NATIONAL HURRICANE CENTER
TROPICAL CYCLONE REPORT

TROPICAL STORM DANNY

(AL042021)

27–29 June 2021

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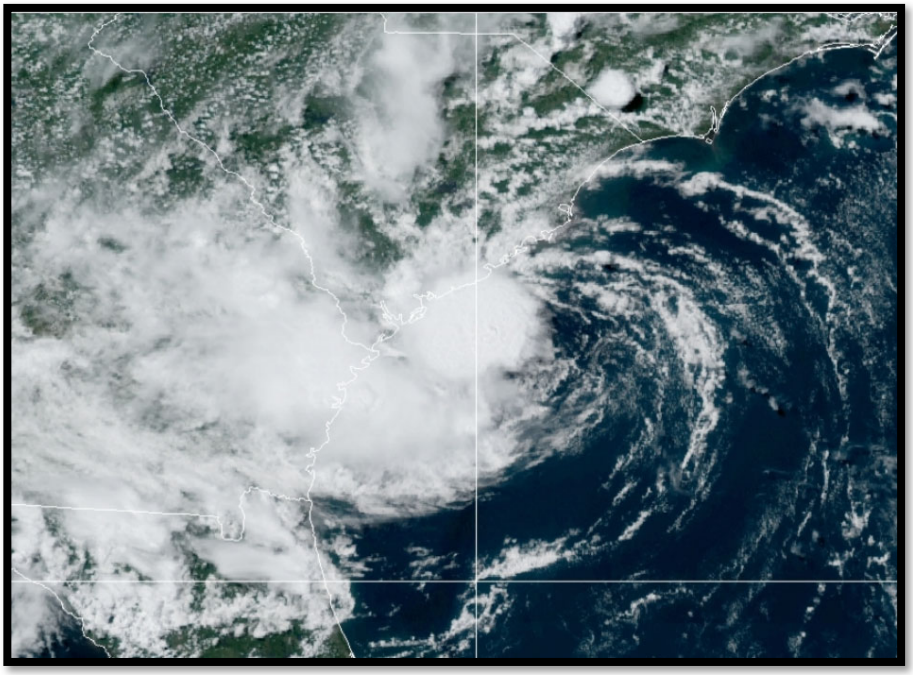

GOES-16 TRUE COLOR VISIBLE SATELLITE IMAGE OF TROPICAL STORM DANNY NEAR THE TIME OF ITS PEAK INTENSITY AS IT APPROACHED THE COAST OF SOUTH CAROLINA AT 1910 UTC 28 JUNE 2021. IMAGE COURTESY NOAA/NESDIS/STAR.

Danny was a small tropical storm that formed over the subtropical waters of the western Atlantic and made landfall in South Carolina one day later. The storm caused no significant damage.

[1] Original report dated 14 October 2021. This version corrects the peak storm surge at Charleston, SC, in the text and in Table 2 and adds additional information on the timing of peak water levels in the text.

Tropical Storm Danny

27–29 JUNE 2021

SYNOPTIC HISTORY

Danny had non-tropical origins. An upper-level trough cut off from the mid-latitude jet stream on 22 June and transitioned into an upper-level low over the next couple of days as it moved generally southwestward over the subtropical central Atlantic Ocean. By 24 June, shower and thunderstorm activity increased as the system turned westward over warmer waters, while steered around a strong, deep-layer ridge to its north. Around this same time a surface trough in association with the upper-level low became more pronounced. Shower and thunderstorm activity continued near the vicinity of the trough and upper low over the next few days as the system moved westward with little change in organization. The upper low gradually filled, and by early on 27 June, satellite images and surface observations indicated that a well-defined surface low pressure area had formed in association with the disturbance. Over the next 12 h, the convection increased in organization, and it is estimated that a tropical depression formed by 1800 UTC that day about 400 n mi east-southeast of Charleston, South Carolina. 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[2].

Shortly after formation, the convection waned, and the low-level center become partially exposed as the depression moved quickly west-northwestward to the south of a low- to mid-level ridge. This motion continued for the remainder of the cyclone's short existence. Early on 28 June, an ASCAT overpass indicated the cyclone was producing 30–35-kt winds, and within a couple of hours of that pass a burst of deep convection developed over the center of the system. Therefore, it is estimated that the system strengthened into a tropical storm around 0600 UTC that day while located about 225 n mi southeast of Charleston. Danny strengthened a little more that day and reached its peak intensity of 40 kt by 1800 UTC 28 June. The deep convection near the storm's center decreased after that time, and the cyclone weakened slightly before making landfall as a 35-kt tropical storm near 2320 UTC 28 June on Pritchards Island, South Carolina. Just a short time later, at 0000 UTC 29 June, Danny weakened to a tropical depression inland over eastern South Carolina. The depression continued its fast west-northwestward motion and dissipated by 0600 UTC that day over eastern Georgia.

METEOROLOGICAL STATISTICS

Observations in Danny (Figs. 2 and 3) include subjective satellite-based Dvorak and intensity estimates from the Tropical Analysis and Forecast Branch (TAFB), the Satellite Analysis

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

Branch (SAB), and objective Advanced Dvorak Technique (ADT) estimates and Satellite Consensus (SATCON) estimates from the Cooperative Institute for Meteorological Satellite Studies/University of Wisconsin-Madison. Data and imagery from NOAA polar-orbiting satellites including the Advanced Microwave Sounding Unit (AMSU), the NASA Global Precipitation Mission (GPM), the European Space Agency's Advanced Scatterometer (ASCAT), and Defense Meteorological Satellite Program (DMSP) satellites, among others, were also useful in constructing the best track of Danny. Observations also include flight-level, stepped frequency microwave radiometer (SFMR), and dropwindsonde observations from 1 flight (4 center fixes) by the 53rd Weather Reconnaissance Squadron of the U.S. Air Force Reserve on 28 June. Radar data from the National Weather Service WSR-88D radar in Charleston, SC, was also beneficial in tracking Danny.

The peak intensity of Danny at 1800 UTC 28 June was based on aircraft measurements and Doppler radar data. The Air Force Reserve aircraft measured 850-mb fight-level winds of 49 kt, which equates to an intensity of about 40 kt at the surface. In addition, Doppler velocity data from the Charleston radar measured average velocities of 49 kt at 6000-7000 ft, which also equate to about 40-kt surface winds. The minimum central pressure of 1009 mb was measured by the aircraft.

There were no ship reports of winds of tropical storm force associated with Danny. Selected surface observations from land stations and data buoys are given in Table 2.

Winds and Pressure

The highest reported sustained wind was 33 kt with a gust of 36 kt at an elevation of 11 m at Springmaid Pier in Myrtle Beach, South Carolina (Table 2). This location was well north of where Danny made landfall, and these winds were likely from a combination of passing convection that developed ahead of Danny, and the tight pressure gradient between the cyclone and high pressure to its north. A wind gust of 41 kt was reported at a Coastal Ocean Research and Monitoring Program buoy 41029 at an elevation of 3 m, just offshore of the coast of Charleston. A Weatherflow site at Winyah Bay reported a wind gust of 40 kt. The lowest pressure reported on land was 1010.8 mb at Hilton Head Airport.

Storm Surge[3]

Isolated areas of minor coastal flooding occurred along the coasts of North and South Carolina, but primarily before Danny even formed. Danny produced storm surges of 1.91 ft and 1.85 ft above normal tide levels at Oyster Landing (North Inlet Estuary) and Charleston, South Carolina, respectively, to the north of its landfall location on 28 June. However, these maximum surges occurred just before low tide and thus did not result in impactful inundation of normally dry

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

ground. Slightly higher water levels were reported by National Ocean Service (NOS) tide gauges along the coasts of South Carolina and southern North Carolina the previous day on 27 June, unrelated to any influence form Danny.

Rainfall and Flooding

Danny produced 3 to 6 inches of rain, with isolated higher amounts across the extreme southern portion of the low country of South Carolina and eastern Georgia (Table 2, Figure 4). Minor roadway flooding occurred due to this rainfall.

Tornadoes

There were no tornadoes reported in association with Danny.

CASUALTY AND DAMAGE STATISTICS

There were no reports of casualties associated with Tropical Storm Danny. Ten water rescues due to rip currents were performed at Carolina and Wrightsville Beaches in North Carolina on 28 June. Sporadic tree damage occurred and just over 1200 power outages were reported over southeastern South Carolina.

FORECAST AND WARNING CRITIQUE

The genesis of Tropical Storm Danny was not well anticipated. The precursor system was initially mentioned in the Tropical Weather Outlook (TWO) only 24 h prior to genesis, introducing a low (< 40%) chance of formation in the 2- and 5-day time periods (Table 3). Although the probability of genesis increased slightly before the cyclone formed, it failed to reach the medium or high categories. The genesis forecast for Danny was challenging, as the small extent of the associated convection and fast motion of the incipient disturbance raised uncertainty as to whether a well-defined low-level circulation would form before the system reached the United States coast. In addition, none of the more reliable global model guidance indicated that this system would undergo genesis prior to its formation.

Due to Danny's short existence, there was only one verifying 12-h forecast. Thus, a comprehensive verification of official and guidance track and intensity forecast errors is not provided. The one official 12-h forecast had a track error of 24.5 n mi and an intensity error of 5.0 kt. These are close to the mean 12-h official track and intensity errors for the previous 5-yr period (2016–2020) of 23.9 n mi and 5.4 kt, respectively.

Watches and warnings associated with Danny are given in Table 4. As noted above, Danny's genesis was not well anticipated and as a result of the low confidence in formation, Potential Tropical Cyclone advisories were not issued for this system. The Tropical Storm Warning for the coast of South Carolina was issued less than 12 h before the storm made landfall, resulting in a much shorter-than-normal lead time.

The initial storm surge inundation forecast issued at 1500 UTC 28 June was 1 to 3 ft above normally dry ground somewhere between Port Royal Sound and South Santee River, South Carolina. This forecast likely did not materialize since the maximum storm surge occurred near the time of low tide. The only NOS tide gauge within that span of coast is the gauge at Charleston, and it measured a peak water level of 0.75 ft MHHW at 0418 UTC 29 June[4] a few hours after Danny's landfall.

[4] The Charleston NOS gauge measured a peak water level of 1.14 ft MHHW at 0318 UTC 28 June. However, this water level occurred before advisories were initiated and the first storm surge forecast was made at 1500 UTC that day. The storm surge forecast verification therefore focuses on the maximum water level that occurred after the first forecast was released.

Table 1. Best track for Tropical Storm Danny, 27–29 June 2021.

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
27 / 1800	29.8	72.8	1013	30	tropical depression
28 / 0000	30.1	74.5	1013	30	"
28 / 0600	30.7	76.1	1011	35	tropical storm
28 / 1200	31.5	77.6	1011	35	"
28 / 1800	32.0	79.5	1009	40	"
28 / 2320	32.3	80.5	1010	35	"
29 / 0000	32.4	80.7	1011	30	tropical depression
29 / 0600					dissipated
28 / 1800	32.0	79.5	1009	40	maximum wind and minimum pressure
28 / 2320	32.3	80.5	1010	35	Landfall on Pritchards Island, SC

Table 2. Selected surface observations for Tropical Storm Danny, 27–29 June 2021.

Location	Minimum Sea Level Pressure		Maximum Surface Wind Speed			Storm surge (ft)[c]	Storm tide (ft)[d]	Estimated Inundation (ft)[e]	Total rain (in)
	Date/ time (UTC)	Press. (mb)	Date/ time (UTC)[a]	Sustained (kt)[b]	Gust (kt)				
Georgia									
Hydrometeorological Automated Data System (HADS) Sites									
3 NNE O'Leary (ACMG1) (32.25N 81.15W)									5.60
South Carolina									
International Civil Aviation Organization (ICAO) Sites									
Hilton Head AP (KHXD) (32.22N 80.70W)	28/2250	1010.8	28/1950	16 (2 min, 10 m)	24				
Charleston Intl. AP (KCHS) (32.90N 80.04W)	28/2056	1017.6	28/2256	17 (2 min, 10 m)	31				
Coastal-Marine Automated Network (C-MAN) Sites									
Folly Island (FBIS1) (32.69N 79.89W)	28/2100	1017.8	28/1940	28 (10 min, 10 m)	35				
National Ocean Service (NOS) Sites									
Springmaid Pier (MROS1) (33.66N 78.92W)	28/0718	1022.1	28/1506	33 (11 m)	36	1.40		0 36	
Oyster Landing (NITS1) (33.35N 79.19W)						1.91		0.50	
Charleston, Cooper River Entrance (CHTS1) (32.78N 79.92W)	28/2042	1017.6	28/1842	23 (9 m)	30	1.85		0.75	
Hydrometeorological Automated Data System (HADS) Sites									
3 SW Limehouse (LUCS1) (32.19N 81.12W)									4.73
3 ENE Port Wentworth (SVNS1) (32.17N 81.12W)									4.52
1 SSE Monteith (FWDS1) (32.17N 81.12W)									4.37
4 NE Lepageville (ELBS1) (32.10N 81.01W)									4.14
Community Collaborative Rain, Hail and Snow Network (CoCoRaHS) Sites									

Location	Minimum Sea Level Pressure		Maximum Surface Wind Speed			Storm surge (ft)[c]	Storm tide (ft)[d]	Estimated Inundation (ft)[e]	Total rain (in)
	Date/ time (UTC)	Press. (mb)	Date/ time (UTC)[a]	Sustained (kt)[b]	Gust (kt)				
2 SW Pritchardville (SC-BF-50) (32.22N 80.98W)									6.22
Weatherflow Sites									
Folly Beach South (XFSE) (32.64N 79.97W)	28/2041	1015.0	28/1851	25 (10 m)	36				
Isle of Palms Pier (XIOP) (32.78N 79.79W)	28/2024	1016.2	28/1851	28 (9 m)	34				
Winyah Bay (XWIN) (33.19N 79.18W)	28/1942	1018.8	28/1402	26 (15 m)	40				
North Carolina									
National Ocean Service (NOS) Sites									
Wrightsville Beach (JMPN7) (34.21N 77.79W)	28/0800	1021.3	28/1600	24 (15 m)	28	0.98		0.60	
Offshore									
NOAA Buoys									
Capers (41029) (32.81N 79.63W)	28/1823	1016.4	28/2353	29 (8 min, 3 m)	41				
Fripps (41033) (32.28N 80.41W)	28/2208	1012.1	28/2108	23 (8 min, 3 m)	37				

[a] Date/time is for sustained wind when both sustained and gust are listed.
[b] Except as noted, sustained wind averaging periods for C-MAN and land-based reports are 2 min; buoy averaging periods are 8 min.
[c] Storm surge is water height above normal astronomical tide level.
[d] For most locations, storm tide is water height above the North American Vertical Datum of 1988 (NAVD88). Storm tide is water height above Mean Lower Low Water (MLLW) for NOS stations in Puerto Rico, the U.S. Virgin Islands, and Barbados.
[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. Values in the table are from 28-29 June after Danny made landfall. Slightly higher water levels occurred on 27 June, unrelated to Danny.

Table 3. Number of hours in advance of formation associated with the first NHC Tropical Weather Outlook forecast in the indicated likelihood category. Note that the timings for the "Low" category do not include forecasts of a 0% chance of genesis.

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

Table 4. Wind watch and warning summary for Tropical Storm Danny, 27–29 June 2021.

Date/Time (UTC)	**Action**	**Location**
28 / 1500	Tropical Storm Warning issued	Edisto Beach to South Santee River
29 / 0300	Tropical Storm Warning discontinued	All

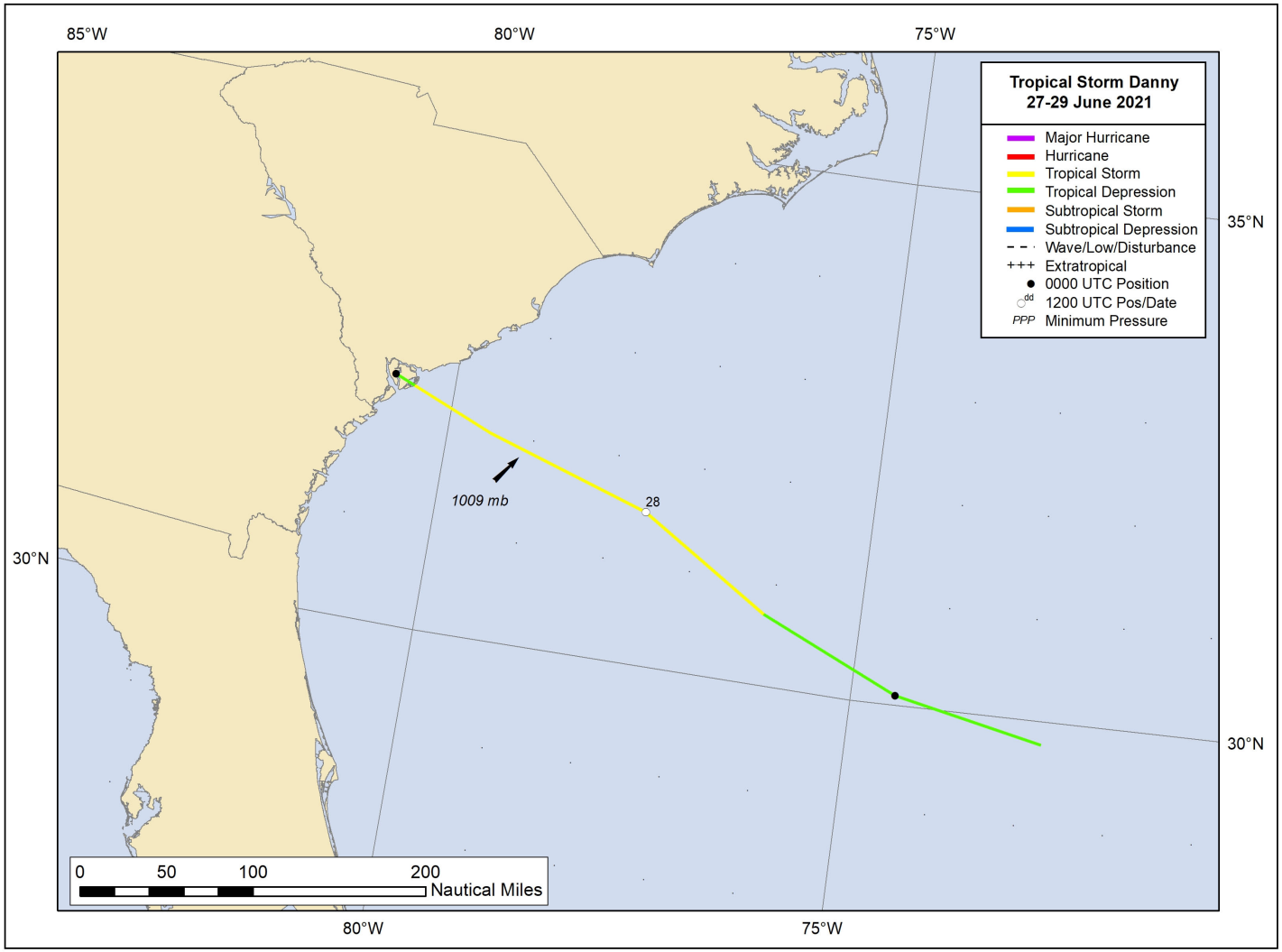

Figure 1. Best track positions for Tropical Storm Danny, 27–29 June 2021.

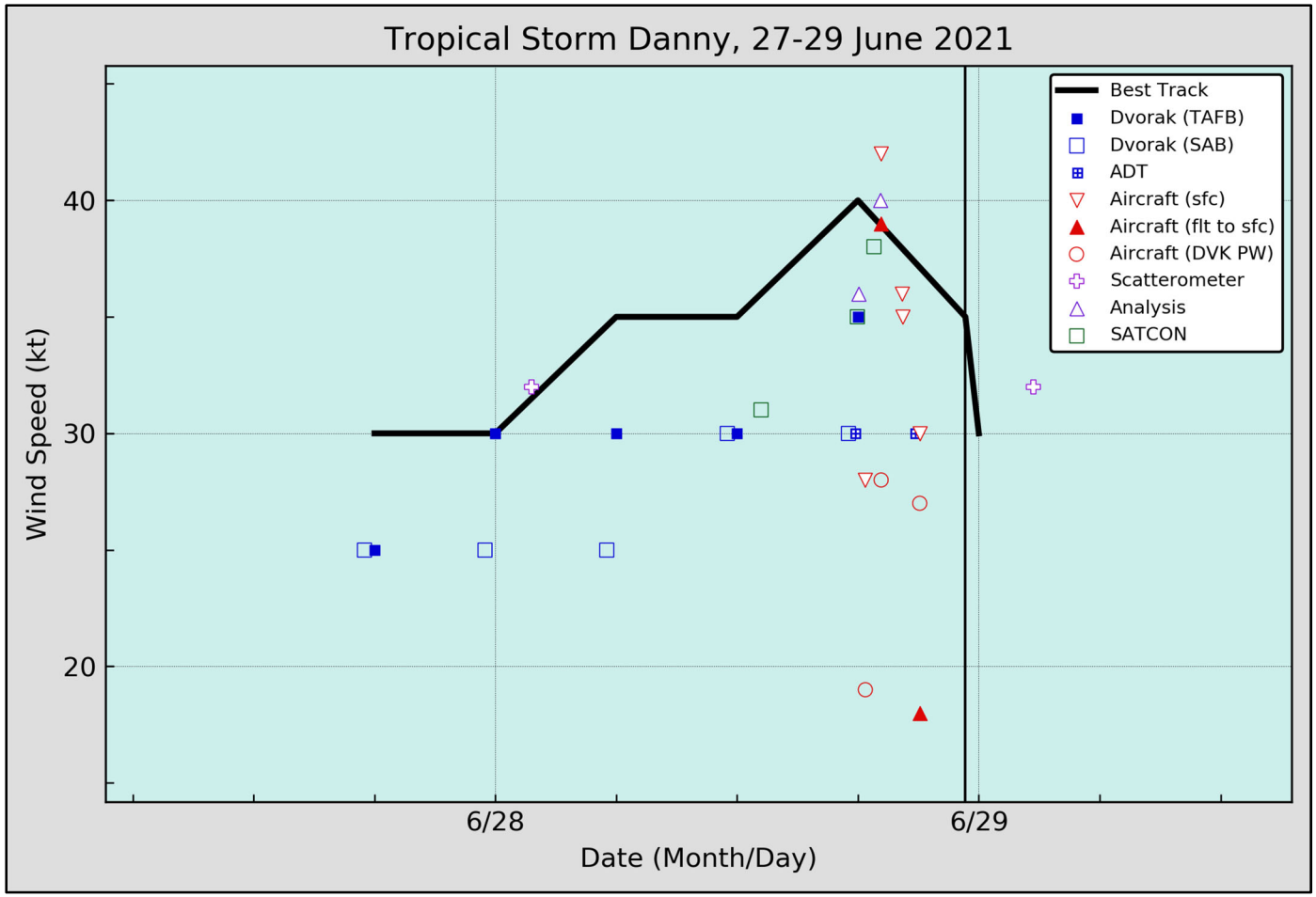

Figure 2. Selected wind observations and best track maximum sustained surface wind speed curve for Tropical Storm Danny, 27–29 June 2021. Advanced Dvorak Technique estimates represent the Current Intensity at the nominal observation time. SATCON intensity estimates are from the Cooperative Institute for Meteorological Satellite Studies. 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. The solid vertical line corresponds with landfall.

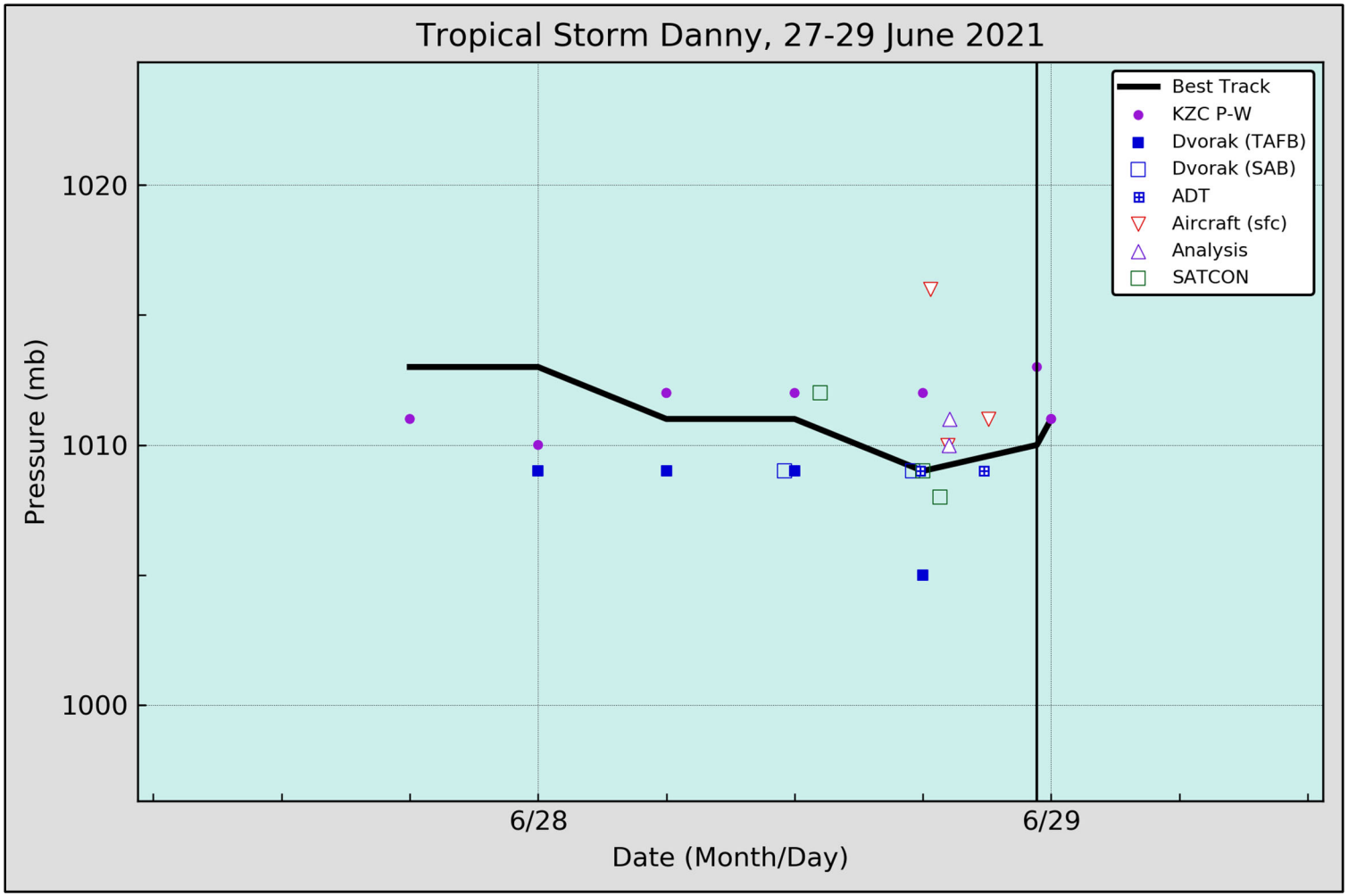

Figure 3. Selected pressure observations and best track minimum central pressure curve for Tropical Storm Danny, 27–29 June 2021. Advanced Dvorak Technique estimates represent the Current Intensity at the nominal observation time. SATCON intensity estimates are from the Cooperative Institute for Meteorological Satellite Studies. KZC P-W refers to pressure estimates derived using the Knaff-Zehr-Courtney pressure-wind relationship. Dashed vertical lines correspond to 0000 UTC. The solid vertical line corresponds with landfall.

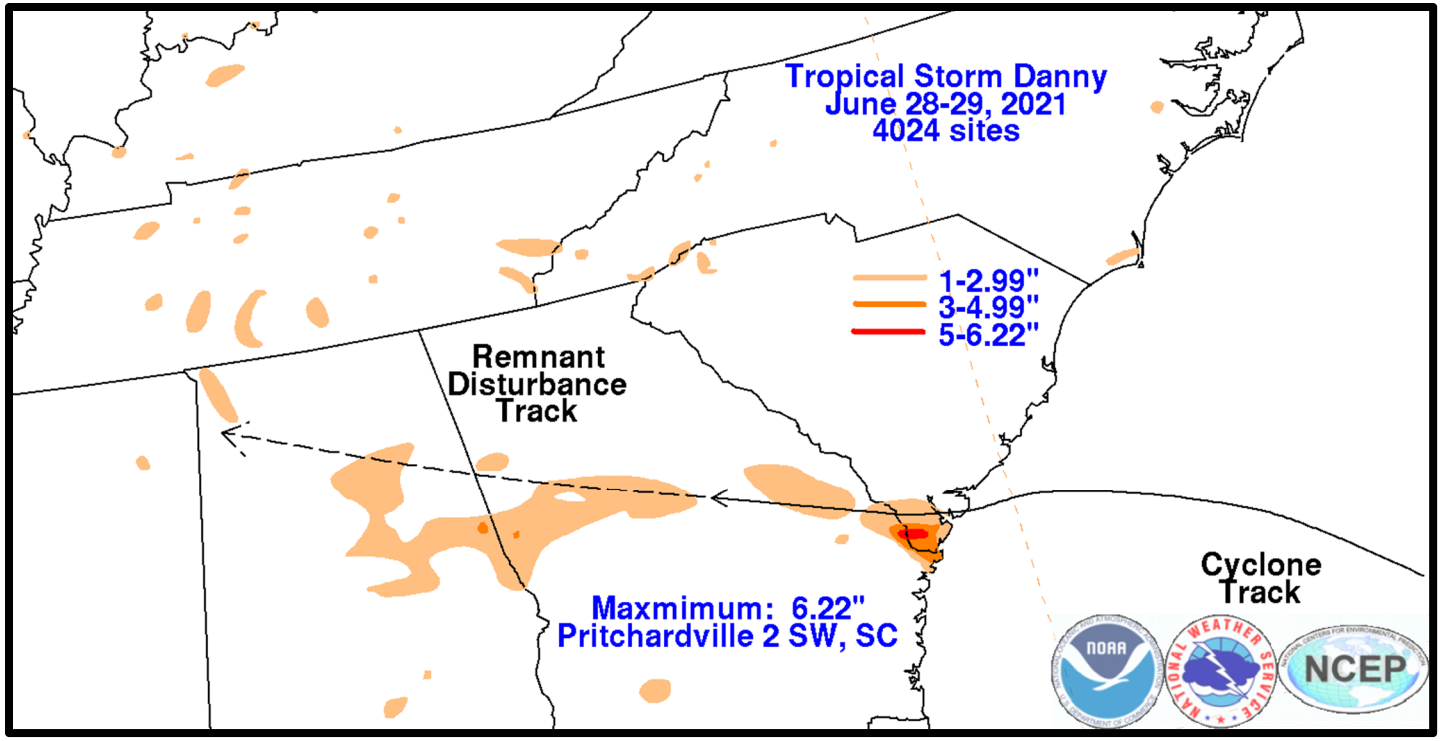

Figure 4. Tropical Storm Danny total rainfall map (inches) over the U.S. compiled from 4024 rain gauges from 28–29 June 2021. Image courtesy of the NOAA Weather Prediction Center.