Tropical Cyclone Report
Hurricane Isabel
6-19 September 2003

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Hurricane Isabel was a long-lived Cape Verde hurricane that reached Category 5 status on the Saffir-Simpson Hurricane Scale. It made landfall near Drum Inlet on the Outer Banks of North Carolina as a Category 2 hurricane. Isabel is considered to be one of the most significant tropical cyclones to affect portions of northeastern North Carolina and east-central Virginia since Hurricane Hazel in 1954 and the Chesapeake-Potomac Hurricane of 1933.

## a. Synoptic History

Isabel formed from a tropical wave that moved westward from the coast of Africa on 1 September. Over the next several days, the wave moved slowly westward and gradually became better organized. By 0000 UTC 5 September, there was sufficient organized convection for satellite-based Dvorak intensity estimates to begin. Development continued, and it is estimated that a tropical depression formed at 0000 UTC 6 September, with the depression becoming Tropical Storm Isabel six hours later. The "best track" chart of Isabel 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.

Isabel turned west-northwestward on 7 September and intensified into a hurricane. Strengthening continued for the next two days while Isabel moved between west-northwest and northwest. Isabel turned westward on 10 September and maintained this motion until 13 September on the south side of the Azores-Bermuda High. Isabel strengthened to a Category 5 hurricane on 11 September with maximum sustained winds estimated at 145 kt at 1800 UTC that day. After this peak, the maximum winds remained in the 130-140 kt range until 15 September. During this time, Isabel displayed a persistent 35-45 n mi diameter eye.

Isabel approached a weakness in the western portion of the Azores-Bermuda High, which allowed the hurricane to turn west-northwestward on 13 September, northwestward on 15, September, and north-northwestward on 16 September. The latter motion would continue for the rest of Isabel's life as a tropical cyclone.

Increased vertical wind shear on 15 September caused Isabel to gradually weaken. The system weakened below major hurricane status (96 kt or Category 3 on the Saffir-Simpson Hurricane Scale) on 16 September. It maintained Category 2 status with 85-90 kt maximum winds for the next two days while the overall size of the hurricane increased. Isabel made landfall near Drum Inlet,

North Carolina near 1700 UTC 18 September as a Category 2 hurricane, then weakened as it moved across eastern North Carolina. It weakened to a tropical storm over southern Virginia, then lost tropical characteristics as it moved across western Pennsylvania on 19 September. Extratropical Isabel moved northward into Canada and was absorbed into a larger baroclinic system moving eastward across south central Canada early the next day.

b. Meteorological Statistics

Observations in Isabel (Figs. 2 and 3) include satellite-based Dvorak technique intensity estimates from the Tropical Analysis and Forecast Branch (TAFB), the Satellite Analysis Branch (SAB) and the U. S. Air Force Weather Agency (AFWA). Also included are flight-level and dropwindsonde observations from flights by the 53rd Weather Reconnaissance Squadron of the U. S. Air Force Reserve Command, the NOAA Aircraft Operations Center, and a Canadian research aircraft. Observations from ships (Table 2), land stations, and data buoys (Table 3) are included where appropriate. Microwave satellite imagery from the National Aeronautics and Space Administration (NASA) Tropical Rainfall Measuring Mission (TRMM), the NASA Quikscat, and the Defense Meteorological Satellite Program (DMSP) satellites were also useful in tracking Isabel.

The Air Force Reserve Hurricane Hunters made 39 center fixes during Isabel. The NOAA Hurricane Hunters made two formal center fixes and flew seven research missions into the storm. The highest winds measured by the aircraft were 158 kt (Air Force at 700 mb) and 157 kt (NOAA at 8400 ft) between 1700-1730 UTC 13 September. A 156-kt flight-level wind (700 mb) was also observed at 1719 UTC 12 September. Stronger winds were observed on eyewall dropsondes, with a maximum of 203 kt reported at 806 mb (4500 ft) at 1753 UTC 13 September. This is the strongest wind ever observed in an Atlantic hurricane, although it likely does not represent a 1-min average.

Comparison of the aircraft and satellite data makes the peak intensity of Isabel somewhat speculative. Aircraft data on 12 September indicate that Isabel had winds near 140 kt. However, the maximum intensity based on satellite imagery was reached on 11 September before the first reconnaissance mission, and the satellite signature was weaker at the time of the first mission. The maximum intensity estimate of 145 kt on 11 September is based on the aircraft data of 12 September and the stronger satellite signature on the previous day. The minimum central pressure of 915 mb on 11 September has a similar basis.

Isabel's intensity is also somewhat uncertain during 16-18 September. During this time, a large outer eyewall formed, which disrupted the inner core wind structure. Dropsonde data indicated that the usual 90% reduction for 700 mb winds to the surface in the eyewall was not valid, with the actual reductions being closer to 70-75%. Both Air Force and NOAA aircraft measured 118-kt flight-level winds in the northeast eyewall just as Isabel was making landfall, which using the 90% reduction would support 105 kt sustained surface winds. However, using a 75% reduction gives a sustained surface wind of near 90 kt, which is in better agreement with maximum surface winds estimated by a dropsonde (83 kt) and the Stepped Frequency Microwave Radiometer on the NOAA aircraft (90 kt) near the same time. Based on this, the best estimate of the landfall intensity is 90 kt.

Isabel brought hurricane conditions to portions of eastern North Carolina and southeastern Virginia. The highest observed wind on land (Table 3) was sustained at 70 kt with a gust to 88 kt at an instrumented tower near Cape Hatteras, North Carolina at 1648 UTC 18 September. Another tower in Elizabeth City, North Carolina reported 64-kt sustained winds with a gust to 84 kt at 1851 UTC that day. The National Ocean Service (NOS) station at Cape Hatteras reported 68-kt sustained winds with a gust to 83 kt at 1518 UTC that day just before the station was destroyed. The Coastal Marine Automated Stations (C-MAN) at Chesapeake Light, Virginia and Duck, North Carolina reported similar winds. Elsewhere in Virginia, Gloucester Point reported 60-kt sustained winds with a gust to 79 kt at 2200 UTC 18 September, while the Norfolk Naval Air Station reported 50-kt sustained winds with a gust to 72 kt at 2100 UTC that day. Unofficial reports from the affected area include a gist of 102 kt at Kitty Hawk, North Carolina, a gust of 93 kt from Gwynns Island, Virginia, a gust of 91 kt at Ocracoke, North Carolina, and a gust of 88 kt at New Bern, North Carolina. The wind record from the most seriously affected areas is incomplete, as several observing stations were either destroyed or lost power as Isabel passed.

Isabel brought tropical-storm conditions to a large area from eastern North Carolina northward to the eastern Great Lakes and western New England. The C-MAN station at Thomas Point, Maryland reported 42 kt sustained winds with a gust to 58 kt at 0850 UTC 19 September. Reagan National Airport in Washington, DC reported 39-kt sustained winds with a gust to 50 kt at 0139 UTC that day. Sustained tropical storm-force winds were reported at Kennedy and LaGuardia Airports in New York City, while a gust of 52 kt was reported in Middletown, Pennsylvania. Extratropical Isabel brought gale-force winds to portions of the eastern Great Lakes and southeastern Canada.

Shipping for the most part avoided Isabel. The most significant ship report was from the ZIPR7 (name unknown), which reported 52-kt winds at 1200 UTC 17 September (Table 2). Additionally, NOAA buoy 41002 reported a 10-min average wind of 52 kt with a gust to 70 kt at 0540 UTC 18 September.

The lowest pressure observed by reconnaissance aircraft was 920 mb at 1712 and 1901 UTC 12 September. The lowest pressures observed on land were unofficial reports of 957 mb at Arrowhead Beach, North Carolina, and 958 mb from a storm chaser in Hobucken, North Carolina. The lowest pressures from official observation sites were 962.8 mb from an instrumented tower in Atlantic Beach, North Carolina at 1645 UTC 18 September, and 963.5 mb at Washington, North Carolina at 1944 UTC that day.

Isabel produced storm surges of 6-8 ft above normal tide levels near the point of landfall along the Atlantic coast of North Carolina. Farther north, storm surge values ranged from 4-6 ft along the Virginia coast, 2-4 ft along the Maryland, Delaware and New Jersey shorelines, and 1- 2 ft along the coast of Long Island.

In the North Carolina estuaries, storm surge values were generally 4-6 ft above normal tide levels over the eastern portions of the Pamlico Sound and most of the Albemarle Sound. Values of 6-10 ft above normal tide levels were observed in the western end of the Pamlico Sound with a maximum value of 10.5 ft reported on the Neuse River in Craven County (Table 3).

Storm surges of 3-5 ft above normal tide levels were observed over the central portions of the Chesapeake Bay and 5-6 ft over the southern portion of the Bay in the vicinity of Hampton Roads, Virginia. Surge values of 6-8 ft above normal levels were observed in the upper reaches of the Chesapeake Bay near Annapolis, Baltimore, and Chesapeake City, Maryland, as well as in most of the main stem rivers draining into the Chesapeake Bay. Even higher surges occurred at the heads of the rivers, with values of 8.5 ft above normal levels at the Richmond City locks along the James River in Virginia and 8 ft along the Potomac River in Washington, DC. Raw water levels exceeded previous record levels established in the Chesapeake-Potomac Hurricane of 1933 in Washington, D.C., Baltimore and Annapolis. However, due to sea-level rise since the 1933 hurricane, the NOS has calculated that storm would have produced higher tide levels than Isabel in those places.

Storm surges in Delaware Bay were generally 3-4 ft at the mouth of the bay and 5-6.5 ft at the head of the bay and along the Delaware River in the vicinity of Philadelphia, Pennsylvania.

Isabel also caused tidal perturbations in Lake Erie. Easterly winds north of the center pushed the lake waters to the western end of the lake as Isabel approached, then westerly winds pushed the waters back to the eastern end of the lake after the center moved north of the lake.

Rainfall from Hurricane Isabel averaged 4-7 in over large portions of eastern North Carolina, east-central Virginia and Maryland. Rainfall totals of 8-12 in with locally higher amounts occurred in the Shenandoah valley in northern Virginia. Upper Sherando, Virginia, reported a storm total of 20.20 in (Table 4.) Lesser amounts in the 2-4 in range occurred elsewhere over eastern Virginia and the Delmarva Peninsula.

One tornado occurred in association with Hurricane Isabel. It touched down in the Ocean View section of Norfolk, Virginia at approximately 2200 UTC 18 September and was verified only by visual confirmation from law enforcement officials. No Fujita scale rating has been assigned to the tornado since its damage could not be distinguished from the extensive hurricane-related wind damage in the area.

c. Casualty and Damage Statistics

Isabel is directly responsible for 17 deaths: 10 in Virginia, 2 in New Jersey and 1 each in North Carolina, Maryland, New York, Rhode Island, and Florida. The deaths in Florida and Rhode Island were drownings in high surf generated by Isabel. Isabel was indirectly responsible for 34 deaths: 22 in Virginia, 6 in Maryland, 2 in North Carolina and Pennsylvania, and 1 each in New Jersey and the District of Columbia.

Isabel caused widespread wind and storm surge damage in coastal eastern North Carolina and southeastern Virginia. Storm surge damage also occurred along Chesapeake Bay and the associated river estuaries, while wind damage occurred over portions of the remaining area from southern Virginia northward to New York. The current estimate for insured property damage is $1.685 billion - $925 million in Virginia, $410 million in Maryland, $170 million in North Carolina, $80 million in Pennsylvania, $45 million in New York, $25 million in New Jersey, $20 million in Delaware, and $10 million in West Virginia. The total damage for Isabel is estimated to be about twice that of the

insured damage, or $3.37 billion. *Note - in 2011 the U.S. damage estimate was revised to $5.370 billion.*

The destruction in Isabel included several weather and tide stations along the U. S. Atlantic coast and in Chesapeake Bay. NOAA buoy 41025 broke loose from its moorings near Diamond Shoals, North Carolina, and was later found on the mainland coast of the Pamlico Sound. In addition to the Cape Hatteras station, several NOS stations were destroyed, as were stations of the Chesapeake Bay Observing System and the Neuse Estuary Monitoring Project.

d. Forecast and Warning Critique

The track of Isabel was in general well forecast. Average official track errors (with the number of cases in parentheses) for Hurricane Isabel were 22 (51), 39 (49), 52 (47), 60 (45), 80 (41), 104 (37), and 146 (33) n mi for the 12, 24, 36, 48, 72, 96, and 120 h forecasts, respectively[1]. These errors are much lower than the average official track errors for the 10-yr period 1993-2002[2] (45, 81, 116, 150, 225, 282, and 374 n mi, respectively) (Table 5) - 50-65 % smaller than the average forecast errors at all times. The track forecasts also showed tremendous skill when compared to the errors of the Climatology-Persistence (CLP5) model (32, 68, 109, 148, 231, 350, and 537 n mi for the 12, 24, 36, 48, 72, 96, and 120 h forecasts, respectively) - including an almost 75% improvement at 120 h. Overall, the official track forecasts had smaller errors than the dynamical models. However, three ensemble methods that combine the forecasts of the dynamical models (GUNS, GUNA, and FSSE) had smaller errors than the official forecasts.

There appear to be three primary reasons for the excellent track forecasts. First, Isabel was a large and strong hurricane, and this type of tropical cyclone is generally easier to forecast.

Second, Isabel moved slowly through the central and eastern Atlantic in a relatively predictable steering pattern. While an initial northwestward motion was not as well forecast as other parts of the track, the forecasts did correctly anticipate that Isabel would turn westward and maintain that course for several days.

Third, when Isabel reached the western Atlantic, synoptic surveillance missions began using both the NOAA Gulfstream-IV jet and Air Force Reserve aircraft. These mission helped resolve a complex steering flow pattern around Isabel. Preliminary estimates from the Hurricane Research Division indicate that the synoptic surveillance data improved the track forecasts of the NWS Global Forecast System model (AVNO in Table 5) by as much as 40% at 120 h. Qualitative examination of forecasts from the NOGAPS (NGPS) and UKMET models (UKM) also suggest forecast track

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[1] All forecast verifications in this report include the depression stage of the cyclone. National Hurricane Center verifications presented in these reports prior to 2003 did not include the depression stage.

[2] Errors given for the 96 and 120 h periods are averages over the two-year period 2001-2.

improvement due to the data.

The landfall forecasts were exceptionally accurate. The track forecast errors verifying at 1800 UTC 18 September (1 h after landfall) had errors of 6, 12, 6, 16, 31, 86, and 118 n mi for the 12, 24, 36, 48, 72, 96, and 120 h forecasts, respectively.

The intensity forecasts were less accurate than the track forecasts. Average official intensity errors were 7, 11, 14, 17, 22, 25, and 27 kt for the 12, 24, 36, 48, 72, 96, and 120 h forecasts, respectively, which are larger than the average official intensity errors over the 10-yr period 1993-2002 (6, 10, 13, 15, 19, 21, and 22 kt, respectively). However, the intensity forecasts showed skill when compared to intensity climatology and persistence, which had errors of 8, 13, 18, 23, 29, 32, and 35 kt for the 12, 24, 36, 48, 72, 96, and 120 h forecasts, respectively. The greatest contributors to the intensity forecast errors included 1) underforecasting how quickly Isabel would intensify over the eastern Atlantic, and 2) overforecasting how strong Isabel would remain as it reached a less favorable environment in the western Atlantic.

Table 6 lists the watches and warnings associated with Hurricane Isabel. The accurate track forecasts and the large size of Isabel led to longer than normal watch and warning lead times. A hurricane watch was issued for the landfall area 50 h before the center made landfall. A hurricane warning was issued 38 h before landfall.

Acknowledgements

Much of the data from the affected areas were provided by the NWS Weather Forecast Offices at Wilmington, Morehead City, and Raleigh, North Carolina, Wakefield, Sterling, and Blacksburg, Virginia, Mount Holly, New Jersey, Upton, New York, and Pittsburgh and State College, Pennsylvania. NOAA buoy and C-MAN data were provided by the National Data Buoy Center. NOS data were provided by the NOAA National Ocean Service. Remote Automated Weather Stations (RAWS) data were provided by the National Interagency Fire Center. USGS data were provided by the NWISWeb web site. Canadian data were provided by Chris Fogarty of the Canadian Hurricane Center. DCNet data were provided by the NOAA Air Research Laboratory. CHART data were courtesy of the Maryland Coordinated Highways Response Team web site, while other data from bridges in Maryland were provided by the Maryland Department of Transportation (MDOT). The Horn Point observations were courtesy of the Chesapeake Bay Observing System (CBOS) web site, while the Gloucester Point observations were courtesy of the Virginia Institute of Marine Science. Soil Climate Analysis Network (SCAN) and North Carolina EcoNet data were provided by the U. S. Department of Agriculture. Other data were provided by the Weather Underground web site.

Table 1. Best track for Hurricane Isabel, 6-19 September 2003.

| Date/Time (UTC) | Latitude (°N) | Longitude (°W) | Pressure (mb) | Wind Speed (kt) | Stage |
|---|---|---|---|---|---|
| 06 / 0000 | 13.8 | 31.4 | 1009 | 30 | tropical depression |
| 06 / 0600 | 13.9 | 32.7 | 1005 | 35 | tropical storm |
| 06 / 1200 | 13.6 | 33.9 | 1003 | 40 | " |
| 06 / 1800 | 13.4 | 34.9 | 1000 | 45 | " |
| 07 / 0000 | 13.5 | 35.8 | 994 | 55 | " |
| 07 / 0600 | 13.9 | 36.5 | 991 | 60 | " |
| 07 / 1200 | 14.4 | 37.3 | 987 | 65 | hurricane |
| 07 / 1800 | 15.2 | 38.5 | 984 | 70 | " |
| 08 / 0000 | 15.8 | 39.7 | 976 | 80 | " |
| 08 / 0600 | 16.5 | 40.9 | 966 | 95 | " |
| 08 / 1200 | 17.1 | 42.0 | 952 | 110 | " |
| 08 / 1800 | 17.6 | 43.1 | 952 | 110 | " |
| 09 / 0000 | 18.2 | 44.1 | 948 | 115 | " |
| 09 / 0600 | 18.9 | 45.2 | 948 | 115 | " |
| 09 / 1200 | 19.4 | 46.3 | 948 | 115 | " |
| 09 / 1800 | 20.0 | 47.3 | 948 | 115 | " |
| 10 / 0000 | 20.5 | 48.3 | 952 | 110 | " |
| 10 / 0600 | 20.9 | 49.4 | 952 | 110 | " |
| 10 / 1200 | 21.1 | 50.4 | 948 | 115 | " |
| 10 / 1800 | 21.1 | 51.4 | 942 | 120 | " |
| 11 / 0000 | 21.2 | 52.3 | 935 | 125 | " |
| 11 / 0600 | 21.3 | 53.2 | 935 | 125 | " |
| 11 / 1200 | 21.4 | 54.0 | 925 | 135 | " |
| 11 / 1800 | 21.5 | 54.8 | 915 | 145 | " |
| 12 / 0000 | 21.6 | 55.7 | 920 | 140 | " |
| 12 / 0600 | 21.7 | 56.6 | 920 | 140 | " |
| 12 / 1200 | 21.6 | 57.4 | 920 | 140 | " |
| 12 / 1800 | 21.7 | 58.2 | 920 | 140 | " |
| 13 / 0000 | 21.8 | 59.1 | 925 | 135 | " |
| 13 / 0600 | 21.9 | 60.1 | 935 | 130 | " |
| 13 / 1200 | 22.1 | 61.0 | 935 | 135 | " |

| Date/Time (UTC) | Latitude (°N) | Longitude (°W) | Pressure (mb) | Wind Speed (kt) | Stage |
|---|---|---|---|---|---|
| 13 / 1800 | 22.5 | 62.1 | 932 | 140 | " |
| 14 / 0000 | 22.9 | 63.3 | 935 | 135 | " |
| 14 / 0600 | 23.2 | 64.6 | 939 | 135 | " |
| 14 / 1200 | 23.5 | 65.8 | 935 | 135 | " |
| 14 / 1800 | 23.9 | 67.0 | 933 | 140 | " |
| 15 / 0000 | 24.3 | 67.9 | 937 | 130 | " |
| 15 / 0600 | 24.5 | 68.8 | 940 | 125 | " |
| 15 / 1200 | 24.8 | 69.4 | 946 | 120 | " |
| 15 / 1800 | 25.3 | 69.8 | 949 | 115 | " |
| 16 / 0000 | 25.7 | 70.2 | 952 | 105 | " |
| 16 / 0600 | 26.3 | 70.5 | 955 | 100 | " |
| 16 / 1200 | 26.8 | 70.9 | 959 | 95 | " |
| 16 / 1800 | 27.4 | 71.2 | 959 | 95 | " |
| 17 / 0000 | 28.1 | 71.5 | 957 | 95 | " |
| 17 / 0600 | 28.9 | 71.9 | 957 | 95 | " |
| 17 / 1200 | 29.7 | 72.5 | 957 | 90 | " |
| 17 / 1800 | 30.6 | 73.0 | 955 | 90 | " |
| 18 / 0000 | 31.5 | 73.5 | 953 | 90 | " |
| 18 / 0600 | 32.5 | 74.3 | 956 | 90 | " |
| 18 / 1200 | 33.7 | 75.2 | 956 | 90 | " |
| 18 / 1800 | 35.1 | 76.4 | 958 | 85 | " |
| 19 / 0000 | 36.7 | 77.7 | 969 | 65 | " |
| 19 / 0600 | 38.6 | 78.9 | 988 | 50 | tropical storm |
| 19 / 1200 | 40.9 | 80.3 | 997 | 35 | extratropical |
| 19 / 1800 | 43.9 | 80.9 | 1000 | 30 | " |
| 20 / 0000 | 48.0 | 81.0 | 1000 | 25 | " |
| 20 / 0600 | | | | | absorbed by extratropical low |
| 11 / 1800 | 21.5 | 54.8 | 915 | 145 | minimum pressure |
| 18 / 1700 | 34.9 | 76.2 | 957 | 90 | landfall at Drum Inlet, North Carolina |

Table 2. Selected ship reports with winds of at least 34 kt for Hurricane Isabel, 6-19 September 2003.

| Date/Time (UTC) | Ship call sign | Latitude (°N) | Longitude (°W) | Wind dir/speed (kt) | Pressure (mb) |
|---|---|---|---|---|---|
| 17/ 0300 | **Duncan Island** | 27.4 | 68.7 | 160/42 | 1007.5 |
| 17/ 0900 | **Duncan Island** | 29.1 | 67.9 | 160/45 | 1010.0 |
| 17/ 0900 | ZIPR7 | 32.0 | 68.3 | 110/45 | 1010.7 |
| 17/ 1200 | ZIPR7 | 30.2 | 67.4 | 150/52 | 1011.6 |
| 17/ 1800 | **Sealand Hawaii** | 31.0 | 68.5 | 130/40 | 1010.2 |
| 17/ 1800 | **Galveston Bay** | 33.4 | 76.7 | 020/37 | 1010.8 |
| 19/ 0000 | **Oriental Bay** | 35.5 | 73.1 | 140/37 | 1010.6 |
| 19/ 0300 | **P&O Ned Lloyd Pegasus** | 34.7 | 74.8 | 190/37 | 1010.5 |
| 19/ 0600 | **P&O Ned Lloyd Piraeus** | 38.9 | 72.9 | 160/45 | 1015.3 |
| 19/ 1200 | **James R. Barker** | 42.2 | 81.1 | 060/42 | 1001.0 |

Table 3. Selected surface observations for Hurricane Isabel, 6-19 September 2003.

| Location | Minimum Sea Level Pressure | | Maximum Surface Wind Speed | | | Storm surge (ft)[c] | Storm tide (ft)[d] | Total rain (in) |
|---|---|---|---|---|---|---|---|---|
| | Date/ time (UTC) | Press. (mb) | Date/ time (UTC)[a] | Sustained (kt)[b] | Gust (kt) | | | |
| **South Carolina** | | | | | | | | |
| Springmaid Pier | | | 18/1545 | 24 | 39 | | | |
| | | | | | | | | |
| **North Carolina** | | | | | | | | |
| Alligator River NWR RAWS | | | 18/1900 | 50 | | | | 3.75 |
| Atlantic Beach (Clemson/UF Tower) | 18/1645 | 962.8 | 18/1558 | 55 | 67 | | | |
| Aurora NCECONet | 09/1900 | 960.0 | | | | | | |
| Back Island RAWS | | | 18/1813 | | 53 | | | 1.65 |
| Beaufort RAWS | | | 18/1815 | | 64 | | | 5.64 |
| Beaufort (NOS) | | | | | | 2.84 | 5.75 | |
| Burlington (KBUY) | | | | | 48 | | | |
| Cape Hatteras (Clemson/UF Tower) | 18/1644 | 968.2 | 18/1648 | 70 | 88 | | | |
| Cape Hatteras Pier NOS[f] | 18/1518 | 974.0 | 18/1518 | 68 | 83 | 5.7 | 7.68 | |
| Caswell Gamelands RAWS | | | 18/2017 | | 46 | | | 1.95 |
| Cherry Point (KNKT) | 18/1840 | 968.2 | 18/1818 | | 62 | | | 5.24 |
| Clinton (KCTZ) | | | | | 40 | | | |
| Craven Co. (Neuse river) | | | | | | | 10.5 | |
| Duke Forest RAWS | | | 18/1907 | | 53 | | | 1.70 |
| Duck Corps of Engineers Pier NOS[e] | 18/1918 | 984.0 | 18/2100 | 55 | 72 | 4.70 | 7.82 | 4.72 |
| Elizabeth City (KECG) | | | 18/1543 | 51[e] | 64[e] | | | 2.72 |
| Elizabeth City (Clemson/UF Tower) | 18/1940 | 981.9 | 18/1852 | 64 | 84 | | | |
| Elizabethtown | | | 18/2320 | 22 | 43 | | | 2.26 |
| Erwin-Dunn (KHRJ) | | | | | 38 | | | |
| Fayetteville (KFAY) | | | | 35 | 50 | | | |
| Fort Bragg (KFBG) | | | | | 52 | | | |
| Fort Bragg RAWS | | | 18/2007 | | 48 | | | 1.33 |
| Franklinton (KLHZ) | | | | | 39 | | | |
| Goldsboro (KGSB) | | | | 35 | 51 | | | |
| Greensboro (KGSO) | | | | | 40 | | | |
| Greens Cross RAWS | | | 18/1708 | | 50[e] | | | 6.29 |

| Location | Minimum Sea Level Pressure | | Maximum Surface Wind Speed | | | Storm surge (ft)[c] | Storm tide (ft)[d] | Total rain (in) |
|---|---|---|---|---|---|---|---|---|
| | Date/ time (UTC) | Press. (mb) | Date/ time (UTC)[a] | Sustained (kt)[b] | Gust (kt) | | | |
| Greenville (KPGV) | | | 18/1855 | 34 | 44 | | | 5.75 |
| Henderson (KHNZ) | | | | | 39 | | | |
| Hoffman Forest RAWS | | | 18/1509 | | 50 | | | 2.35 |
| Laurinburg (KMEB) | | | | | 35 | | | |
| Lumberton (KLBT) | | | 18/1921 | 32 | 45 | | | 3.39 |
| Manteo (KMQI) | 18/1743 | 982.4 | 18/1843 | 44 | 68 | | | |
| Nature Conservancy RAWS | | | 18/1658 | | 54 | | | 1.91 |
| New Bern (KEWN) | | | 18/1608 | | 50[e] | | | |
| New River (KNCA) | 18/1756 | 981.7 | 18/1556 | 39 | 56 | | | 2.02 |
| Newport (KMHX) | 18/1730 | 968.9 | 18/1800 | | 46 | | | 5.87 |
| Oregon Inlet Marina NOS | | | | | | 4.72 | 5.42 | |
| Plymouth/Tidewater SCAN | | | 18/2000 | | 36 | | | |
| Pocosin Lake NWR RAWS | | | 18/1823 | | 64 | | | 5.94 |
| Raleigh (KRDU) | | | | | 39 | | | |
| Rocky Mount (KRWI) | | | | 35 | 54 | | | |
| Rocky Mount RAWS | | | 18/2113 | | 52[e] | | | 4.20 |
| Roanoke Rapids[e] (KRZZ) | | | 18/2147 | 38 | 55 | | | |
| Sanford (KTTA) | | | | | 43 | | | |
| Smithfield (KJNX) | | | | | 34 | | | |
| Sunny Point RAWS | | | 18/2158 | | 51 | | | 2.09 |
| Turnbull Creek RAWS | | | 18/2313 | | 41 | | | 2.19 |
| Washington (KOCW) | 18/1944 | 963.5 | 18/1803 | 37 | 49 | | | |
| Wilmington (KILM) | 18/1843 | 990.5 | 18/2143 | 39 | 51 | | | 1.98 |
| Wilmington (Clemson/UF Tower) | 18/1730 | 990.8 | 18/1315 | | 43 | | | |
| Wilmington NOS | | | | | | 1.55 | 4.66 | |
| | | | | | | | | |
| **Virginia** | | | | | | | | |
| Back Bay NWR RAWS | | | 18/1935 | 38 | 53 | | | 4.12 |
| Blacksburg (WFO) | | | 19/0120 | | 34 | | | |
| Chesapeake Bay Bridge Tunnel NOS | 18/2154 | 992.4 | 18/2048 | 52 | 64 | 4.78 | 7.53 | |
| Colonial Beach NOS[e] | | | | | | 3.7 (6.5)[h] | 5.42 | 7.53 |

| Location | Minimum Sea Level Pressure | | Maximum Surface Wind Speed | | | Storm surge (ft)[c] | Storm tide (ft)[d] | Total rain (in) |
|---|---|---|---|---|---|---|---|---|
| | Date/ time (UTC) | Press. (mb) | Date/ time (UTC)[a] | Sustained (kt)[b] | Gust (kt) | | | |
| Culpeper (KCJR) | 19/0303 | 995.0 | | | | | | |
| Danville (KDAN) | | | 18/1922 | | 45 | | | |
| Dulles Airport (KIAD) | 19/0359 | 997.6 | 19/0122 | 32 | 42 | | | 1.96 |
| Fort Belvoir (KDAA) | | | | | | | | 2.32 |
| Fredericksburg (KEZF) | | | | | | | | 2.79 |
| Gloucester Point NOS[e] | | | | | | 6.4 | 8.32 | |
| Gloucester Point (VIMS) | | | 18/2200 | 60 | 79 | | | |
| Great Dismal Swamp RAWS | | | 18/1945 | | 39 | | | |
| Kingsmill NOS[e] | | | | | | 4.3 | 6.60 | |
| Kiptopeake NOS | | | 18/2342 | 39 | 60 | 3.92 | 6.51 | |
| Langley AFB (KLFI) | 18/2348 | 991.9 | 18/1808 | 46 | 66 | | | 2.67 |
| Leesburg (KJYO) | | | 19/0444 | | 42 | | | |
| Lewisetta NOS[e] | 19/0012 | 997.3 | 19/0100 | 46 | 59 | 3.97 | 5.47 | |
| Manassas (KHEF) | 19/0335 | 997.0 | | | | | | |
| Melfa (KMFV) | 18/2102 | 1000.0 | | | | | | |
| Money Point NOS | | | 18/2318 | 38 | 52 | 5.68 | 8.33 | |
| Newport News[e] (KPHF) | 18/2237 | 990.2 | 18/1756 | 38 | 57 | | | 3.16 |
| Norfolk Airport[e] (KORF) | 18/2151 | 990.2 | 18/2049 | 41 | 64 | | | 2.50 |
| Norfolk N.A.S. (KNGU) | | | 18/2110 | 50 | 72 | | | 4.21 |
| N Piedmont SCAN | | | 19/0300 | | 45 | | | 3.90 |
| Oceana N.A.S. (KNTU) | 18/2056 | 990.9 | 18/2056 | 48 | 60 | | | |
| Portsmouth | 18/2225 | 987.2 | | | | | | |
| Quantico (KNYG) | 19/0355 | 996.8 | 19/0322 | 47 | 67 | | | |
| Roanoke (KRNK) | | | 18/2143 | | 38 | | | |
| Rappahannock Light NOS | 18/2354 | 995.4 | 18/2318 | | 60 | | | |
| Richmond (KRIC) | | | 19/0013 | 33 | 63 | | | 4.32 |
| Scotland NOS[e] | | | | | | 4.8 | 6.82 | |
| Sewells Point NOS | 18/2130 | 991.4 | 18/1642 | 50 | 64 | 5.62 | 7.89 | |
| Tidewater SCAN | | | 18/2200 | | 46 | | | 4.10 |
| Wakefield (KAKQ) | | | | | | | | 5.76 |
| Wallops Island (KWAL) | 19/0012 | 1003.1 | 18/1747 | 43 | 54 | | | 0.80 |
| Wachapreague NOS[e] | 18/2300 | 1001.8 | | | | 5.04 | 8.39 | |
| Wakefield WFO | | | | | | | | 5.66 |
| Washington Reagan Airport (KDCA) | 19/0359 | 999.3 | 19/0139 | 39 | 50 | | | 2.31 |
| Windmill Point NOS | | | | | | 3.8 | | |
| | | | | | | | | |
| **District of Columbia** | | | | | | | | |

| Location | Minimum Sea Level Pressure | | Maximum Surface Wind Speed | | | Storm surge (ft)[c] | Storm tide (ft)[d] | Total rain (in) |
|---|---|---|---|---|---|---|---|---|
| | Date/ time (UTC) | Press. (mb) | Date/ time (UTC)[a] | Sustained (kt)[b] | Gust (kt) | | | |
| National Academy of Science (DCNet) | | | | 19/ N/A | 62 | | | |
| Washington NOS | | | | | | 8.10 | 10.28 | |
| | | | | | | | | |
| **West Virginia** | | | | | | | | |
| Martinsburg | 19/0654 | 997.3 | 19/0318 | 26 | 40 | | | |
| Petersburg (W99) | 19/0537 | 995.0 | | | | | | |
| | | | | | | | | |
| **Maryland** | | | | | | | | |
| Andrews AFB (KADW) | | | 18/2051 | 33 | 60 | | | |
| Annapolis NOS | | | | | | 6.33 | 7.20 | |
| Baltimore NOS | | | | | | 7.26 | 8.14 | |
| Baltimore (KBWI) | 19/0358 | 1001.4 | 19/0211 | 38 | 48 | | | 3.21 |
| Black NWR RAWS | | | 18/2227 | | 40 | | | 1.42 |
| Brandywine CHART[e] | | | 19/0334 | | 38 | | | |
| Cambridge CHART[e] | | | 18/1911 | | 39 | | | |
| Cambridge NOS[e] | 19/0154 | 1003.0 | 18/2054 | 37 | 49 | 5.17 | 6.18 | 2.20 |
| Chesapeake Bay Bridge MDOT[ek] | | | 19/0230 | 52 | 60 | | | |
| Chesapeake City NOS | | | | | | 8.16 | 8.76 | |
| Forestville CHART | | | 19/0415 | | 34 | | | |
| Francis Scott Key Bridge MDOT[l] | | | 19/0740 | 66 | 86 | | | |
| Frederick | | | 19/0543 | | 43 | | | |
| Hagerstown (KHGR) | 19/0548 | 998.6 | 18/2328 | 34 | 45 | | | |
| Harry W. Nice Bridge MDOT[m] | | | 19/0300 | 54 | 88 | | | |
| Horn Point CBOS | 19/0230 | 1002.0 | 19/0300 | | 51 | | | |
| Hyattstown CHART | | | 19/0501 | | 38 | | | |
| JCT Maryland 136-646 CHART[e] | | | 19/0357 | | 39 | | | |
| JCT US 340-Maryland 180 CHART[e] | | | 18/2230 | | 34 | | | |
| Lutherville-Timonium CHART[e] | | | 18/2339 | | 35 | | | |
| Maryland Science Center (KDMH) | 19/0301 | 1002.4 | | | | | | |
| Ocean City (KOXB) | 18/2257 | 1006.1 | 18/2252 | 36 | 46 | | 6.5 | 1.97 |
| Ocean City NOS | | | | | | 2.65 | 4.39 | |
| Patuxent River (KNHK) | 19/0355 | 999.0 | 19/0355 | 48 | 60 | | | |

| Location | Minimum Sea Level Pressure | | Maximum Surface Wind Speed | | | Storm surge (ft)[c] | Storm tide (ft)[d] | Total rain (in) |
|---|---|---|---|---|---|---|---|---|
| | Date/ time (UTC) | Press. (mb) | Date/ time (UTC)[a] | Sustained (kt)[b] | Gust (kt) | | | |
| Reisterstown CHART | | | 19/0417 | | 41 | | | |
| Salisbury (KSBY) | 19/0331 | 1005.1 | 18/2009 | 32 | 44 | | | 2.08 |
| Salisbury CHART | | | 19/0517 | | 43 | | | |
| Silver Springs (DCNet) | | | 19/ N/A | | 72 | | | |
| Solomons Island NOS[e] | 19/0018 | 1000.7 | 19/0106 | 45 | 56 | 2.9 | 4.47 | |
| Tolchester Beach NOS | 19/0354 | 1003.2 | 19/0124 | | 38 | 6.94 | 7.91 | |
| Vienna CHART | | | 18/2100 | | 46 | | | |
| Westminster CHART | | | 19/0517 | | 39 | | | |
| | | | | | | | | |
| **Delaware** | | | | | | | | |
| Brandywine Shoal NOS | 19/0424 | 1007.3 | 19/0742 | | 54 | 3.54 | 6.75 | |
| Delaware City NOS | 19/0630 | 1005.6 | 19/0606 | 34 | 47 | 5.42 | 8.62 | |
| Dover AFB (KDOV) | | | 19/0419 | | 53 | | | |
| Georgetown (KGED) | | | 19/0613 | | 52 | | | 1.74 |
| Lewes NOS | 19/0336 | 1006.6 | 18/2024 | 46 | 54 | 3.07 | 6.51 | |
| Prime Hook NWR RAWS | | | 18/2127 | | 44 | | | 1.06 |
| Reedy Point NOS | | | | | | 5.00 | 10.01 | |
| Wilmington (KILG) | | | 19/0720 | | 46 | | | 1.46 |
| | | | | | | | | |
| **New Jersey** | | | | | | | | |
| Atlantic City (KACY) | | | 19/0034 | | 42 | | | |
| Atlantic City NOS | | | | | | 2.48 | 5.65 | |
| Atlantic City USGS | 19/0300 | 1011.9 | 19/0100 | | 46 | | | |
| Barnegat Light USGS | 19/0500 | 1014.6 | 19/1930 | | 39 | | | |
| Burlington NOS | 19/0706 | 1010.4 | | | | 6.40 | 10.55 | |
| Cape May NOS | 19/0500 | 1008.1 | 18/2124 | | 47 | 3.12 | 6.45 | |
| Cape May USGS | 19/0100 | 1005.2 | 18/2100 | 34 | 53 | | | |
| Forsythe NWR RAWS | | | 19/0827 | | 34 | | | 0.31 |
| Keansburg USGS | 19/0600 | 1014.6 | 19/0100 | | 45 | | | |
| Millville (KMIV) | | | 19/0046 | | 48 | | | |
| Newark (KEWR) | 19/0757 | 1013.9 | 19/0619 | 28 | 38 | | | 0.66 |
| Point Pleasant USGS | 19/0500 | 1014.6 | 19/0100 | | 40 | | | |
| Sandy Hook NOS | 19/0736 | 1014.2 | 19/0142 | | 39 | 2.19 | 5.64 | |
| Ship John Shoal NOS | 19/0518 | 1007.1 | 19/0206 | 47 | 62 | 4.66 | 8.03 | |
| Tacony-Palmyra Bridge NOS | | | | | | 5.75 | 9.86 | |
| Teterboro (KTEB) | | | | | 35 | | | |
| Trenton (KTTN) | | | 19/0304 | | 38 | | | |
| Wildwood (KWWD) | | | 19/0835 | | 41 | | | 1.30 |

| Location | Minimum Sea Level Pressure | | Maximum Surface Wind Speed | | | Storm surge (ft)[c] | Storm tide (ft)[d] | Total rain (in) |
|---|---|---|---|---|---|---|---|---|
| | Date/ time (UTC) | Press. (mb) | Date/ time (UTC)[a] | Sustained (kt)[b] | Gust (kt) | | | |
| Wrightstown/McGuire AFB (KWRI) | | | 19/0337 | | 47 | | | |
| | | | | | | | | |
| **Pennsylvania** | | | | | | | | |
| Allentown (KABE) | | | 19/0907 | | 41 | | | |
| Altoona (KAOO) | 19/0804 | 998.7 | 19/0429 | | 37 | | | |
| Capital City | 19/0513 | 1003.0 | 19/0530 | | 50 | | | |
| Clearfield (KFIG) | 19/0926 | 1000.3 | 19/0604 | | 35 | | | |
| Hazelton (KFET) | | | | | | | | |
| Lancaster (KLNS) | 19/0634 | 1004.4 | 19/0637 | | 46 | | | |
| Marcus Hook | | | | | | 5.62 | 9.04 | |
| Middletown | 19/0509 | 1003.0 | 19/0517 | | 52 | | | |
| Mt Pocono (KMPO) | | | | | 40 | | | |
| Newbold NOS | | | | | | 6.10 | 11.16 | |
| Philadelphia (KPHL) | | | 19/0747 | | 43 | | | 1.14 |
| Philadelphia NOS | 19/0530 | 1010.6 | 18/2312 | | 37 | 5.42 | 9.47 | |
| Reading (KRDG) | | | 19/0735 | | 43 | | | |
| Scranton Wilkes-Barre (KAVP) | | | | | 35 | | | |
| Sherburne RAWS | | | 19/1808 | | 41 | | | |
| Williamsport (KIPT) | 19/0843 | 1003.0 | 19/0841 | | 45 | | | |
| York (KTHV) | 19/0603 | 1002.7 | 19/0601 | | 38 | | | |
| | | | | | | | | |
| **New York** | | | | | | | | |
| Binghamton (KBGM) | | | | | 39 | | | |
| Buffalo (KBUF) | | | 19/2012 | | 35 | | | |
| Buffalo NOS | 19/1648 | 1002.5 | 19/2000 | 30 | 37 | | | |
| Farmingdale (KFMG) | 19/0902 | 1016.3 | 19/0725 | 28 | 36 | | | 0.00 |
| Kings Point NOS | | | 19/1912 | | 34 | 1.6 | 8.4 | |
| Monticello (KMSV) | | | | | 38 | | | |
| New York Kennedy Airport (KJFK) | 19/0815 | 1015.2 | 19/0802 | 35 | 43 | | | 0.16 |
| New York LaGuardia Airport (KLGA) | 19/0827 | 1014.9 | 19/0736 | 35 | 44 | | | 0.26 |
| Oswego NOS | 19/1730 | 1004.8 | 19/1800 | | 39 | | | |
| Saranac Lake (KSLK) | | | 19/1827 | | 38 | | | |
| Shinnecock Inlet | | | 18/2330 | 30 | 45 | | | |
| Syracuse (KSYR) | | | | | 35 | | | |
| Utica (KUCA) | | | | | 37 | | | |

| Location | Minimum Sea Level Pressure | | Maximum Surface Wind Speed | | | Storm surge (ft)[c] | Storm tide (ft)[d] | Total rain (in) |
|---|---|---|---|---|---|---|---|---|
| | Date/ time (UTC) | Press. (mb) | Date/ time (UTC)[a] | Sustained (kt)[b] | Gust (kt) | | | |
| Watertown (KART) | | | 19/1605 | | 35 | | | |
| Wellsville (KELZ) | | | 19/0958 | | 35 | | | |
| | | | | | | | | |
| **Vermont** | | | | | | | | |
| Burlington (KBTV) | | | 19/1940 | | 40 | | | |
| Rutland (KRUT) | | | 19/1535 | | 35 | | | |
| | | | | | | | | |
| **Canada** | | | | | | | | |
| Burlington | | | | | 39 | | | |
| Hamilton | | | | | 36 | | | |
| Long Point | | | | 37 | 42 | | | |
| Point Petre | | | | | 43 | | | |
| Port Colburne | | | | 35 | 44 | | | |
| Toronto Island | | | | | 43 | | | |
| Toronto Pearson Airport (CYYZ) | | | 19/1350 | | 39 | | | |
| | | | | | | | | |
| **Buoy/CMAN** | | | | | | | | |
| NOAA Buoy 41001 | 18/0900 | 997.7 | 18/0150 | 40[g] | 51 | | | |
| NOAA Buoy 41002 | 18/0800 | 978.8 | 18/0540 | 52[g] | 70 | | | |
| NOAA Buoy 44004 | | | 18/2331 | | 35 | | | |
| NOAA Buoy 44009 | 19/0000 | 1006.6 | 19/2200 | 38 | 51 | | | |
| NOAA Buoy 44014 | 18/1900 | 995.5 | 18/1250 | 43[g] | 60 | | | |
| NOAA Buoy 44017 | 19/0900 | 1018.5 | 18/2300 | 29 | 36 | | | |
| NOAA Buoy 44025 | 19/0800 | 1015.0 | 19/0100 | 30 | 38 | | | |
| NOAA Buoy 45005 | 19/1300 | 1002.6 | 19/2100 | 27[g] | 35 | | | |
| NOAA Buoy 45008 | 19/1700 | 1002.6 | 20/0030 | 28 | 34 | | | |
| NOAA Buoy 45012 | 19/1700 | 1004.2 | 19/1220 | 32[g] | 41 | | | |
| Canadian Buoy 45135 | | | | 34 | 42 | | | |
| Canadian Buoy 45139 | | | | 32 | 40 | | | |
| Canadian Buoy 45160 | | | | 32 | 40 | | | |
| Ambrose Tower (ALSN7) | 19/0700 | 1014.1 | 19/2350 | 44[g] | 52 | | | |
| Chesapeake Light (CHLV2) | 18/2100 | 990.6 | 18/2140 | 65[g] | 83 | | | |
| Cape Lookout (CKLN7) | 18/1600 | 964.9 | 18/1530 | 60[g] | 79 | | | |
| Dunkirk (DBLN6) | 19/1500 | 1000.3 | 19/1900 | 31 | 39 | | | |
| Diamond Shoals Light (DSLN7) | 18/1600 | 970.5 | | | | | | |
| Duck (DUCN7) | 18/1900 | 984.4 | 18/1930 | 66[g] | 82 | | | |

| Location | Minimum Sea Level Pressure | | Maximum Surface Wind Speed | | | Storm surge (ft)[c] | Storm tide (ft)[d] | Total rain (in) |
|---|---|---|---|---|---|---|---|---|
| | Date/ time (UTC) | Press. (mb) | Date/ time (UTC)[a] | Sustained (kt)[b] | Gust (kt) | | | |
| Frying Pan Shoals (FPSN7) | 18/1700 | 993.4 | 18/1610 | 63[g] | 77 | | | |
| Lake St Clair (LSCM4) | 19/1400 | 1004.1 | 19/2100 | 31 | 36 | | | |
| South Bass Island (SBOI1) | 19/1400 | 1003.8 | 19/2050 | 32[g] | 36 | | | |
| Thomas Point Light (TPLM2) | 19/0500 | 1001.1 | 19/0850 | 42[g] | 58 | | | |
| | | | | | | | | |
| **Unofficial Observations:** | | | | | | | | |
| **South Carolina** | | | | | | | | |
| Little River | | | 18/1723 | | 36 | | | |
| Loris EMS | | | 18/1742 | | 37 | | | 1.34 |
| Myrtle Beach Pavilion | | | 18/1638 | | 34 | | | |
| Pawleys Island | | | 18/1624 | | 35 | | | |
| | | | | | | | | |
| **North Carolina** | | | | | | | | |
| Arrowhead Beach | 18/2030 | 957.0 | | | | | | |
| Atlantic Beach (Sudduth) | 18/1644 | 967.5 | 18/1531 | 48 | 59 | | | |
| Battleship | | | | | 43 | | | |
| Cape Lookout[e] | | | 18/1415 | | 71 | | | |
| Carolina Beach | | | 18/1405 | | 45 | | | |
| Cary (Weather Underground) | 18/2209 | 988.0 | 18/2149 | | 43 | | | 1.22 |
| Cedar Island | | | 18/1440 | | 75 | | | |
| Clayton (Weather Underground) | 19/0102 | 990.4 | 18/1752 | | 40 | | | |
| Edenton | | | | | | | 7.0 | |
| Elizabeth City | | | | | | | 5.0 | |
| Harkers Island Bridge | | | 18/1430 | | 85 | | | |
| Hobucken (Leonard) | 18/1750 | 958.0 | | | | | | |
| Holly Shelter | | | 18/2020 | | 53 | | | |
| Indian Beach | 18/1645 | 970.6 | 18/ N/A | 51 | 63 | | | |
| Isabelle Homes Bridge (Cape Fear River) | | | 18/1330 | | 50 | | | |
| Kitty Hawk | 18/1925 | 984.5 | 18/ N/A | | 102 | | | |
| Kure Beach Pier | | | 18/1605 | | 41 | | | |
| Kyre Beach La Que Center | | | 18/1300 | | 48 | | | |
| Lillington (Weather Underground) | | | 18/1808 | | 37 | | | |

| Location | Minimum Sea Level Pressure | | Maximum Surface Wind Speed | | | Storm surge (ft)[c] | Storm tide (ft)[d] | Total rain (in) |
|---|---|---|---|---|---|---|---|---|
| | Date/ time (UTC) | Press. (mb) | Date/ time (UTC)[a] | Sustained (kt)[b] | Gust (kt) | | | |
| New Bern (Weather Underground) | 18/1912 | 970.1 | 18/1327 | 80 | 88 | | | |
| Ocean Isle | | | 18/1600 | | 50 | | | |
| Ocracoke | | | 18/1545 | | 91 | | | |
| Plymouth | | | 18/1805 | | 83 | | | |
| Southport NC State Pilot | | | 18/2334 | | 56 | | | |
| Southport Elementary School | | | | | 46 | | | |
| Southport Brunswick County Airport | | | 18/1600 | | 44 | | | 1.95 |
| Sunny Point Military Ocean Terminal | | | 18/2020 | | 45 | | | |
| Surf City (Weather Underground) | 18/1846 | 991.8 | 18/1206 | 44 | 75 | | | |
| Topsail Beach | | | 18/1430 | | 50 | | | |
| Trenton | | | 18/1912 | | 70 | | | |
| Whiteville Chamber of Commerce | | | | | 43 | | | 4.51 |
| Wilmington (NC State Port) | | | 18/1400 | | 57 | | | |
| Wilmington (Weather Underground) | 18/1730 | 994.1 | 18/1800 | | 36 | | | |
| Wilmington (WECT TV) | | | | | 46 | | | 2.24 |
| Wilson (Weather Underground) | 18/2110 | 976.5 | 18/1955 | | 47 | | | |
| Wrightsville Beach Police | | | 18/1500 | | 39 | | | |
| Wrightsville Beach FD | | | 18/1230 | | 52 | | | |
| Wrightsville Beach Oceanic Pier | | | 18/2128 | | 49 | | | |
| | | | | | | | | |
| **Virginia** | | | | | | | | |
| Boone | | | 18/2241 | | 40 | | | |
| Chase City | | | 18/2010 | | 46 | | | |
| Chesapeake Bay Bridge | | | 18/2125 | 62 | 76 | | | |
| Chincoteague | | | 18/2315 | | 41 | | | |
| Chincoteague CGS | | | | | 62 | | | |
| Chincoteague (Weather Underground) | 18/2311 | 1004.3 | 18/2231 | 36 | 40 | | | |
| Dublin | | | 19/0220 | | 49 | | | |
| Dunnsville | | | | | | | 6.0 | |
| Five Forks | | | | | 70 | | | |

| Location | Minimum Sea Level Pressure | | Maximum Surface Wind Speed | | | Storm surge (ft)[c] | Storm tide (ft)[d] | Total rain (in) |
|---|---|---|---|---|---|---|---|---|
| | Date/ time (UTC) | Press. (mb) | Date/ time (UTC)[a] | Sustained (kt)[b] | Gust (kt) | | | |
| Gwynns Island | | | 19/0042 | | 93 | | | |
| Hampton | | | 18/2130 | 58 | 80 | | | |
| Hillsville | | | 19/0240 | | 37 | | | |
| Hopewell | | | | | | | 8.0 | |
| Hot Springs | | | 19/0020 | | 38 | | | |
| Jefferson | | | 19/0220 | | 35 | | | |
| Norfolk Fred Heutte Center | | | 18/1944 | | 61 | | | 4.88 |
| Oak Hall | | | | | 50 | | | |
| Onley | | | | | 54 | | | |
| Parksley | | | | | 57 | | | |
| Portsmouth (WRS) | | | 18/1944 | | 48 | | | |
| Reedville | | | | | 87 | | | |
| Richmond (WWBT-TV) | | | | | 55 | | | |
| Richmond County | | | | 42[j] | 57[j] | | | |
| Smith Island | | | | | 72 | | | |
| Smithfield | | | | | | 10.75[j] | 8.0[j] | |
| Tappahannock | | | | | | | 5.5 | |
| West Point | | | | | | | 9.0[j] | |
| White Stone (NNWS)[e] | | | 18/ N/A | | 55 | | | |
| Williamsburg (Weather Underground) | 18/2247 | 993.5 | 18/1917 | | 50 | | | |
| Yorktown (Weather Underground)[e] | | | 18/1820 | | 41 | | | |
| | | | | | | | | |
| **Maryland** | | | | | | | | |
| Frederick (Weather Underground) | 19/0705 | 1001.2 | 18/ N/A | | 42 | | | |
| Hagerstown (Weather Underground) | | | 19/0500 | | 55 | | | 2.89 |
| Hurlock | | | | | 54 | | | |
| Millersville (Weather Underground) | 19/ N/A | 1001.3 | 18/ N/A | | 41 | | | 2.14 |
| Montgomery Village (Weather Underground) | 19/0344 | 1000.3 | 19/0300 | | 43 | | | 2.30 |
| Ocean Pines | | | | | 52 | | | |
| Perry Hall (Weather Underground) | 19/0430 | 1000.9 | 19/0350 | | 37 | | | 0.68 |
| Pocomoke | | | | | 43 | | | |

| Location | Minimum Sea Level Pressure | | Maximum Surface Wind Speed | | | Storm surge (ft)[c] | Storm tide (ft)[d] | Total rain (in) |
|---|---|---|---|---|---|---|---|---|
| | Date/ time (UTC) | Press. (mb) | Date/ time (UTC)[a] | Sustained (kt)[b] | Gust (kt) | | | |
| **Delaware** | | | | | | | | |
| Bear | | | | | 46 | | | |
| Sussex Pilot Tower | | | | | 61 | | | |
| | | | | | | | | |
| **New Jersey** | | | | | | | | |
| Berlin (Weather Underground) | 19/0525 | 1010.0 | 19/0540 | | 42 | | | |
| Buena (Weather Underground) | | | 19/0030 | | 42 | | | |
| Cape May City | | | | | 55 | | | |
| Harrison | | | 19/0720 | | 37 | | | |
| Oceanport (Weather Underground) | 19/0649 | 1013.8 | 18/2209 | | 39 | | | |
| Sparta | | | | | 41 | | | |
| Strathmere | | | | | 54 | | | |
| TOMS River (Weather Underground) | 19/0700 | 1015.5 | 18/2200 | | 37 | | | |
| Williamstown (Weather Underground) | | | 19/0740 | | 53 | | | |
| | | | | | | | | |
| **Pennsylvania** | | | | | | | | |
| Aston (Weather Underground) | 19/0615 | 1010.0 | 19/0030 | | 34 | | | |
| Elk Lake | | | | | 40 | | | |
| Exeter | | | | | 37 | | | |
| Forks Township | | | | | 52 | | | |
| Gettysburg | | | 19/0701 | | 50 | | | |
| Jermyn | | | | | 40 | | | |
| Kinzer (Weather Underground)[e] | | | 19/0600 | | 39 | | | |
| Lancaster (Weather Underground) | | | 19/0800 | | 40 | | | |
| Lancaster (WGAL) | | | 19/0608 | | 63 | | | |
| Millersville (University) | | | 19/0800 | | 44 | | | |
| Moscow | | | | | 41 | | | |
| New Holland | | | 19/0742 | | 47 | | | |
| Perkasie (Weather Underground) | | | 19/0845 | | 35 | | | |
| Plymouth | | | | | 34 | | | |
| Rock Spring | | | 19/0723 | | 40 | | | |

| Location | Minimum Sea Level Pressure | | Maximum Surface Wind Speed | | | Storm surge (ft)[c] | Storm tide (ft)[d] | Total rain (in) |
|---|---|---|---|---|---|---|---|---|
| | Date/ time (UTC) | Press. (mb) | Date/ time (UTC)[a] | Sustained (kt)[b] | Gust (kt) | | | |
| Saylorsburg (Weather Underground) | | | 19/0744 | | 34 | | | |
| Shiremanstown | | | 19/0645 | | 59 | | | |
| | | | | | | | | |
| **New York** | | | | | | | | |
| Brooklyn (New Utrech HS) | | | | | 41 | | | |
| Hornell | | | | | 39 | | | |
| Liverpool | | | | | 38 | | | |
| Long Beach (HS) | | | 19/0200 | 33 | 43 | | | |
| Lowville (Weather Underground) | 19/1916 | 1008.4 | 19/1847 | | 37 | | | |
| Madison | | | | | 38 | | | |
| Manhattan (Center for Science and Math) | | | | | 40 | | | |
| Marathan | | | | | 36 | | | |
| Rochester (Weather Underground) | 19/1602 | 1003.3 | 19/1446 | | 34 | | | |
| Romulus | | | | | 35 | | | |
| | | | | | | | | |
| **Vermont** | | | | | | | | |
| Cambridge | | | 19/1720 | | 45 | | | |
| Lincoln (Weather Underground) | | | 19/1231 | | 44 | | | |
| Mt Mansfield | | | 19/1805 | | 72 | | | |
| Pleasant Valley | | | 19/1728 | | 48 | | | |
| Salisbury | | | 19/1620 | | 43 | | | |
| Starkboro | | | 19/ N/A | | 52 | | | |

[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 ASOS reports are 2 min; buoy averaging periods are 8 min; NOS stations averaging periods are 6 min; RAWS stations report 10 min average sustained winds.

[c] Storm surge is water height above normal astronomical tide level.

[d] Storm tide is water height above National Geodetic Vertical Datum (1929 mean sea level).

[e] Incomplete record - more extreme values may have occurred

[f] Station destroyed - more extreme values may have occurred

[g] 10-min average

[h] Subsequent Survey Storm Surge value

[i] 15-min average

[j] Estimated

[k] Sustained wind averaging time unknown, station elevation 203 ft
[l] Sustained wind averaging time unknown, station elevation 275 ft
[m] Sustained wind averaging time unknown, station elevation 150 ft

Table 4. Selected storm rainfalls (in) from Hurricane Isabel, 6-19 September 2003.

| Location | Total | Location | Total |
|---|---|---|---|
| **Virginia** | | **North Carolina** | |
| Amelia (Amelia) | 5.50 | Croatan RAWS | 5.91 |
| Apple Orchard Mountain (Botetourt) | 8.76 | Havelock | 6.05 |
| Ash RAWS | 4.33 | Kinston (KNNN7) | 3.02 |
| Ashland (Hanover) | 5.20 | Longwood | 3.10 |
| Bent Gap (Nelson) | 6.68 | Lumberton 3 SE | 3.22 |
| Big Meadows (Madison) | 8.60 | New Bern RAWS | 5.69 |
| Big Meadows (Page) | 11.10 | Perrytown | 5.23 |
| Blackstone (Nottoway) | 7.00 | Shallotte 5W | 3.20 |
| Bowling Green (Caroline) | 4.22 | Whiteville 7NW | 4.16 |
| Bumpass (Louisa) | 5.45 | Whiteville 5S | 3.37 |
| Carson (Dinwiddie) | 6.20 | Whiteville RAWS | 5.16 |
| Cartersville (Goochland) | 4.91 | Williamston (WLLN7) | 3.45 |
| Charles City (Charles City) | 4.90 | | |
| Chester (Chesterfield) | 5.50 | **West Virginia** | |
| Chesterfield (Chesterfield) | 5.80 | Bayard (Grant) | 5.28 |
| Craigsville (Augusta) | 3.44 | Berkeley Springs (Morgan) | 3.06 |
| Crewe (Nottoway) | 5.10 | Keyser (Mineral) | 3.12 |
| Dale Enterprise (Rockingham) | 4.17 | Leak Mountain (Hampshire) | 3.72 |
| Devils Knob (Nelson) | 10.70 | Lost River (Hardy) | 5.30 |
| Emporia (Greenville) | 6.41 | Moorefield (Hardy) | 3.94 |
| Farmville (Prince Edward) | 5.00 | Petersberg (Grant) | 3.18 |
| Glen Allen (Henrico) | 5.50 | Romney (Romney) | 3.45 |
| Green Bay (Prince Edward) | 4.76 | Sugar Grove (Pendelton) | 6.10 |
| Grottoes (Rockingham) | 6.25 | Wardensville (Hardy) | 4.10 |
| Hogback Mountain (Warren) | 7.55 | | |
| Homeville (Sussex) | 7.10 | **Maryland** | |
| Hood (Madison) | 4.00 | Accident (Garrett) | 3.17 |
| Hopewell | 6.00 | Damascus (Montgomery) | 3.14 |
| Ida (Page) | 8.59 | Denton (Caroline) | 3.13 |
| Irish Gap (Rockbridge) | 6.96 | Federalsburg | 3.40 |
| James River NWR RAWS | 5.42 | Frostburg (Allegany) | 3.74 |
| Jordan's Point (Prince George) | 5.67 | Maryland City (Anne Arundel) | 3.86 |
| Lewis Mountain (Page) | 6.82 | Savage River Dam (Garrett) | 3.46 |
| Linden (Warren) | 4.23 | Steele's Neck | 3.20 |

| Location | Total | Location | Total |
|---|---|---|---|
| Long Run (Rockingham) | 7.08 | Westernport (Allegany) | 3.50 |
| Lynnwood (Rockingham) | 5.48 | | |
| Madison/Green Line (Madison) | 4.36 | **Pennsylvania** | |
| Madison (Madison) | 4.10 | Buffalo Mills | 4.10 |
| Mathews Arm (Page) | 8.40 | Cairnbrook | 3.00 |
| McDowell (Highland) | 4.76 | Mount Davis | 3.36 |
| Mechanicsville (Hanover) | 4.50 | | |
| Mills Creek Dam (Augusta) | 9.16 | | |
| Montebello 1SSE (Nelson) | 6.10 | | |
| Monterey (Highland) | 4.24 | | |
| Montpelier | 4.00 | | |
| Mustoe (Highland) | 3.20 | | |
| Nethers (Madison) | 4.23 | | |
| Newland (Richmond) | 3.50 | | |
| New Market (Shenandoah) | 4.50 | | |
| Newport News | 3.70 | | |
| Orange (Orange) | 3.42 | | |
| Paineville (Amelia) | 4.17 | | |
| Petersberg | 5.59 | | |
| Portsmouth | 4.04 | | |
| Powhatan (Powhatan) | 5.00 | | |
| Prince George (Prince George) | 6.00 | | |
| Richmond (WBBT TV) | 6.88 | | |
| Richmond (WTVR-TV) | 4.01 | | |
| Robinson Hollow (Augusta) | 7.24 | | |
| Ruther Glen (Caroline) | 4.22 | | |
| Sandston (Henrico) | 5.08 | | |
| Sherando (Augusta) | 8.32 | | |
| Short Pump (Henrico) | 3.78 | | |
| Skyland (Page) | 9.54 | | |
| Somerset (Orange) | 4.73 | | |
| Sperryville (Rappahannock) | 3.62 | | |
| Stuarts Draft (Augusta) | 6.50 | | |
| Suffolk | 4.79 | | |
| Swift Run (Rockingham) | 6.90 | | |
| The Plains (Fauquier) | 3.45 | | |

| Location | Total | Location | Total |
|---|---|---|---|
| Toano (James City) | 10.60 | | |
| Toms Branch (Augusta) | 7.12 | | |
| Upper Sherando (Augusta) | 20.20 | | |
| Urbanna (Middlesex) | 7.00 | | |
| Watkins Landing (Powhatan) | 4.00 | | |
| Waynesboro (Augusta) | 6.11 | | |
| West Point (King William) | 3.86 | | |
| Williamsburg | 4.50 | | |
| Woodstock (Shenandoah) | 3.50 | | |

Table 5. Preliminary forecast evaluation (heterogeneous sample) for Hurricane Isabel, 6-19 September 2003. Forecast errors (n mi) are followed by the number of forecasts in parentheses. Errors smaller than the NHC official forecast are shown in bold-face type. Verification includes the depression stage, but does not include the extratropical stage, if any.

| Forecast Technique | Forecast Period (h) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 12 | 24 | 36 | 48 | 72 | 96 | 120 |
| CLP5 | 32 (52) | 68 (50) | 109 (48) | 148 (46) | 231 (42) | 350 (38) | 537 (34) |
| A90E | 29 (52) | 60 (50) | 93 (48) | 144 (46) | 235 (42) | 373 (38) | 503 (34) |
| A98E | 29 (52) | 59 (50) | 92 (48) | 142 (46) | 238 (42) | 384 (38) | 492 (34) |
| A9UK | 28 (24) | 52 (23) | 70 (22) | 99 (21) | 151 (19) | | |
| LBAR | 26 (51) | 49 (49) | 75 (47) | 104 (45) | 163 (41) | 205 (37) | 227 (33) |
| BAMD | 26 (52) | 43 (50) | 66 (48) | 93 (46) | 156 (42) | 190 (38) | 236 (34) |
| BAMM | 29 (52) | 52 (50) | 79 (48) | 110 (46) | 169 (42) | 190 (38) | 223 (34) |
| BAMS | 41 (52) | 72 (50) | 101 (48) | 130 (46) | 201 (42) | 254 (38) | 300 (34) |
| COAI | **20** (27) | **35** (25) | **50** (23) | 65 (21) | 100 (17) | | |
| COAL* | 31 (14) | **38** (13) | 52 (12) | 60 (11) | 95 ( 9) | | |
| COEI | **20** (14) | 42 (14) | 65 (14) | 75 (12) | | | |
| COCE* | 22 ( 8) | **33** ( 8) | 53 ( 7) | 71 ( 6) | | | |
| AF1I | 31 (47) | 51 (45) | 78 (43) | 103 (41) | 157 (37) | | |
| AFW1* | 56 (24) | 75 (23) | 83 (22) | 105 (21) | 144 (19) | | |
| GFNI | **21** (44) | **35** (42) | **45** (40) | 63 (38) | 109 (34) | | |
| GFDN* | 24 (23) | **36** (22) | **46** (21) | **52** (20) | 97 (18) | | |
| GFDI | 26 (51) | 45 (49) | 60 (47) | 69 (43) | 97 (39) | 117 (35) | 149 (31) |
| GFDL* | 22 (50) | 39 (48) | 54 (46) | 67 (44) | 95 (40) | 111 (36) | **143** (32) |
| UKMI | 23 (49) | 41 (47) | 57 (45) | 67 (43) | 88 (39) | 111 (35) | 154 (31) |
| UKM* | 31 (25) | 47 (24) | 60 (23) | 73 (22) | 94 (20) | 119 (18) | **145** (16) |
| NGPI | **21** (52) | 39 (50) | 58 (48) | 78 (46) | 129 (42) | 192 (37) | 250 (33) |
| NGPS* | 25 (51) | **36** (49) | **50** (47) | 63 (45) | 105 (41) | 159 (37) | 215 (33) |
| AVNI | 25 (49) | 41 (47) | 58 (45) | 79 (43) | 123 (39) | 155 (35) | 204 (31) |
| AVNO* | 29 (50) | 43 (48) | 57 (46) | 75 (44) | 123 (40) | 154 (36) | 191 (32) |
| AEMI | **15** ( 8) | 39 ( 8) | 73 ( 7) | 112 ( 6) | 202 ( 3) | | |
| AEMN* | **16** ( 8) | **32** ( 7) | **49** ( 6) | 84 ( 5) | 160 ( 3) | 205 ( 1) | |
| GUNS | **18** (49) | **32** (47) | **45** (45) | **52** (43) | **72** (39) | **86** (34) | **93** (30) |
| GUNA | **19** (49) | **32** (47) | **43** (45) | **53** (43) | **75** (39) | **97** (34) | **114** (30) |
| FSSE | **18** (24) | **32** (23) | **44** (22) | **51** (21) | **72** (19) | | |
| OFCI | 24 (50) | 42 (48) | 54 (46) | 64 (44) | 85 (40) | 108 (36) | 157 (32) |
| OFCL | 22 (51) | 39 (49) | 52 (47) | 60 (45) | 80 (41) | 104 (37) | 146 (33) |
| NHC Official (1993-2002 mean) | 45 (2985) | 81 (2726) | 116 (2481) | 150 (2230) | 225 (1819) | 282 (265) | 374 (216) |

* Output from these models was unavailable at forecast time.

Table 6. Watch and warning summary for Hurricane Isabel, 6-19 September 2003.

| Date/Time (UTC) | Action | Location |
|---|---|---|
| 16/1500 | Hurricane Watch Issued | Little River Inlet, S.C. Chincoteague Virginia including Albemarle and Pamlico Sounds, the lower Chesapeake Bay south of North Beach Maryland, and the tidal Potomac. |
| 16/1500 | Tropical Storm Watch Issued | South Santee River SC to Little River Inlet, SC |
| 16/2100 | Tropical Storm Watch Issued | North of Chincoteague, VA to Little Egg Inlet, NJ including Delaware Bay. |
| 17/0300 | Hurricane Warning Issued | Cape Fear North Carolina to the North Carolina-Virginia border including Albemarle and Pamlico sounds. |
| 17/0300 | Tropical Storm Warning Issued | Little River Inlet, SC to Cape Fear, NC |
| 17/0900 | Hurricane Warning extended northward | North Carolina-Virginia border to Chincoteague including the Chesapeake Bay south of Smith Point. |
| 17/0900 | Tropical Storm Watch extended northward | Little Egg Inlet, NJ to Sandy Hook, NJ |
| 17/1500 | Hurricane Watch changed to Tropical Storm warning | South Santee River, SC to Cape Fear, NC and Chincoteague, VA to Sandy Hook, NJ including Delaware Bay and Chesapeake Bay north of Smith Point including the tidal Potomac. |
| 18/0900 | Tropical Storm warning extended eastward | Sandy Hook, NJ to Moriches Inlet, NY |
| 18/2100 | Hurricane Warning changed to Tropical Storm warning | Cape Fear, NC to Surf City, NC |
| 18/2100 | Tropical Storm warning discontinued | South Santee River, SC to Cape Fear, NC |
| 19/0100 | Hurricane Warning changed to Tropical Storm warning | Surf City, NC to Chincoteague, VA including Albemarle and Pamlico sounds and Chesapeake Bay south of Smith Point. |
| 19/0300 | Tropical Storm warning discontinued | Surf City, NC to Currituck Beach Light, NC including the Albemarle and Pamlico sounds. |
| 19/0900 | Tropical Storm warning discontinued | Currituck Beach Light, NC to Chincoteague, VA including the Chesapeake Bay south of Smith Point |
| 19/1500 | All coastal warnings discontinued | |

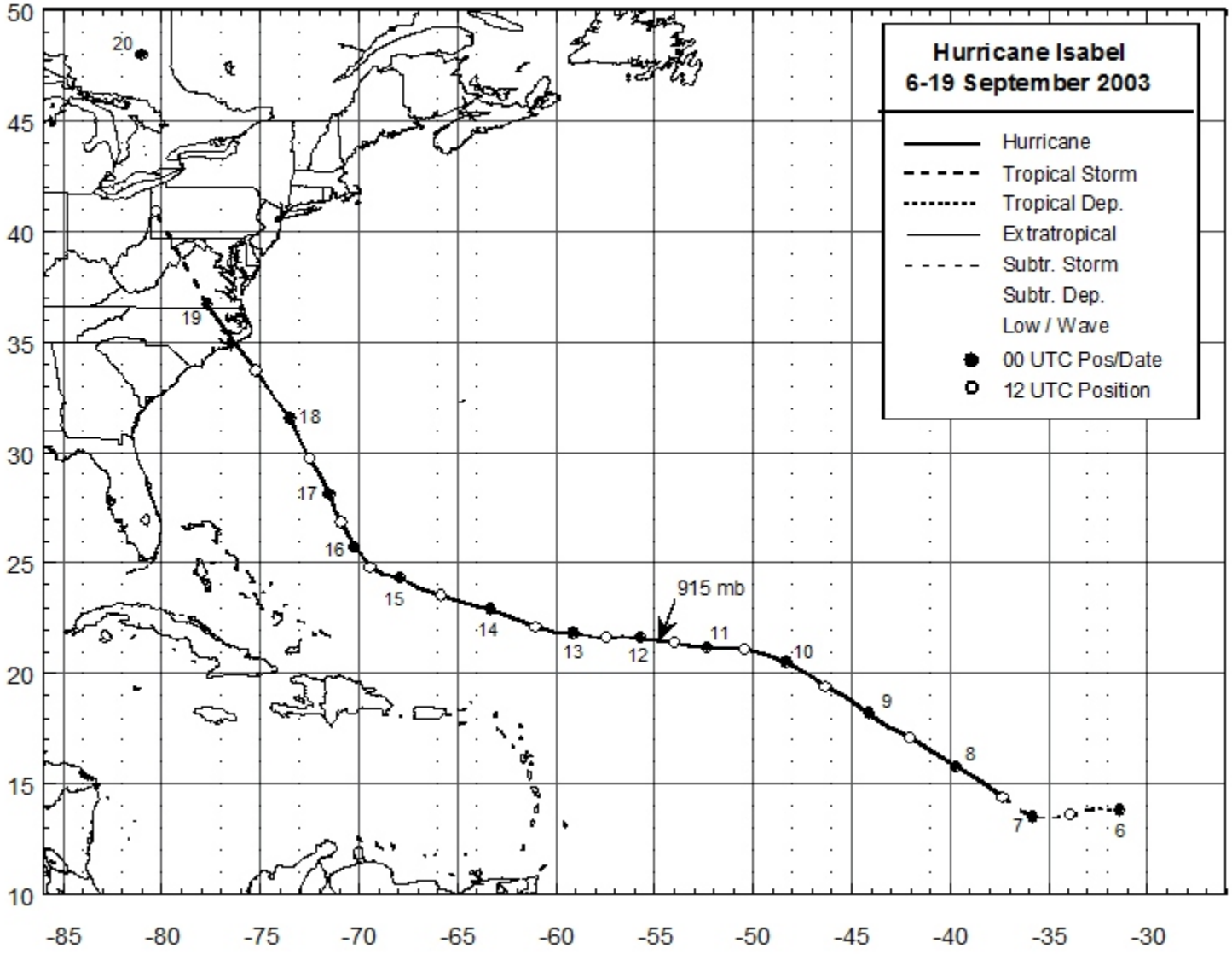


Figure 1. Best track positions for Hurricane Isabel, 6-19 September 2003.

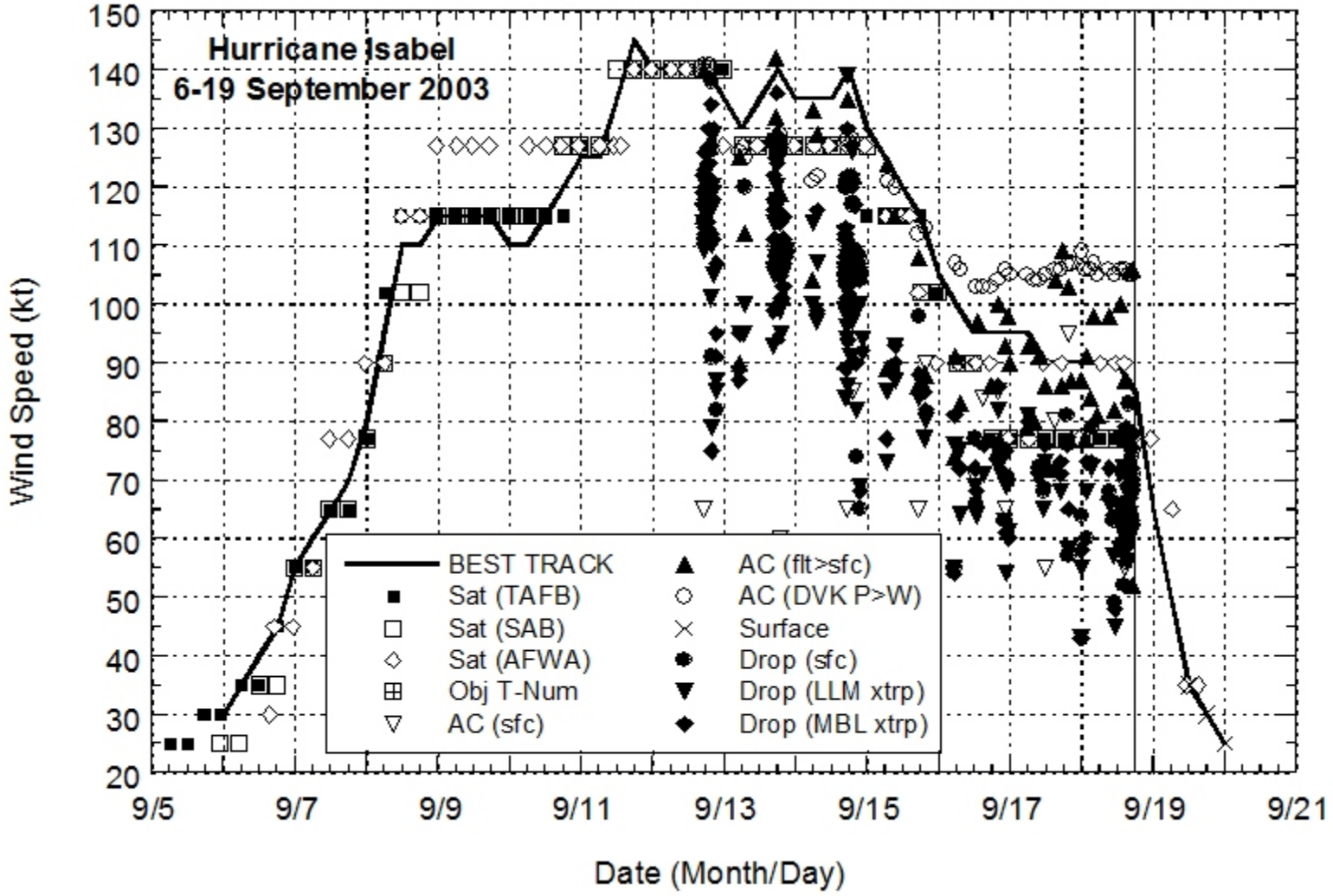


Figure 2. Selected wind estimates/observations and best track maximum sustained surface wind speed curve for Hurricane Isabel, 6-19 September 2003. Aircraft observations have been adjusted for elevation using 90% and 80% reduction factors for observations from 700 mb and 850 mb respectively. Dropwindsonde observations include actual 10 m winds (sfc), as well as surface estimates derived from the mean wind over the lowest 150 m of the wind sounding (LLM), and from the sounding boundary layer mean (MBL).

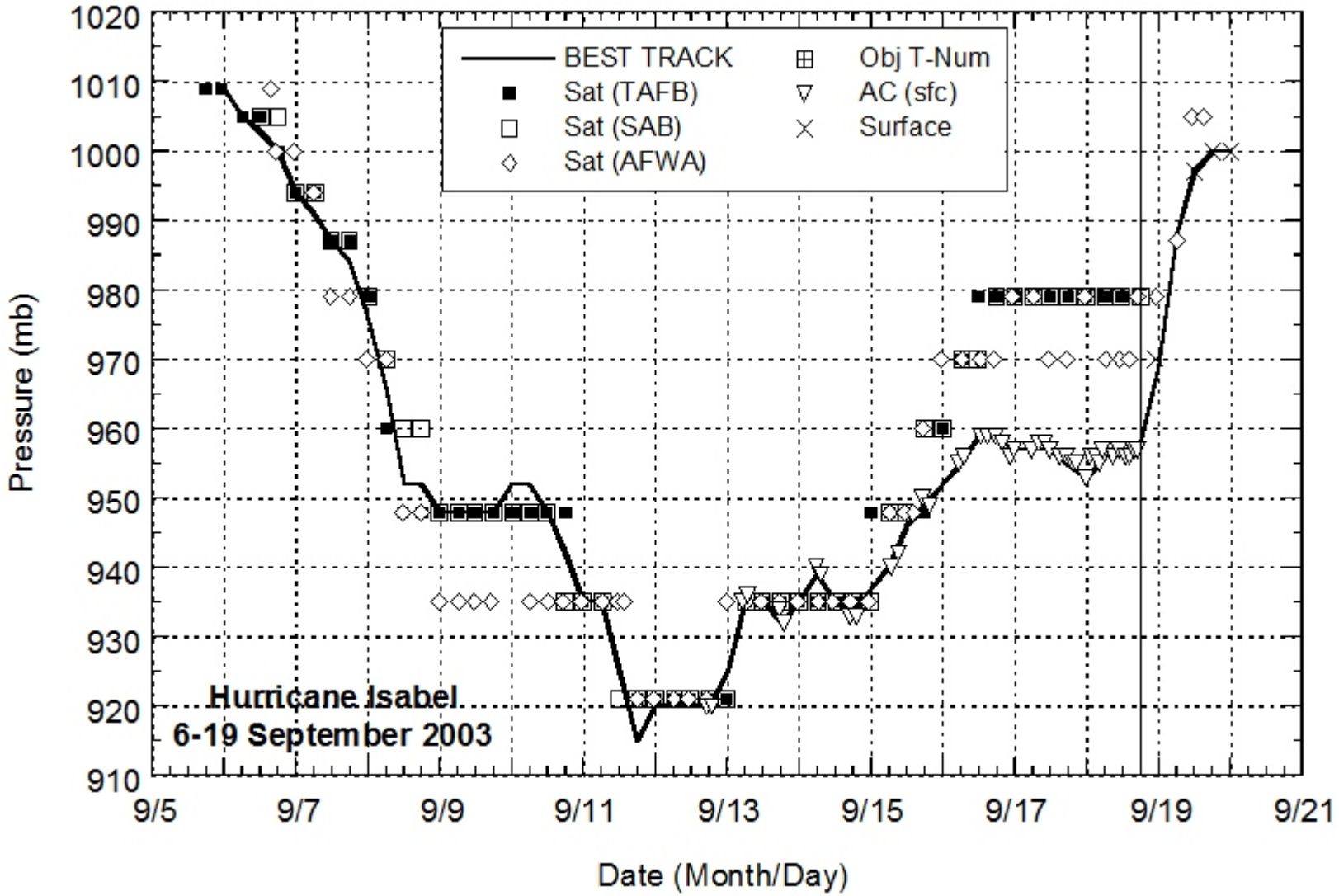


Figure 3. Selected pressure estimates/observations and best track minimum central pressure curve for Hurricane Isabel, 6-19 September 2003.