

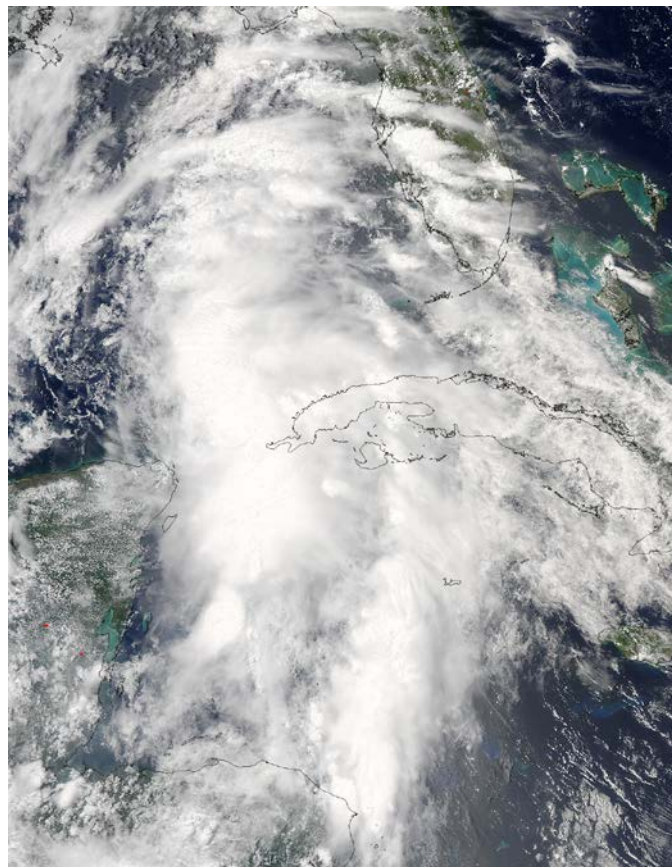


# NATIONAL HURRICANE CENTER TROPICAL CYCLONE REPORT

## TROPICAL STORM COLIN (AL032016)

5 – 7 June 2016

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MODIS SATELLITE IMAGE OF TROPICAL STORM COLIN OVER THE SOUTHERN GULF OF MEXICO AT 1845 UTC 5 JUNE 2016. IMAGE COURTESY OF NASA.

Colin was a short-lived, poorly organized tropical storm that produced heavy rains over portions of northern and central Florida. It was the earliest third tropical storm of the Atlantic season on record.

# Tropical Storm Colin

5 – 7 JUNE 2016

## SYNOPTIC HISTORY

Colin originated from a tropical wave that moved off the west coast of Africa on 27 May. The wave moved westward across the tropical Atlantic and entered the Caribbean Sea on 1 June, and the associated deep convection began to increase on 3 June. By 4 June, when the wave was in the western Caribbean, there was an increase in the organization of the convection, with some curved banding features becoming evident. By late on 4 June, a broad area of low pressure had formed near the east coast of the Yucatan Peninsula. The system moved northwestward to north-northwestward, and by 1200 UTC 5 June the system had acquired enough of a closed circulation and organized deep convection to designate the formation of a tropical depression, centered near the north coast of the Yucatan Peninsula. About 6 h later, while moving into the southern Gulf of Mexico, the cyclone strengthened into a tropical storm. The “best track” chart of Colin’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<sup>1</sup>.

During all of its relatively brief lifetime, Colin never became a well-organized tropical cyclone. Strong shear displaced most of the associated deep convection well east of the storm’s center, and the strongest winds were also located well to the east of the center, near the Florida Gulf coast. Colin moved generally northward, to the east of a mid-level trough over the northwestern Gulf of Mexico, for a day or two. Despite the strong shear, the storm strengthened to its peak intensity of 45 kt by 1200 UTC 6 June while located over the eastern Gulf of Mexico. A broad mid-level trough moved into the eastern United States, causing Colin to turn toward the northeast and accelerate late on 6 June and early on 7 June. The center of the cyclone made landfall in the Big Bend area of northern Florida near Keaton Beach around 0200 UTC 7 June, while the storm’s maximum winds were still near 45 kt. All of the significant weather associated with the storm preceded the landfall of the center, however. Colin moved over northern Florida and extreme southeastern Georgia, the center emerging over the Atlantic later that day. Moving roughly parallel to the coasts of the Carolinas, the storm became a frontal low around 1200 UTC 7 June. The extratropical cyclone, with winds near 50 kt, moved rapidly northeastward to east-northeastward over the Atlantic well offshore of the northeastern United States coast through 8 June, and the system merged with another extratropical low near Atlantic Canada by 9 June.

## METEOROLOGICAL STATISTICS

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<sup>1</sup> 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 *bt*k directory, while previous years’ data are located in the *archive* directory.

Observations in Colin (Figs. 2 and 3) include subjective satellite-based Dvorak technique intensity estimates from the Tropical Analysis and Forecast Branch (TAFB) and the Satellite Analysis Branch (SAB), and objective Advanced Dvorak Technique (ADT) 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 flights of the 53<sup>rd</sup> Weather Reconnaissance Squadron of the U. S. Air Force Reserve Command. 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 Colin.

Although it is unusual for the intensity of a tropical cyclone to be determined from surface measurements, in this case the system's wind field was so broad that its highest winds could be sampled from synoptic data. These data, over the northeastern Gulf of Mexico and northern Florida, indicate that the cyclone's estimated maximum intensity was 45 kt and its minimum central pressure was 1001 mb. It should be noted that the pressure estimates derived using the Knaff-Zehr-Courtney pressure-wind relationships shown in Fig. 3 had a low bias compared to *in situ* pressure measurements, apparently due to the unusually large and asymmetric tropical-storm-force wind field of this storm.

Selected surface observations from land stations and data buoys are given in Table 2; note that this table only includes rainfall totals of 4 inches or greater. Ship reports of winds of tropical storm force associated with Colin are given in Table 3.

## Winds and Pressure

A wind gust of 57 kt was observed at an elevation of 16 m at the Kennedy Space Center at 2155 UTC 6 June. A sustained wind of 47 kt with a gust to 53 kt at an elevation of 16 m was measured at the Skyway Fishing Pier at the mouth of Tampa Bay at 2015 UTC 6 June. A minimum pressure of 1001.7 mb was measured at NDBC buoy 42036 at 1950 UTC 6 June over the extreme northeastern Gulf of Mexico 112 n mi west of Tampa, FL.

## Storm Surge<sup>2</sup>

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<sup>2</sup> 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).

Highest storm surge inundations were generally less than 3 ft from Apalachicola to the Tampa Bay area, but there was one inundation observation of 3.6 ft above MHHW at Cedar Key. There was also some minor coastal flooding in northeast Florida, Georgia, South Carolina, and North Carolina.

### **Rainfall and Flooding**

Colin produced locally heavy rainfall over northern and central Florida. A few regions saw totals in excess of 10 inches, and a peak value of 17.54 inches was reported near Seminole in Pinellas County. There was localized flooding in the Tampa Bay area, which prompted some evacuations, but overall damage was minimal. Some flooding, mainly of roads, was also reported at other locations in northern Florida. Figure 4 shows the overall rainfall distribution from Colin.

### **Tornadoes**

There was one confirmed tornado associated with Colin, an EF-1 (on the Enhanced Fujita scale) in Duval County Florida, about 3 miles west-northwest of Jacksonville Heights. This tornado snapped trees, caused some roof damage, and flipped over three trucks.

## **CASUALTY AND DAMAGE STATISTICS**

There were no direct deaths caused by Colin while it was a tropical cyclone. Although two persons drowned in Camden County, Georgia, while the storm was over the south-central Gulf of Mexico, Colin was too far away to have produced hazardous conditions along the Georgia coast at the time. Also, there were 3 drownings in rip currents along the Florida panhandle that occurred after Colin became a post-tropical cyclone. There was a report of \$10,000 in damage in Pinellas County, Florida. No other amounts are known, but the overall damage due to Colin appears to be minor.

## **FORECAST AND WARNING CRITIQUE**

The genesis of Colin was not well anticipated until about a day or so in advance of the event (Table 4). It was first mentioned in the Tropical Weather Outlook (TWO), 90 h prior to genesis, that an area of low pressure might form over the southern Gulf of Mexico with a 5-day probability in the “low” category. The 5-day genesis probability was raised to medium 66 h before genesis, and a 2-day genesis probability was introduced in the TWO, in the low category, 48 h prior to formation. The 5-day genesis probability was raised to high 36 h before formation, and the 2-day probability was raised to medium 30 h before genesis and to high just 24 h prior to formation.



A verification of NHC official track forecasts for Colin is given in Table 5a, and a homogeneous comparison of the official track errors with selected guidance models is given in Table 5b. A verification of NHC official intensity forecasts for Colin is given in Table 6a, and a homogeneous comparison of the official intensity errors with selected guidance models is given in Table 6b. There were too few cases in these samples for much in the way of meaningful conclusions to be drawn. It is worth noting, however, that the NHC forecasts correctly indicated that Colin would not strengthen significantly.

Watches and warnings associated with Colin are given in Table 7.



Table 1. Best track for Tropical Storm Colin, 5-7 June 2016.

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
05 / 1200	21.6	88.0	1005	30	tropical depression
05 / 1800	22.4	87.9	1005	35	tropical storm
06 / 0000	23.2	87.8	1003	35	"
06 / 0600	24.6	87.6	1004	40	"
06 / 1200	26.4	87.3	1004	45	"
06 / 1800	28.1	86.1	1003	45	"
07 / 0000	29.4	84.3	1001	45	"
07 / 0600	30.7	82.1	1003	45	"
07 / 1200	33.2	78.5	1000	45	extratropical
07 / 1800	35.5	74.4	996	50	"
08 / 0000	38.0	70.0	994	50	"
08 / 0600	40.0	65.0	992	50	"
08 / 1200	41.0	61.0	988	50	"
08 / 1800	43.0	58.0	987	45	"
09 / 0000					Merged with another extratropical low
07 / 0000	29.4	84.3	1001	45	Maximum winds and minimum pressure
07 / 0200	29.8	83.6	1001	45	Landfall near Keaton Beach, FL





Location	Minimum Sea Level Pressure		Maximum Surface Wind Speed			Storm surge (ft) <sup>c</sup>	Storm tide (ft) <sup>d</sup>	Estimated Inundation (ft) <sup>e</sup>	Total rain (in)
	Date/time (UTC)	Press. (mb)	Date/time (UTC) <sup>a</sup>	Sustained (kt) <sup>b</sup>	Gust (kt)				
2 NE Saint Petersburg (D9933) (27.78N 82.64W)									6.91
1 WNW Pinellas Park (AP039) (27.86N 82.72W)									6.81
Seminole (D8494) (27.85N 82.79W)									6.79
1 SE Kenneth City (E4549) (27.80N 82.70W)									6.65
2 ESE Pinellas Park (E5225) (27.84N 82.67W)									6.33
4 SE Odessa (D6922) (28.14N 82.55W)									5.98
Belleair (E6508) (27.94N 82.81W)			06/2339		34 (16 m)				5.64
5 S Odessa (D5033) (28.11N 82.60W)									5.09
1 WSW Valdez (D2709) (28.83N 81.36W)									4.57
Lake Mary (D3228) (28.75N 81.33W)									4.18
<b>Coastal-Marine Automated Network (C-MAN) Sites</b>									
Venice (VENF1) (27.07N 82.45W)	07/0000	1007.0	07/0000	38	46				
Station SAUF1, Saint Augustine (29.86N 81.26W)	07/0900	1004.0	07/0900	34 (25 m)	45				
Station PLSF1, Pulaski Shoals Light (24.69N 82.77W)	06/0900	1009.3	06/0320	36 (18 m)	44				
Station KTNF1, Keaton Beach (29.82N 83.59W)	07/0100	1003.4	06/2111		36				
Cedar Key (8727520) (29.14N 83.03W)	07/0036	1003.4	07/0148	32	36				
<b>Coastal Ocean Monitoring and Prediction System (COMPS) Sites</b>									
Station 42022, C12 WFS Central Buoy (27.50N 83.73W)			06/1630	33.6 (3 m)	45.3				
Station 42023, C13 WFS South Buoy (26.01N 83.09W)			06/1800	29.4 (3 m)	45.1				
Station 42013, C10 WFS Central Buoy (27.17N 82.92W)			06/2130	31.7 (3 m)	43.7				





Location	Minimum Sea Level Pressure		Maximum Surface Wind Speed			Storm surge (ft) <sup>c</sup>	Storm tide (ft) <sup>d</sup>	Estimated Inundation (ft) <sup>e</sup>	Total rain (in)
	Date/time (UTC)	Press. (mb)	Date/time (UTC) <sup>a</sup>	Sustained (kt) <sup>b</sup>	Gust (kt)				
Station FHPF1 (28.15N 82.80W)	06/2224	1003.6	06/2342	35.6	42.4				
<b>Hydrometeorological Automated Data System (HADS) Sites (NWS)</b>									
Pinellas Park (RRCF1) (27.87N 82.69W)									8.78
Pinellas Park (PNBF1) (27.87N 82.74W)									8.78
Largo (MKYF1) (27.90N 82.82W)									8.65
Alligator Creek (PIAF1) (27.97N 82.73W)									8.63
Oldsmar (OLDF1) (28.05N 82.63W)									7.83
Kapok Park (KAPF1) (27.97N 82.71W)									7.57
Baker Creek (MCNF1) (28.02N 82.25W)									7.22
Citrus Park (CPKF1) (28.06N 82.56W)									6.61
Dunedin (CRCF1) (28.04N 82.76W)									6.55
Lealman (SJOF1) (27.81N 82.69W)									6.34
Roy Haynes Park (RHFP1) (28.06N 82.49W)									5.99
2 WNW Lithia (LITF1) (27.87N 82.21W)									5.41
Tarpon Springs (BTRF1) (28.14N 82.66W)									5.06
<b>International Civil Aviation Organization (ICAO) Sites</b>									
1 W Macdill AFB (KMCF) (27.85N 82.52W)	06/2258	1006	07/0109	36	45				7.36
Tyndall AFB (KPAM) (30.08N 85.61W)	06/2358	1005							7.07
Sarasota (KSRQ) (27.40N 82.55W)	06/2353	1005.6	06/1953	33	46				
New Smyrna Beach (KEVB) (29.06N 80.95W)			06/2147	25	45				
Tampa Intl Airport (KTPA) (27.97N 82.53W)	06/2253	1005.4	06/1602	32	45				6.31
Saint Petersburg (KPIE) (27.91N 82.69W)	06/2253	1005.2	06/1515	35	44				
Albert Whitted (KSPG) (27.77N 82.63W)	06/2253	1004.8	07/0011	31	44				



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	Date/time (UTC)	Press. (mb)	Date/time (UTC) <sup>a</sup>	Sustained (kt) <sup>b</sup>	Gust (kt)				
Leesburg (KLEE) (28.82N 81.80W)	07/0053	1004.8	07/0053	23	39				
Orlando Executive (KORL) (28.54N 81.33W)	07/0853	1006.2	07/0629	21	38				
Jacksonville Intl (KJAX) (30.49N 81.69W)	07/0756	1003.0	06/1950	27	37				
Mayport Naval Station (KNRB) (30.39N 81.42W)	07/0852	1002.7	06/0853	15	37				
Jacksonville Naval Air Station (KNIP) (30.24N 81.68W)	07/0751	1002.9	07/0553	26	36				
Ocala Intl (KOCF) (29.18N 82.22W)			06/1750	22	36				
Daytona Beach Intl (KDAB) (29.18N 81.05W)	07/0853	1005.0	07/0705	20	35				
Gainesville Regional (KGNV) (29.68N 82.27W)	07/0753	1003.4	06/1812	20	35				6.34
Saint Augustine (KSGJ) (29.97N 81.33W)	07/0858	1003.3	07/0224	24	35				4.71
Fort Pierce/St. Lucie (KFPR) (27.49N 80.36W)	07/0753	1008.6	06/1953	17	34				
Vero Beach (KVRB) (27.65N 80.41W)	07/0853	1008.2	07/1453	17	34				
<b>National Data Buoy Center (NDBC) Sites</b>									
Station 41009, 20 E Cape Canaveral (28.52N, 80.19W)	06/2320	1008.6	06/2350	31	40				
Station 41010, 120 E Cape Canaveral (28.90N 78.46W)	06/1020	1007.2	06/1020	29	36				
<b>National Ocean Service (NOS) Sites</b>									
Station 8727520, Cedar Key (29.14N 83.03W)						4.37	5.17	3.6	
Station 8726724, Clearwater Beach (27.98N 82.83W)	06/2236	1004.3	07/0818	41 (8 m)	48	3.01	3.80	2.8	
Station 8726667, Mckay Bay Entrance (27.91N 82.43W)						4.48	3.58	2.6	









Location	Minimum Sea Level Pressure		Maximum Surface Wind Speed			Storm surge (ft) <sup>c</sup>	Storm tide (ft) <sup>d</sup>	Estimated Inundation (ft) <sup>e</sup>	Total rain (in)
	Date/time (UTC)	Press. (mb)	Date/time (UTC) <sup>a</sup>	Sustained (kt) <sup>b</sup>	Gust (kt)				
2 W Palm Coast (29.57N 81.25W)									4.62
4 W Bellair-Meadowbrook (30.18N 81.81W)									4.59
2 SSW Tallahassee (30.41N 84.29W)									4.49
1 NE Tallahassee (30.44N 84.27W)									4.41
6 N Tallahassee (30.52N 84.28W)									4.37
1 NNW Jacksonville Beach (30.29N 81.39W)									4.37
2 NNW Tallahassee (30.46N 84.30W)									4.35
8 N Florahome (29.85N 81.89W)									4.26
4 W Tallahassee (30.43N 84.28W)									4.22
2 ENE Tallahassee (30.44N 84.25W)									4.10
2 SE Bloxham (30.36N 84.61W)									4.08
2 WNW San Pablo (30.31N 81.47W)									4.05
6 NW Salt Springs (29.40N 81.81W)									4.00
Kennedy Space Center-1007 (28.53N 80.77W)			06/2155	25 (16 m)	57				
3 SSW Ponce Inlet (29.05N 80.95W)			06/2147		48				
4 SW Cape Canaveral (28.36N 80.65W)			06/2150		38				
4 WNW Cape Canaveral (28.41N 80.66W)			06/2150		36				
<b>Weatherflow Sites</b>									
Skyway Fishing Pier (XSKY) (27.60N 82.65W)			06/2015	47 (16 m)	53				
Egmont Channel (XEGM) (27.61N 82.76W)			07/0010	37 (13 m)	49				
Belleair (XBLA) (27.94N 82.80W)			06/1514	25 (36 m)	49				



Location	Minimum Sea Level Pressure		Maximum Surface Wind Speed			Storm surge (ft) <sup>c</sup>	Storm tide (ft) <sup>d</sup>	Estimated Inundation (ft) <sup>e</sup>	Total rain (in)
	Date/time (UTC)	Press. (mb)	Date/time (UTC) <sup>a</sup>	Sustained (kt) <sup>b</sup>	Gust (kt)				
Tampa Bay Cut J (XTAM) (27.77N 82.57W)	07/0025	1004.2	06/2015	37 (15 m)	48				
Sarasota Bay Marker 17 (XSRB) (27.34N 82.56W)	06/2349	1006.8	06/1959	39 (5 m)	47				
Clam Bayou Nature Park (XCBN) (27.74N 82.70W)	06/2288	1004.7	07/0058	38 (10 m)	46				
Jax Beach Pier (XJAX) (30.29N 81.39W)	07/0326	1002.7	07/0331	36 (12 m)	45				
Dinner Key Light 1 (XDIN) (25.71N 80.21W)	07/2119	1009.1	07/0113	38 (5 m)	43				
Sarasota (XSAR) (27.35N 82.52W)			06/2001	32 (29 m)	42				
Smith Shoal Light (XSMS) (24.72N 81.92W)			06/1748	37 (19 m)	41				
Government Cut (XGVT) (25.75N 80.10W)			07/0128	38 (23 m)	40				
Tarpon Pt. (XTRP) (26.54N 82.00W)	06/2214	1008.1	06/0454	30 (10 m)	40				
Boca Grande (XBCG) (26.72N 82.26W)	06/2250	1006.6	06/1910	30 (10 m)	40				
Dunedin Causeway (XDUN) (28.06N 82.81W)	06/2220	1004.5	06/2335	31 (6 m)	39				
Banana River-520 (XCCB) (28.36N 80.65W)	07/0835	1007.1	06/2150	32 (5 m)	38				
Jensen Beach (XJEN) (27.22N 80.20W)	07/2045	1007.3	06/2140	23 (5 m)	38				
Jacksonville (XJAK) (30.39N 81.48W)	07/0332	1001.8	07/1952	32 (13 m)	37				
Naples City (XNPL) (26.15N 81.79W)	06/2215	1007	06/1945	26 (10 m)	37				
Dania Pier (XDAN) (26.06N 80.11W)			07/0149	23 (9 m)	37				
Grove City (XGRV) (26.90N 82.31W)			06/1946	22 (23 m)	37				
Charlotte Harbor YC (XCHL) (26.96N 82.08W)	06/2255	1006.6	07/0105	32 (10 m)	36				
Upper Matecumbe Key (XUMK) (24.92N 80.64W)			06/2346	25 (20 m)	36				



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	Date/time (UTC)	Press. (mb)	Date/time (UTC) <sup>a</sup>	Sustained (kt) <sup>b</sup>	Gust (kt)				
Banana River-528 (XMER) (28.40N 80.66W)	07/0915	1005.2	06/2150	20 (9 m)	36				
Hobe (XHOB) (27.05N 80.17W)			06/2137	28 (19 m)	35				
Land o' Lakes (XLLOL) (28.19N 82.52W)			07/0004	26 (33 m)	35				
Lewis (XLWS) (29.92N 81.33W)	07/0824	1000.3	07/0249	28 (15 m)	34				
<b>Georgia</b>									
<b>ICAO Sites</b>									
Hinesville (KLHW) (31.88N 81.56W)									4.32
<b>National Estuary Research Reserve System (NERRS) Sites</b>									
Station SAXG1, Sapelo Island Reserve (31.42N 81.30W)	07/0700	1003.0	06/2215	28	46				
<b>NOS Sites</b>									
Station 8670870, Fort Pulaski (32.03N 80.90W)						1.53	5.64	2.2	
<b>Public/Other</b>									
3 N Boston (30.83N 83.79W)									5.65
Quitman (30.78N 83.56W)									5.22
5 SSW Dawesville (30.89N 84.05W)									5.18
Attapulcus (30.74N 84.48W)									4.73
Camilla (31.22N 84.21W)									4.42
<b>Weatherflow Sites</b>									
Jekyll Island (XJEK) (31.05N 81.41W)			06/2055	33 (15 m)	40				
<b>North Carolina</b>									
<b>C-MAN Sites</b>									
Station CLKN7, Cape Lookout (34.60N 76.52W)	07/1800	999.2	07/1150	26 (10 m)	37				
<b>Coastal Ocean Research and Monitoring Program (CORMP) Sites</b>									





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	Date/time (UTC)	Press. (mb)	Date/time (UTC) <sup>a</sup>	Sustained (kt) <sup>b</sup>	Gust (kt)				
Station 41037, Wrightsville Beach Offshore (33.98N 77.36W)	07/1508	999.8	07/0808	27 (3 m)	42				
Station 41064, 30 SE Onslow Bay (34.21N 76.95W)	07/1608	1000.2	07/1208	27 (3 m)	37				
<b>Community Collaborative Rain, Hail and Snow Network (CoCoRaHS) Sites</b>									
8.2 ESE Havelock (34.84N 76.80W)									5.44
1 N Newport (34.80N 76.86W)									4.35
6.3 ENE Havelock (34.92N 76.83W)									4.19
<b>METAR Observations</b>									
Mitchell Field (KHSE) (35.22N 75.62W)	07/1951	998.7	07/1338	28	38				
Beaufort Smith Field (KMRH) (34.72N 76.65W)	07/1758	999.7	07/1258	24	34				
<b>NDBC Sites</b>									
Station 41025, Diamond Shoals (35.01N 75.40W)	07/1850	997.5	07/1530	36 (5 m)	45				
Station 41013, Frying Pan Shoals (33.43N 77.74W)	07/1400	997.6	07/1240	31 (4 m)	42				
<b>NOS Sites</b>									
Station 8658163, Wrightsville Beach (34.21N 77.79W)						1.60	3.56	1.8	
Station 8652587, Oregon Inlet Marina (35.80N 75.55W)						1.86	2.18	1.7	
Station 8658120, Wilmington (34.23N 77.95W)						1.56		1.5	
Station 8656483, Beaufort (34.72N 76.67W)						1.63	2.97	1.5	
Station 8654467, Hatteras (35.21N 75.70W)	07/1854	998.1	07/1354	23 (8 m)	34	1.70		1.3	
Station 8651370, Duck (36.18N 75.75W)						0.80	2.77	1.3	
<b>Public/Other</b>									



Location	Minimum Sea Level Pressure		Maximum Surface Wind Speed			Storm surge (ft) <sup>c</sup>	Storm tide (ft) <sup>d</sup>	Estimated Inundation (ft) <sup>e</sup>	Total rain (in)
	Date/time (UTC)	Press. (mb)	Date/time (UTC) <sup>a</sup>	Sustained (kt) <sup>b</sup>	Gust (kt)				
Avon-Sound (35.34N 75.50W)	07/1858	998.4	07/1433	22 (7 m)	38				
Fort Macon (34.70N 76.69W)	07/1803	996.9	07/1253	26 (10 m)	36				
Frisco Woods (35.24N 76.70W)	07/1905	997.7	07/1355	25 (6 m)	36				
<b>Weatherflow Sites</b>									
Ocracoke (XOCR) (35.14N 76.01W)	07/1830	998.3	07/1425	28 (8 m)	38				
Avon Sound (XAVN) (35.37N 75.51W)	07/1858	998.4	07/1348	24 (5 m)	38				
Fort Macon (XMAC) (34.70N 76.69W)	07/1808	996.8	07/1253	26 (15 m)	36				
Pamlico Sound (XPM2) (35.43N 75.83W)	07/1949	996.9	07/1349	25 (13 m)	35				
<b>South Carolina</b>									
<b>CoCoRaHS Sites</b>									
ENE Okatie (SC-BF-5) (32.32N 80.86W)									4.00
<b>NDBC Sites</b>									
Station 41004, Edisto Buoy, 41 SE Charleston (32.50N 79.10W)	07/0950	999.9	07/0940	35 (5 m)	43				
<b>NOS Sites</b>									
Station 8665530, Charleston (32.78N 79.93W)						1.28	4.42	1.8	
Station 8661070, Springmaid Pier (33.66N 78.92W)						1.56	4.17	1.7	
Station 8662245, Oyster Landing (33.35N 79.19W)						1.61	3.91	1.5	
<b>Offshore</b>									
<b>NDBC Sites</b>									
Station 41002, 225 S Cape Hatteras, NC (31.76N 74.84W)	07/1850	1002.3	07/1650	33 (5 m)	42.8				
Station 42056, Yucatan Basin, 120 ESE Cozumel, Mexico (19.92N 84.94W)	05/1010	1005.3	05/1100	26.4 (5 m)	38.1				
Station 42003, East Gulf, 208 W Naples, FL (26.01N 85.65W)	06/0850	1004.8	06/0950	28.6 (5 m)	34.4				



Location	Minimum Sea Level Pressure		Maximum Surface Wind Speed			Storm surge (ft) <sup>c</sup>	Storm tide (ft) <sup>d</sup>	Estimated Inundation (ft) <sup>e</sup>	Total rain (in)
	Date/time (UTC)	Press. (mb)	Date/time (UTC) <sup>a</sup>	Sustained (kt) <sup>b</sup>	Gust (kt)				
Station 42036, 112 WNW Tampa, FL (28.50N 84.52W)	06/2250	1001.7	06/1950	27 (5 m)	33				

- <sup>a</sup> Date/time is for sustained wind when both sustained and gust are listed.
- <sup>b</sup> Except as noted, sustained wind averaging periods for C-MAN and land-based reports are 2 min; buoy averaging periods are 8 min. Values in parentheses below sustained or gust speeds are instrument elevations, when available.
- <sup>c</sup> Storm surge is water height above normal astronomical tide level.
- <sup>d</sup> For most locations, storm tide is water height above the North American Vertical Datum of 1988 (NAVD88). Storm tide is water height above Mean Lower Low Water (MLLW) for NOS stations in Puerto Rico, the U.S. Virgin Islands, and Barbados.
- <sup>e</sup> Estimated inundation is the maximum height of water above ground. For NOS tide gauges, the height of the water above Mean Higher High Water (MHHW) is used as a proxy for inundation.

Table 3. Selected ship reports with winds of at least 34 kt for Tropical Storm Colin, 5-7 June 2016.

Date/Time (UTC)	Ship call sign	Latitude (°N)	Longitude (°W)	Wind dir/speed (kt)	Pressure (mb)
06 / 2300	C6FZ8	28.0	80.1	200 / 37	1010.0
07 / 0500	KABL	31.2	79.7	180 / 38	1007.7
07 / 0600	C6VG8	28.7	79.9	200 / 35	1007.0
07 / 0600	DGSE	30.4	80.2	180 / 38	1006.3
07 / 0600	KABL	31.0	79.7	190 / 35	1005.7

Table 4. Number of hours in advance of the formation of Colin 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%)	48	90
Medium (40%-60%)	30	66
High (>60%)	24	36



Table 5a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) track forecast errors (n mi) for Tropical Storm Colin, 5-7 June 2016. 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	39.5	<b>28.2</b>	<b>15.9</b>				
OCD5	87.5	184.9	270.7				
Forecasts	6	4	2	0	0	0	0
OFCL (2011-15)	28.4	45.0	60.4	77.1	113.1	157.8	210.0
OCD5 (2011-15)	48.3	101.5	161.5	222.6	329.8	412.6	483.9

Table 5b. Homogeneous comparison of selected track forecast guidance models (in n mi) for Tropical Storm Colin, 5-7 June 2016. 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	38.5	10.3					
OCD5	120.0	285.7					
GFSI	51.3	18.0					
GHMI	62.4	86.0					
HWFI	40.4	23.9					
EMXI	<b>34.9</b>	20.6					
NVGI	49.6	20.7					
GFNI	59.7	119.6					
CMCI	39.3	78.9					
CTCI	<b>29.6</b>	11.9					
TVCA	40.3	16.6					
FSSE	42.0	21.5					
HCCA	42.1	20.6					
AEMI	45.7	20.6					
BAMS	113.1	207.4					
BAMM	57.6	107.8					
BAMD	<b>35.8</b>	52.1					
Forecasts	3	1					



Table 6a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) intensity forecast errors (kt) for Tropical Storm Colin, 5-7 June 2016. 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	<b>1.7</b>	<b>1.3</b>	<b>0.0</b>				
OCD5	6.8	8.8	12.0				
Forecasts	6	4	2				
OFCL (2011-15)	6.2	9.4	11.5				
OCD5 (2011-15)	7.3	10.8	13.3				



Table 6b. Homogeneous comparison of selected intensity forecast guidance models (in kt) for Tropical Storm Colin, 5-7 June 2016. 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	0.0	0.0					
OCD5	8.0	8.0					
GFSI	6.0	1.0					
HWFI	2.7	1.0					
GHMI	9.0	10.0					
CTCI	4.7	3.0					
DSHP	7.3	11.0					
LGEM	8.0	15.0					
ICON	4.3	4.0					
IVCN	3.7	3.0					
GFNI	8.7	5.0					
EMXI	4.3	7.0					
HCCA	4.3	1.0					
FSSE	3.7	1.0					
Forecasts	3	1					





Table 7. Watch and warning summary for Tropical Storm Colin, 5-7 June 2016.

<b>Date/Time (UTC)</b>	<b>Action</b>	<b>Location</b>
<b>5 / 1500</b>	Tropical Storm Warning issued	Indian Pass to Englewood
<b>5 / 2100</b>	Tropical Storm Watch issued	Flagler/Volusia County Li to Altamaha Sound
<b>6 / 0300</b>	Tropical Storm Watch modified to	Altamaha Sound to South Santee River
<b>6 / 0300</b>	Tropical Storm Warning issued	Sebastian Inlet to Altamaha Sound
<b>6 / 1500</b>	Tropical Storm Watch discontinued	All
<b>6 / 1500</b>	Tropical Storm Warning modified to	Sebastian Inlet to South Santee River
<b>6 / 2100</b>	Tropical Storm Warning modified to	Sebastian Inlet to Oregon Inlet
<b>7 / 0600</b>	Tropical Storm Warning modified to	Suwannee River to Englewood
<b>7 / 0900</b>	Tropical Storm Warning discontinued	Suwannee River to Englewood
<b>7 / 0900</b>	Tropical Storm Warning modified to	Altamaha Sound to Oregon Inlet
<b>7 / 1200</b>	Tropical Storm Warning modified to	Surf City to Oregon Inlet
<b>7 / 1500</b>	Tropical Storm Warning modified to	Cape Lookout to Oregon Inlet
<b>7 / 1800</b>	Tropical Storm Warning discontinued	All

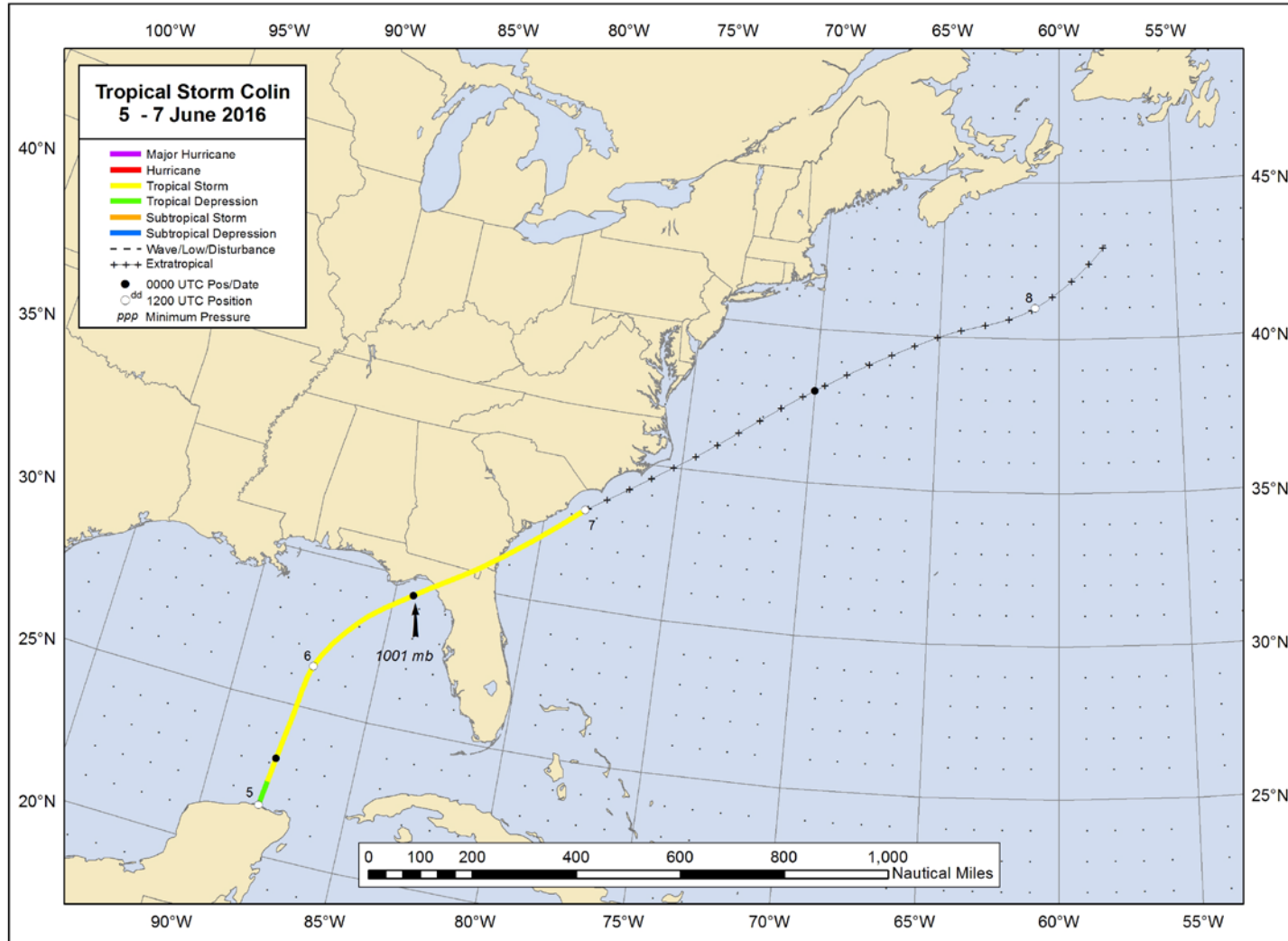


Figure 1. Best track positions for Tropical Storm Colin, 5-7 June 2016. Tracks over the United States and during the extratropical stage are partially based on analyses from the NOAA Weather Prediction Center and the NOAA Ocean Prediction Center.

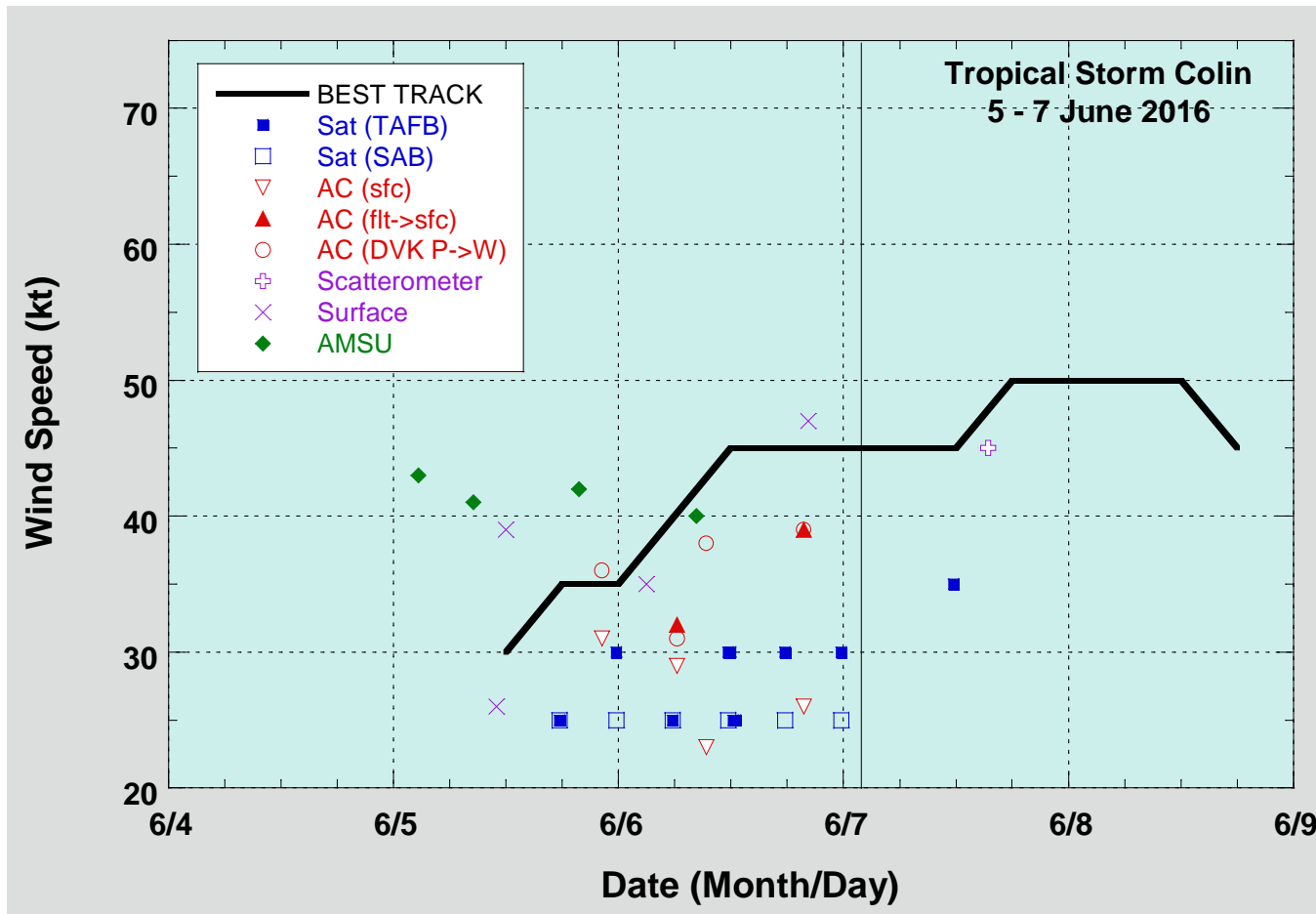


Figure 2. Selected wind observations and best track maximum sustained surface wind speed curve for Tropical Storm Colin, 5-7 June 2016. Aircraft observations have been adjusted for elevation using 90%, 80%, and 80% adjustment factors for observations from 700 mb, 850 mb, and 1500 ft, respectively. Dashed vertical lines correspond to 0000 UTC, and the solid vertical line corresponds to landfall.



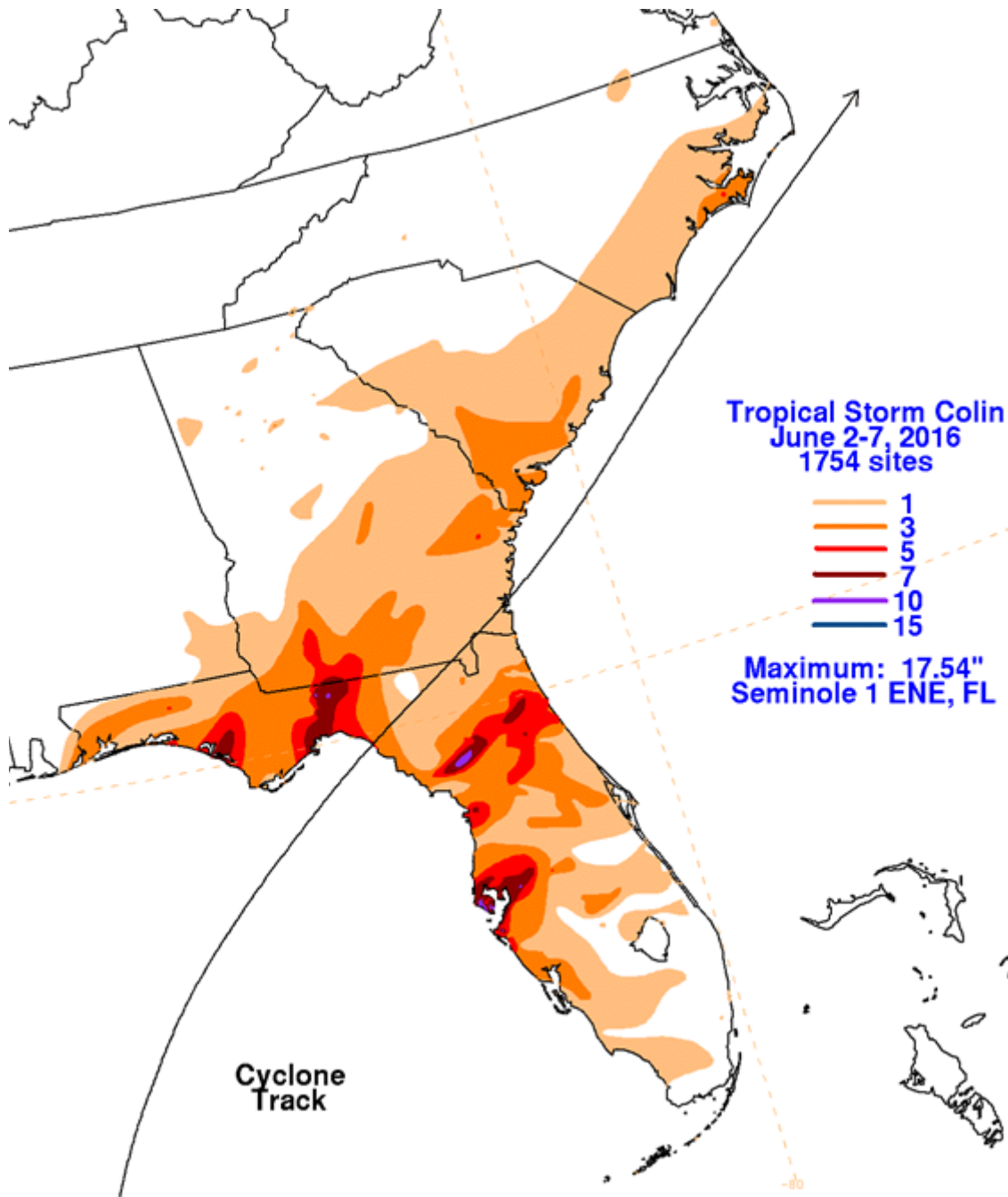


Figure 4. Analyzed rainfall totals for Tropical Storm Colin. Note that, although most of the rainfall occurred during the tropical cyclone stage of Colin, some of these rains fell outside of that stage. Figure courtesy of David Roth of the NOAA Weather Prediction Center.