity at Elbow Cay in the Abacos, is based on a blend of flight-level winds, dropwindsonde WL150 winds (average wind speed over the lowest 150 m), and multiple SFMR surface wind speed measurements made by both the Air Force Reserve and NOAA Hurricane Hunters during that time period. This estimate integrates the highest SFMR wind value of 178 kt, a 700-mb flight-level peak wind measurement of 161 kt (which is equivalent to an intensity of 145 kt), and a 1325 UTC WL150 wind speed of 177 kt (which is equivalent to a 10-m wind speed of

147 kt) (Fig. 2). It is important to note that the relationship between the SFMR wind values and the flight-level winds was quite consistent for wind speeds of 120 kt or less in Dorian, but not so for equivalent surface wind speeds exceeding 120 kt. As has been noted for other recent intense hurricanes, the discrepancy between surface winds estimated from historical relationships with the peak flight-level winds and SFMR-derived surface winds leads to greater-than-normal uncertainty in Dorian's peak intensity estimate. The estimated peak intensity may be revised if SFMR data at high winds are recalibrated.

The estimated minimum central pressure of 910 mb is based on a reconnaissance dropwindsonde instrument that measured a pressure of 912 mb in the eye just prior to landfall. That pressure observation was accompanied by a 23-kt surface wind, which indicates that the central pressure was approximately 910 mb. There were also several *in situ* observations provided by local observers that supported this minimum pressure value. There was a pressure observation of 909 mb measured with a smartphone at Marsh Harbor by Mr. Jimmy Ge, a visitor there, but the value has not been calibrated at the time of this report.

Caribbean Islands

Around 0130 UTC 27 August, as its center passed over or just south of Barbados, Dorian produced sustained winds of 33 kt with a gust to 48 kt. Data from an Air Force reconnaissance aircraft during that time indicated that the estimated intensity associated with Dorian was 45 kt. These winds occurred mainly over waters near the island. Dorian moved over St. Lucia around 1100 UTC that day with the same intensity. It appears that the high terrain there was partially responsible for the disruption of Dorian's circulation, causing the center to re-form to the north of that island.

The center of an intensifying Dorian crossed the eastern portion of St. Croix around 1530 UTC 28 August, when it became a hurricane. The sustained winds reached 71 kt with gusts to 96 kt at Buck Island. These winds, however, could have been somewhat enhanced by topography.

United States

Florida and Georgia

Although Dorian's center remained offshore the coasts of eastern Florida and Georgia, tropical-storm-force winds occurred over the coastal sections of these two states, primarily north of Broward County, Florida, because the hurricane's wind field had expanded considerably by then. The highest observed surface wind speed in those states was a 60-kt gust measured at New Smyrna Beach, Florida, around 0640 UTC 4 September. Some higher gusts were observed, but those occurred at elevated stations.

South Carolina, North Carolina, and Virginia

In South Carolina, most of the coastal observation sites reported northwesterly sustained winds ranging from 45 to 55 kt. A wind gust of 77 kt was measured at Winyah Bay Range at 1827 UTC 5 September. Stronger winds were reported in coastal North Carolina, primarily along the Outer Banks as the core of Dorian moved by the area. Reconnaissance data indicate that the winds were 85 kt at that time, but these winds occurred mainly over water in the eastern portion of the circulation. Nags Head, North Carolina, reported sustained winds of 72 kt with a gust to 85 kt at 1618 UTC 6 September. The strongest wind gust measured was 96 kt at 0920 UTC 6 September at Cedar Island in the Outer Banks. As Dorian's eye moved very near Cape Hatteras, North Carolina, the winds reached 80 kt in gusts and the pressure dropped to 959.7 mb at a NOAA National Ocean Service site there. As the hurricane turned northeastward away from the U. S. east coast, tropical-storm-force winds reached as far west as coastal Virginia due to Dorian's expansive outer wind field. A peak wind gust of 72 kt was measured at 1501 UTC 6 September at Chesapeake Light. However, this is an elevated observing station.

Canada

Dorian was already a post-tropical cyclone by the time it moved over Atlantic Canada. However, the wind field had continued to expand, and most of Nova Scotia was affected by sustained tropical-storm-force winds, with hurricane-force wind gusts confined primarily to some coastal sections. Most areas within a few hundred miles of the center of Dorian experienced winds gusts up to 54 kt, impacting Nova Scotia, eastern New Brunswick, Prince Edward Island, the Magdalen Islands, western and northeastern Newfoundland, and the Lower North Shore of Quebec. The highest winds were experienced just east of the storm track from Osborne Head to Sheet Harbour. The highest wind speed reported was from Wreckhouse, Newfoundland, where a gust to 85 kt was observed. This was likely enhanced due to topographical effects. Other notable wind gusts included 78 kt from Beaver Island and 76 kt at Osbourne Head in the approaches of Halifax Harbour.

Storm Surge[2]

Catastrophic storm surge flooding occurred on the Abaco Islands and Grand Bahama Island located in the northwestern Bahamas. A University of Hawaii Sea Level Center (UHSLC) tide gauge at Settlement Point on the western tip of Grand Bahama Island measured a water level of 6.4 ft above Mean Higher High Water (MHHW). This observation suggests that inundation levels were 6–7 ft above ground level on the western end of Grand Bahama Island. Higher water levels occurred farther east on Grand Bahama Island and on the Abaco Islands. No tide gauge measurements are available from those areas, but eyewitness accounts suggest that water levels reached more than 20 ft above ground level in some areas. For example, Bahamas Minister of Agriculture, Michael Pintard, shared a video on Twitter of seawater entering his house in the Marco City area of Freeport, reaching his kitchen windows which he estimated to be a minimum of 20 ft above ground level.

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

Storm surge flooding also occurred along portions of the southeastern United States coast from Florida to the Hampton Roads area of Virginia, with the most significant inundation occurring on portions of the North Carolina Outer Banks (Fig. 7). The highest measured storm surge from Dorian in the U.S. was 5.55 ft above normal tide levels at a NOAA National Ocean Service gauge at the U.S. Coast Guard Station Hatteras on the Pamlico Sound side of the Outer Banks. The combined effect of the surge and tide produced inundation levels of 5 to 7 ft above ground level on parts of Hatteras Island, including within the communities of Buxton, Avon, Hatteras, and Frisco. A United States Geological Survey (USGS) storm tide pressure sensor in Buxton recorded a peak wave-filtered water level of 6.92 ft above the North American Vertical Datum of 1988 (NAVD88), which converts to 6.7 ft MHHW (Fig. 8). Several other USGS sensors measured water levels around 6 ft MHHW, while the NOS tide gauge at the U.S. Coast Guard Station in Hatteras recorded a peak water level of 5.4 ft MHHW.

Inundation levels of 3 to 5 ft above ground level occurred elsewhere on the Outer Banks, as well as along some portions of Pamlico and Albemarle Sounds (including the Neuse and Pamlico Rivers). USGS pressure sensors in the Kitty Hawk and Kill Devil Hills areas measured peak water levels of 5.2 ft MHHW, while a sensor on the Neuse River at Havelock recorded a water level of 5.3 ft MHHW. Elsewhere along the North Carolina coast, inundation levels were generally 3 ft or less from Cape Lookout southwestward to the South Carolina border, and only a few isolated USGS sensors measured water levels of 3–4 ft MHHW.

Farther south, inundation heights of 2 to 4 ft above ground level occurred along the South Carolina coast, with the highest values being measured in the Grand Strand area near Myrtle Beach. An NOS gauge at Oyster Landing near Georgetown recorded a storm surge of 4.08 ft above normal tide levels, which led to a peak water level of 3.5 ft MHHW. In addition, a USGS sensor at Surfside Beach (just south of Myrtle Beach) measured a peak water level of 3.9 ft MHHW.

In Georgia and Florida, inundation heights of 1 to 3 ft above ground level were observed, although a few USGS sensors along the northeastern coast of Florida measured peak water levels slightly over 3 ft MHHW (Fig. 9). A sensor at Jacksonville Beach, Florida, measured a wave-filtered water level of 3.6 ft MHHW, while a sensor on Sea Island, Georgia, recorded a water level of 2.9 ft MHHW. The highest levels sampled by a tide gauge were at Fernandina Beach, Florida, where the NOS instrument measured a storm surge of 4.25 ft above normal tide levels and a storm tide of 2.6 ft MHHW.

North of North Carolina, inundation levels of 2 to 3 ft above ground level occurred in the Hampton Roads area of Virginia. The NOS tide gauge at the mouth of Chesapeake Bay measured a peak water level of 3.6 ft MHHW, and a gauge at Sewells Point in Norfolk, Virginia, recorded a peak water level of 3.1 ft MHHW. Every other tide gauge within Chesapeake Bay and along the mid-Atlantic coast as far north as Massachusetts measured peak water levels less than 3 ft MHHW, with the highest being 2.8 ft MHHW at Kiptopeke on the Eastern Shore of Virginia.

As a post-tropical cyclone, Dorian also caused storm surge flooding along parts of the Atlantic Canada coastline, including along the shores of the Gulf of St. Lawrence and Northumberland Strait. The highest storm surge measured by a tide gauge in Canada was

6.50 ft above normal tide levels at Shediac, New Brunswick, which resulted in a peak water level of 4.9 ft above Higher High Water Large Tide (HHWLT -- a tidal datum similar to MHHW used in the United States). A peak water level of 2.9 ft HHWLT was measured in Lower Escuminac, New Brunswick, which was a record for that location. In Nova Scotia, a storm surge of 4.66 ft above normal tide levels was measured at Halifax, resulting in a peak water level of 2.8 ft HHWLT, near the all-time record for that location. Elsewhere, peak storm surges of 4.95 ft above normal tide levels were measured at Charlottetown, Prince Edward Island; 4.13 ft at Port-aux-Basques, Newfoundland; and 4.13 ft on the Magdalen Islands, Quebec.

In the U.S. Virgin Islands and Puerto Rico, the highest measured storm surge was 1.21 ft above normal tide levels at a NOS gauge at Charlotte Amalie on St. Thomas. Observations on these islands suggest that the combined effect of the surge and tide produced little to no coastal flooding, with inundation levels less than a foot above ground level.

Rainfall and Flooding

Since Dorian was moving relatively quickly when it crossed the islands of the eastern Caribbean, and associated thunderstorm activity was limited, the cyclone did not produce significant rainfall amounts in that area. However, the hurricane slowed down to a crawl over the northwestern Bahamas, resulting in a storm-total rainfall of 22.84 inches at Hope Town in the Bahamas. While Dorian moved near the coasts of South Carolina and North Carolina, the hurricane produced significant rainfall, with a peak of 15.21 inches measured at Pawleys Island, South Carolina (Fig. 10). In Atlantic Canada, rainfall accumulations of 5 to 6 inches were observed across Nova Scotia, with a maximum of 6.45 inches measured at Mahone Bay.

Tornadoes

A total of 21 tornadoes – 19 across eastern North Carolina and 2 in northeastern South Carolina – were spawned by Dorian during the period from 4–6 September. Of the 21 tornadoes that formed, 17 were EF0 strength, 2 were rated EF1, and 2 reached EF2 intensity on the Enhanced Fujita scale. The most significant tornado damage occurred in Brunswick County and Emerald Island in North Carolina (Figs. 11 and 12).

CASUALTY AND DAMAGE STATISTICS

Bahamas

The Health Minister in the Bahamas estimated that more than 200 people lost their lives in Dorian. The Bahamas Weather Service estimated the total at 74, with 63 these occurring in Abaco, and 11 in Grand Bahama. The Bahamas Weather Service also reported that there were 245 people missing at the time of their report.

Dorian caused catastrophic damage mainly in Abaco and eastern Grand Bahama Islands with total damage estimated at $3.4 billion (USD). The Inter-American Development Bank (IDB), an agency which the government of the Bahamas asked to conduct a study following Dorian's trail of destruction, stated that the hurricane left 29,500 people homeless and/or jobless. The island of Abaco was hardest hit, suffering 87 percent of the damage. More than 75 percent of all homes on the island were damaged (Fig. 13).

United States

There were no direct[3] fatalities from Dorian in the United States. However, the hurricane caused four indirect deaths in the United States: three in Florida and one in North Carolina. A Florida landscaper was electrocuted while trimming trees at a hotel in Naples. Two other men in Florida died while preparing their homes for the storm. In North Carolina, an 85-year-old man in Columbus County was killed when he fell from a ladder while preparing his home for the storm.

In coastal South Carolina near Charleston, strong wind gusts felled numerous trees and powerlines. That resulted in widespread power outages affecting more than 160,000 buildings in the state. This type of damage extended northward over coastal North Carolina, where more than 190,000 people lost power.

Several people on Ocracoke Island were trapped in their attics caused by saltwater flooding from the storm surge inundation, and required rescue on boats. Some people were airlifted off the island while food and water were brought in for residents remaining there. North Carolina Highway 12 along Ocracoke Island suffered damage from the storm surge flooding and inundation. In Charleston, South Carolina, the city was especially hit hard due to flooding. The National Park Service Incident Management Team also reported that wave erosion caused by Dorian reshaped parts of the barrier islands in the Outer Banks. High waves also swept away a herd of cows from Cedar Island; three cows survived after being carried four miles away to Core Banks. Waves from the hurricane caused erosion to the beaches in Delaware. In Bethany Beach, the waves narrowed the beaches and also damaged dune fencing. The New Jersey shore experienced gusty winds and rough waves from the storm.

The NOAA National Centers for Environmental Information (NCEI) estimated total damage in the United States at $1.6 billion (USD).

Canada

The effects of Dorian were felt over a large area due to the storm's expansive wind field and rain shield to the left of Dorian's track. There were large uprooted trees, downed power lines, damage to roofs and sidings of buildings, as well as major flooding from heavy rainfall across parts of the Canadian Maritimes. Coastal impacts included widespread storm surge and waves,

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[3] Deaths occurring as a direct result of the forces of the tropical cyclone are referred to as "direct" deaths. These would include those persons who drowned in storm surge, rough seas, rip currents, and freshwater floods. Direct deaths also include casualties resulting from lightning and wind-related events (e.g., collapsing structures). Deaths occurring from such factors as heart attacks, house fires, electrocutions from downed power lines, vehicle accidents on wet roads, etc., are considered "indirect" deaths.

often combining with flooding due to rain along parts of the Atlantic Coast. Many coastal communities had damage to docks and other structures, and wave overwash onto the roads. Coastal erosion due to waves and surge was widespread, but particularly devastating for the north coast of Prince Edward Island where 7–10 feet of erosion occurred, as well as to parts of the Magdalene Islands. The tree damage in Cavendish Provincial Park in Prince Edward Island was so severe that the park was closed down for the rest of the season. There was also extensive damage in the provincial parks on the north shore (Fig. 14).

FORECAST AND WARNING CRITIQUE

Genesis

The genesis of Dorian was not very well forecast. The disturbance from which Dorian developed was first introduced in the Tropical Weather Outlook with a low probability (<40%) of formation within 48 h only 18 h prior to genesis. The probabilities were raised to the medium category (40%–60%) in both the 2-day and 5-day periods only 12 h before Dorian formed. (Table 4). The poor genesis forecasts were likely due to the small size of the incipient disturbance and the abundance of very dry mid-level air (relative humidity values <50%) surrounding the cyclone. The ECMWF global model did not even have a hint of genesis 48 h in advance; the GFS model showed genesis, but much farther east than where it actually occurred.

Track

A verification of NHC official track forecasts for Dorian is given in Table 5a. Official forecast track errors were lower than the mean official errors for the previous 5-yr period. A homogeneous comparison of the official track errors with selected guidance models is given in Table 5b. Although the average NHC official track forecast errors were quite low, some models performed much better than NHC at some time periods. The TVDG consensus model, which doubles the weight of three global models (GFS, ECMWF and UK) and places less weight on the solutions of the HWRF and HMON models, performed better than the official forecast as well as the other guidance at all times.

It is interesting to point out that during the early stages of Dorian, while it was located in the southeastern Caribbean Sea, the re-formation of the center after crossing St. Lucia resulted in a significant shift in track. Prior to crossing St. Lucia, most of the models incorrectly brought Dorian's center over eastern Hispaniola, and the cyclone instead moved east of Puerto Rico (Fig. 15). These errors resulted in the lack of adequate warning for some of the islands of the northeastern Caribbean Sea and also a low bias for the intensity forecast.

While some of the models and the official forecast indicated Dorian's forward speed would decrease near the Northwestern Bahamas, none of them indicated that Dorian was going to stall there.

Several NHC forecasts issued on 28–30 August brought the center of Dorian over the Florida peninsula. However, subsequent NHC forecasts turned Dorian northward east of Florida (Fig. 16). This resulted in low track forecast errors during a time when many models still indicated a landfall in Florida. This forecasted northward turn east of Florida was the basis for not issuing a hurricane warning for Miami-Dade and Broward Counties in South Florida.

Intensity

A verification of NHC official intensity forecasts for Dorian is given in Table 6a. The official 1- to 3-day forecast intensity errors were larger than the mean official errors for the previous 5-yr period. A homogeneous comparison of the official intensity errors with selected guidance models is given in Table 6b. With the exception of the Corrected Consensus model HCCA and the Florida State Super Ensemble (FSSE), which both performed better than the NHC forecast at various times, the rest of the models produced errors larger than the official forecast. Most of the large errors are related to the fact that Dorian's center did not move over Hispaniola, and the failure in forecasting rapid intensification when Dorian was near the Bahamas. It is important to note that none of the intensity models were able to capture the intensity trend of Dorian five days prior to the hurricane reaching its peak intensity of 160 kt (Fig. 17).

Wind Watches and Warnings

Tropical Storm and Hurricane wind watches and warnings associated with Dorian are given in Table 7. Advisories on Tropical Depression Five, which later became Dorian, were initiated at 1500 UTC 24 August when the cyclone was centered a little more than 750 n mi east-southeast of Barbados. The first Tropical Storm Watch was then issued by the government of Barbados for Barbados at 0900 UTC 25 August and was upgraded to a Tropical Storm Warning 9 h later. Watches and warnings were gradually extended westward and northwestward across the eastern Caribbean, including Puerto Rico and adjacent islands. A portion of these islands, including Puerto Rico, were under a Tropical Storm Warning and a Hurricane Watch since 0900 UTC 27 August, or 33 h before Dorian reached the area. However, since the intensification of Dorian occurred sooner than anticipated, the Tropical Storm Warning for the British and U.S. Virgin Islands was upgraded to a Hurricane Warning while Dorian was already producing hurricane conditions in the U.S. Virgin Islands.

The government of the Bahamas issued a Hurricane Watch for the northwestern Bahamas at 0900 UTC 30 August, and it was upgraded to a Hurricane Warning 12 h later. The hurricane made its first landfall in the northwestern Bahamas at Elbow Cay 43 h after the issuance of the hurricane warning. However, tropical-storm-force winds started a few hours earlier.

Since Dorian took a track parallel to and not far from the southeastern U.S. seaboard, most of the United States East Coast from Florida to Virginia was under a watch or warning for wind and storm surge as indicated in Table 7 and Table 8, respectively. Although at one point Dorian was forecast by the models and NHC to reach the Florida coast, subsequent NHC forecasts shifted offshore, and it was not necessary to issue a Hurricane Watch or Warning for Miami-Dade or Broward counties in South Florida. Historically, it has been uncommon to issue Hurricane Watches or Warnings for the northwestern Bahamas and not issue them for South Florida, particularly for a westward-moving hurricane.

Tropical storm watches and warnings were also issued for portions of southeastern Massachusetts and eastern Maine. While the strongest winds associated with Dorian remained offshore, sustained tropical-storm-force winds were observed in Cape Cod and eastern Maine.

Storm Surge Forecasts and Warnings

NHC issued its first storm surge forecast for the Bahamas at 1200 UTC 30 August, anticipating that water levels would rise by as much as 10 to 15 ft above normal tide levels in areas of onshore winds. Once it became increasingly likely that Dorian would be a powerful major hurricane and slow down while near and over the northwestern Bahamas, the storm surge forecast was raised to 15 to 20 ft above normal tide levels at 0300 UTC 1 September and then 18 to 23 ft above normal tide levels at 1500 UTC 1 September, specifically for the Abaco Islands and Grand Bahama Island. While no gauge measurements are available from the hardest-hit areas, eyewitness accounts indicate that at least 20 ft of inundation occurred on those islands.

Due to Dorian's forecast track parallel to the southeastern U.S. coastline, storm surge watches and warnings were in effect at various times along an extended, continuous segment of that coast (Table 8). Storm surge warnings ultimately extended from Lantana, Florida (central Palm Beach County), northward to Poquoson, Virginia (Fig. 18). These warnings included land areas bordering Pamlico and Albemarle Sounds in North Carolina, as well as the southern portion of Chesapeake Bay. In addition, a Storm Surge Watch was issued, but never upgraded to a warning, for a small segment of the Florida coast north of Deerfield Beach to Lantana (the southern Palm Beach County coast). Based on NOS tide gauge and USGS pressure sensor data, at least 3 ft of inundation (which NHC uses as a first-cut threshold for the storm surge watch/warning) occurred within some parts of the warning area, particularly portions of northeastern Florida, the Grand Strand of South Carolina, eastern North Carolina, and southeastern Virginia. Other portions of the warning area did not verify, with inundation being less than 3 ft above ground level along the east-central Florida coast, the Georgia coast, the South Carolina Low Country coast, and much of the North Carolina coast between Cape Fear and Cape Lookout.

Although a sizeable portion of the Storm Surge Warning area did not verify, the issuance of the watch and warning was justified given that a slight westward deviation of Dorian's track, or an expansion of its wind field, would have caused significant storm surge flooding to occur along a larger proportion of the coast. This dilemma is illustrated by NWS Probabilistic Storm Surge (P-Surge) ensemble tracks from the NHC forecast released at 1500 UTC 1 September, when the storm surge watch was first issued for a portion of the Florida east coast (Fig. 19). Given typical uncertainties in tropical cyclone track forecasts, there was the potential for Dorian to move closer to, or even over the Florida peninsula, which would have caused significant storm surge flooding along the east-central coast of Florida. The solid black line in the figure is Dorian's actual track, which shows that the hurricane ultimately moved on the eastern side of the ensemble spread and consequently lowered the threat of significant storm surge along the east-central Florida coast.

The first storm surge forecast for a portion of the U.S. east coast was issued at 1500 UTC 1 September and called for maximum inundation heights of 4 to 7 ft above ground level between Jupiter Inlet and the Volusia/Brevard County Line in Florida. That same inundation forecast was extended northward along the southeastern U.S. coast, eventually reaching as far north as Cape Lookout, North Carolina, by 2100 UTC 3 September. Forecast inundation amounts were also increased as high as 5 to 8 ft above ground level from Isle of Palms to Myrtle Beach in South Carolina at 0900 UTC 4 September. Maximum water levels along the southeastern U.S. coast south of Cape Lookout were around 4 ft above ground level, which was at the lower bound of the storm surge forecast. Because Dorian stayed far enough offshore to prevent significant storm surge flooding along the coast, the range of forecast inundation heights in that area ended up being a few feet too high.

In eastern North Carolina between Cape Lookout and Duck, including the Pamlico and Albemarle Sounds, the initial storm surge forecasts were 3 to 5 ft above ground level at 2100 UTC 3 September. This forecast was gradually raised over time, ultimately peaking at 4 to 7 ft above ground level for the forecast issued at 1200 UTC 5 September. The storm surge forecast for this area proved to be accurate, as maximum water levels of 5 to 7 ft above ground level were observed on parts of Hatteras Island, and 4 to 6 ft above ground level was measured on other parts of the Outer Banks and the western side of Pamlico Sound. Farther north, maximum inundation heights of 2 to 4 ft above ground level were forecast north of Duck to Poquoson, Virginia, including the Hampton Roads area. Maximum observed water levels in that region were 2 to 3 ft above ground level.

Impact-Based Decision Support Services (IDSS) and Public Communication

NHC coordinated extensively with the meteorological services of numerous countries in the eastern Caribbean Sea beginning on 25 August, as they issued various tropical storm and hurricane watches and warnings for their respective areas of responsibility. Coordination and discussion of the issuance of watches and warnings with the Bahamas Meteorological Service began on 29 August.

NHC began providing decision support to emergency managers on 24 August when Dorian formed east of the Lesser Antilles. These initial briefings were in support of Puerto Rico and the U.S. Virgin Islands and included FEMA headquarters and FEMA Region 2. As the threat expanded to the continental U.S., NHC briefings included FEMA Region 3, FEMA Region 4, and the states of Florida, Georgia, South Carolina, North Carolina, and Virginia. These briefings were coordinated through the FEMA Hurricane Liaison Team, embedded at NHC, and included telephone briefings and Federal/State video-teleconferences. The coordination of information and briefings continued through September 7 when the impacts associated with Dorian wound down across the far northeastern U.S.

The Tropical Analysis and Forecast Branch of NHC provided 25 live briefings on Hurricane Dorian to the U.S. Coast Guard Districts 7 and 8 between 26 August and 6 September, in support of their life-saving mission.

A limited media pool was initiated on 27 August, operating from 0700–0930 EDT (1100–1330 UTC), and again from 1700–1830 EDT (2100–2230 UTC). For three days while the storm was in the Caribbean Sea and not yet a direct threat to the mainland United States, live interviews were offered to network pool members and to South Florida media affiliates.

The media pool was expanded to continuous operations on 30 August, operating from 0700–2330 EDT (1100–0330 UTC). A Spanish-language media pool was also initiated to address a high Spanish media demand. With the threat to South Florida over on 3 September, a change from a local media pool to a network pool was made. This provided a high priority to networks and more availability to those local stations elsewhere in the potential path of the storm. In total during the pool for Dorian, NHC provided 241 network interviews, 124 local station interviews, and 52 Spanish language interviews through the media pool, in addition to 105 generic updates made available to all pool members.

In addition, NHC provided 32 Facebook Live broadcasts via its Facebook page during the 11-day span of the media pool (0830, 1130, and 1730 EDT/1230, 1530, 2130 UTC). NHC experienced 6 million views, with a single peak live view of 456,000 on the 1130 EDT (1530 UTC) 1 September broadcast as Dorian neared landfall in the northwestern Bahamas.

NHC provided Key Messages in the Tropical Cyclone Discussion and in graphical format on the NHC webpage and through social media posts from 25 August through 8 September.

NHC web pages were accessed approximately 340 million times between 24 August and 8 September resulting in approximately 6.5 billion hits. Products specific to Dorian were viewed 186 million times during this period, with a majority of the views going to graphical products such as the key messages, cone graphic, and the wind speed probabilities.

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Table 1. Best track for Hurricane Dorian, 24 August–7 September 2019.

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
24 / 0600	10.3	46.4	1011	25	tropical depression
24 / 1200	10.4	47.5	1010	30	"
24 / 1800	10.6	48.7	1008	35	tropical storm
25 / 0000	10.8	49.9	1008	35	"
25 / 0600	11.0	51.0	1008	35	"
25 / 1200	11.2	52.3	1007	40	"
25 / 1800	11.4	53.5	1007	45	"
26 / 0000	11.6	54.7	1007	45	"
26 / 0600	11.9	56.0	1006	45	"
26 / 1200	12.2	57.2	1006	45	"
26 / 1800	12.6	58.3	1006	45	"
27 / 0000	13.0	59.2	1005	45	"
27 / 0130	13.1	59.4	1005	45	"
27 / 0600	13.5	60.2	1005	45	"
27 / 1100	14.0	60.9	1005	45	"
27 / 1200	14.2	61.2	1005	45	"
27 / 1800	15.0	62.0	1004	45	"
28 / 0000	15.7	62.8	1003	50	"
28 / 0600	16.4	63.5	1001	55	"
28 / 1200	17.3	64.2	999	60	"
28 / 1530	17.8	64.6	995	65	hurricane
28 / 1800	18.4	65.1	993	70	"
29 / 0000	19.2	65.7	989	75	"
29 / 0600	20.0	66.3	988	75	"
29 / 1200	21.0	66.9	986	75	"
29 / 1800	22.0	67.4	983	75	"
30 / 0000	22.8	68.0	978	80	"
30 / 0600	23.5	68.8	978	90	"
30 / 1200	24.3	69.5	972	95	"

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
30 / 1800	24.8	70.3	968	100	"
31 / 0000	25.3	71.1	949	115	"
31 / 0600	25.6	72.1	947	120	"
31 / 1200	25.9	73.0	944	125	"
31 / 1800	26.1	74.0	942	130	"
01 / 0000	26.3	74.7	939	135	"
01 / 0600	26.4	75.6	934	145	"
01 / 1200	26.5	76.5	927	155	"
01 / 1640	26.5	77.0	910	160	"
01 / 1800	26.5	77.1	910	160	"
02 / 0000	26.6	77.7	914	155	"
02 / 0215	26.6	77.8	914	155	"
02 / 0600	26.6	78.0	916	145	"
02 / 1200	26.7	78.3	927	135	"
02 / 1800	26.8	78.4	938	125	"
03 / 0000	26.9	78.5	944	115	"
03 / 0600	27.0	78.5	950	105	"
03 / 1200	27.1	78.5	954	100	"
03 / 1800	27.6	78.6	959	95	"
04 / 0000	28.1	78.8	959	90	"
04 / 0600	28.8	79.2	964	90	"
04 / 1200	29.5	79.6	963	90	"
04 / 1800	30.1	79.7	960	95	"
05 / 0000	30.7	79.7	955	100	"
05 / 0600	31.4	79.6	958	100	"
05 / 1200	32.1	79.2	958	100	"
05 / 1800	32.7	78.9	958	95	"
06 / 0000	33.4	77.9	956	90	"
06 / 0600	34.1	76.9	956	90	"
06 / 1200	35.1	75.7	956	85	"
06 / 1230	35.2	75.6	956	85	"

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
06 / 1800	36.2	73.7	956	85	"
07 / 0000	37.4	71.2	956	85	"
07 / 0600	38.9	68.9	955	85	"
07 / 1200	40.8	66.9	954	85	"
07 / 1800	42.8	64.6	954	80	low
08 / 0000	45.2	62.9	956	80	"
08 / 0600	47.6	61.9	960	75	extratropical
08 / 1200	49.4	60.4	962	70	"
08 / 1800	50.8	57.9	966	60	"
09 / 0000	51.6	54.8	980	50	"
09 / 0600					dissipated
01 / 1640	26.5	77.0	910	160	maximum winds minimum pressure
27 / 0130	13.1	59.4	1005	45	landfall at Barbados
27 / 1100	14.0	60.9	1005	45	landfall at St. Lucia
28 / 1530	17.8	64.6	995	65	landfall at St. Croix
28 / 1800	18.4	65.1	993	70	landfall at St. Thomas
01 / 1640	26.5	77.0	910	160	landfall Elbow Cay, Abacos
02 / 0215	26.6	77.8	914	155	landfall at South Riding Point, Grand Bahama
06 / 1230	35.3	75.5	956	85	landfall at Cape Hatteras, NC

Table 2. Selected ship reports with winds of at least 34 kt for Hurricane Dorian, 24 August–7 September 2019.

Date/Time (UTC)	Ship call sign	Latitude (°N)	Longitude (°W)	Wind dir/speed (kt)	Pressure (mb)
28 / 1500	J8PB	18.2	63.8	110 / 35	1012.0
03 / 1800	DGZL	25.9	76.5	180 / 35	1005.8
04 / 0900	J8QX6	25.8	77.2	230 / 35	1008.6
05 / 0700	WHED	28.6	76.5	190 / 37	1012.3
05 / 0800	C6BX8	28.1	80.3	230 / 38	1008.9
05 / 0800	CQIV4	28.9	76.3	190 / 35	1012.0
05 / 1000	HPYE	27.5	79.5	220 / 36	1012.1
05 / 1800	VRLZ4	30.2	76.0	200 / 41	1010.8
05 / 2100	DFDG2	30.6	79.5	220 / 40	1005.7
06 / 0700	WNTL	31.9	72.9	320 / 50	1009.0
06 / 1200	FMEK	32.6	73.5	200 / 45	1005.0
06 / 1300	9V6210	39.4	74.0	080 / 35	1010.0
06 / 1600	VRNY4	30.8	75.5	260 / 35	1010.0
07 / 0000	WAIU	33.1	67.4	210 / 37	1011.8
07 / 0200	C6BR3	33.3	66.7	230 / 35	1016.0
07 / 0400	VRID5	38.3	74.3	010 / 35	1006.1
07 / 0500	9HJC9	32.6	67.7	230 / 36	1007.0
07 / 0600	C6BR3	32.2	67.9	240 / 40	1014.0
07 / 1100	KABL	35.4	64.2	020 / 40	1009.7

Table 3. Selected surface observations for Hurricane Dorian, 24 August–7 September 2019.

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									
Barbados Grantley Adams (TBPB) (13.08N 59.49W)	27/0200	1007.1	27/0100	33	48				
U.S. Virgin Islands and Puerto Rico									
International Civil Aviation Organization (ICAO) Sites									
St. Thomas (TIST) (18.33N 64.97W)	28/1800	1000.0		46	65				
Weatherflow									
Buck Island (XBUK) (18.28N 64.89W)	28/1720	993	28/1720	71	96				
Culebra Is, PR (XCUL) (18.31N 65.23W)	28/1914	993	28/1914	48	58				
Rupert Rock, VI (XRUP) (18.33N 64.93W)	28/1827	1000	28/1827	44	57				
Two Brothers, VI (XBRO) (18.34N 64.82W)	28/1753	1003	28/1753	51	65				
National Ocean Service (NOS) Sites									
St. Croix (CHSV3) (17.75N 64.71W)	28/1524	1006.3	28/1500	30	38				
St. Thomas Charlotte Amalie (CHAV3) (18.34N 64.92W)	28/1806	1000.3							
Culebra, PR (CLBP4) (18.30N 65.30W)	28/1930	1005.9							
Public/Other									
St. Thomas – Estate Bovoni (AU730) (18.32N 64.89W)	28/1807	999.7	28/1717	63 (70 m)	84				
Bahamas									
Dunmore Town, Eleuthera (25.50N 76.64W)	01/1214	1006.1[l]	01/1214	25[l]	37[l]				
Great Cuana Cay (26.67N 77.12W)	01/1149	1004.1[l]	01/1149	25[l]	42[l]				
Hopetown, Abaco (26.54N 76.96W)			01/1444		87[l] e				
Coastal-Marine Automated Network (C-MAN) Sites									
Settlement Point (SPGF1) (26.70N 79.00W)	03/0500	983.7	03/0500	55 (8 m, 10-min)	77			6.4	
Public/Other									
Hopetown, Abaco (Edds) (26.54N 76.96W)	01/1654	912.0							
Marsh Harbour, Great Abaco (ICyclone)(26.54N 77.08W)	01/1750	913.4							

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)				
Buoys									
41001 NOAA (34.50N 72.52W)	06/1850	998.1	06/1829	52 (4 m, 1-min)	63				
41002 NOAA (31.89N 74.93W)	06/0720	1005.7	06/0433	44 (4 m, 1-min)	54				
41004 NOAA (32.50N 79.10W)	05/1600	959.2	05/1801	74 (4 m, 1-min)	86				
41008 NOAA (31.40N 80.87W)	05/0550	994.1	04/2312	52 (5 m, 1-min)	64				
41009 NOAA (28.50N 80.18W)	04/0710	988.1	04/0700	52 (4 m, 8-min)	70				
41010 NOAA (28.91N 78.47W)	04/0440	983.1	04/0056	61 (4 m, 1-min)	78				
41013 NOAA (33.44N 77.73W)	06/0120	958.5	06/0244	66 (4 m, 1-min)	78				
41024 CORMP (33.85N 78.48W)	06/0038	985.4	06/0223	37 (3 m)	56				
41025 NOAA (35.01N 75.40W)	06/1220	959.2	06/1335	64 (4 m, 1-min)	78				
41029 CORMP (32.81N 79.63W)	05/1553	983.7	05/1523	49 (3 m, 8-min)	80				
41033 CORMP (32.28N 80.41W)	05/1008	992.0	05/1208	53 (3 m, 8-min)	80				
41033 CORMP (32.28N 80.41W)	05/1208	992.6[l]	05/1208	62 (10 m)					
41037 CORMP (33.99N 77.36W)	06/0408	959.2	06/0308	49 (3 m)	68				
41038 CORMP (34.10N 77.70W)	06/0408	976.4	06/0253	39 (3 m)	58				
41046 NOAA (23.82N 68.38W)	30/0610	1002.9	30/0614	46 (4 m)	54				
41052 CarICOOS (18.25N 64.76W)	28/1750	1004.2	28/1700	37[l] (4 m)	47[l]				
41064 CORMP (34.21N 76.95W)	06/0608	959.1	06/0708	45 (3 m)	68				
44008 NOAA (40.50N 69.25W)	07/0840	982.9	07/1011	56 (5 m, 1-min)	70				
44011 NOAA (41.07N 66.59W)	07/1300	955.3	07/1547	63 (4 m, 1-min)	81				
44014 NOAA (36.61N 74.84W)	06/1750	984.5	06/1805	62 (5 m, 1-min)	71				
44020 NOAA (41.49N 70.28W)	07/0800	997.6	07/0804	37 (4 m, 1-min)	45				
44027 NOAA (44.27N 67.31W)	07/1950	994.7	07/1949	37 (5 m, 1-min)	43				
44037 NRACOOS (43.50N 67.88W)	07/1704	994.0[l]	07/1704	35[l] (4 m)					
44064 CBIBS (37.00N 76.09W)	06/1440	998.4	06/1440	38 (3 m)	52				
44137 E&CCC (42.26N 62.00W)				51 (5 m)	58				
44150 E&CCC (42.50N 64.02W)	07/1800	964.8	07/2000	53 (5 m)	65				

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)				
44258 E&CCC (44.50N 63.40W)	07/2300	965.3	07/1900	49 (5 m)	61				
United States Mainland									
Florida									
International Civil Aviation Organization (ICAO) Sites									
Cape Canaveral (KXMR) (28.46N 80.56W)	04/0856	996.9	04/0706		52				
Cape Canaveral (KTTS) (28.61N 80.69W)	04/0856	997.7	04/0451	27	53				
Cocoa Beach (KCOF) (28.23N 80.59W)	04/0555	998.1	03/2250	33	46				
Melbourne (KMLB) (28.10N 80.64W)	04/0653	999.3	03/2305	33	44				1.83
Pompano Beach Airpark (KPMP) (26.25N 80.12W)	03/0935	1001.3	03/1825	32	42				
St. Augustine (KSGJ) (29.97N 81.33W)	04/1656	1001.8	04/0546	33[l]	41[l]				
West Palm Beach (KPBI) (26.68N 80.12W)	03/0820	1000.3		30	38				
Coastal-Marine Automated Network (C-MAN) Sites									
St. Augustine (SAUF1) (29.86N 81.26W)	04/1300	1001.3	04/1300	44 (16 m)	54				
National Ocean Service (NOS) Sites									
Blount Island Command (BLIF1) (30.39N 81.52W)	04/1906	1004.0	04/1742		36 (11 m)				
Dames Point (DMSF1) (30.39N 81.56W)						2.39	3.18	1.8	
Fernandina Beach (FRDF1) (30.67N 81.47W)	04/2012	1003.5	04/1618		41 (9 m)	4.25	5.29	2.6	
Key West (KYWF1) (24.55N 81.81W)	03/0730	1007.0				0.77	0.98	0.9	
Lake Worth Pier (LKWF1) (26.61N 80.03W)	03/0818	1001.4	02/1906		40 (12 m)	2.00	2.70	2.2	
Mayport (Bar Pilots Dock) (MYPF1) (30.40N 81.43W)	04/2030	1002.3	04/1648		40 (11 m)	3.09	4.09	2.1	
Southbank Riverwalk St. John River (MSBF1) (30.32N 81.66W)						1.91	2.29	1.7	
S Port Everglades (PEGF1) (26.08N 80.12W)	03/0918	1001.7	03/1900		37 (44 m)	1.68	2.54	2.0	
Trident Pier, Port Canaveral (TRDF1) (28.42N 80.59W)	04/0636	999.1	04/0230		45 (10 m)	2.11	3.34	2.2	
Vaca Key, Florida Bay (VCAF1) (24.71N 81.11W)	03/0712	1006.0				1.09	0.71	1.1	
Virginia Key, Biscayne Bay (VAKF1) (25.73N 80.16W)	03/0742	1002.5				1.55	2.05	1.9	
Weatherflow									
Banana River at 520 (XCCB) (28.36N 80.66W)	04/0717	998.6	03/2247	36 (5 m)	52				

Location	Minimum Sea Level Pressure		Maximum Surface Wind Speed			Storm surge (ft)[c]	Storm tide (ft)[d]	Estimated Inundation (ft)[e]	Total rain (in)
	Date/ time (UTC)	Press. (mb)	Date/ time (UTC)[a]	Sustained (kt)[b]	Gust (kt)				
Buck Island (XJAK) (30.39N 81.48W)	04/1918	998	04/1623	37 (10 m)	48				
Crescent Beach (XHSE) (29.72N 81.23W)	04/1648	1000	04/1048	34	50				
Government Cut (XGVT) (25.75N 80.10W)			02/1945	30 (23 m)	45				
Grant Indian River (XIND) (27.96N 80.53W)	04/0704	999.3	03/2234	35 (5 m)	53				
Huguenot Park (XHUP) (30.42N 81.41W)	04/2030	1001	04/1805	36 (12 m)	47				
Jacksonville Beach Pier (XJAX) (30.29N 81.39W)	04/2030	1000	04/1215	38 (10 m)	48				
Juno Beach Pier (XJUP) (26.89N 80.06W)	03/1949	999.9	03/0459	43 (6 m)	53				
Malabar Indian River (XRPT) (27.98N 80.55W)	04/0642	1000.1	04/0037	36 (6 m)	48				
Melbourne Beach (XMBI) (27.90N 80.47W)	04/0740	996.8	03/2220	42 (10 m)	52				
New Smyrna Beach (XNSB) (29.05N 80.90W)	04/0849	996.3	04/0644	41 (10 m)	60				
Florida Institute of Technology Weather Stations									
Sebastian Inlet Pier (SIPF1) (27.86N 80.44W)	04/0811	999.3	03/2221	42 (11 m)	53				
United States Geological Survey (USGS) High Water Marks									
Jacksonville – Sawpit Creek (FLDUV03108) (30.51N 81.46W)							5.42	2.7	
USGS Storm Tide Sensors									
Cocoa Beach – Atlantic Ocean (FLBRE03167) (28.37N 80.60W)							3.81	2.6	
Crescent Beach – Matanzas River (FLSTJ03125) (29.76N 81.25W)							5.06	3.2	
Daytona Beach Shores – Atlantic Ocean (FLVOL03141) (29.15N 80.96W)							4.44	2.9	
Fernandina Beach – Atlantic Ocean (FLNAS21014) (30.62N 81.44W)							5.65	3.0	
Fort Matanzas – Atlantic Ocean (FLSTJ03126) (29.72N 81.23W)							5.39	3.4	
Grant-Valkaria Indian River (FLBRE03160) (27.92N 80.52W)							1.70	2.5	
Jacksonville – Ft. George River (FLSTJ03125) (30.42N 81.42W)							5.61	3.1	

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)				
Jacksonville – Pablo Creek (FLDUV03114) (30.29N 81.42W)							3.72	2.2	
Jacksonville – Sawpit Creek (FLDUV03108) (30.51N 81.46W)							5.09	2.7	
Jacksonville Beach – Atlantic Ocean (FLDUV21045) (30.29N 81.39W)							6.03	3.6	
New Smyrna Beach – Atlantic Ocean (FLVOL03146) (29.01N 80.88W)							4.34	2.9	
Ormond Beach – Halifax River (FLVOL03138) (29.29N 81.05W)							2.23	2.3	
Palm Bay – Indian River (FLBRE03158) (28.04N 80.58W)							1.55	2.4	
Palm Coast – Intracoastal Waterway (FLFLA03131) (29.56N 81.18W)							2.89	2.7	
Palm Valley Landing – Intracoastal Waterway (FLSTJ03117) (30.13N 81.38W)							4.19	2.2	
Ponce Inlet Beach – Atlantic Ocean (FLVOL03143) (29.08N 80.92W)							4.31	2.8	
Ponte Vedra Beach – Intracoastal Waterway (FLSTJ03117) (30.21N 81.41W)							4.06	2.2	
Sebastian Inlet Intracoastal (FLIND03149) (27.86N 80.45W)							2.13	2.8	
St. Augustine – Salt Run (FLSTJ17848) (29.89N 81.29W)							5.21	3.2	
Usina Beach – Tolomato River (FLSTJ03118) (29.95N 81.31W)							4.68	2.7	
Other									
USAF Tower 3 (KSC0003) Kennedy Space Center (28.46N 80.53W)			04/0305	42 (16 m, 1-min)	60				
USAF Tower 311 (KSC0311) (28.60N 80.64W)			04/0600	34 (16 m, 1-min)	55				
USAF Tower 313 (KSC0313) (28.63N 80.66W)			04/0657	44 (16 m, 1-min)	62				
USAF Tower 313 (KSC0313) (28.63N 80.66W)				60 (90 m, 1-min)	70				
USAF Tower 415 (KSC0415) (28.66N 80.70W)			04/0405		61 (2 m)				

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)				
Georgia									
National Ocean Service (NOS) Sites									
Fort Pulaski (FPKG1) (32.04N 80.90W)	05/0800	998.1	05/0542	38 (7 m, 2-min)	50	4.00	5.97	2.5	
Weatherflow									
Tybee Island North (XTYB) (32.03N 80.84W)	05/0804	993.5	05/0539	33 (10 m, 5-min)	52				
Tybee Island South (XTYE) (31.99N 80.84W)	05/0812	995.1	05/1247	36 (9 m, 5-min)	48				
USGS Storm Tide Sensors									
Brunswick – Brunswick River (GAGLY17821) (31.15N 81.50W)							5.60	2.4	
Cumberland Island – St. Marys River (GACAM17823) (30.72N 81.55W)							4.93	2.2	
Jekyll Island State Park – Jekyll Sound (GAGLY17790) (31.02N 81.43W)							5.32	2.3	
Sea Island – Atlantic Ocean (GAGLY17903) (31.17N 81.35W)							5.90	2.9	
St. Simons – Brunswick River (GAGLY18414) (31.13N 81.40W)							5.18	2.2	
St. Simons – Mackay River (GAGLY17810) (31.17N 81.43W)							5.21	2.1	
Skidaway Island – Wilmington River (GACHA17861) (31.96N 81.01W)							5.79	2.2	
South Carolina									
International Civil Aviation Organization (ICAO) Sites									
Beaufort County Airport (KARW) (32.41N 80.63W)		999.7	05/0615	35[l]	45[l]				
Charleston Intl (KCHS) (32.90N 80.04W)	05/1456	993.2	05/1549	45	60				5.54
Georgetown (KGGE) (33.31N 79.32W)	05/1855	988.5	05/1815	35	48				6.11
Hilton Head (KHXD) (32.22N 80.70W)	05/0855	996.3	05/0535	46	58				
Mount Pleasant Regional (KLRO) (32.90N 79.78W)	05/1515	988.5	05/1655	31	51				
Myrtle Beach AFB (KMYR) (33.69N 78.93W)	05/2128	989.4	05/2300	40	48				8.87
North Myrtle Beach (KCRE) (33.81N 78.72W)	05/2214	989.5	05/1224	34	53				10.74
Coastal-Marine Automated Network (C-MAN) Sites									

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)				
Folly Beach (FBIS1) (32.69N 79.89W)	05/1400	988.5	05/0510	43 (10 m, 2-min)	58				
National Ocean Service (NOS) Sites									
Charleston (CHTS1) (32.78N 79.93W)	05/1506	990.0	05/0342	36 (9 m, 2-min	51	3.54	4.78	2.2	
Oyster Landing (N Inlet Estuary) (NITS1) (33.35N 79.19W)						4.08	5.87	3.5	
Springmaid Pier (MROS1) (33.66N 78.92W)	05/2130	993.2				3.14	4.96	2.5	
National Estuarine Research Reserve System Stations									
Winyah Bay (NIWS1) (33.35N 79.19W)	05/1945	987	05/1545	43 (5 m)					10.49
Weatherflow									
Beaufort (XBUF) (32.35N 80.59W)	05/0902	993.1	05/0902	30 (10 m, 5-min)	53				
Calibogue Sound (XCLB) (32.11N 80.83W)	05/0755	994.3	05/0615	35 (6 m, 5-min)	51				
Charleston Battery Point (XCHA) (32.76N 79.95W)	05/1528	986.4	05/1548	44 (10 m, 5-min)	58				
Folly Beach Pier (XFOL) (32.65N 79.94W)	05/1327	987.9	05/0417	42 (13 m, 5-min)	59				
Ft. Sumter (XSUM) (32.75N 79.87W)	05/1516	985.3	05/1606	54 (12 m, 5-min)	70				
Georgetown (33.37N 79.27W)	06/1850	987	05/1840		55 (10 m)				
Isle of Palms (XIOP) (32.78N 79.79W)	05/1511	986.2	05/0441	36 (9 m, 5-min)	53				
Murrells Inlet (33.52N 79.03W)	05/2030	987	05/1845		56 (7 m)				
Shutes Folly (XSHF) (32.77N 79.91W)	05/1528	986.0	05/1538	53 (13 m, 5-m in)	70				
Sullivan's Island (XSUL) (32.77N 79.82W)	05/1513	985.0	05/1548	34 (13 m, 5-min)	57				
Winyah Bay Range (33.19N 79.18W)	05/1822	982[l]	05/1827	59 (15 m)	77				
RAWS									
Ace Basin (ABRS1) (32.66N 80.40W)			05/1255	27[l]	52				
USGS Storm Tide Sensors									
Bluffton – May River (SCBEA14284) (32.23N 80.86W)							6.53	2.6	
Briarcliff Acres – Singleton Swash (SCHOR17780) (33.76N 78.79W)							5.18	2.8	
Forest Brook (SCHOR17780) (33.70N 78.94W)							4.59	2.8	

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)				
Garden City – Intracoastal Waterway (SCHOR14327) (33.58N 79.00W)							5.53	3.4	
Georgetown – Pee Dee River (SCGEO14315) (33.37N 79.27W)							4.25	2.1	
Georgetown – Sampit River (SCGEO14322) (33.36N 79.38W)							4.56	2.4	
Huntington State Park – Murrells Inlet (SCGEO14321) (33.53N 79.03W)							5.35	3.0	
James Island – Seaside Creek (SCCHA14312) (32.71N 79.95W)							4.68	2.0	
Murrells Inlet – Parsonage Creek (SCGEO14320) (33.55N 79.03W)							5.10	3.0	
Myrtle Beach – Intracoastal Waterway (SCHOR14332) (33.76N 78.82W)							4.77	3.0	
Myrtle Beach – Withers Swash (SCHOR00003) (33.68N 78.89W)							5.62	3.3	
North Myrtle Beach – Whitepoint Swash (SCHOR14333) (33.79N 78.74W)							4.98	2.5	
North Myrtle Beach – Williams Creek (SCHOR14329) (33.84N 78.62W)							4.79	2.4	
Pawleys Island Creek (SCGEO14316) (33.44N 79.12W)							5.77	3.1	
Springmaid Beach – Midway Swash (SCHOR17779) (33.66N 78.92W)							5.74	3.3	
Surfside Beach Swash (SCHOR14328) (33.60N 78.97W)							6.34	3.9	
Public/Other									
Charleston (KXCM) (32.78N 79.93W)	05/1540	984.4	05/0840	37 (10 m, 10-min)	49				
Litchfield by the Sea (KSCPAWLE20) (33.48N 79.09W)									13.44
Mount Pleasant (32.87N 79.82W)	05/1455	989.8[l]							
Myrtle Beach KSCMYRTL2 (33.65N 78.94W)	05/2134	987.8	05/2329		55				
Socastee 3 NE KSCMYRTL78 (33.71N 78.96W)					48				10.18

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)				
Summerville			05/1018	30	53				
COOP Sites (NWS)									
Georgetown Co Apt (GEOS1) (33.32N 79.32W)									13.38
McClellanville 7 NE (SRES1) (33.15N 79.36W)									11.79
Myrtle Beach (MYBS1) (33.75N 78.82W)									10.00
Community Collaborative Rain, Hail and Snow Network (CoCoRaHS) Sites									
Georgetown 11.2 SW (SC-GT-38) (33.23N 79.41W)									12.10
McClellanville (SC-CR-10) (33.08N 79.46W)									10.70
McClellanville 1 ESE (SC-CR-33) (33.08N 79.46W)									10.12
Mount Pleasant 4 NE (SC-CR-158) (32.87N 79.82W)									10.12
Murrells Inlet 0.9 NNE (SC-GT-19) (33.57N 79.05W)									10.13
Myrtle Beach 5.2 SW (SC-HR-73) (33.65N 78.96W)									12.77
Myrtle Beach 9.2 WSW (SC-HR-66) (33.62N 79.03W)									11.63
Myrtle Beach 2.4 ENE (SC-HR-64) (33.72N 78.86W)									10.62
Pawley's Island 5.6 NNE (SC-GT-9) (33.49N 79.08W)									15.21
Pawley's Island 2.6 N (SC-GT-24) (33.46N 79.12W)									14.80
Pawley's Island 2.7 W (SC-GT-18) (33.43N 79.17W)									12.00
Pawley's Island 0.8 WNW (SC-GT-26) (33.43N 79.14W)									10.20
Surfside Beach 1.0 NE (SC-HR-39) (33.62N 78.97W)									10.25
North Carolina									
International Civil Aviation Organization (ICAO) Sites									
Bouge Field (KNJM) (34.69N 77.04W)	06/0743	980.4[I]	06/0647	31[I]	46[I]				
Beaufort (KMRH) (34.73N 76.66W)	06/0820	969.5[I]	06/0845	43[I]	59[I]				
Cherry Pt (KNKT) (34.90N 76.88W)	06/0854	981.8	06/0954	46	63				4.57
Edenton (KEDE) (36.03N 76.56W)	06/1400	996	06/1400	27	51				
Elizabeth City (KECG) (36.26N 76.17W)	06/1254	994.0	06/1144	47	61				
Hatteras (KHSE) (35.22N 75.62W)	06/1151	960.7[I]	06/1040	45[I]	68[I]				

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)				
Kill Devil Hills (KFFA) (36.02N 75.67W)	06/1340	986.8	06/1500	26[l]	51[l]				
Kinston/Stallings Fld (KISO) (35.33N 77.61W)	06/0840	993.2	06/0740	35[l]	47[l]				3.39
Manteo (KMQI) (35.92N 75.70W)	06/1355	985.4	06/1455	39[l]	53[l]				
New River (KNCA) (34.71N 77.43W)	06/0656	986.5	06/1004	37	54				5.12
Stumpy Point (K2DP) (35.69N 75.90W)	06/1306	983.7	06/1451	45	63				3.93
Wilmington (KILM) (34.28N 77.92W)	06/0417	986.5	06/0445	37	49				10.05
Coastal-Marine Automated Network (C-MAN) Sites									
Cape Lookout (CLKN7) (34.60N 76.52W)	06/0800	960.1	06/1000	59 (10 m)	82				
National Ocean Service (NOS) Sites									
Beaufort (BFTN7) (34.72N 76.67W)	06/0818	970.5	06/0842	52 (7 m)	64	2.08	2.90	1.4	
Duck (DUKN7) (36.18N 75.75W)	06/1448	987.3	06/1512	65 (9 m)	79	3.89	5.01	3.5	
Hatteras (HCGN7) (35.21N 75.70W)	06/1212	959.7	06/1300	65 (8 m)	80	5.55	5.56	5.4	
Oregon Inlet (ORIN7) (35.78N 75.53W)	06/1347	981.8	06/1630	48 (7 m)	69	3.15	3.65	3.2	
Wilmington (WLON7)	06/0400	986.5				2.01	3.64	1.6	
Wrightsville Beach (JMPN7) (34.21N 77.79W)	06/0412	983.6	06/0248	48 (8 m)	60	2.05	3.77	2.0	
Advanced Hydrological Prediction Service (AHPS) Sites									
Carolina Beach (CBCN7) (34.04N 77.89W)			06/0256		53				
Southport (STHN7) (33.92N 78.02W)			05/2243	44	61				
Surf City (SRFN7) (34.42N 77.54W)			06/0435		61				
Weatherflow									
Alligator River Bridge (35.90N 76.01W)	06/1108	990.4[l]	06/1408	67[l] (12 m)	82[l]				
Avon Sound (35.34N 75.50W)	06/1307	959.5[l]	06/1342	68[l] (5 m)	85[l]				
Avon (35.35N 75.50W)	06/1238	959.2[l]	06/1208	73[l] (12 m)	86				
Buxton (35.26N 75.59W)	06/1249	957.3[l]	06/1139	59[l] (10 m)	79[l]				
Carolina Beach (34.04N 77.90W)	06/0252	982	06/0152		52 (10 m)				
Federal Point (33.96N 77.94W)	06/0245	979	06/0145		65 (15 m)				
Fort Fisher (33.97N 77.92W)	06/0245	980	06/0010		65 (10 m)				

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	Date/ time (UTC)	Press. (mb)	Date/ time (UTC)[a]	Sustained (kt)[b]	Gust (kt)				
Fort Macon (34.70N 76.71W)	06/0816	963.7	06/0806	61 (10 m)	78				
Frisco Woods (35.24N 75.60W)	06/1250	958.6[l]	06/1310	62[l] (6 m)	77[l]				
Hatteras High (35.26N 75.55W)	06/1248	956.7[l]	06/1328	67[l] (10 m)	87[l]				
Kites Resort (35.58N 75.47W)	06/1329	967.8[l]	06/1619	62[l] (16 m)	96[l]				
Nags Head (35.91N 75.59W)	06/1403	983.7[l]	06/1618	72[l] (18 m)	85[l]				
Oak Island (33.91N 78.12W)	06/0111	980	06/0236		53 (10 m)				
Ocracoke Sound (35.14N 76.00W)	06/1119	960.8[l]	06/1044	60[l] (8 m)	77[l]				
Oregon Inlet CG (35.77N 75.53W)	06/1335	978.2	06/1620	69 (10 m)	86				
Pamlico Sound (35.42N 75.83W)	06/1218	969.9	06/1453	64 (13 m)	82				
Waves (35.57N 75.49W)	06/1314	970.1	06/1659	58 (10 m)	75				
North Carolina ECONET									
Bald Head Island (33.85N 77.97W)	06/0018	976.7	05/2257	36 (10 m)	49				
RAWS									
Sunny Point (NSUN) (34.00N 77.96W)			06/0400		55 (6 m)				4.58
USGS High Water Marks									
Aurora – Pamlico River (NCBEA11728) (35.38N 76.75W)							4.37	2.0	
Avon – Pamlico Sound (NCDAR00004) (35.35N 75.51W)							6.14	2.0	
Avon – Pamlico Sound (NCDAR06914) (35.35N 75.51W)							6.26	3.5	
Buxton – Atlantic Ocean (NCDAR12790) (35.27N 75.52W)							8.07	2.6	
Buxton – Pamlico Sound (NCDAR00002) (35.27N 75.56W)							7.84	4.0	
Hatteras – The Slash to Pamlico Sound (NCDAR12749) (35.22N 75.69W)							6.00	2.7	
USGS Storm Tide Sensors									
Atlantic Beach – Atlantic Ocean (NCCAR12328) (34.70N 76.73W)							4.96	3.2	

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	Date/ time (UTC)	Press. (mb)	Date/ time (UTC)[a]	Sustained (kt)[b]	Gust (kt)				
Aurora – Pamlico River (NCBEA11728) (35.38N 76.75W)							3.34	3.2	
Avon – Atlantic Ocean (NCDAR00003) (35.35N 75.50W)							5.83	4.4	
Avon – Pamlico Sound (NCDAR00004) (35.35N 75.51W)							6.32	6.1	
Belhaven – Pantego Creek, Pungo River (NCBEA13648) (35.53N 76.61W)							2.35	2.2	
Buxton – Atlantic Ocean (NCDAR12790) (35.27N 75.52W)							7.83	6.4	
Buxton – Pamlico Sound (NCDAR00002) (35.27N 75.56W)							6.92	6.7	
Carolina Beach – Atlantic Ocean (NCNEW00004) (34.06N 77.88W)							4.53	2.6	
Chocowinity Bay (NCBEA11788) (35.50N 77.05W)							3.22	3.1	
Columbia – Albemarie Sound (NCTYR13548) (35.99N 76.18W)							2.70	2.7	
Columbia – Alligator River (NCTYR13568) (35.91N 76.03W)							3.31	3.4	
Davis – Core Sound (NCCAR12128) (34.80N 76.46W)							2.42	2.0	
Edenton – Chowan River (NCCHO12448) (36.06N 76.68W)							2.98	2.9	
Frisco – Pamlico Sound (NCDAR18739) (35.22N 75.64W)							6.75	5.3	
Hampstead – Intracoastal Waterway near Rich Inlet (NCPEN00001) (34.31N 77.73W)							4.26	2.3	
Harkers Island – Back Sound (NCCAR00001) (34.68N 76.53W)							3.50	2.8	
Hatteras – Pamlico Sound (NCDAR00001) (35.21N 75.70W)							5.68	5.6	
Havelock – Neuse River (NCCRA00003) (34.94N 76.81W)							5.02	5.3	
Hobucken – Pamlico Sound (NCPAM13270) (35.24N 76.59W)							3.15	3.4	

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	Date/ time (UTC)	Press. (mb)	Date/ time (UTC)[a]	Sustained (kt)[b]	Gust (kt)				
Kill Devil Hills – Albemarle Sound at Kitty Hawk Bay (NCDAR12668) (36.02N 75.73W)							2.37	2.4	
Kill Devil Hills – Atlantic Ocean (NCDAR13668) (36.04N 75.67W)							6.73	5.2	
Kitty Hawk – Atlantic Ocean (NCDAR12669) (36.10N 75.71W)							6.74	5.2	
Kure Beach – Cape Fear River (NCNEW00002) (33.96N 77.94W)							3.74	2.0	
Leonards Point – Albemarle Sound (NCWAS13588) (35.96N 76.49W)							3.07	3.1	
Manns Harbor – Croatan Sound (NCDAR00011) (35.91N 75.77W)							2.60	2.6	
Nags Head – Motts Creek at Pamlico Sound (NCDAR00005) (35.80N 75.55W)							3.51	3.0	
New Bern – Trent River (NCCRA12488) (35.10N 77.04W)							3.27	3.5	
North Topsail Beach – Atlantic Ocean (NCONS00002) (34.50N 77.40W)							5.55	3.5	
North Topsail Beach – Intracoastal Waterway (NCONS13189) (34.52N 77.37W)							2.48	2.3	
Oak Island – Atlantic Ocean (NCBRU11888) (33.91N 78.15W)							5.31	3.0	
Oak Island – Atlantic Ocean (NCBRU11891) (33.90N 78.08W)							4.74	2.6	
Oak Island – Intracoastal Waterway (NCBRU11890) (33.93N 78.14W)							4.22	2.1	
Ocean Isle Beach – Atlantic Ocean (NCBRU00012) (33.89N 78.44W)							5.98	3.6	
Ocean Isle Beach – Intracoastal Waterway (NCBRU00014) (33.90N 78.44W)							4.63	2.2	
Oriental – Neuse River (NCPAM13231) (35.02N 76.70W)							4.60	4.9	

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	Date/ time (UTC)	Press. (mb)	Date/ time (UTC)[a]	Sustained (kt)[b]	Gust (kt)				
Pond Island – Roanoke Sound (NCDAR12629) (35.90N 75.62W)							3.36	3.2	
Rodanthe – Atlantic Ocean (NCDAR12788) (35.59N 75.46W)							6.26	4.8	
Rodanthe – Pamlico Sound (NCDAR12709) (35.58N 75.47W)							4.71	4.2	
Shallotte – Intracoastal Waterway (NCBRU11908) (33.91N 78.37W)							4.74	2.4	
Sneads Ferry – New River (NCONS13128) (34.58N 77.40W)							2.36	2.2	
Straits – North River (NCCAR12428) (34.72N 76.58W)							2.64	2.0	
Stumpy Point Bay, Pamlico Sound (NCDAR00010) (35.70N 75.77W)							2.53	2.3	
Sunset Beach – Bull Creek, Intracoastal Waterway (NCBRU11850) (33.87N 78.52W)							4.55	2.1	
Sunset Beach – Intracoastal Waterway (NCBRU11893) (33.88N 78.51W)							4.53	2.2	
Supply – Intracoastal Waterway (NCBRU12008) (33.92N 78.27W)							4.38	2.2	
Swan Quarter Bay, Pamlico Sound (NCHYD00001) (35.39N 76.33W)							2.00	2.2	
Swansboro – White Oak River (NCONS00001) (34.69N 77.12W)							2.69	2.2	
Varnamtown – Intracoastal Waterway at Lockwoods Folly Inlet (NCBRU11909) (33.92N 78.24W)							4.49	2.2	
Public/Other									
Beaufort (34.76N 76.55W)	06/0724	979.0[l]							
Carolina Beach KNCAROL11 (34.05N 77.89W)	06/0245	982.1	06/0200		47				
Castle Hayne (34.32N 77.92W)									11.40
Caswell Bch KNCCASWE3 (33.91N 78.06W)	06/0115	982.4	06/0200		53				
Cedar Island (35.02N 76.32W)	06/0950	974.0[l]	06/0920	65[l] (10 m)	96[l]				
Jacksonville (34.76N 77.46W)	06/0228	990.5[l]							

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)				
Jacksonville (34.80N 77.39W)	06/0254	987.0[I]							
Kure Beach KNCKUREB10 (34.00N 77.91W)	06/0109	982.7	06/0109		53				
Southport KNCSOUTH1 (33.92N 78.02W)	05/2339	981.7	05/2249		60 (20 m)				
Southport KG4RGN	06/0012	983.1[I]	06/0012	61[I]					
Sunset Beach KNCSUNSE6 (33.87N 78.51W)	05/2339	986.8	05/2329		57				
Wilmington KNCWILMI3 (34.26N 77.87W)		985.8							10.24
COOP Sites (NWS)									
NWS Wilmington Office (34.28N 77.91W)									10.80
Community Collaborative Rain, Hail and Snow Network (CoCoRaHS) Sites									
Kinston 5 ESE (NC-LR-7) (35.25N 77.51W)									8.77
Smith Creek 0.8 E (NC-NH-63) (34.26N 77.85W)									11.36
Wilmington 7.3 NE (NC-NH-83) (34.29N 77.83W)									13.07
Wilmington 8.0 ENE (NC-NH-10) (34.25N 77.81W)									12.25
Wilmington 6.7 NE (NC-NH-81) (34.27N 77.81W)									12.13
Wilmington 7.3 NE (NC-NH-68) (34.28N 77.81W)									11.78
Virginia									
International Civil Aviation Organization (ICAO) Sites									
Norfolk (KORF) (36.91N 76.20W)	06/1451	999.8	06/1516	37	56				
Coastal-Marine Automated Network (C-MAN) Sites									
Chesapeake Light (CHLV2) (36.91N 75.70W)			06/1501	61 (37 m)	72				
Rappahannock Light Tower (RPLV2) (37.54N 76.02W)	06/1712	1001.7	06/1806	41 (17 m)	49				
S Craney Island (CRYV2) (36.89N 76.34W)	06/1336	999.4	06/1148	34 (8 m)	45				
Willoughby (WDSV2) (36.98N 76.32W)	06/1536	1000.1	06/1318	41 (4 m)	49				
York River (YKRV2) (37.25N 76.33W)	06/1518	1001.3	06/1536	38 (16 m)	45				
National Ocean Service (NOS) Sites									
Cape Henry (CHYV2) (36.91N 75.78W)	06/1542	998.4	06/1436	50 (23 m)	61				
Cape Henry (CHYV2) (36.91N 75.78W)	06/1542	998.4	06/1239	36 (6 m)	45				

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)				
Chesapeake Channel BBT (CHBV2) (37.03N 76.08W)	06/1506	997.0	06/1500	46 (14 m)	58	3.63		3.6	
Dahlgren (NCDV2) (38.32N 77.04W)	06/1948	1006.1				2.03	2.89	2.0	
Dominion Terminal (DOMV2) (36.96N 76.42W)	06/1412	1000.8	06/1206		36 (9 m)				
Kiptopeke (KPTV2) (37.17N 75.99W)			06/1542		42 (7 m)	2.95	3.86	2.8	
Lewisetta (LWTV2) (38.00N 76.46W)	06/1736	1005.0				2.03	2.80	2.1	
Money Point (MNPV2) (36.78N 76.30W)	06/1324	998.8	06/1336		35 (6 m)	3.69		3.0	
Sewells Point (SWPV2) (36.95N 76.33W)	06/1336	1000.4				3.60	4.26	3.1	
Wachapreague (WAHV2) (37.61N 75.69W)	06/1624	1000.0	06/1548		43 (7 m)	2.87	4.53	2.7	
Windmill Point (WNDV2) (37.62N 76.29W						2.03	2.32	2.1	
Yorktown USCG Training Center (YKTV2) (37.23N 76.48W)	06/1418	1001.4	06/1348		37 (10 m)	2.79	3.60	2.5	
Weatherflow									
Hampton (36.98N 76.34W)			06/1247	36 (7 m)	47				
3rd Island Chesapeake Bay Brdg Tunnel (37.03N 76.08W)			06/1454	46 (16 m)	59				
Tangier Island (37.78N 75.98W)			06/1741	40 (16 m)	46				
District of Columbia									
NOS Sites									
Washington (WASD2) (38.87N 77.02W)	06/2000	1007.6				2.24	3.65	1.9	
Maryland									
NOS Sites									
Annapolis (APAM2) (38.98N 76.48W)	06/1924	1006.8				2.08	2.70	2.0	
Baltimore, Fort McHenry (BLTM2) (39.27N 76.58W)	06/1942	1007.3				2.00	2.69	1.9	
Bishops Head (BISM2) (38.22N 76.04W)	06/1742	1004.6				1.98	2.91	2.1	
Cambridge (CAMM2) (38.57N 76.07W)	06/1848	1005.2				2.13	2.92	2.0	
Chesapeake City (CHCM2) (39.53N 75.81W)	06/1924	1007.8				2.11		1.5	
Cove Point LNG Pier (COVM2) (38.40N 76.39W)	06/1754	1006.5	06/2042		36 (28 m)				
Ocean City Inlet (OCIM2) (38.33N 75.09W)	06/1912	1001.7	06/1948		39 (11 m)	2.05	2.69	1.9	
Solomons Island (SLIM2) (38.32N 76.45W)	06/1842	1005.4				1.98	2.71	2.1	

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)				
Tolchester Beach (TCBM2) (39.21N 76.25W)	06/1918	1007.6				1.90		2.0	
Delaware									
NOS Sites									
Lewes (LWSD1) (38.78N 75.12W)	06/1912	1003.8	06/1500	34 (12 m)	42	2.68	4.10	2.1	
New Jersey									
NOS Sites									
Atlantic City (ACYN4) (39.36N 74.42W)	06/2048	1004.6				2.27	3.67	1.7	
Cape May (CMAN4) (38.97N 74.96W)	06/1954	1003.3				2.41	4.02	1.6	
New York									
NOS Sites									
Kings Point (KPTN6) (40.81N 73.77W)	07/0742	1007.2				2.36	5.71	2.1	
Montauk (MTKN6) (41.05N 71.96W)	07/0706	1002.4				1.74	2.44	1.5	
Connecticut									
NOS Sites									
New London (NLNC3) (41.36N 72.09W)	07/0712	1003.1				1.58	2.67	1.5	
Rhode Island									
NOS Sites									
Conimicut Light (CPTR1) (41.72N 71.34W)	07/0800	1002.7	07/0930		37 (21 m)	1.57			
Newport (NWPR1) (41.51N 71.33W)	07/0724	1001.9	07/0942		34 (11 m)	1.53	3.28		
Quonset Point (QPTR1) (41.59N 71.41W)	07/0754	1002.3	07/0930		34 (9 m)	1.46			
Massachusetts									
International Civil Aviation Organization (ICAO) Sites									
Nantucket (KACK) (41.25N 70.06W)	07/0853	996.2	07/0953	33	44				
Coastal-Marine Automated Network (C-MAN) Sites									
Buzzards Bay (BUZM3) (41.40N 71.03W)	07/0800	999.8	07/0900	34 (25 m, 8-min)	38				
NOS Sites									
Nantucket Island (NTKM3) (41.29N 70.10W)	07/0824	996.4	07/0912		37 (11 m)	2.06		1.5	
Woods Hole (BZBM3) (41.52N 70.67W)	07/0812	999.4				1.61	2.26	1.4	

Location	Minimum Sea Level Pressure		Maximum Surface Wind Speed			Storm surge (ft)[c]	Storm tide (ft)[d]	Estimated Inundation (ft)[e]	Total rain (in)
	Date/ time (UTC)	Press. (mb)	Date/ time (UTC)[a]	Sustained (kt)[b]	Gust (kt)				
Weatherflow									
Duxbury (XDUX) (42.06N 70.65W)	07/0925	999.9	07/1030	35 (12 m, 1-min)	43				
Sagamore Beach (XSAG) (41.79N 70.52W)	07/0650	999.3	07/1100	35 (8 m, 1-min)	44				
Wellfleet (XWEL) (41.93N 69.98W)	07/0941	994.4	07/0946	33 (6 m, 1-min)	43				
Community Collaborative Rain, Hail and Snow Network (CoCoRaHS) Sites									
Nantucket 4 WNW (MA-NT-1) (41.29N 70.17W)									3.15
Maine									
National Ocean Service (NOS) Sites									
Eastport (PSBM1) (44.90N 66.98W)	07/2100	995.8	07/1906	31 (14 m)	40	2.25			
Coastal-Marine Automated Network (C-MAN) Sites									
Desert Rock (MDRM1) (43.97N 68.22W)	07/1700	997.3	07/1620	39 (22 m)	45				
Hydrometeorological Automated Data System (HADS)									
Eastport 1 WNW (EPOM1) (44.91N 67.01W)									3.37
Canada									
Meteorological Service of Canada									
Baccaro Point, NS (43.45N 65.47W)			07/1600	50	66				5.17
Beaver Island, NS (44.82N 62.33W)			07/2100	57	78				
Belledune, NB (47.90N 65.85W)						2.72	9.22		
Brier Island, NS (44.25N 66.39W)					57				
Cap-au-Meules, Magdalen Islands, Quebec (47.38N 61.86W)						4.13	7.71		
Caribou Point, NS (45.76N 62.68W)					64				
Charlottetown, PEI (46.23N 63.12W)						4.95	10.79		
Eastpoint, PEI (46.46N 61.99W)			07/2300	51	65				
Eskasoni, NS (45.95N 60.6W)					55				
Grand Etang, NS (46.55N 61.05W)			08/0700	43	74				
Halifax, NS (44.67N 63.58W)						4.66	9.48	2.8	
Halifax Dockyard, NS (44.66N 63.58W)					58				

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)				
Halifax Kootenay, NS (44.59N 63.55W)			07/1800	50	65				
Hart Island, NS (45.35N 60.98W)			07/2300	48	68				
Lower Escuminac, NB (47.08N 64.88W)						4.69	8.46	2.9	
Lunenburg, NS (44.38N 64.32W)					55				
McNabs Island, NS (44.62N 63.54W)					54				
Miscou Island, NB (48.01N 64.49W)			08/0300	43	57				
North Cape, PEI (47.06N 64.00W)			08/0100	49	66				
North Lake, PEI (46.47N 62.07W)						2.62	11.91		
North Mountain, NS (45.10N 64.75W)					58				
North Sydney, NS (46.22N 60.25W)						1.71	5.25		
Oxford, NS (45.74N 63.87W)									5.43
Port Hawkesbury, NS (45.62N 61.37W)						3.48	7.28		
Saint John, NB (45.32N 65.89W)			08/0000	32	55				3.23
Shearwater Jetty, NS (44.64N 63.51W)					55				
Shediac, NB (46.22N 64.55W)						6.50	10.53	4.9	
Sluce Point, NS (43.79N 65.97W)					77				
Stanhope, PEI (46.42N 63.08W)			07/2200	30	50				
St. Peters, PEI (46.45N 62.58W)				31	53				
Summerside, PEI (46.44N 63.84W)			08/0000	46	63				3.54
Summerside, PEI (46.39N 63.79W)						2.76	12.47		
Tignish, PEI (46.95N 64.00W)						3.94	17.16		
Tracadie, NS (45.63N 61.66W)					51				
Yarmouth, NS (43.83N 66.12W)			07/1900	40	70	2.00	14.90		
Nav Canada									
Charlottetown Airport, PEI (CYYG) (46.29N 63.12W)			07/2100	37	55				
Greenwood, NS (CYZX) (44.98N 64.92W)					50				3.23
Halifax International Airport, NS (44.88N 63.51W)					54				

Location	Minimum Sea Level Pressure		Maximum Surface Wind Speed			Storm surge (ft)[c]	Storm tide (ft)[d]	Estimated Inundation (ft)[e]	Total rain (in)
	Date/ time (UTC)	Press. (mb)	Date/ time (UTC)[a]	Sustained (kt)[b]	Gust (kt)				
Moncton, NB (CYQM) (46.11N 64.68W)			07/2300	38	54				4.76
Sydney Airport, NS (46.17N 60.05W)					56				
Other/Public									
Colpitts Selltement, NB (45.98N 64.97W)			08/0003	42[I]					
Grand Etang, NS (46.55N 61.05W)	07/1950	991.9[I]	07/1850	44[I]	72[I]				
Henry Island, NS (45.98N 61.60W)	07/1858	990.2[I]	07/1858	43[I]	65[I]				
Lower Sackville, NS (44.8N 63.7W)	08/0018	973[I]	08/0018	54[I] (7 m)					5.43
St. Joseph du Moine, NS (46.53N 61.05W)	07/1915	994.6[I]	07/1915	45	71				

[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). Storm tide is water height above Lower Low Water Large Tide (LLWLT) for Canadian stations.
[e] Estimated inundation is the maximum height of water above ground. For some USGS storm tide pressure sensors, inundation is estimated by subtracting the elevation of the sensor from the recorded storm tide. For other USGS storm tide sensors and USGS high-water marks, inundation is estimated by subtracting the elevation of the land derived from a Digital Elevation Model (DEM) from the recorded and measured storm tide. For NOS tide gauges, The height of the water above Mean Higher High Water (MHHW) is used as a proxy for inundation for NOS tide gauges, and Higher High Water Large Tide (HHWLT) for Canadian gauges.

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%)	18	18
Medium (40%-60%)	12	12
High (>60%)	0	6

Table 5a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) track forecast errors (n mi) for Hurricane Dorian. 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	72	96	120
OFCL	**14.3**	**27.0**	**38.9**	**49.5**	**70.6**	**109.4**	**159.7**
OCD5	28.0	67.8	116.8	164.1	269.4	386.3	471.2
Forecasts	55	53	51	49	45	41	37
OFCL (2014-18)	23.6	35.5	47.0	61.8	96.0	136.0	179.6
OCD5 (2014-18)	44.8	97.6	157.4	220.1	340.7	446.6	536.6

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

Model ID	Forecast Period (h)						
	12	24	36	48	72	96	120
OFCL	14.8	27.1	38.4	48.8	66.5	71.3	102.2
OCD5	28.8	68.9	120.1	170.2	284.0	402.2	548.4
GFSI	16.7	31.2	47.9	63.3	86.2	117.7	172.9
HMNI	23.5	42.7	61.2	80.8	113.8	91.3	130.8
HWFI	19.2	36.0	50.9	65.8	95.6	135.1	212.8
EGRI	16.2	29.8	**38.1**	**42.7**	**48.9**	71.4	121.8
EMXI	16.7	28.1	41.2	54.3	69.2	**63.8**	**93.5**
CMCI	19.9	35.8	53.3	72.2	109.1	94.3	172.0
NVGI	20.4	36.5	47.3	57.9	85.7	110.5	175.0
CTCI	17.1	31.3	46.8	57.4	79.6	82.4	115.7
AEMI	17.4	33.0	49.5	65.7	95.7	120.1	164.1
HCCA	16.0	27.6	39.2	49.3	66.9	**67.9**	**101.5**
FSSE	15.2	**26.2**	**37.7**	**45.7**	**60.3**	82.5	123.2
TVCX	15.0	27.1	**38.0**	**48.2**	**63.9**	**60.5**	**94.6**
GFEX	15.0	27.7	41.4	54.4	70.5	78.3	115.0
TVCA	14.8	27.5	38.7	**48.4**	**64.2**	**62.9**	**98.8**
TVDG	**14.5**	**26.6**	**37.3**	**45.5**	**60.9**	**63.3**	**97.6**
TABD	19.2	39.2	65.6	94.8	172.7	265.1	345.6
TABM	22.5	43.0	59.9	74.3	106.2	158.6	264.1
TABS	30.4	63.8	92.1	115.4	180.7	244.2	348.8
Forecasts	41	41	40	39	34	25	20

Table 6a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) intensity forecast errors (kt) for Hurricane Dorian. 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	72	96	120
OFCL	6.6	10.7	13.1	14.3	17.8	25.7	38.9
OCD5	8.7	15.3	21.7	25.4	30.4	45.0	54.1
Forecasts	55	53	51	49	45	41	37
OFCL (2014-18)	5.3	7.9	9.9	11.2	13.3	14.4	14.2
OCD5 (2014-18)	6.9	10.9	14.3	17.4	20.9	22.0	22.8

Table 6b. Homogeneous comparison of selected intensity forecast guidance models (in kt) for Hurricane Dorian. 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	72	96	120
OFCL	7.0	11.7	14.2	15.2	18.6	22.1	28.5
OCD5	9.4	15.9	22.0	24.9	32.5	48.5	55.2
DSHP	9.4	14.2	16.9	18.7	21.9	23.6	41.4
LGEM	9.2	14.3	16.8	18.6	19.8	**17.1**	35.8
ICON	8.5	12.8	15.5	17.0	19.2	23.3	37.0
IVCN	8.7	13.1	15.5	16.4	18.7	22.4	32.9
IVDR	8.6	13.1	16.2	18.1	20.8	25.0	33.9
EMXI	11.1	16.8	21.3	24.0	30.6	32.5	41.6
CTCI	9.9	15.8	17.3	17.1	19.7	**19.7**	**19.3**
FSSE	8.4	12.1	**14.0**	**14.7**	**15.9**	**19.7**	**24.2**
HMNI	8.9	13.9	17.5	21.0	30.4	40.4	46.2
HWFI	9.8	14.5	18.4	20.4	21.9	30.1	35.4
HCCA	8.2	12.5	14.4	**14.7**	**18.5**	23.7	30.2
GFSI	10.3	15.9	22.7	27.3	34.0	33.4	45.5
Forecasts	44	44	42	41	36	29	24

Table 7. Wind watch and warning summary for 24 August–7 September 2019.

Date/Time (UTC)	Action	Location
25 / 0900	Tropical Storm Watch issued	Barbados
25 / 1500	Tropical Storm Watch changed to Tropical Storm Warning	Barbados
25 / 1500	Tropical Storm Watch issued	St. Vincent, Grenadines
25 / 1500	Tropical Storm Watch issued	St. Lucia
25 / 2100	Tropical Storm Watch changed to Tropical Storm Warning	St. Vincent, Grenadines
25 / 2100	Tropical Storm Watch changed to Tropical Storm Warning	St. Lucia
25 / 2100	Tropical Storm Watch issued	Martinique
25 / 2100	Tropical Storm Watch issued	Grenada and its dependencies
26 / 0300	Tropical Storm Watch issued	Dominica
26 / 0900	Tropical Storm Watch issued	Saba and St. Eustatius
26 / 1500	Tropical Storm Watch changed to Tropical Storm Warning	Martinique
26 / 1500	Hurricane Watch issued	St. Lucia
26 / 2100	Tropical Storm Watch issued	Puerto Rico
27 / 0300	Hurricane Watch changed to Tropical Storm Warning	St. Lucia
27 / 0600	Tropical Storm Warning discontinued	Barbados
27 / 0900	Tropical Storm Watch changed to Tropical Storm Warning	Puerto Rico

Date/Time (UTC)	Action	Location
27 / 0900	Tropical Storm Watch changed to Hurricane Watch	Puerto Rico
27 / 0900	Tropical Storm Watch issued	Punta Palenque to Isla Saona and from Samana to Puerto Plata
27 / 0900	Hurricane Watch issued	Isla Saona to Samana
27 / 1200	Tropical Storm Warning discontinued	St. Lucia
27 / 1500	Tropical Storm Watch discontinued	Grenada and its dependencies
27 / 1500	Tropical Storm Warning discontinued	St. Vincent and Grenadines
27 / 1500	Tropical Storm Warning issued	Isla Saona to Samana
27 / 1800	Tropical Storm Watch discontinued	Dominica
27 / 1800	Tropical Storm Warning discontinued	Martinique
27 / 2100	Tropical Storm Watch discontinued	Saba and St. Eustatius
27 / 2100	Tropical Storm Warning issued	United States Virgin Islands
28 / 0000	Tropical Storm Watch discontinued	Punta Palenque to Isla Saona
28 / 0000	Hurricane Watch discontinued	Isla Saona to Samana
28 / 0300	Tropical Storm Watch modified to	Isla Saona to Puerto Plata
28 / 0300	Tropical Storm Warning discontinued	Isla Saona to Samana

Date/Time (UTC)	Action	Location
28 / 0300	Tropical Storm Warning issued	British Virgin Islands
28 / 0900	Tropical Storm Warning changed to Hurricane Watch	U.S. Virgin Islands
28 / 1200	Tropical Storm Watch modified to	Isla Saona to Samana
28 / 1500	Tropical Storm Warning changed to Hurricane Warning	British Virgin Islands
28 / 1500	Hurricane Watch changed to Hurricane Warning	British Virgin Islands
28 / 1800	Tropical Storm Watch discontinued	All
29 / 0000	Tropical Storm Warning discontinued	All
29 / 0000	Hurricane Watch discontinued	All
29 / 0000	Hurricane Warning discontinued	All
30 / 0900	Hurricane Watch issued	Northwestern Bahamas
30 / 2100	Hurricane Watch changed to Hurricane Warning	Northwestern Bahamas
30 / 2100	Hurricane Watch issued	Andros
31 / 2100	Tropical Storm Watch issued	Deerfield Beach to Sebastian Inlet
01 / 0900	Tropical Storm Watch changed to Tropical Storm Warning	Deerfield Beach to Sebastian Inlet
01 / 0900	Tropical Storm Watch issued	Golden Beach to Deerfield Beach
01 / 1500	Hurricane Watch issued	Deerfield Beach to Volusia/Brevard CL

Date/Time (UTC)	Action	Location
01 / 2100	Tropical Storm Warning modified to	Deerfield Beach to Jupiter Inlet
01 / 2100	Hurricane Watch modified to	Deerfield Beach to Jupiter Inlet
01 / 2100	Hurricane Warning issued	Jupiter Inlet to Volusia/Brevard CL
02 / 0300	Hurricane Watch modified to	Volusia/Brevard CL to FL/GA border
02 / 0900	Hurricane Watch discontinued	Andros
02 / 0900	Hurricane Warning discontinued	Northwestern Bahamas
02 / 0900	Hurricane Warning issued	Grand Bahama and Abacos
02 / 1500	Hurricane Watch discontinued	Volusia/Brevard CL to FL/GA border
02 / 1500	Hurricane Watch issued	Flagler/Volusia CL to Altamaha Sound
02 / 1500	Hurricane Warning modified to	Jupiter Inlet to Flagler/Volusia CL
02 / 2100	Hurricane Watch discontinued	Flagler/Volusia CL to Altamaha Sound
02 / 2100	Hurricane Watch issued	Ponte Vedra Beach to South Santee River
02 / 2100	Hurricane Warning modified to	Jupiter Inlet to Ponte Vedra Beach
03 / 0900	Tropical Storm Warning issued	Ponte Vedra Beach to Altamaha Sound
03 / 1500	Hurricane Watch changed to Tropical Storm Warning	Deerfield Beach to Jupiter Inlet
03 / 1500	Tropical Storm Watch discontinued	All
03 / 1500	Tropical Storm Warning modified to	Ponte Vedra Beach to Edisto Beach
03 / 1500	Hurricane Watch modified to	Ponte Vedra Beach to Edisto Beach

Date/Time (UTC)	Action	Location
03 / 1500	Hurricane Warning issued	Edisto Beach to South Santee River
03 / 1800	Hurricane Warning changed to Tropical Storm Warning	Grand Bahamas and Abaco
03 / 2100	Tropical Storm Watch issued	NC/VA border to Chincoteague
03 / 2100	Tropical Storm Warning modified to	Jupiter Inlet to Sebastian Inlet
03 / 2100	Tropical Storm Warning modified to	Ponte Vedra Beach to Savannah River
03 / 2100	Hurricane Watch modified to	Ponte Vedra Beach to Savannah River
03 / 2100	Hurricane Watch discontinued	South Santee River to Duck
03 / 2100	Hurricane Watch issued	Surf City to NC/VA border
03 / 2100	Hurricane Warning modified to	Sebastian Inlet to Ponte Vedra Beach
03 / 2100	Hurricane Warning discontinued	Edisto Beach to South Santee River
03 / 2100	Hurricane Warning issued	Savannah River to Surf City
04 / 0900	Tropical Storm Warning modified to	Sebastian Inlet to Volusia/Brevard CL
04 / 0900	Tropical Storm Warning discontinued	Grand Bahama and Abaco
04 / 0900	Hurricane Warning modified to	Volusia/Brevard CL to Ponte Vedra Beach
04 / 1500	Tropical Storm Warning changed to Hurricane Watch	Ponte Vedra Beach to Savannah River
04 / 1500	Tropical Storm Warning modified to	Volusia/Brevard CL to Savannah River

Date/Time (UTC)	Action	Location
04 / 1500	Hurricane Watch discontinued	Surf City to NC/VA border
04 / 1500	Hurricane Warning discontinued	Volusia/Brevard CL to Ponte Vedra Beach
04 / 1500	Hurricane Warning modified to	Savannah River to NC/VA border
04 / 2100	Tropical Storm Watch changed to Tropical Storm Warning	NC/VA border to Chincoteague
04 / 2100	Tropical Storm Watch issued	Chincoteague to Fenwick Island
04 / 2100	Tropical Storm Warning modified to	Flagler/Volusia CL to Savannah River
05 / 0300	Tropical Storm Warning modified to	FL/GA border to Savannah River
05 / 0300	Hurricane Watch modified to	FL/GA border to Savannah River
05 / 0900	Tropical Storm Watch issued	Woods Hole to Sagamore Beach
05 / 0900	Tropical Storm Watch issued	Martha's Vineyard
05 / 0900	Tropical Storm Watch issued	Nantucket
05 / 0900	Tropical Storm Warning modified to	Altamaha Sound to Savannah River
05 / 0900	Hurricane Watch discontinued	All
05 / 1500	Tropical Storm Watch discontinued	Chincoteague to Fenwick Island
05 / 1500	Tropical Storm Warning modified to	NC/VA border to Fenwick Island
05 / 1800	Tropical Storm Warning discontinued	Altamaha Sound to Savannah River

Date/Time (UTC)	Action	Location
05 / 2100	Tropical Storm Watch changed to Tropical Storm Warning	Woods Hole to Sagamore Beach
05 / 2100	Tropical Storm Watch changed to Tropical Storm Warning	Martha's Vineyard
05 / 2100	Tropical Storm Watch changed to Tropical Storm Warning	Nantucket
05 / 2100	Tropical Storm Warning issued	Savannah River to Edisto Beach
05 / 2100	Hurricane Warning modified to	Edisto Beach to NC/VA border
06 / 0000	Tropical Storm Warning modified to	Edisto Beach to South Santee River
06 / 0000	Hurricane Warning modified to	South Santee River to NC/VA border
06 / 0300	Tropical Storm Watch issued	Prince Edward Island
06 / 0300	Tropical Storm Watch issued	Magdalen Islands
06 / 0300	Tropical Storm Watch issued	Fundy National Park to Shediac
06 / 0300	Tropical Storm Watch issued	Francois to Boat Harbour
06 / 0300	Tropical Storm Warning discontinued	Edisto Beach to South Santee River
06 / 0300	Hurricane Watch issued	Nova Scotia
06 / 0900	Tropical Storm Warning issued	South Santee River to Little River Inlet
06 / 0900	Hurricane Warning modified to	Little River Inlet to NC/VA border
06 / 1200	Tropical Storm Warning discontinued	South Santee River to Little River Inlet
06 / 1200	Hurricane Warning modified to	Surf City to NC/VA border

Date/Time (UTC)	Action	Location
06 / 1500	Tropical Storm Warning issued	Bar Harbor to Eastport
06 / 1500	Hurricane Warning modified to	Bogue Inlet to NC/VA border
06 / 1800	Tropical Storm Watch changed to Tropical Storm Warning	Prince Edward Island
06 / 1800	Tropical Storm Watch changed to Hurricane Watch	Prince Edward Island
06 / 1800	Tropical Storm Watch changed to Hurricane Watch	Magdalen Islands
06 / 1800	Tropical Storm Watch modified to	Parson's Pond to Boat Harbour
06 / 1800	Tropical Storm Watch issued	Indian Harbour to Stone's Cove
06 / 1800	Tropical Storm Warning issued	Western Nova Scotia to Western Nova Scotia
06 / 1800	Hurricane Watch discontinued	Nova Scotia
06 / 1800	Hurricane Watch issued	Western Nova Scotia to Western Nova Scotia
06 / 1800	Hurricane Watch issued	Parson's Pond to Indian Harbour
06 / 1800	Hurricane Warning issued	Eastern Nova Scotia
06 / 2100	Tropical Storm Watch modified to	Parson's Pond to Triton
06 / 2100	Hurricane Warning discontinued	Bogue Inlet to NC/VA border
07 / 0000	Tropical Storm Warning discontinued	NC/VA border to Fenwick Island
07 / 0300	Tropical Storm Watch changed to Tropical Storm Warning	Fundy National Park to Shediac

Date/Time (UTC)	Action	Location
07 / 0900	Tropical Storm Watch changed to Tropical Storm Warning	Indian Harbour to Stone's Cove
07 / 0900	Hurricane Watch changed to Tropical Storm Warning	Western Nova Scotia to Western Nova Scotia
07 / 0900	Tropical Storm Watch discontinued	All
07 / 0900	Tropical Storm Warning issued	Magdalen Islands
07 / 0900	Tropical Storm Warning issued	Hawke's Bay to Fogo Island
07 / 0900	Tropical Storm Warning issued	Mutton Bay to Mary's Harbour
07 / 0900	Hurricane Watch discontinued	Parson's Pond to Indian Harbour
07 / 0900	Hurricane Warning issued	Indian Harbour to Hawke's Bay
07 / 1500	Tropical Storm Warning discontinued	Woods Hole to Sagamore Beach
07 / 1500	Tropical Storm Warning discontinued	Martha's Vineyard
07 / 1500	Tropical Storm Warning discontinued	Nantucket
08 / 0000	Tropical Storm Warning discontinued	Bar Harbor to Eastport
08 / 0900	Hurricane Watch changed to Tropical Storm Warning	Prince Edward Island
08 / 0900	Tropical Storm Warning discontinued	Western Nova Scotia to Western Nova Scotia
08 / 0900	Tropical Storm Warning discontinued	Fundy National Park to Shediac

Date/Time (UTC)	Action	Location
08 / 1500	Tropical Storm Warning discontinued	Prince Edward Island
08 / 1500	Tropical Storm Warning discontinued	Magdalen Islands
08 / 1500	Hurricane Watch discontinued	All
08 / 1500	Hurricane Warning discontinued	Eastern Nova Scotia
08 / 2100	Tropical Storm Warning discontinued	Indian Harbour to Stone's Cove
08 / 2100	Tropical Storm Warning modified to	Cape Anguille to Fogo Island
08 / 2100	Hurricane Warning discontinued	All
09 / 0300	Tropical Storm Warning discontinued	All

Table 8. Storm Surge watch and warning summary for Hurricane Dorian, 24 August–7 September 2019.

Date/Time (UTC)	Action	Location
01 / 1500	Storm Surge Watch issued	North of Deerfield Beach to Volusia/Brevard County Line
01 / 2100	Storm Surge Warning issued	Lantana to Volusia/Brevard County Line
01 / 2100	Storm Surge Watch issued	Lantana to Volusia/Brevard County Line to Flagler/Volusia County Line
02 / 0300	Storm Surge Watch extended northward	Flagler/Volusia County Line to Mouth of St. Mary's river
02 / 1500	Storm Surge Warning extended northward to	Flagler/Volusia County Line
02 / 1500	Storm Surge Watch extended northward to	Savannah River
02 / 2100	Storm Surge Warning extended northward to	Altamaha Sound Georgia
02 / 2100	Storm Surge Watch extended northward to	South Santee River SC
03 / 0300	Storm Surge Warning extended northward to	Savannah River
03 / 1500	Storm Surge Warning extended northward to	South Santee River SC
03 / 1500	Storm Surge Watch extended northward to	Cape Lookout NC
03 / 1500	Storm Surge Watch discontinued	South of Lantana FL
03 / 2100	Storm Surge Warning extended northward to	Surf City NC

Date/Time (UTC)	Action	Location
03 / 2100	Storm Surge Watch extended northward to	Duck NC, including the Pamlico and Albemarle Sounds and the Neuse and Pamlico Rivers
04 / 0300	Storm Surge Warning extended northward	from Duck NC to Poquoson VA, including Hampton Roads
04 / 0600	Storm Surge discontinued	South of Sebastien Inlet
04 / 1500	Storm Surge Warning extended northward to	NC/VA border, including Albemarle and Pamlico Sounds and the Neuse and Pamlico Rivers
04 / 1500	Storm Surge discontinued from	Port Canaveral, Florida southward
04/ 2100	Storm Surge Warning extended northward to	Poquoson, Virginia, including Hampton Roads
05 / 0900	Storm Surge Warning discontinued south of	Poquoson, Virginia, including Hampton Roads
05 / 0900	Storm Surge Warning discontinued	South of Savannah River
05 / 1500	Storm Surge Warning discontinued	South of Edisto Beach SC
05 / 1500	Storm Surge Warning discontinued	South of South Santee River SC
05 / 2100	Storm Surge Warning discontinued	South of Little River Inlet
06 / 0000	Storm Surge Warning discontinued	West of Cape Fear
06 / 0600	Storm Surge Warning discontinued	South of Wrightsville Beach NC
06 / 0900	Storm Surge Warning discontinued	South of Surf City NC
06 / 1200	Storm Surge Warning discontinued	South of Salter Path NC
06/1800	Storm Surge Warning discontinued	Pamlico and Neuse Rivers

Date/Time (UTC)	Action	Location
06 / 2100	Storm Surge Warning discontinued	North of NC/VA border
07 / 0000	Storm Surge Warning discontinued	All

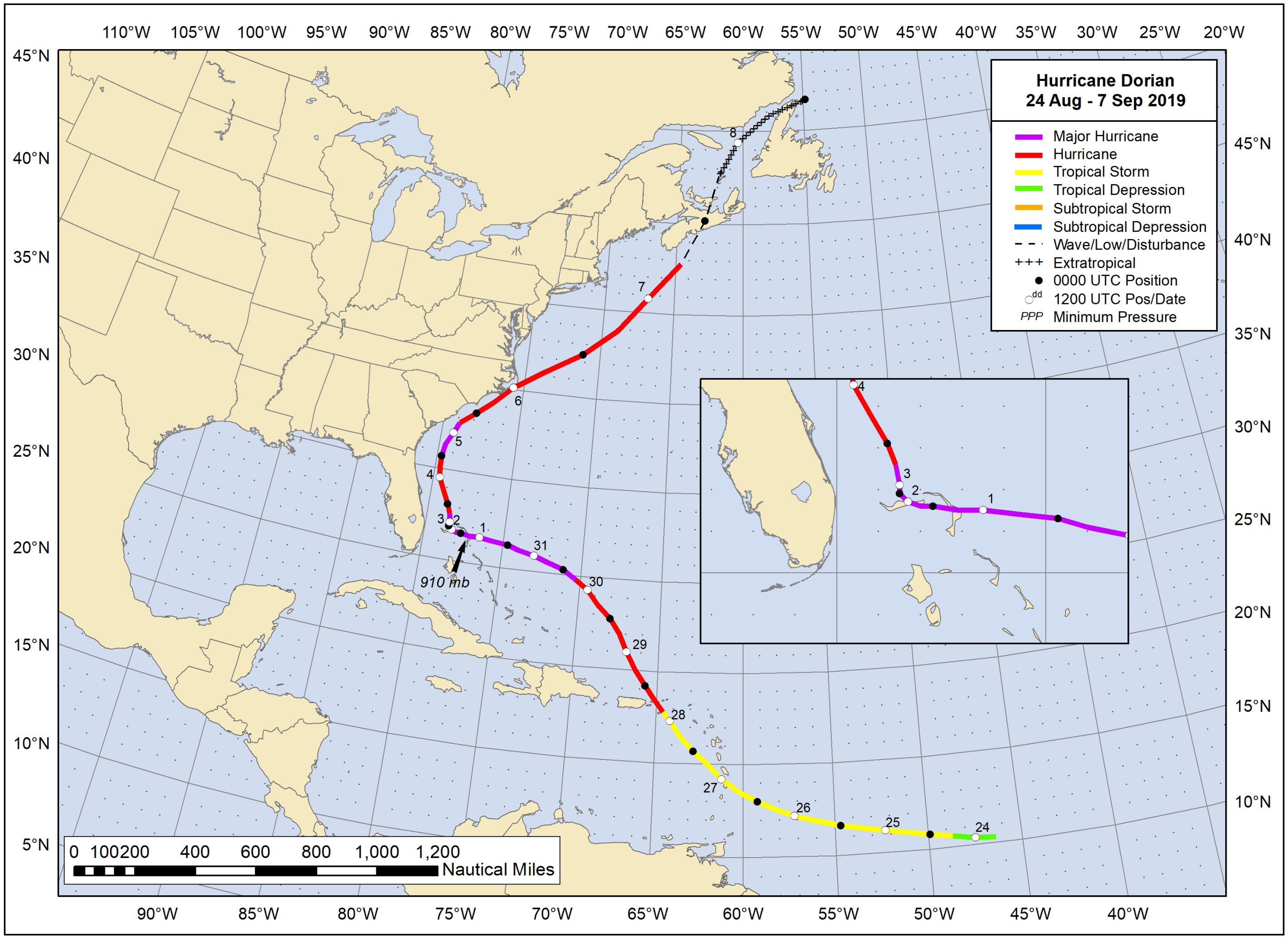

Figure 1. Best track positions for Hurricane Dorian, 24 August−7 September 2019.

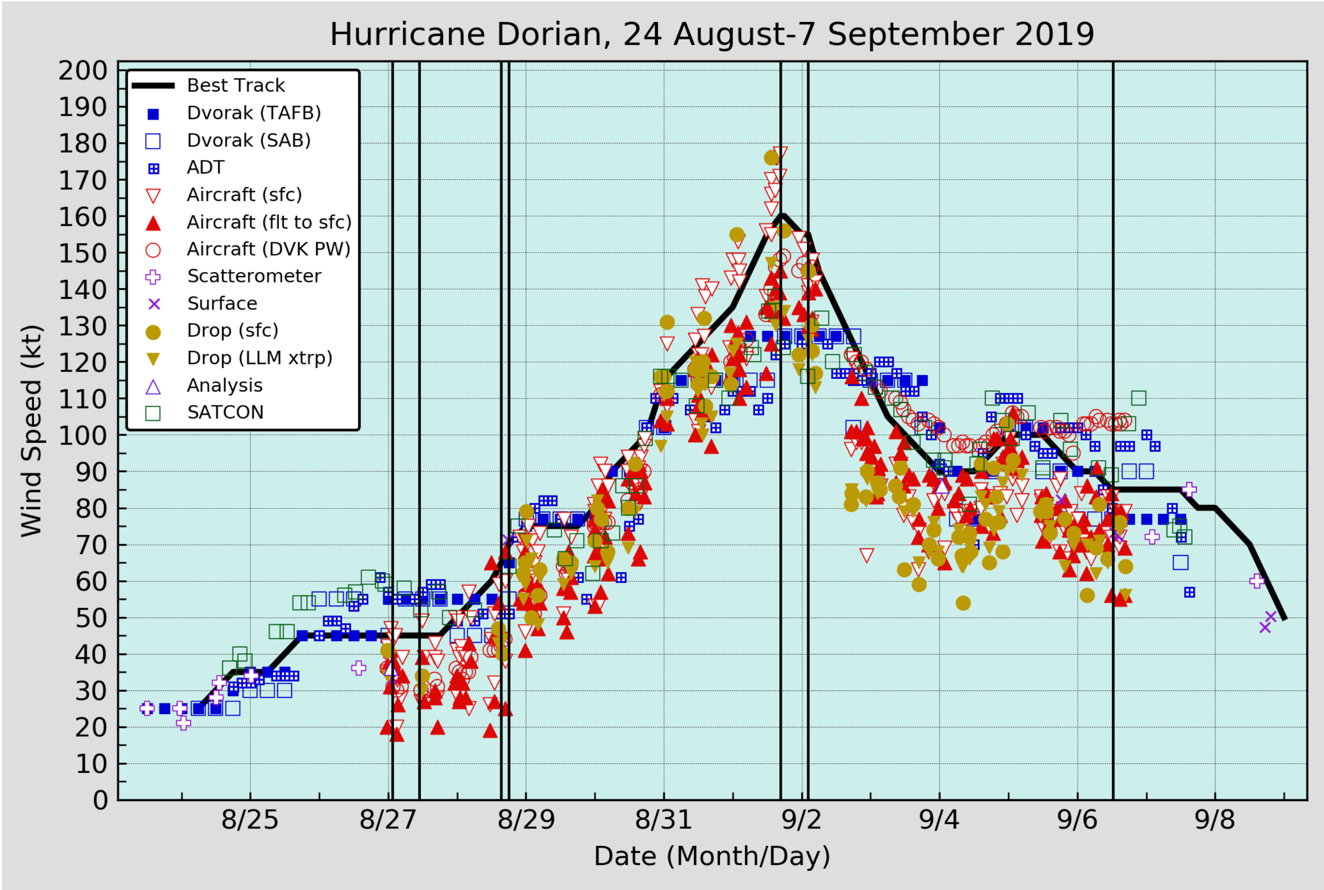

Figure 2. Selected wind observations and best track maximum sustained surface wind speed curve for Hurricane Dorian 24 August–7 September 2019. Aircraft observations have been adjusted for elevation using 90%, 80%, and 80% adjustment factors for observations from 700 mb, 850 mb, and 1500 ft, respectively. 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.

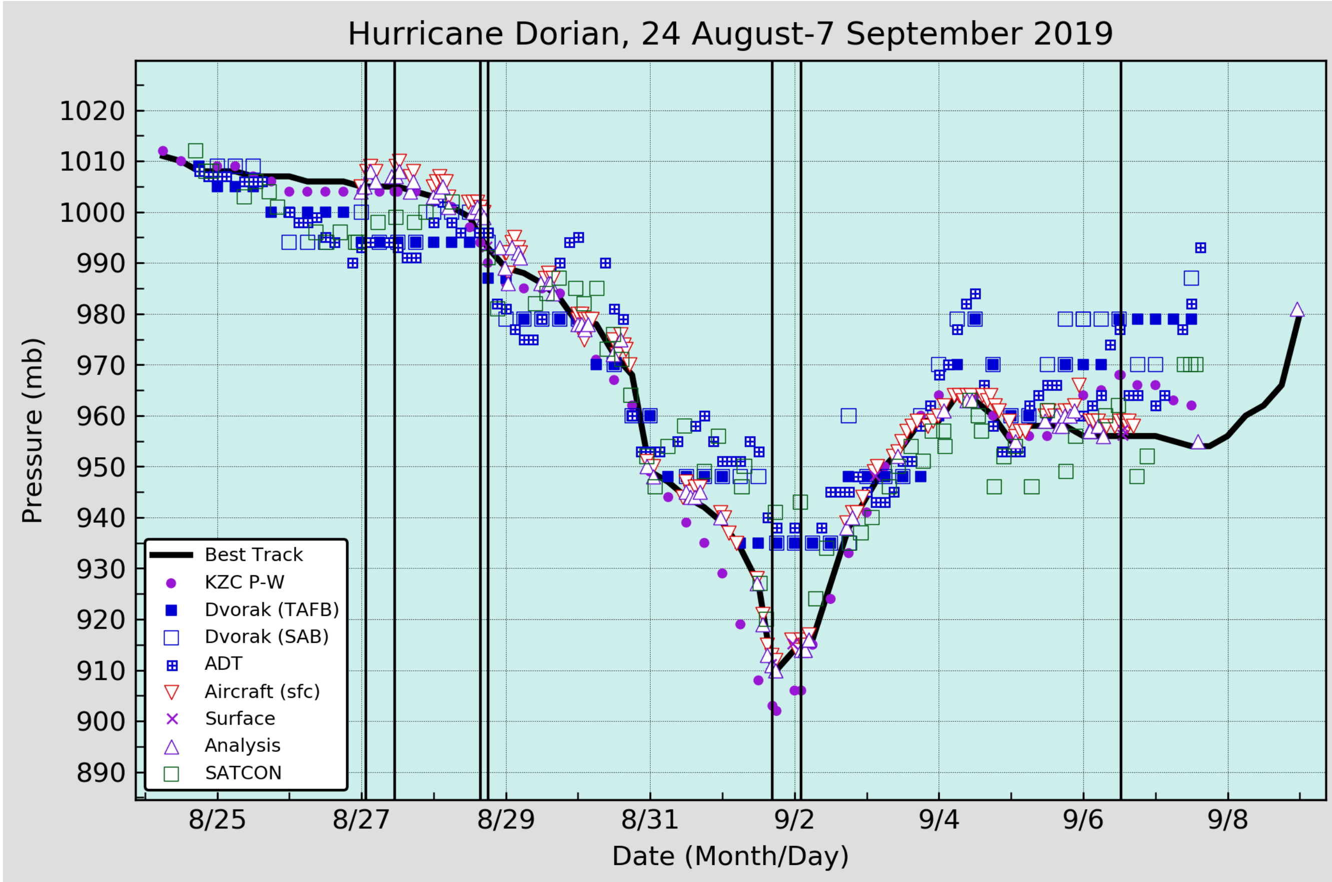

Figure 3. Selected pressure observations and best track minimum central pressure curve for Hurricane Dorian 24 August–7 September 2019. Advanced Dvorak Technique estimates represent the Current Intensity at the nominal observation time. SATCON intensity estimates are from the Cooperative Institute for 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.

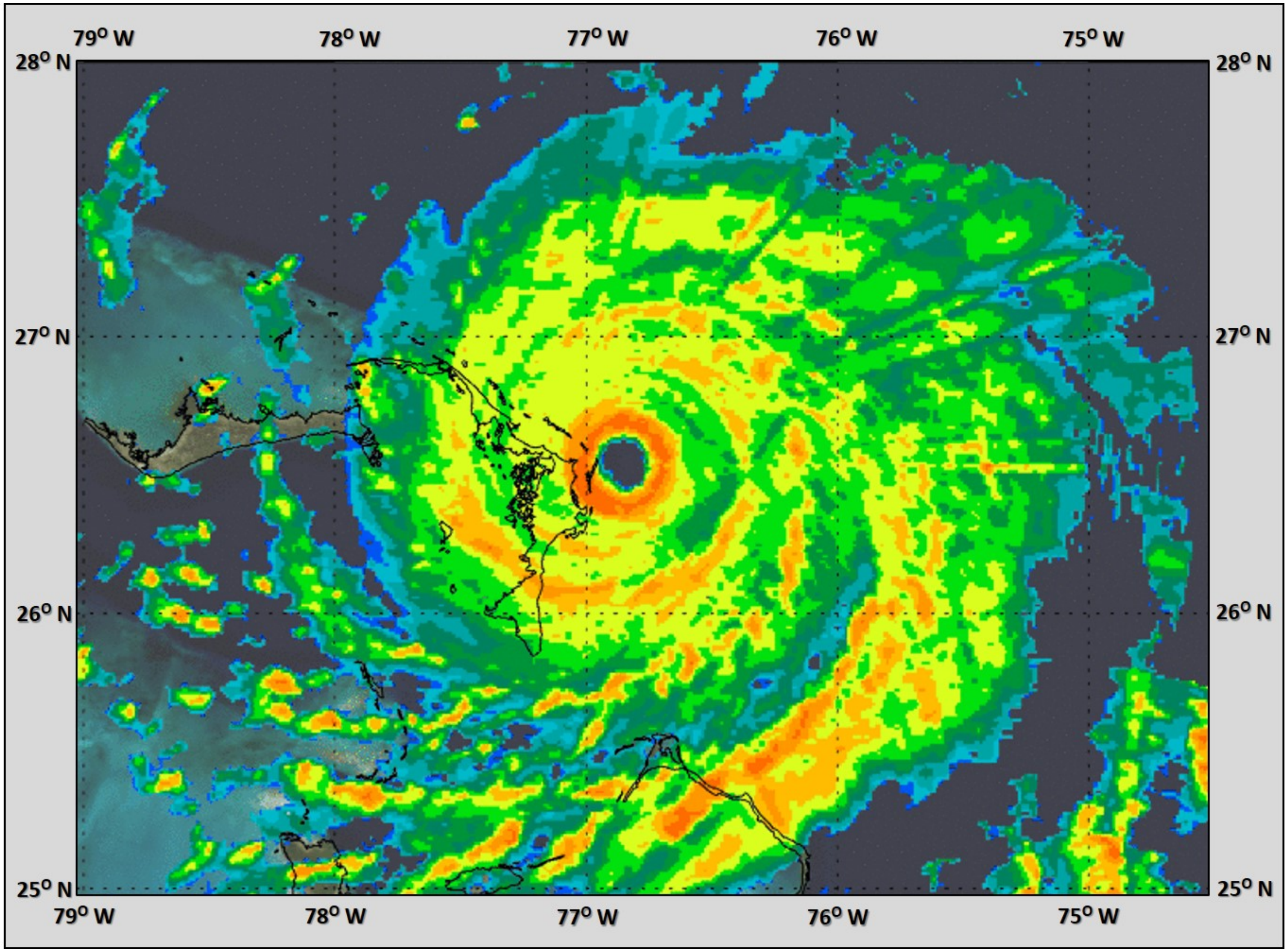

Figure 4. Radar reflectivity display of Category 5 Hurricane Dorian approaching Great Abaco Island in the northwestern Bahamas at 1545 UTC 1 September. Radar data courtesy of the Bahamas Department of Meteorology, and image courtesy of Brian McNoldy, RSMAS, Univ. of Miami.

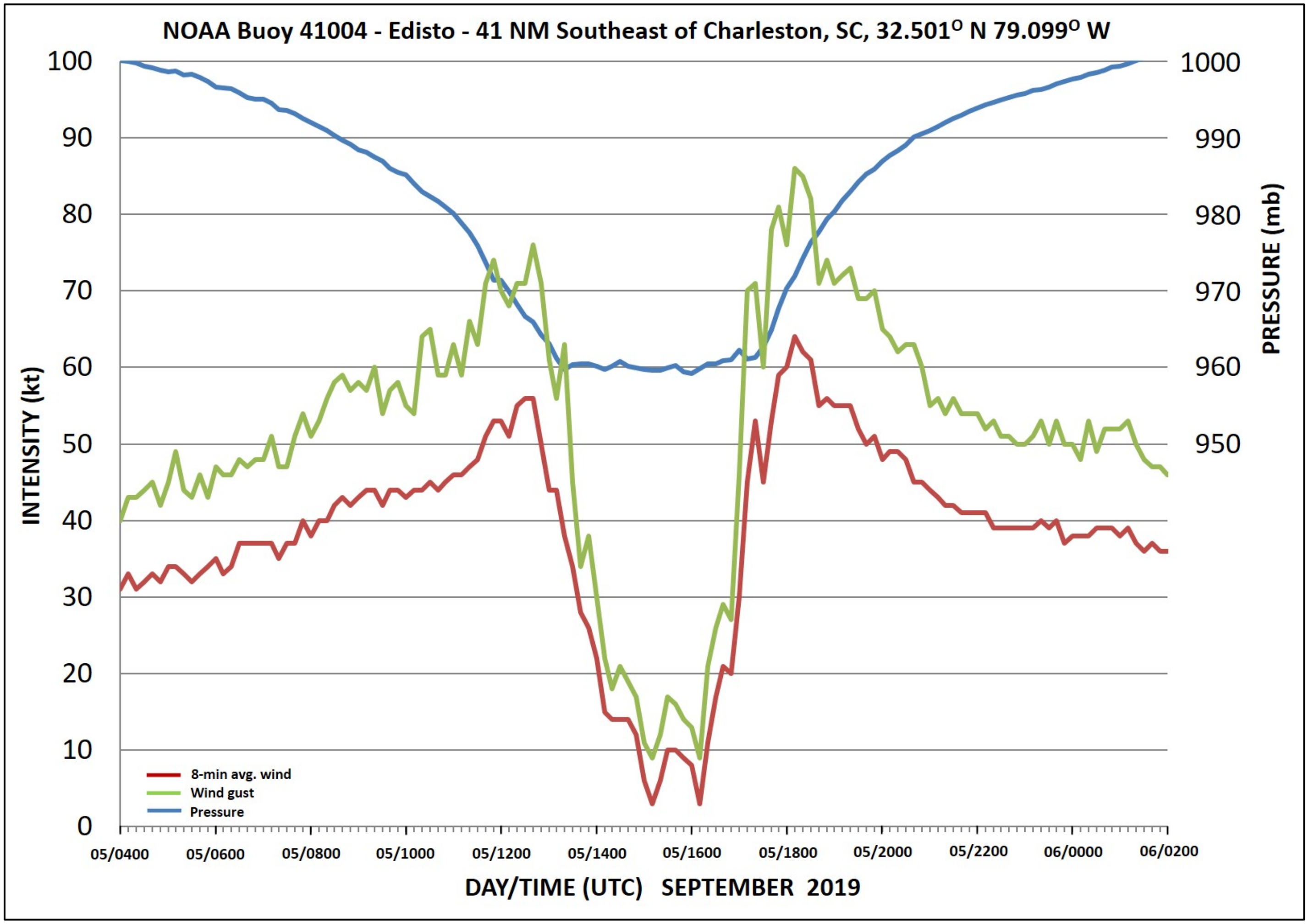

Figure 5. NOAA buoy 41004 plot of sea-level pressure (mb), 8-min-average wind (kt), and wind gusts (kt) on 5–6 September 2019. The center of Dorian's eye passed over the buoy at 1600 UTC 5 September when a pressure of 959.2 mb was measured.

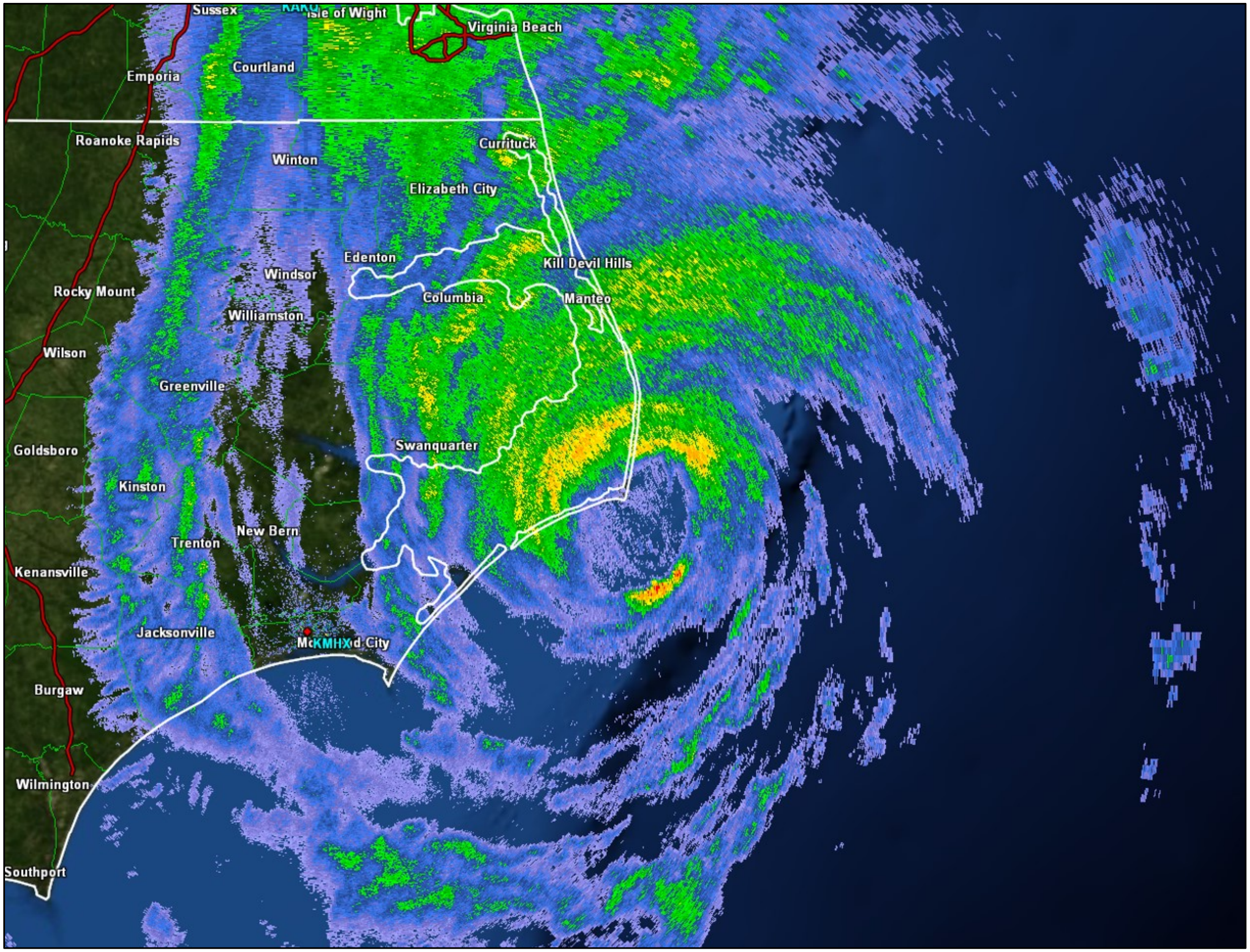

Figure 6. NOAA WSR-88D Doppler radar reflectivity data at 1230 UTC 6 September showing Dorian's elliptical-shaped eye passing over Cape Hatteras, North Carolina. Image courtesy of GR2Analyst software.

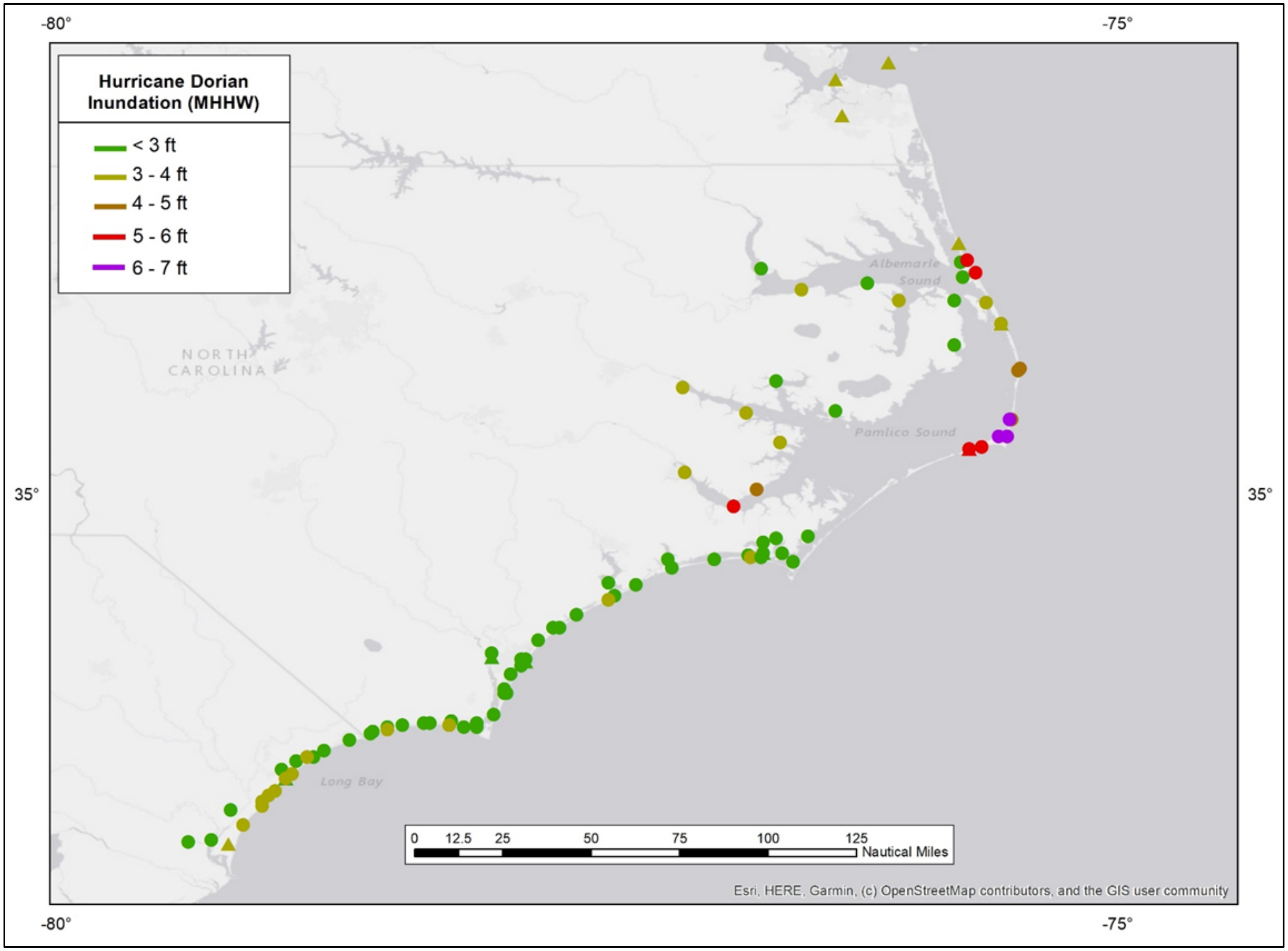

Figure 7. NOS tide gauge observations and USGS storm tide pressure sensor measurements (circles) from portions of the Carolinas and southeastern Virginia from Hurricane Dorian, converted to feet above Mean Higher High Water, which is used as a proxy for inundation.

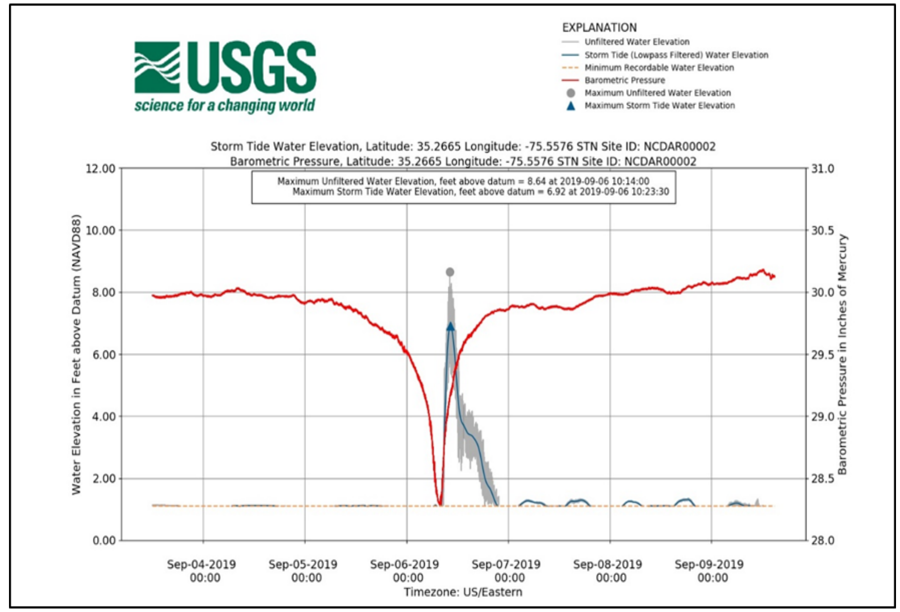

Figure 8. (a) A USGS pressure sensor installed on a bulkhead on Pamlico Sound in Buxton, NC (highlighted by the white ellipse). (b) Instantaneous water level (gray, ft above NAVD88), wave-filtered water level (blue, ft above NAVD88) and barometric pressure (red, in Hg) recorded from the sensor. Images courtesy of the USGS.

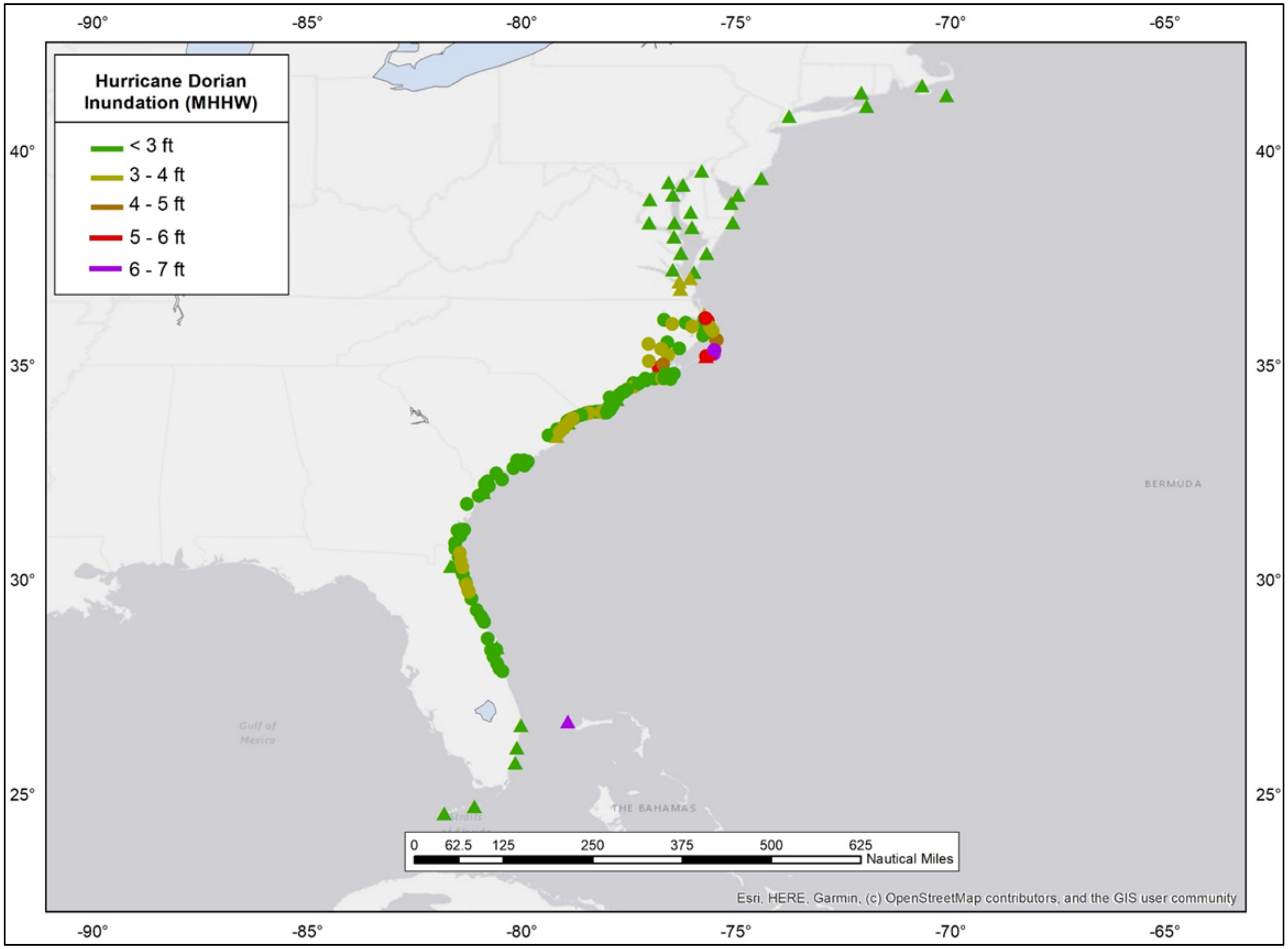

Figure 9. Tide gauge and USGS storm tide pressure sensor measurements from the east coast of the United States and the Bahamas from Hurricane Dorian, converted to feet above Mean Higher High Water, which is used as a proxy for inundation.

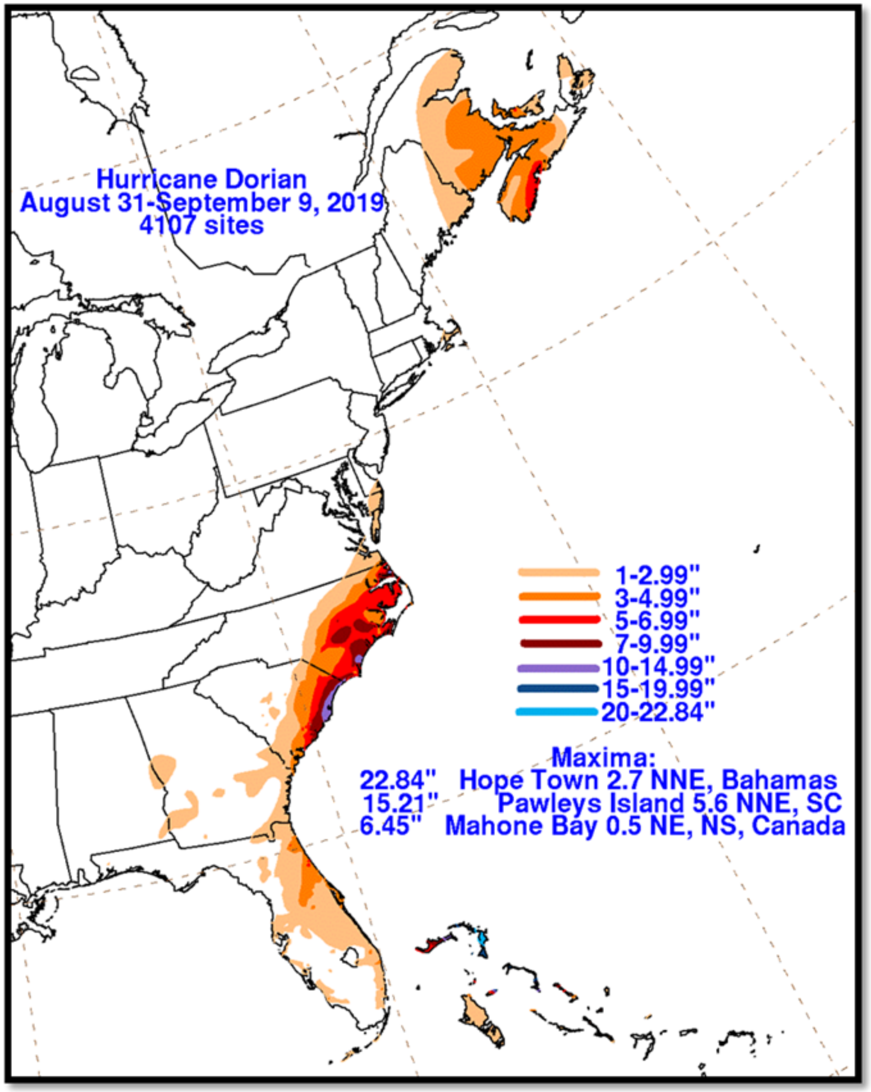

Figure 10. Hurricane Dorian rainfall analysis (inches) during the period 31 August to 9 September 2019, which includes the extratropical phase. Graphic courtesy of the NOAA Weather Prediction Center.

Figure 11. Roof damage to homes in Brunswick County, North Carolina, caused by an EF2 tornado on 5 September 2019. Picture courtesy of Brunswick County Sheriff's Office.

Figure 12. Significant damage to RV-type homes in Emerald Island, North Carolina, caused by an EF2 tornado on 5 September 2019 as Hurricane Dorian was moving northward toward the Outer Banks. Picture courtesy of WCTI-TV12, New Bern.

Figure 13. Extensive damage to residential areas on the northwestern Bahamas due to damaging wind, storm surge, and waves associated with the passage of Hurricane Dorian.

Figure 14. Drone footage of the tree damage to the Cavendish area. Photo provided by the Canadian Hurricane Center.

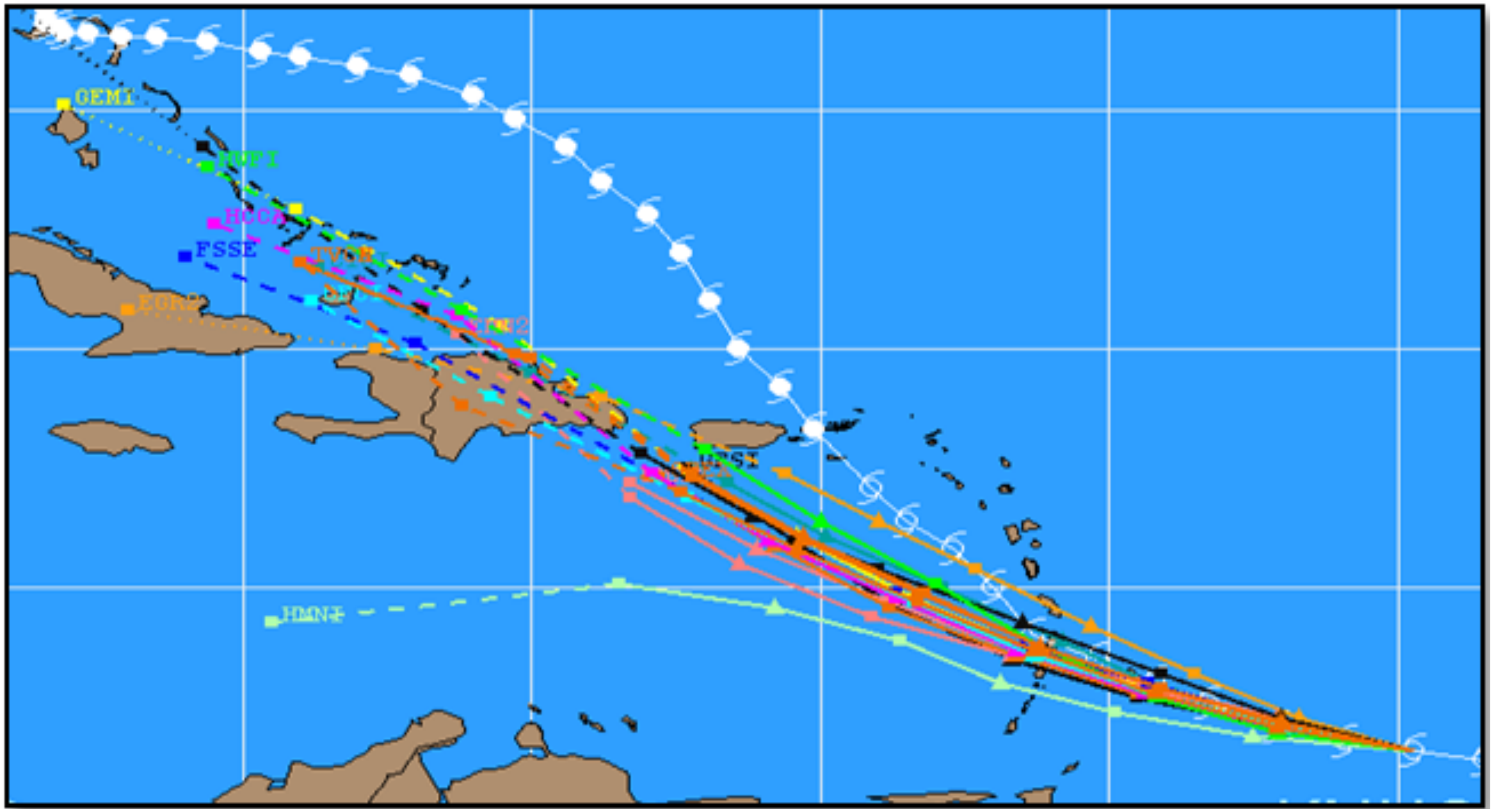

Figure 15. Selected model track forecasts for Dorian at 0000 UTC 26 August 2019. The best track is given by the solid white line with positions marked with a cyclone symbol at 6 h interval.

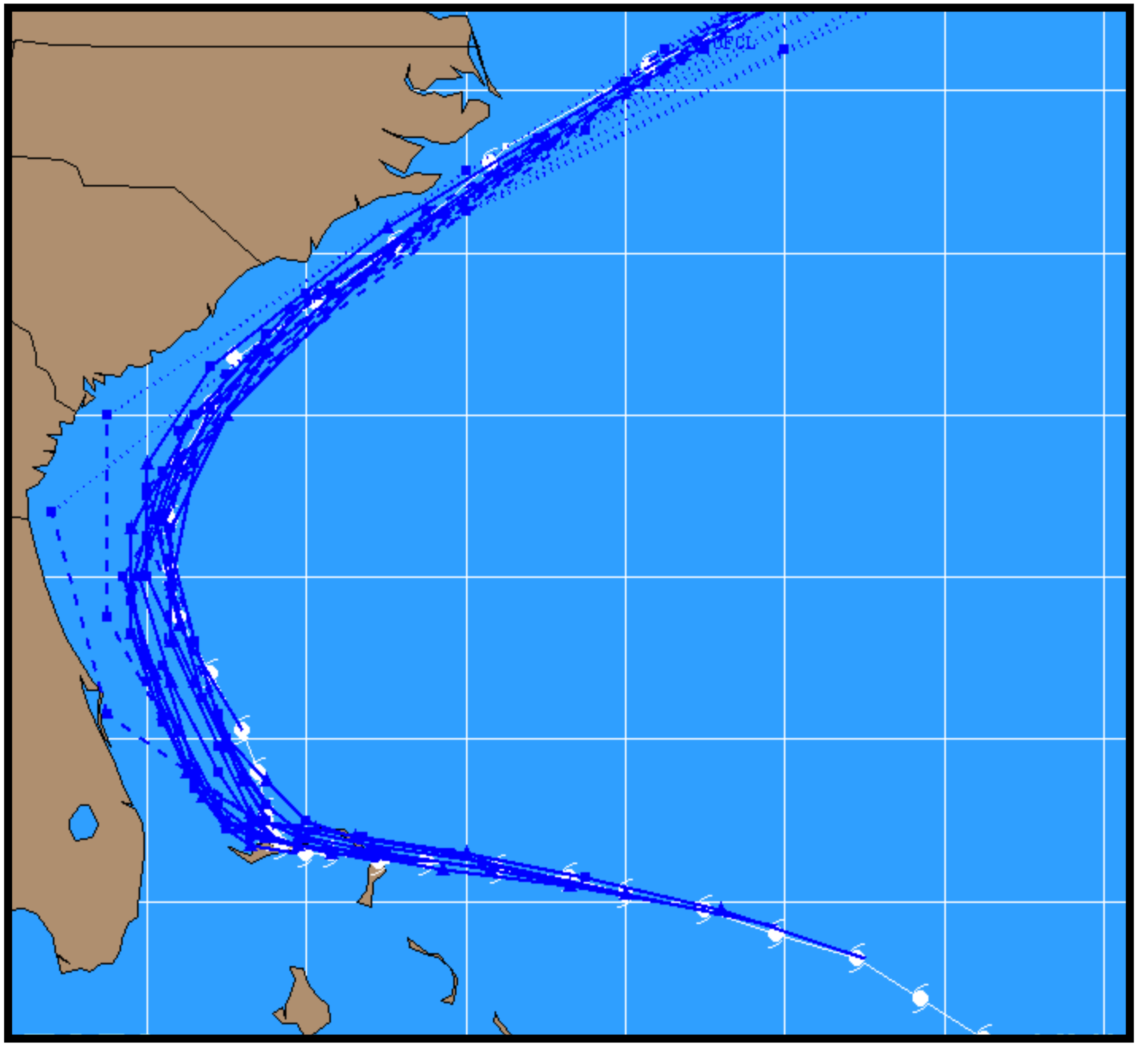

Figure 16. Selected official track forecasts (blue lines, with 0, 12, 24, 36, 48, 72, 96, and 120 h positions indicated) for Hurricane Dorian from 0000 UTC 31 August to 0000 UTC 4 September 2019. The best track is given by the white line with positions shown at 6 h intervals.

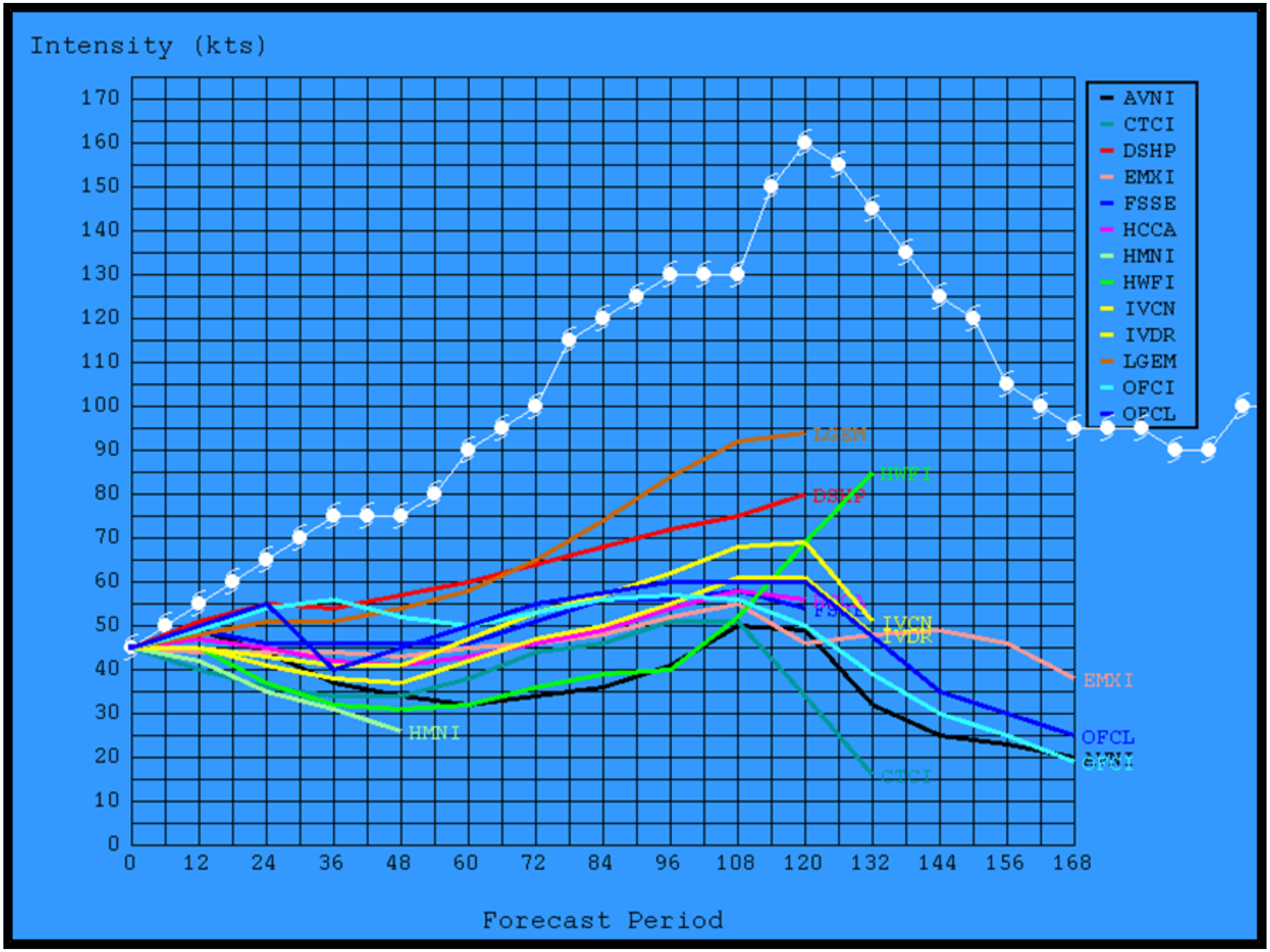

Figure 17. Selected intensity model forecasts (kt) for Dorian at 1800 UTC 27 August 2019. The best track intensity (kt) is given by the solid white line, with intensity values marked with a cyclone symbol at 6 h interval.

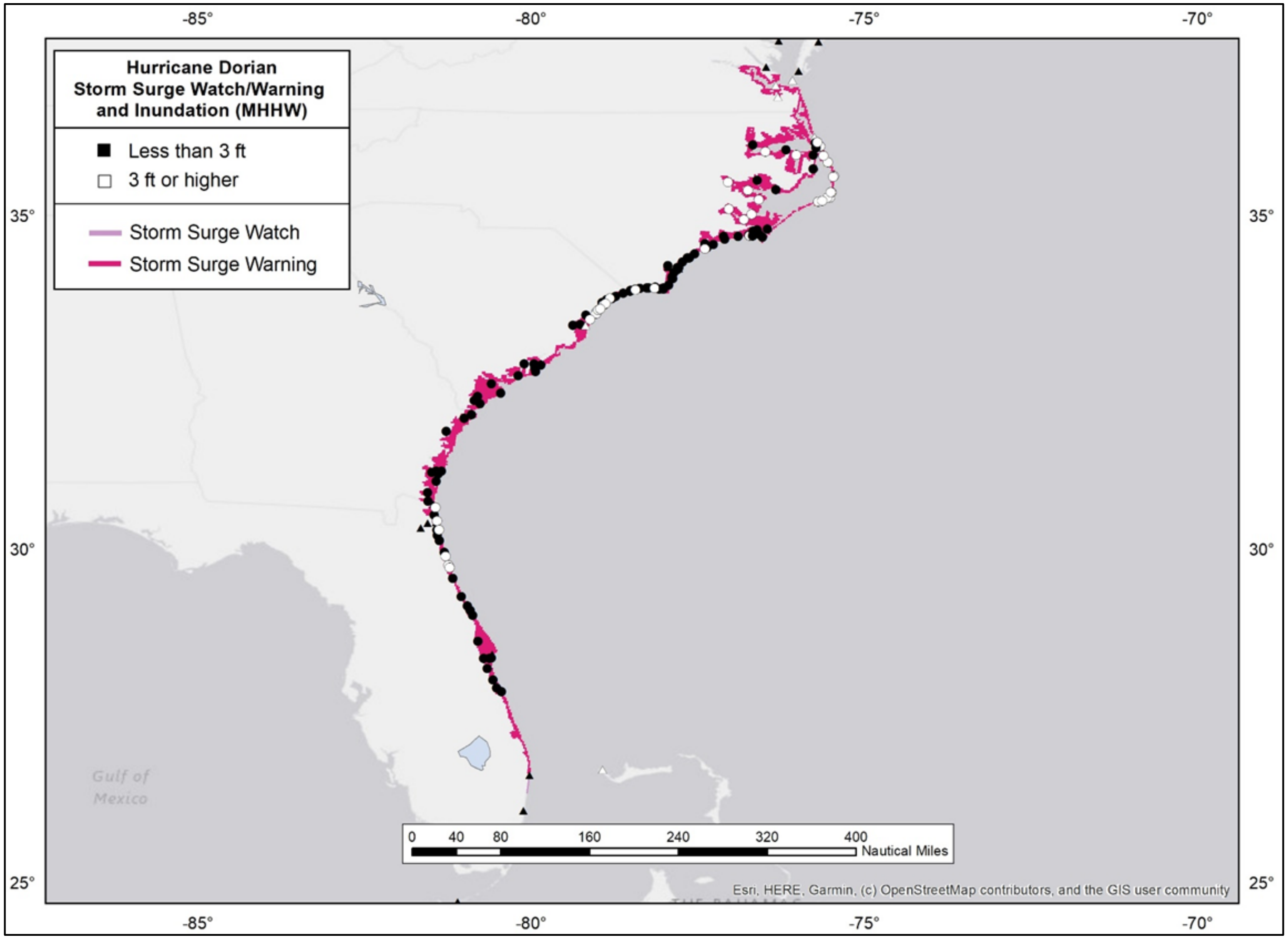

Figure 18. Maximum water levels measured from tide gauges (triangles) and pressure sensors (circles) along the southeastern United States coast during Hurricane Dorian and areas covered by storm surge watches (lavender) and warnings (magenta). Water levels are referenced as feet above Mean Higher High Water (MHHW), which is used as a proxy for inundation (above ground level) on normally dry ground along the immediate coastline. Black markers denote water levels less than 3 ft above ground level, and white markers denote water levels 3 ft or higher above ground level.

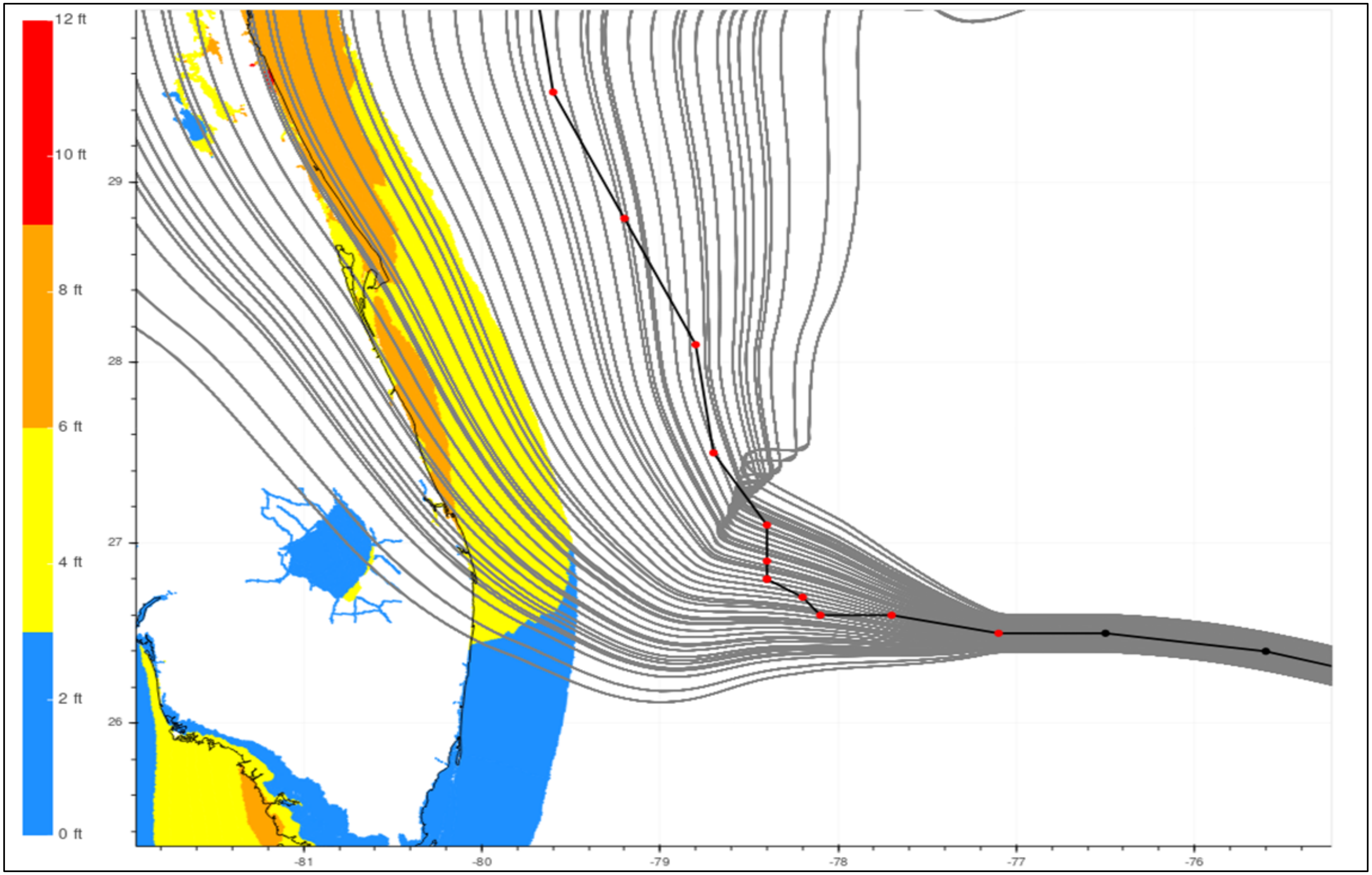

Figure 19. NWS Probabilistic Storm Surge (P-Surge) model ensemble members (gray lines) and 10% exceedance heights in feet above NAVD88 (colors) from the 1500 UTC 1 September forecast for Hurricane Dorian when a storm surge watch was first issued for a portion of the east coast of Florida. The black solid line depicts Dorian's best track.