NATIONAL HURRICANE CENTER TROPICAL CYCLONE REPORT

TROPICAL STORM ARTHUR

(AL012020)

16–19 May 2020

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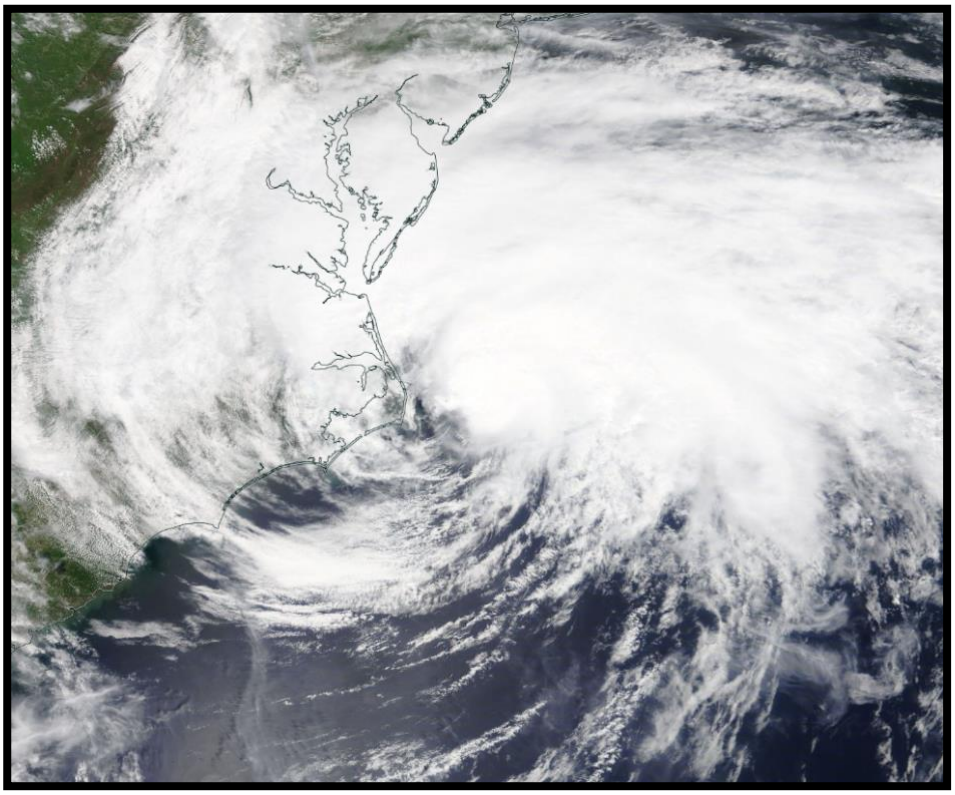
National Hurricane Center
10 September 2020



GOES-16 GEOCOLOR VISIBLE SATELLITE IMAGE OF TROPICAL STORM ARTHUR AT 1600 UTC 18 MAY 2020. IMAGE COURTESY OF NOAA/NESDIS/STAR.

Arthur was a tropical storm that passed near the Outer Banks of North Carolina before transitioning to an extratropical cyclone over the western Atlantic. Arthur's formation prior to the official start of the hurricane season marked the sixth consecutive year of at least one named storm forming prior to 1 June.

Tropical Storm Arthur

16–19 MAY 2020

SYNOPTIC HISTORY

Arthur's origins can be traced to a front that stalled over the Florida Straits around 10 May. This boundary meandered over the region for a few days while generating showers and thunderstorms. On 14 May, an upper-level trough moved into the central Gulf of Mexico and began to interact with the front, increasing the coverage of convection over the Florida Straits. By 1800 UTC 15 May, Key West Doppler radar and scatterometer data indicated that a broad area of low pressure had developed over the Florida Straits. Over the next 24 h, the low moved north-northeastward, steered around an Atlantic subtropical ridge to its east, and passed just east of the southeastern Florida coast, offshore of central Florida near the northwestern Bahamas, and over the warm waters of the Gulf Stream. By 1800 UTC May 16, satellite imagery, radar data, and surface observations indicated that the system had become sufficiently organized to be designated as a tropical depression while located about 110 n mi east of Melbourne, Florida. By 0000 UTC 17 May, an Air Force Reserve reconnaissance aircraft found that the depression had become a tropical storm while located about 165 n mi east-northeast of Cape Canaveral, Florida. 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].

Arthur's north-northeastward motion offshore of Georgia and South Carolina brought it briefly away from the Gulf Stream, which resulted in little change in intensity through 17 May. Once the storm moved back over the warmer Gulf Stream by 18 May, vertical wind shear was on the increase, and Arthur strengthened only slightly before nearing the North Carolina Outer Banks. Arthur made its closest approach to land as a tropical cyclone when its center passed about 20 n mi east-southeast of Cape Hatteras, North Carolina, on 18 May (cover photo). Arthur turned northeastward around the northwestern periphery of the Atlantic ridge as it passed by North Carolina, and strengthened a little more early on 19 May, reaching its peak intensity of 50 kt as a tropical cyclone. At that same time, the storm began to interact with a frontal boundary to its north and transitioned to an extratropical cyclone and turned eastward by 1200 UTC 19 May while located about 350 n mi east-northeast of Cape Hatteras. The extratropical cyclone turned toward the southeast on 20 May as the mid- to upper-level trough associated with the cold front bypassed the cyclone to the north and imparted a northwesterly steering flow, and the system produced gale-force winds on Bermuda before it dissipated early on 21 May near that island.

[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.

METEOROLOGICAL STATISTICS

Observations in Arthur (Figs. 2 and 3) include subjective satellite-based Dvorak and Hebert-Poteat technique intensity estimates from the Tropical Analysis and Forecast Branch (TAFB) and objective Advanced Dvorak Technique (ADT) estimates and Satellite Consensus (SATCON) estimates from the Cooperative Institute for Meteorological Satellite Studies/University of Wisconsin-Madison. Observations also include flight-level, stepped frequency microwave radiometer (SFMR), and dropwindsonde observations from five flights (14 center fixes) by the 53rd Weather Reconnaissance Squadron of the U.S. Air Force Reserve. 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 Arthur. The National Weather Service WSR-88D radar network provided data for tracking Arthur while it was near the eastern United States.

Selected surface observations from land stations and data buoys are given in Table 2.

Winds and Pressure

An Air Force Reserve reconnaissance aircraft investigating the system early on 17 May found maximum 925-mb flight-level winds of 45 kt to the southeast and east of the center, which equated to surface winds of about 35 kt. The aircraft also reported SFMR surface wind speeds of 33–36 kt. Arthur's estimated peak intensity of 50 kt as a tropical cyclone is based on a 0129 UTC 19 May ASCAT-B overpass that revealed several 50-kt wind vectors in the northwestern quadrant.

The minimum pressure reported on land was 999 mb at 1457 UTC at Kite's Resort, North Carolina. The minimum pressure reported by aircraft was 993 mb at 1636 UTC 18 May, when the system was near the North Carolina coast. The minimum central pressure of Arthur decreased further after the last reconnaissance flight, while the winds speeds briefly increased to 55 kt as the cyclone became extratropical and the wind field expanded.

As the center of Arthur passed near the Outer Banks of North Carolina, the cyclone produced peak sustained winds of 34 kt at a Weatherflow station on Alligator River Bridge (station id XALI) at 1635 UTC 18 May. Several other wind gusts to tropical storm force were reported over the Outer Banks and at offshore buoys in the region.

Prior to formation, the precursor disturbance that became Arthur produced thunderstorms that resulted in several tropical-storm-force wind gusts across southeastern Florida and the Florida Keys from 14 to 16 May.

Rainfall and Flooding

Prior to genesis, the interaction of Arthur's precursor disturbance with the upper trough to its west produced heavy rainfall across the Florida Keys, southeast Florida, and Cuba. The daily rainfall record for 14 May was set in Marathon, Florida, as that location received 5.76 inches of rainfall, with a storm total of 9.95 inches reported in the eastern portion of the island. The rainfall during this time period produced minor urban flooding in southeastern Florida and in Bayamo, Granma in Cuba. Notable rainfall totals (Fig. 5) in southeast Florida for the period of May 15–16

include 8.04 inches at Ft. Lauderdale Executive Airport (KFXE) and 5.99 inches at Miami-Opa Locka Executive Airport (KOPF), while in Cuba there was a report of 3.03 inches on 15 May in the municipality of Bayamo. When Arthur moved near eastern North Carolina, it produced a swath of 3 to 5 inches of rainfall primarily across Carteret, Craven, Pamlico, and Onslow Counties, with the highest reported total of 5.01 inches at a RAWS station in Croatan in Craven County (Fig. 5). There were no reports of flooding due to the rainfall in North Carolina.

Storm Surge[2]

Minor storm surge occurred from Cape Hatteras to the southeastern Virginia coast as Tropical Storm Arthur passed by to the east. The highest water level relative to Mean Higher High Water (MHHW) recorded was 1.47 feet at 2248 UTC 18 May from a National Ocean Service (NOS) station located at Chesapeake Channel at the opening to Chesapeake Bay in Virginia. In North Carolina, the peak water level recorded was 1.19 ft. MHHW at 2148 UTC 18 May at a NOS station in Duck. North Carolina Emergency Management reported that standing water due to overwash closed a highway on the Outer Banks and another on the mainland. Other secondary roads flooded as well.

CASUALTY AND DAMAGE STATISTICS

There were no known fatalities associated with Arthur.

Enhanced flow around the circulation of Arthur produced rip currents across portions of the southeastern United States coast. On 17 May in Volusia County, Florida, there were 70 water rescues due to these rip currents. Three of the people rescued were hospitalized.

On Grand Bahama Island, squalls caused minor damage to tents and temporary shelters setup for Hurricane Dorian relief efforts. In North Carolina, no damage was reported.

FORECAST AND WARNING CRITIQUE

Genesis

The genesis of Arthur was well anticipated, especially for an out-of-season tropical cyclone. Since Arthur formed before the start of the hurricane season, Special Tropical Weather

[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).

Outlooks (TWO) were issued to communicate the potential for tropical cyclone formation. The first TWO was issued 100 h prior to genesis, introducing a medium (40–60%) chance for formation within the next 5 days (Table 3). The 5-day genesis probabilities were increased into the high category (>60%) 91 h before formation occurred. The TWO first mentioned the possibility for development within 2 days 67 h prior to genesis when it was placed in the low (<40% category). The probabilities for genesis within 2-days were increased to the medium and high categories 54 h and 48 h prior to formation, respectively.

Track

A verification of NHC official track forecasts for Arthur is given in Table 4a. Official track forecast errors were lower than the mean official errors for the previous 5-yr period for all verifying forecast times. In fact, the NHC mean track errors were over 50 percent lower than the long-term average errors at 36 and 48 h. The climatology and persistence errors (OCD5) were also well below their 5-yr means beyond 24 h, indicating that Arthur's track was easier to predict than average at those lead times. A homogeneous comparison of the official track errors with selected guidance models is given in Table 4b. The best-performing model was the corrected consensus aid HCCA, which beat the official NHC forecasts at all verifying times. Most models performed better than the official NHC forecasts at 12 and 24 h, while the official forecasts beat most of the models and 36 and 48 h.

Intensity

A verification of NHC official intensity forecasts for Arthur is given in Table 5a. Official intensity forecast errors were well below the mean official errors for the previous 5-yr period for all verifying forecast times. The NHC mean intensity errors were 0 kt at 36 and 60 h, although the sample size at 60 h is small. The OCD5 errors were close to their 5-yr means, indicating that Arthur's intensity was of about average difficultly to predict. A homogeneous comparison of the official track errors with selected guidance models is given in Table 5b. The NHC forecasts performed better than all models at every verifying time except 24 h. It should be noted that several of the models had errors lower than 5 kt for most forecast times, which helped contribute to the good performance of the official NHC forecasts.

Watches and Warnings

A Tropical Storm Watch was issued at 2100 UTC 16 May for portions of the North Carolina coast (Table 6), about 32 hours before tropical storm force conditions arrived there. These watches were upgraded to Tropical Storm Warnings 12 h later.

Table 1. Best track for Tropical Storm Arthur, 16–19 May 2020.

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
16 / 1800	28.0	78.7	1008	30	tropical depression
17 / 0000	28.9	78.0	1006	35	tropical storm
17 / 0600	29.6	77.6	1004	35	"
17 / 1200	30.3	77.5	1003	35	"
17 / 1800	31.0	77.3	1003	40	"
18 / 0000	31.9	77.0	1003	40	"
18 / 0600	33.1	76.7	1002	40	"
18 / 1200	34.4	75.9	1000	45	"
18 / 1800	35.5	74.7	993	45	"
19 / 0000	36.2	73.1	991	50	"
19 / 0600	36.8	71.4	990	50	"
19 / 1200	37.0	69.5	989	55	extratropical
19 / 1800	36.9	67.8	991	50	"
20 / 0000	36.2	66.8	993	50	"
20 / 0600	35.5	66.0	997	50	"
20 / 1200	34.6	65.6	1002	50	"
20 / 1800	33.7	65.3	1006	45	"
21 / 0000	32.8	65.0	1008	40	"
21 / 0600					dissipated
19 / 0600	36.8	71.4	990	50	minimum pressure and maximum winds

Table 2. Selected surface observations for Tropical Storm Arthur, 16–19 May 2020.

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)				
North Carolina									
International Civil Aviation Organization (ICAO) Sites									
Cherry Point Marine Corps AS (KNKT) (34.90N 76.88W)	18/1157	1006.4	18/0654	21 (2 min, 10 m)	37				
Weatherflow Sites									
Alligator River Bridge (XALI) (35.90N 76.01W)	18/1700	1006.1	18/1635	34 (6 min, 11m)	40				
Avon Ocean (XAVO) (35.35N 75.50W)	18/1517	999.3	18/1457	29 (9 min, 11 m)	36				
Avon Sound (XAVN) (35.37N 75.51W)	18/1520	1000.8	18/1805	30 (6 min, 4 m)	38				
Buxton (XBUX) (35.26N 75.59W)	18/1442	999.5	18/1357	27 (4 min, 10 m)	34				
Jennettes Pier-Nags Head (XJNP) (35.91N 75.59W)	18/1811	1002.0	18/1751	32 (3 min, 18 m)	37				
Kites Resort (XKHK) (35.58N 75.47W)	18/1547	999.1	18/2142	33 (1 min, 16 m)	39				
Oregon Inlet CG (XORE) (35.77N 75.53W)	18/1704	1001.7	18/1709	30 (4 min, 10 m)	37				
Pamlico Sound (XPM2) (35.42N 75.83W)	18/1620	1002.5	18/0850	31 (1 min, 13 m)	36				
Real Slick Waves (XSLK) (35.57N 75.48W)	18/1657	1001.6	18/1727	30 (1 min, 6 m)	36				
Waves (XWAV) (35.57N 75.49W)	18/1650	999.8	18/2140	30 (7 min, 10 m)	38				
National Ocean Service (NOS) Sites									
Duck Tide Gauge (DUKN7) (36.18N 75.75W)	18/1706	1005.7	18/1348	33[f]	39	1.66		1.19	
USCG Station Hatteras (HCGN7) (35.21N 75.70W)						1.41		0.94	

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)				
RAWS Sites									
1 SW Oriental (ORLN7) (35.02N 76.69W)									4.38
Croatan (NPTN7) (34.76N 76.90W)									5.01
Newport (MHXN7) (34.78N 76.88W)									4.37
CWOP Sites									
Beaufort (EW5187) (34.79N 76.67W)									4.02
Newport (EW5742) (34.78N 76.90W)									4.24
Community Collaborative Rain, Hail and Snow Network (CoCoRaHS) Sites									
3 W Newport (NC-CR-33) (34.78N 76.90W)									4.83
1 NE Cape Carteret (NC-CR-109) (34.70N 77.05W)									4.73
2 NE Cape Carteret (NC-CR-146) (34.71N 77.04W)									4.73
1 S Ocean (NC-CR-28) (34.71N 76.99W)									4.70
0 SW Newport (NC-CR-1) (34.79N 76.86W)									4.61
2 SSE Newport (NC-CR-53) (34.76N 76.85W)									4.13
2 WSW Emerald Isle (NC-CR-49) (34.65N 77.07W)									4.11
4 SW Swansboro (NC-ON-114) (34.65N 77.18W)									4.08
1 N Swansboro (NC-ON-86) (34.71N 77.13W)									4.07
Virginia									

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)				
NOS Sites									
Chesapeake Channel (CHBV2) (37.03N 76.08W)						1.89		1.47	
Money Point (MNPV2) (36.78N 76.30W)						1.73		1.21	
Sewells Point (MNPV2) (36.95N 76.33W)						1.62		1.22	
Yorktown USCG Training Center (YKTV2) (37.23N 76.48W)						1.35		1.05	
Bermuda									
AWOS Sites									
Pearl Island (32.29N 64.84W)			21/0453	39	55				
NCDC Offshore Buoys									
30 SE Onslow Bay (41064) 34.21N 76.95W)	18/0908	1004.1	18/1308	24	35				
Diamond Shoals (41025) (35.01N 75.40W)	18/1440	997.8	18/1246	37 (1 min, 4 m)	43				
East Hatteras (41001) (34.72N 72.33W)	18/2250	1007.1	18/2324	31 (1 min, 4 m)	37				
Virginia Beach (44014) (36.60N 74.83W)	18/2220	1003.0	18/2008	33 (1 min, 3 m)	41				

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

Table 3. Number of hours in advance of formation associated with the first NHC Special 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%)	67	-
Medium (40%-60%)	54	100
High (>60%)	48	91

Table 4a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) track forecast errors (n mi) for Tropical Storm Arthur, 16–19 May 2020. Mean errors for the previous 5-yr period are shown for comparison. Official errors that are smaller than the 5-yr means are shown in boldface type.

	Forecast Period (h)							
	12	24	36	48	60	72	96	120
OFCL	**17.4**	**24.6**	**17.4**	**17.6**	**46.8**			
OCD5	51.3	95.8	107.6	71.9	57.1			
Forecasts	9	7	5	3	1	0	0	0
OFCL (2015-19)	24.1	36.9	49.6	65.1	80.7	96.3	133.2	171.6
OCD5 (2015-19)	44.7	96.1	156.3	217.4	273.9	330.3	431.5	511.9

Table 4b. Homogeneous comparison of selected track forecast guidance models (in n mi) for Tropical Storm Arthur, 16–19 May 2020. Errors smaller than the NHC official forecast are shown in boldface type. The number of official forecasts shown here will generally be smaller than that shown in Table 4a due to the homogeneity requirement.

Model ID	Forecast Period (h)							
	12	24	36	48	60	72	96	120
OFCL	18.0	22.9	11.9	24.0	46.8			
OCD5	46.3	93.2	101.7	56.7	57.1			
TABS	40.7	66.4	90.9	152.0	209.3			
TABM	25.4	32.7	51.2	56.2	88.7			
TABD	28.5	58.9	105.0	115.8	127.2			
TVDG	**15.8**	**15.7**	12.2	**21.7**	**34.1**			
TVCE	**15.2**	**15.5**	13.9	32.7	48.4			
TVCA	**14.6**	**15.1**	12.6	27.2	49.5			
GFEX	**16.1**	**13.3**	16.6	**22.7**	46.8			
TVCX	**15.0**	**14.8**	15.1	27.0	**33.6**			
HCCA	**13.8**	**11.7**	**11.7**	**13.4**	**24.5**			
CTCI	**12.0**	**16.6**	23.4	27.1	**43.2**			
CMCI	**16.5**	27.7	30.1	28.9	**38.4**			
EMXI	**17.4**	26.8	36.2	48.4	57.4			
EGRI	20.3	25.5	26.7	38.3	56.8			
HWFI	**16.5**	**20.9**	59.4	105.0	163.6			
HMNI	**16.8**	24.5	34.8	65.5	73.2			
GFSI	**16.1**	**14.8**	41.3	59.8	138.0			
Forecasts	7	6	4	2	1	0	0	0

Table 5a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) intensity forecast errors (kt) for Tropical Storm Arthur, 16–19 May 2020. Mean errors for the previous 5-yr period are shown for comparison. Official errors that are smaller than the 5-yr means are shown in boldface type.

	Forecast Period (h)							
	12	24	36	48	60	72	96	120
OFCL	**1.1**	**3.6**	**0.0**	**1.7**	**0.0**			
OCD5	5.4	10.1	13.6	17.7	20.0			
Forecasts	9	7	5	3	1	0	0	0
(AL) OFCL (2015-19)	5.2	7.7	9.4	10.7	11.9	13.0	14.4	15.5
(AL) OCD5 (2015-19)	6.8	10.8	14.1	17.0	18.8	20.6	22.5	24.6

Table 5b. Homogeneous comparison of selected intensity forecast guidance models (in kt) for Tropical Storm Arthur, 16–19 May 2020. Errors smaller than the NHC official forecast are shown in boldface type. The number of official forecasts shown here will generally be smaller than that shown in Table 5a due to the homogeneity requirement.

Model ID	Forecast Period (h)							
	12	24	36	48	60	72	96	120
OFCL	1.4	4.2	0.0	0.0	0.0			
OCD5	5.7	10.0	12.2	14.5	20.0			
IVDR	3.0	**3.0**	1.8	1.0	2.0			
IVCN	3.0	**3.5**	2.0	2.0	3.0			
ICON	3.6	**3.8**	1.8	0.5	2.0			
LGEM	4.6	5.5	2.2	1.5	2.0			
DSHP	4.1	**3.7**	1.8	3.5	6.0			
HCCA	2.9	**3.5**	5.8	5.5	7.0			
CTCI	3.4	**3.3**	3.0	5.0	7.0			
CMCI	4.0	4.2	4.8	6.5	5.0			
EMXI	5.3	5.3	7.8	8.0	10.0			
EGRI	3.4	**2.7**	3.8	5.0	4.0			
HWFI	3.0	**3.0**	2.5	2.5	1.0			
HMNI	3.6	5.2	5.2	3.0	0.0			
GFSI	4.7	4.8	3.5	5.0	7.0			
Forecasts	7	6	4	2	1	0	0	0

Table 6. Watch and warning summary for Tropical Storm Arthur, 16–19 May 2020.

Date/Time (UTC)	Action	Location
16/2100	Tropical Storm Watch issued	Surf City to Duck
16/2100	Tropical Storm Watch issued	Pamlico and Albemarle Sounds
17/0900	Tropical Storm Watch changed to Tropical Storm Warning	Surf City to Duck
17/0900	Tropical Storm Watch changed to Tropical Storm Warning	Pamlico and Albemarle Sounds
18/1800	Tropical Storm Warning discontinued	Surf City to Ocracoke Inlet
18/2100	Tropical Storm Warning discontinued	All

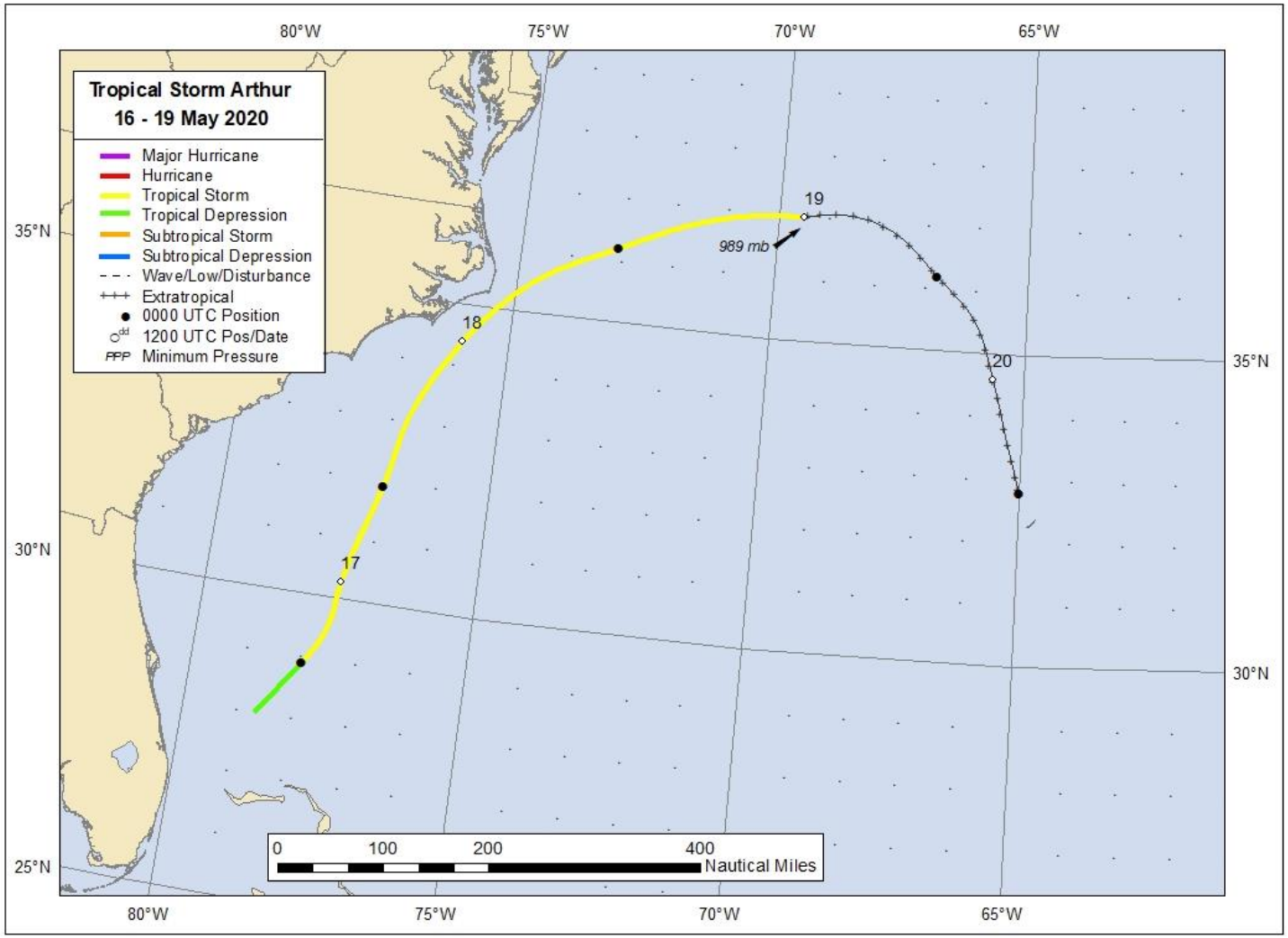


Figure 1. Best track positions for Tropical Storm Arthur, 16–19 May 2020

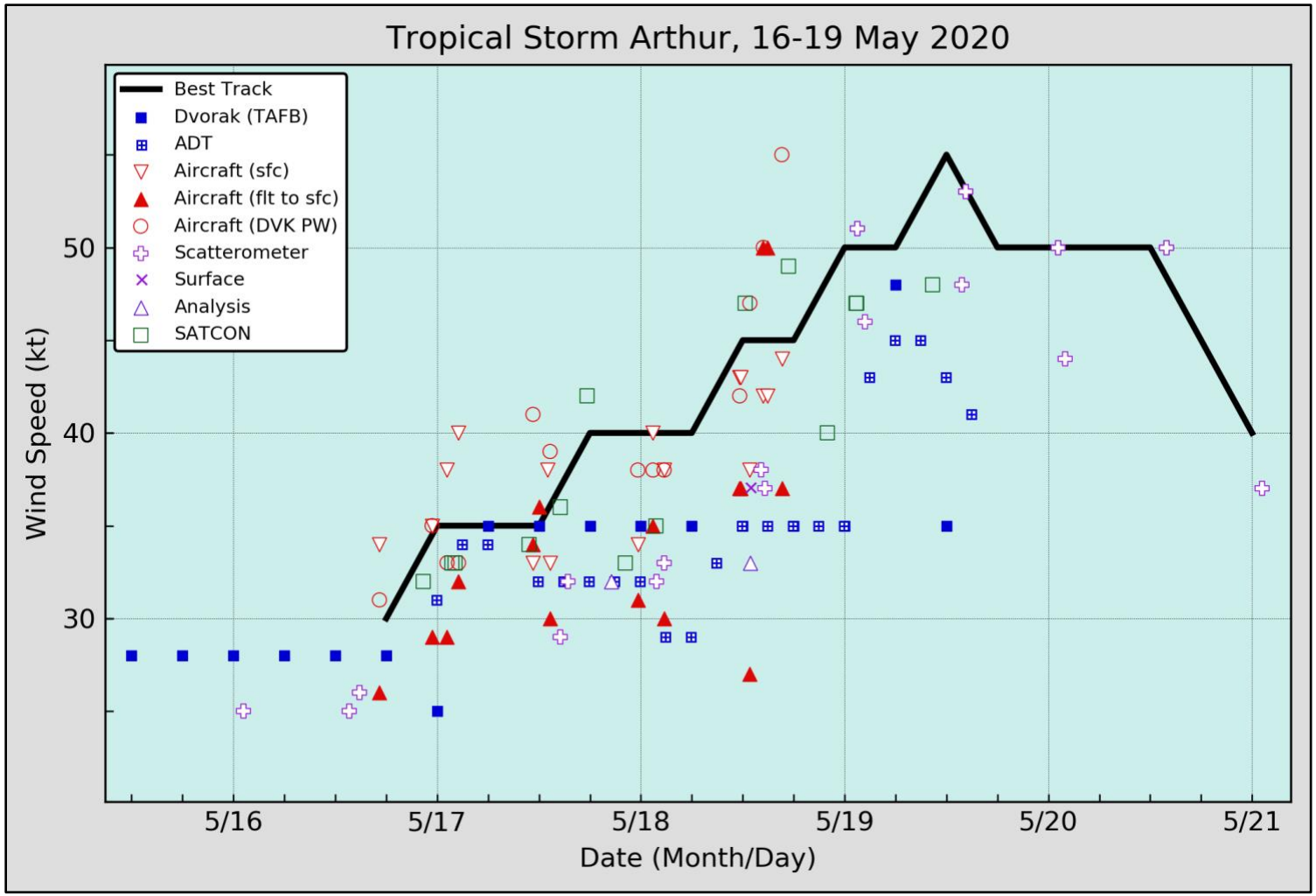


Figure 2. Selected wind observations and best track maximum sustained surface wind speed curve for Tropical Storm Arthur, 16–19 May 2020. Advanced Dvorak Technique estimates represent the Current Intensity at the nominal observation time. SATCON intensity estimates are from the Cooperative Institute for Meteorological Satellite Studies. 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. Dashed vertical lines correspond to 0000 UTC.

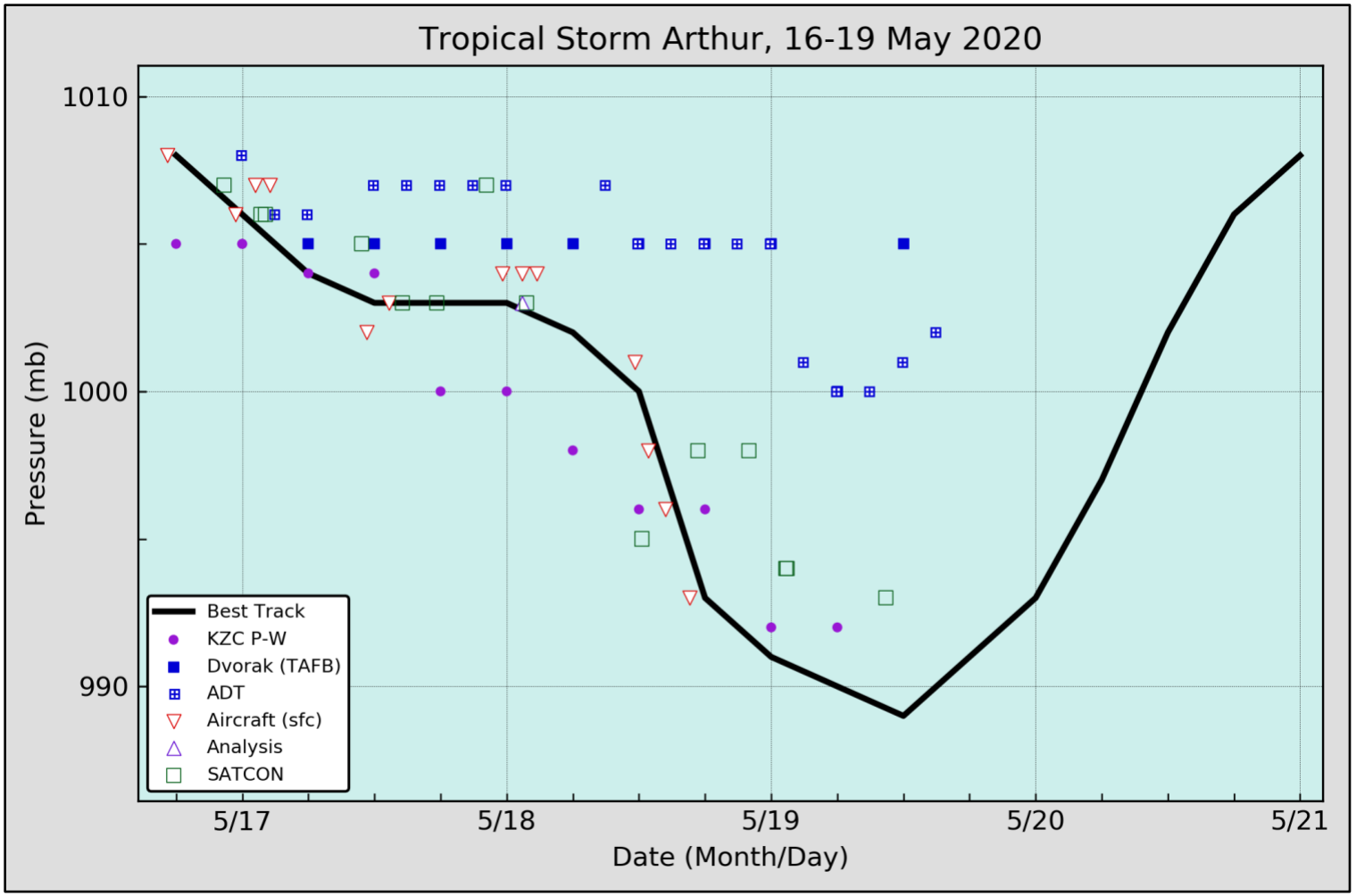


Figure 3. Selected pressure observations and best track minimum central pressure curve for Tropical Storm Arthur, 16–19 May 2020. Advanced Dvorak Technique estimates represent the Current Intensity at the nominal observation time. SATCON intensity estimates are from the Cooperative Institute for Meteorological 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.

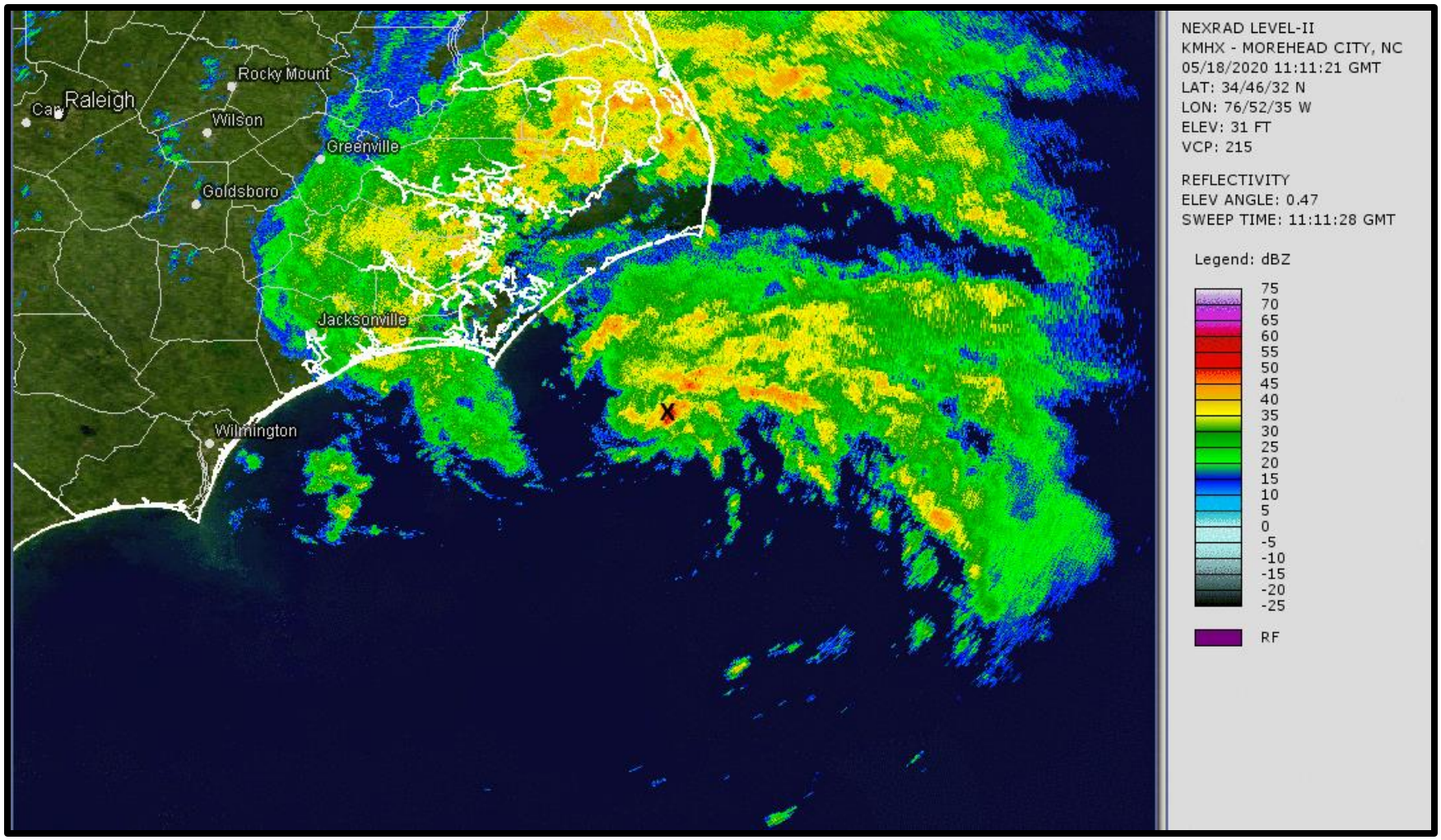


Figure 4. WSR-88D base reflectivity image from KMHX, Morehead City, NC, at 1111 UTC 18 May 2020 showing Tropical Storm Arthur as it produced heavy rainfall over portions of eastern North Carolina. The black 'X' depicts the estimated center position. Image Courtesy of Brian McNoldy of the Rosenstiel School of Marine and Atmospheric Science at the University of Miami.

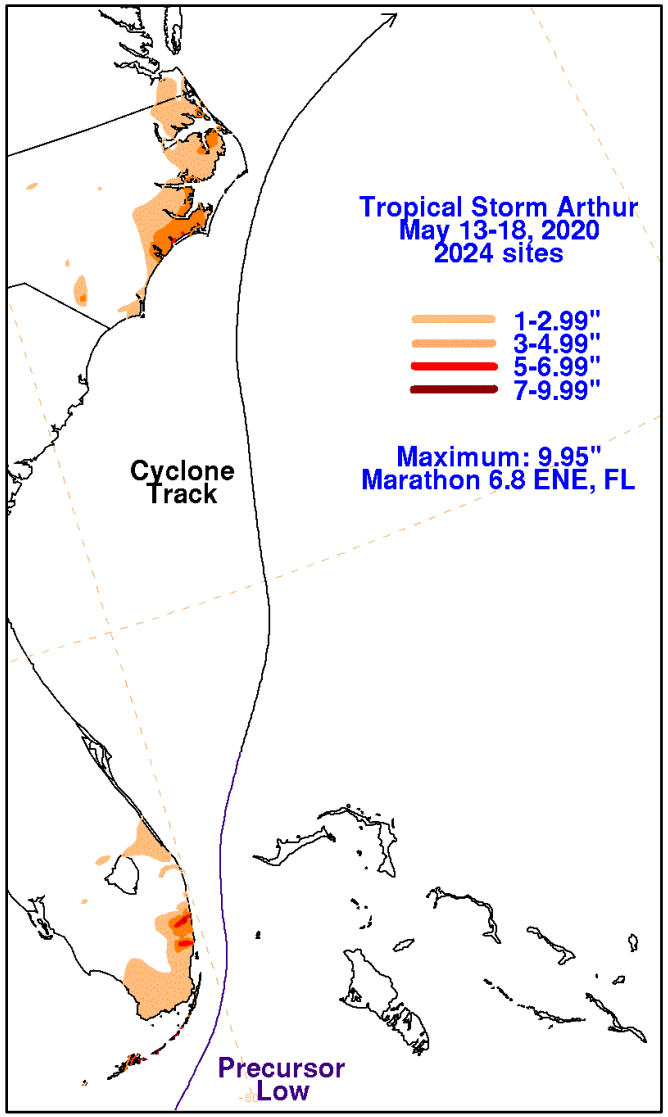


Figure 5. Tropical Storm Arthur, including its precursor disturbance, total rainfall map (inches) over the U.S. compiled from 2,024 rain gauges from 13–18 May 2020. Image courtesy of the NOAA Weather Prediction Center.