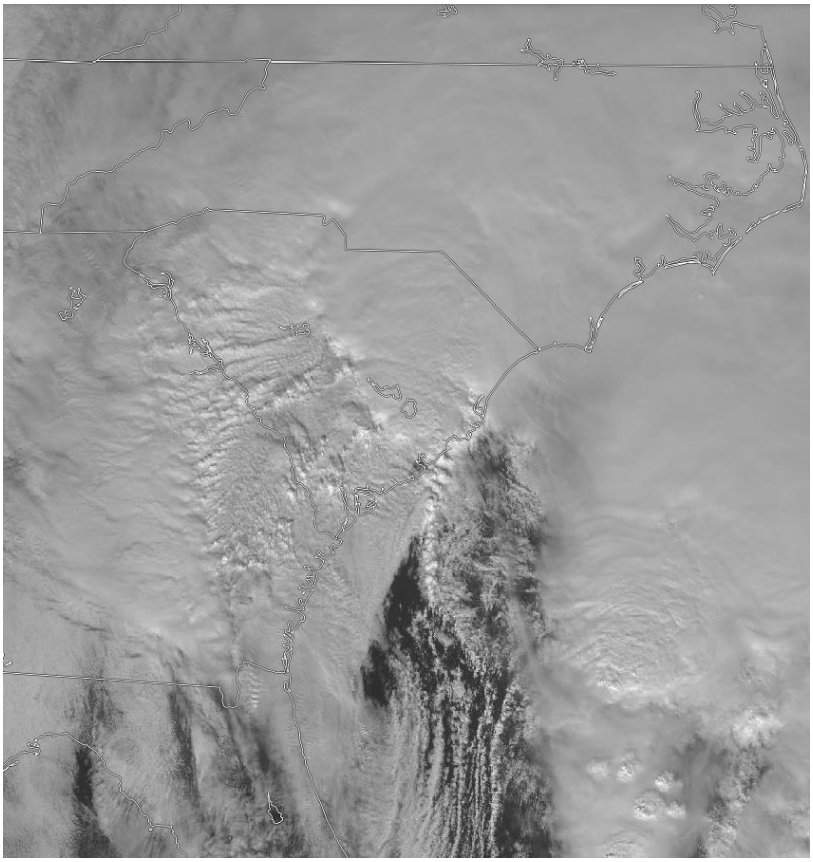
DECEMBER 2023 COASTAL STORM

OPEN FILE REPORT

Prepared by the South Carolina State Climatology Office
Report Issued December 21, 2023
Website: https://www.dnr.sc.gov/climate/sco/

Storm History and Impacts Report

December 17, 2023



A visible satellite image (GOES-East CONUS Band 2) of the storm from 1:00 p.m. EST on Sunday, December 17, 2023, shows clouds associated with the storm covering South Carolina. The storm was centered east of Fernandina Beach, Florida, at the time.

Source: University of Wisconsin RealEarth

Table of Contents

This report serves as a preliminary dissemination of information on the impacts of a coastal storm on December 17 – 18, 2023 across South Carolina. If you have any additional questions regarding the data provided in this document, please contact Hope Mizzell, Frank Strait, or Melissa Griffin at the State Climatology Office.

Hope P. Mizzell
South Carolina State Climatologist
MizzellH@dnr.sc.gov
803-734-9568

Frank Strait
Severe Weather Liaison
StraitF@dnr.sc.gov
803-734-0039

Melissa Griffin
Assistant State Climatologist
GriffinM@dnr.sc.gov
803-734-9091

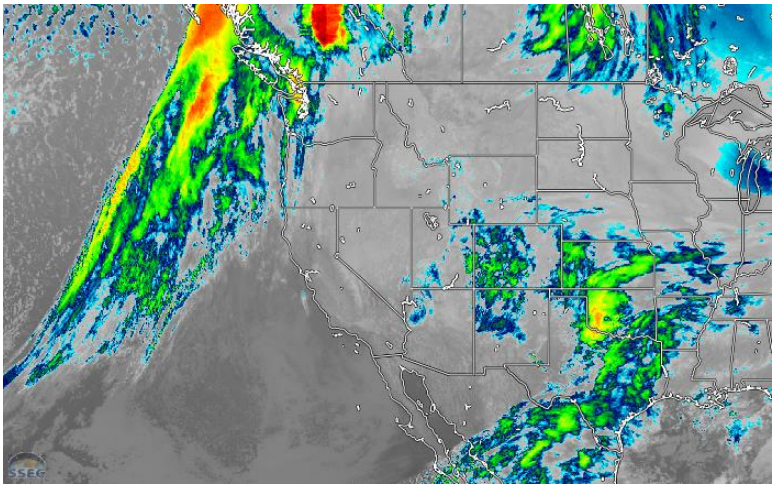
South Carolina Department of Natural Resources
Land, Water, and Conservation Division
1000 Assembly Street, Columbia, SC 29201

Coastal Storm – Synoptic Summary

The East Coast storm of mid-December 2023 had complex origins. Three days before the storm took shape over the Gulf of Mexico, the weather features that merged to form the storm were far away from the area. One of these was a storm that was centered near southern Nevada at 7 a.m. EST on December 13, 2023. Another was a storm system that was over the Pacific Ocean approaching the West Coast at the same time.

Infrared satellite imagery from 7:00 a.m. EST on December 13, 2023, shows cloudiness associated with a storm centered over the southwestern U. S. and more cloudiness just off the West Coast from an approaching Pacific storm system.

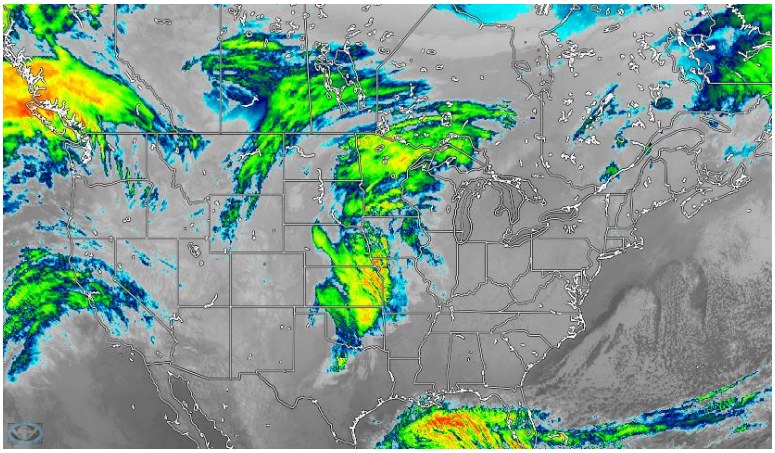
Source: University of Wisconsin RealEarth.



By December 15, the storm from southern Nevada had reached the southern Plains states, while the storm coming from the eastern Pacific was crossing Wyoming, Montana and the Canadian Prairies. After this point, the upper-level features associated with the two storms began to merge.

Infrared satellite imagery from 1:00 p.m. EST on December 15, 2023, shows cloudiness from a storm over the nation's midsection, more clouds from a second storm over Wyoming, Montana and Canada, and clouds growing widespread over the Gulf of Mexico along a stationary front.

Source: University of Wisconsin RealEarth.



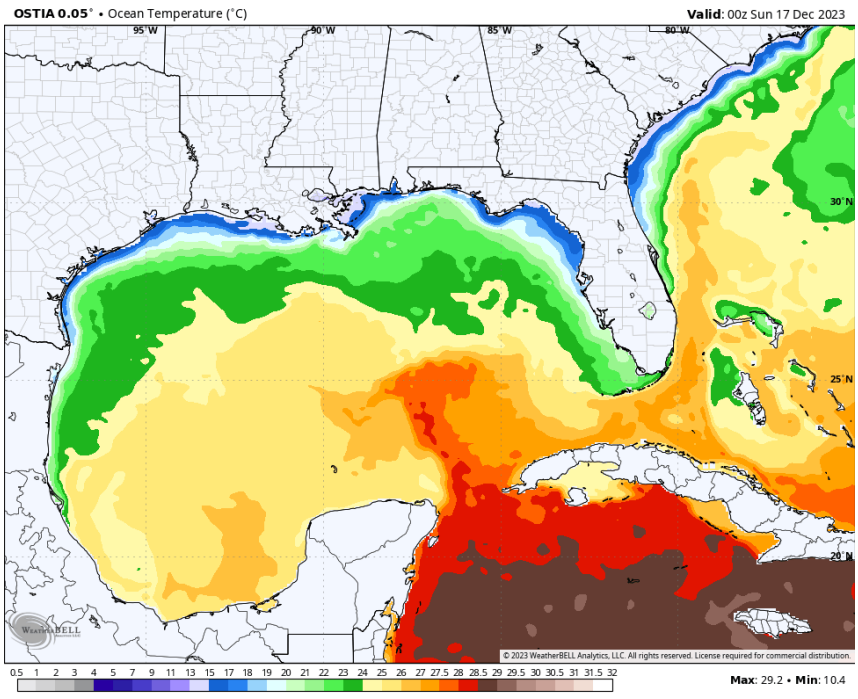
Clouds and thunderstorms began to flare along a stationary front over the Gulf of Mexico as the merger process began. By early December 16, a low-pressure area began to form along this stationary front, which would intensify as it tracked eastward at first on December 16, then northeastward toward Florida's Big Bend.

The storm's development was aided by warmer-than-average water temperatures over the eastern Gulf of Mexico. Most of the area was 0.5-2.0°C (about 1-4°F) warmer than usual for mid-December.

Coastal Storm – Synoptic Summary

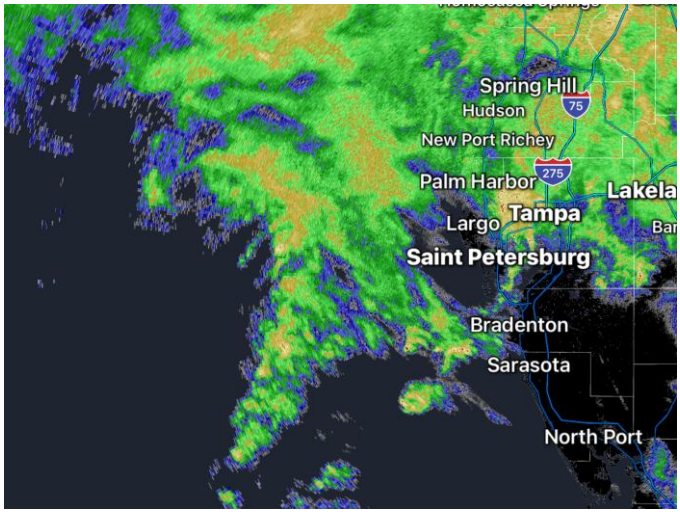
The storm passing over these warm waters helped it to intensify rapidly by similar processes to those occurring in tropical cyclones. The storm's core even briefly resembled that of a tropical cyclone while passing about 100 miles west of Tampa on the evening of December 16. However, this storm did not gain enough tropical characteristics for it to be classified as a tropical or subtropical storm.

Warm waters off the Southeast Coast also played a role in the storm's intensity. Waters beyond the continental shelf were 23-25°C (about 73-77°F), which is 1-3°C (about 2-5°F) above average for the date.



Sea surface temperatures from 7 p.m. EST December 16, 2023, showing temperatures of 24-28°C (75.2-82.4°F) over the southeastern Gulf of Mexico

Image Source: WeatherBELL



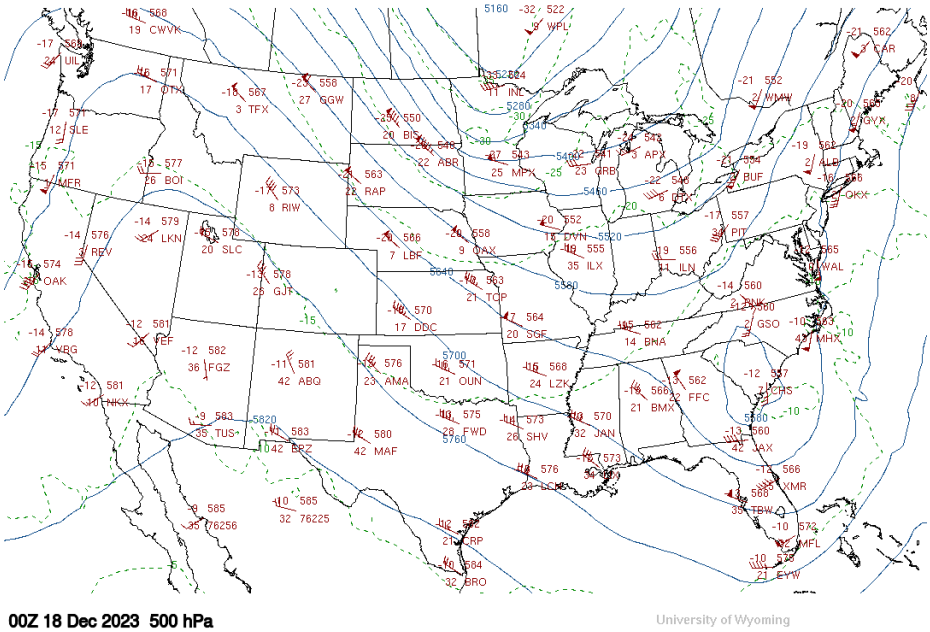
A radar base reflectivity image from 7:09 p.m. EST on December 16, 2023, showing the structure of the storm near its center.

Image Source: RadarScope App

The storm was centered near Jacksonville early on December 17, then it tracked northward along the South Carolina coast during the midday and afternoon hours.

During this time, the storm's forward progress up the coastline slowed considerably as the upper-level features finally coalesced into one, and briefly became detached from the main jet stream aloft. The storm was forced northeastward at a faster rate again on the evening of December 17 as an upper-level trough and accompanying cold front pushed southeastward into the Great Lakes region, acting as a "kicker system" for the coastal storm.

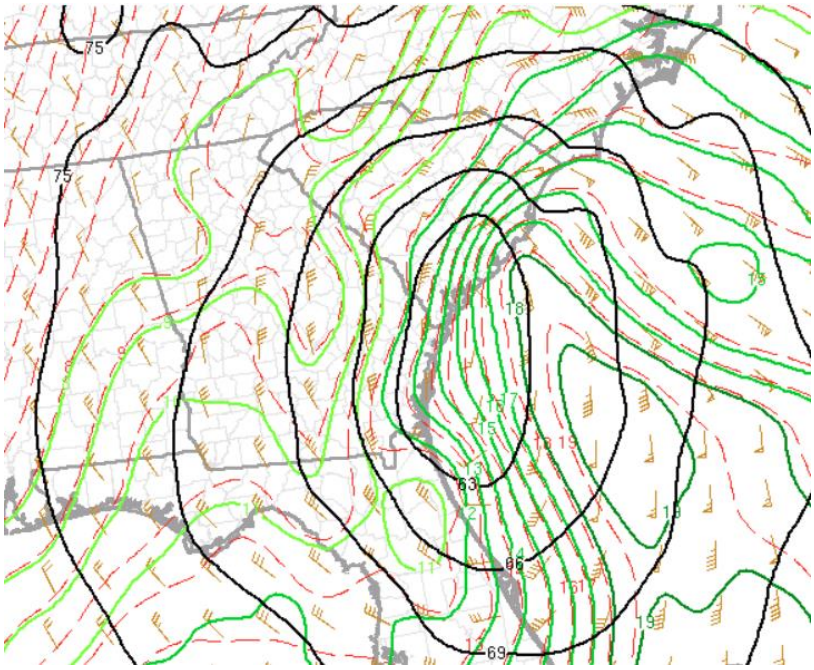
Coastal Storm – Synoptic Summary



This plot of heights of the 500-mb level (around 18,500 feet) from 0000 UTC on December 18, 2023 (7:00 p.m. EST December 17) shows that a closed low had formed aloft over South Carolina, slowing the northeastward progress of the storm. An upper trough digging in over the Great Lakes region that would be the coastal storm's "kicker system" is also evident.

Image source: University of Wyoming Weather Web

Strong winds associated with the storm primarily occurred along the coast. With the storm's center tracking just offshore, most of South Carolina was covered by a cool and stable air mass. The cool and stable air prevented the strong winds aloft from reaching the surface until the surface wind turned to the north in the wake of the storm center's passage.



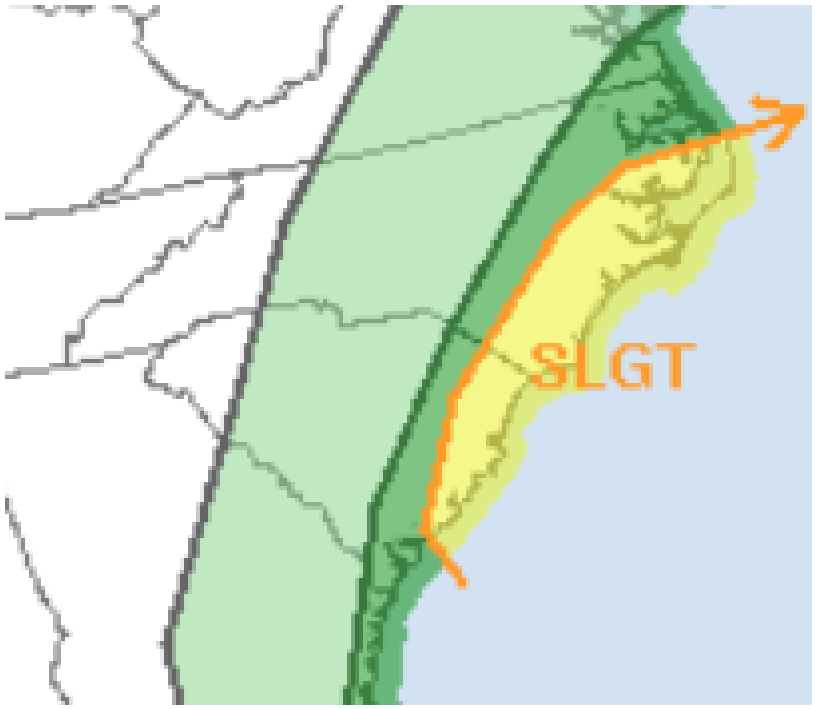
This plot of heights, temperature, dewpoint and wind at the 925 mb level (about 2,100 feet) from 1 p.m. EST on December 17 shows winds of 50-75 knots (58-86 mph) offshore and along the coast.

Image Source: SPC Hourly Mesoscale Analysis Archive

However, the state's coastal areas and the area offshore were in the storm's surface warm sector and unprotected from the strong winds aloft. The storm generated winds aloft from the southeast at up to 85 mph at only around 2,000 feet above the surface. Thunderstorms occurring in a band near the storm's center and near a cold front trailing the storm pulled some of this momentum down to the surface, resulting in strong surface winds that caused tree and power line damage. The strong onshore winds also pushed water ashore near high tide, causing widespread coastal flooding. Heavy rain from the thunderstorms occurring around the same time as the high water exacerbated the flooding.

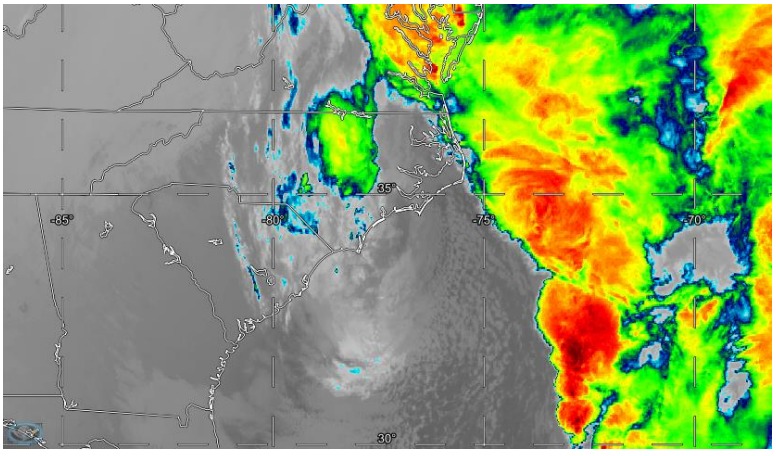
Coastal Storm – Synoptic Summary

The storm's slow forward progress while moving through South Carolina caused the band of thunderstorms to become nearly stationary over Georgetown and Horry Counties. This prolonged both the period with coastal flooding, but also led to prolonged heavy rainfall.



The Storm Prediction Center's Day 1 outlook issued at 12:37 a.m. EST on December 17 highlighted South Carolina's Coastal Plain at risk of severe thunderstorms.

Image Source: Storm Prediction Center



Infrared satellite imagery from 2:00 a.m. EST on December 18 shows the storm centered near Morehead City, NC as it moves away from South Carolina.

Image source: University of Wisconsin RealEarth

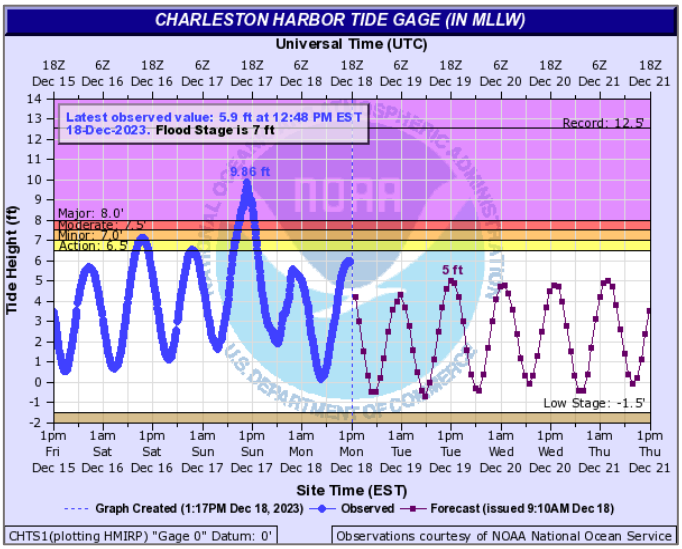
Forecasters were concerned days in advance that a part of South Carolina could see severe thunderstorms associated with the coastal storm, with damaging winds and isolated tornadoes. Thunderstorm-related wind damage occurred in Georgetown and Horry Counties, and a tornado tracked through parts of Socastee and Carolina Forest.

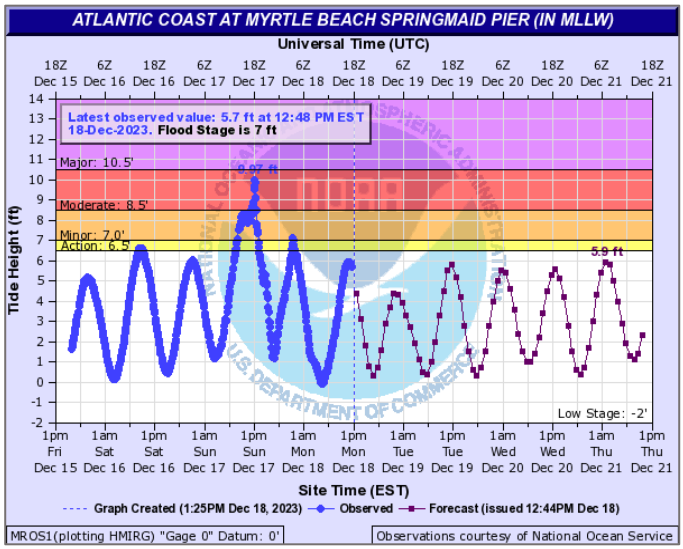
Damaging wind also occurred in Florence County, but not directly related to thunderstorms. These high winds were caused by a gravity wave. Gravity waves behave like ripples on a pond but occur along contrasting air masses in the vertical rather than on a water surface. The wave can transfer the momentum of strong wind aloft to the surface. This occurred over Florence County on December 17. A gravity wave formed along the top of a temperature inversion (where warmer air is present above cool air). The gravity wave pushed strong northeasterly winds aloft to the surface, causing wind gusts of up to 69 mph. A table containing a list of peak wind gusts across South Carolina is on Page 8.

The storm departed South Carolina late on December 17 into December 18. Gusty northwesterly to westerly winds and light to moderate rainfall lingered behind the storm, which tapered from west to east during the evening of December 17.

Coastal Storm – Tides

The storm's track along the South Carolina Coast on the northern side of the circulation, with the prevailing wind direction mainly onshore. This resulted in higher water levels observed along the coastline before the 17th. Unfortunately, the storm impacts occurred during the high tide. The preliminary tide data shows a crest of 9.97 ft MLLW at the Springmaid Pier on Sunday afternoon, which would be the fourth-highest tide at the location, and a crest of 9.86 ft MLLW at the Charleston Harbor Tidal Gauge, which would be the fourth-highest crest on record at the location. The crest at the Charleston Harbor Tidal Gauge is also the highest non-tropical tide of 8.0 ft MLLW or higher on record (1921 – present), surpassing the previous record of 8.81 ft MLLW observed on January 1, 1987.





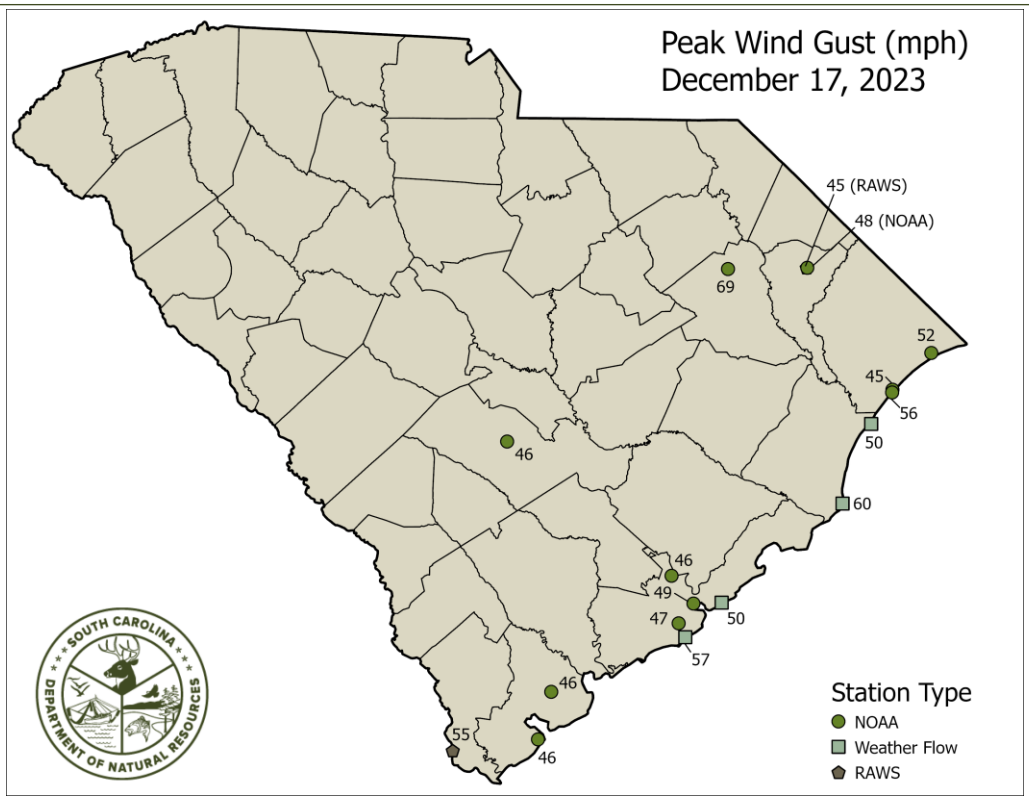
Emergency managers and law enforcement officials reported multiple streets closed due to flooding in Beaufort, Charleston, Colleton, and Georgetown counties. Additional coastal impacts include dune damage and erosion on the Isle of Palms and Kiawah Island.

Flooding in Mt. Pleasant. Courtesy of S. Gibson.

Overwash on Edisto Island. Courtesy of Colleton County EM.

As the storm moved toward the Mid-Atlantic, the wind direction changed (offshore flow), and the water levels dropped below the predicted values as the wind pushed water away from the coast.

Coastal Storm – Wind Gusts



Select Peak Wind Gusts over 45 mph

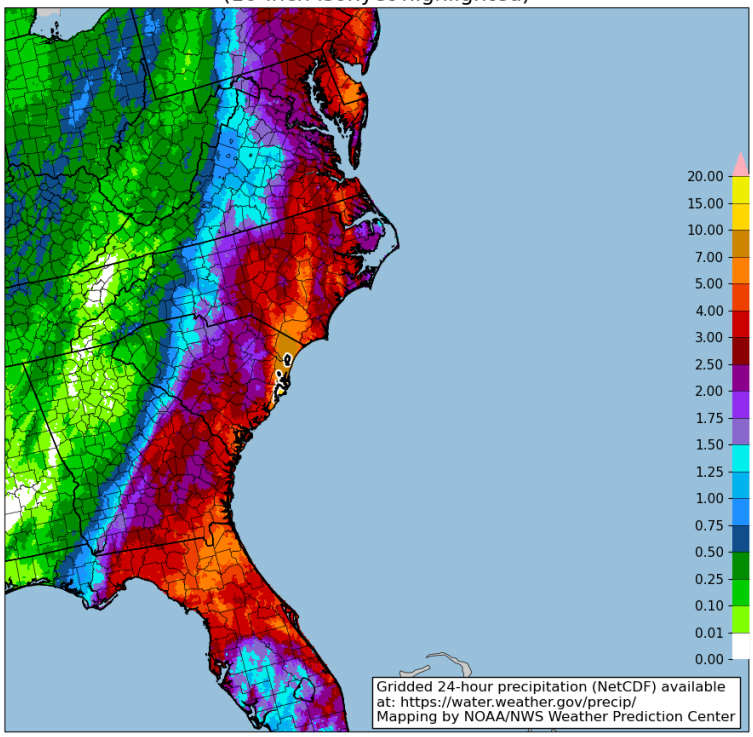
Location	County	Peak Gust (mph)	Time (EDT)	Provider
Florence Regional Airport	Florence	69	1:27 PM	NOAA/NWS
Winyah Bay	Georgetown	60	2:36 PM	WeatherFlow
Folly Beach	Charleston	57	11:06 AM	WeatherFlow
Springmaid Pier	Horry	56	11:42 AM	NOAA/NOS
WFXB-TV	Horry	56	12:20 PM	MESOWEST
Savannah NWR	Jasper	55	11:23 a.m.	RAWS
North Myrtle Beach	Horry	52	11:19 AM	NOAA/NWS
Fort Sumter	Charleston	52	11:03 AM	WeatherFlow
Isle of Palms	Charleston	50	11:10 AM	WeatherFlow
Huntington SP Jetty	Horry	50	12:11 PM	WeatherFlow
Downtown Charleston	Charleston	49	10:06 AM	NOAA/NOS
Marion	Marion	48	1:55 PM	NOAA/NWS
Charleston Int'l Airport	Charleston	46	3:20 PM	NOAA/NWS
Hilton Head Airport	Beaufort	46	8:50 AM	NOAA/NWS
Orangeburg	Orangeburg	46	12:33 PM	NOAA/NWS

Coastal Storm – Rainfall

The highest rainfall totals were reported in Charleston, Georgetown, and Horry counties, which experienced widespread observations of six to twelve inches of rain. One CoCoRaHS observer near McClellanville and one south of Georgetown measured two-day totals of over fourteen inches of rain. Areas of the Midlands and Pee Dee recorded over two inches of rain, and locations in Beaufort and Jasper counties received up to five inches of rain. The Upstate received less than an inch of precipitation from the system.

Additional rainfall totals can be found in a table at the end of the report.

2-day accumulated precipitation (inches) ending 7 am EST, Dec. 18, 2023
(10-inch isohyet highlighted)



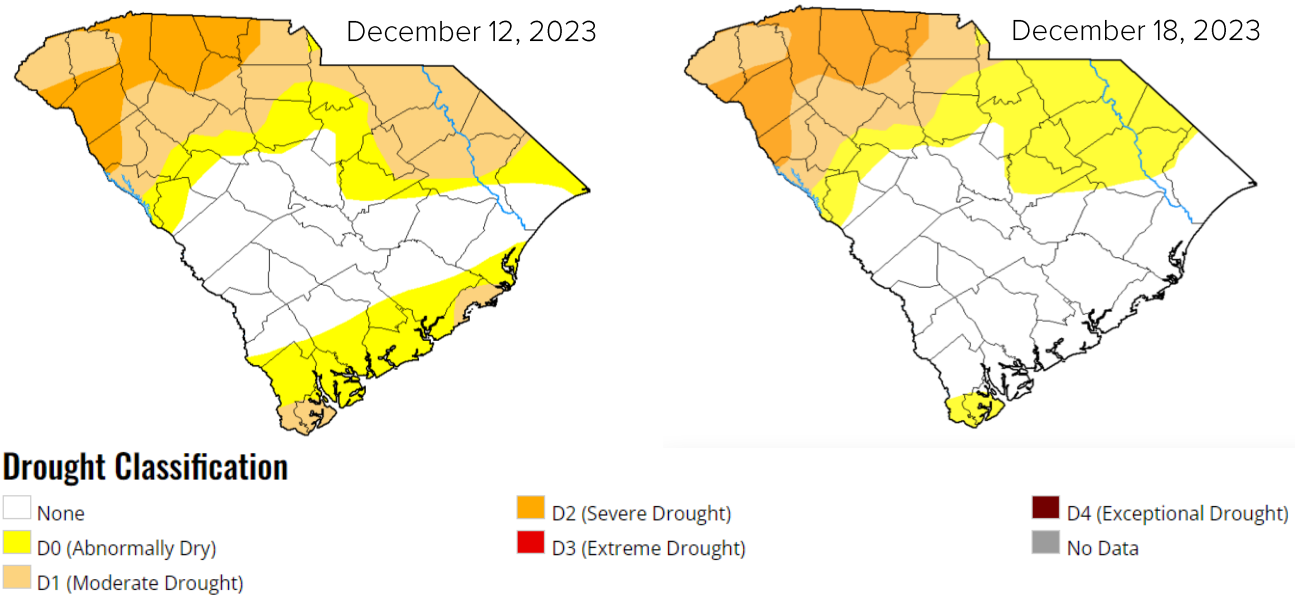
Select Rainfall Reports from Dec 17 – 18, 2023

Station Name	County	Provider	Rainfall (Inches)	Annual Exceedance Probability (%)
McClellanville 0.2 ESE	Charleston	CoCoRaHS	14.59	0.5
Georgetown 11.2 SW	Georgetown	CoCoRaHS	14.42	0.5
McClellanville 0.5 ESE	Charleston	CoCoRaHS	12.88	0.5
Georgetown Co. Airport	Georgetown	NWS	12.45	1
Georgetown 5.3 NNE	Georgetown	CoCoRaHS	11.27	1
Murrells Inlet 2.4 NW	Horry	CoCoRaHS	11.00	1
Hobcaw Barony	Georgetown	CoCoRaHS	10.77	1
Mullins	Marion	NWS	5.52	20
Langley 0.2 SSW	Aiken	NWS	4.69	50
Andrews	Georgetown	NWS	4.50	50
Downtown Charleston	Charleston	NWS	3.92	100
North Myrtle Beach	Horry	NWS	3.77	100

- **Annual Exceedance Probability (AEP):** Percent chance that an event will happen in any given year.

Coastal Storm – Additional Impacts

Drought Improvement



Before the coastal storm's rain, the United States Drought Monitor indicated severe (D2) and moderate drought conditions (D1) in much of the Upstate, with D1 conditions across portions of the northern Midlands and Pee Dee region. Abnormally dry (D0) conditions, with pockets of D1 conditions, were shown in the Lowcountry. After the rain, the USDM map showed improvements in the dry and drought conditions that had persisted in some areas since early October. The Upstate did not receive as much rain as other parts of the states, so the storm had little impact on the drought. Streamflow values across the portions of the state improved from their drought conditions, but the precipitation did not cause any rivers to rise into major flood stage.

Tornado


Storm damage in Myrtle Beach. Courtesy S. Powell

The 2023 Socastee EF-1 Tornado:

- **Rating:** EF1; peak wind 95 mph
- **Date and start time:** December 17, 2023, at 1:16 p.m. EST
- **Narrative:** The tornado touched down south of Socastee Blvd between Everette St. and Tyner St, snapping several large trees and blowing off portions of roofs from a few mobile homes. It moved north, skipped across Socastee Blvd, and eight homes suffered moderate to significant damage from falling trees. The tornado appeared to lift as it crossed the Intracoastal Waterway and touched down again on the Arrowhead Country Club property. Tree debris was blown into several apartments, breaking windows and causing moderate roof and siding damage. Damage upstream of the initial touchdown was straight-line in nature and not the result of a tornado.

Coastal Storm – Photos

Flooding at Folly Beach.
Courtesy of B. Spahr.

Flooding in Mt. Pleasant. Courtesy of S. Gibson.

Erosion at the Isle of Palm. Courtesy of J. Sovine.

Tidal area near Botany Bay Heritage Preserve before coastal storm on December 16 and during high tide on December 17. Courtesy SCDNR Botany Bay WeatherSTEM.

Dune erosion at Kiawah. Courtesy A. Nolte.

Coastal Storm – Photos

Flooding at the SCDNR Marine Resources Division Headquarters facility at Fort Johnson.

SCDNR photo by Justin Yost

Sea oat debris pushed onto the dock at Capers Island.

SCDNR Photo by Lauton Sutley

Additional Rainfall Data

Select Rainfall Reports from Dec 17 – 18, 2023

Station Name	County	Provider	Rainfall (Inches)	Annual Exceedance Probability (%)
Mrytle Beach 8.6 WSW	Horry	CoCoRaHS	9.45	4
Georgetown 13.3 NW	Georgetown	CoCoRaHS	9.41	4
Pawleys Island 2.7 WNW	Georgetown	CoCoRaHS	8.66	10
Mount Pleasant 8.5 NE	Charleston	CoCoRaHS	8.61	4
Hemingway 6.3 SE	Georgetown	CoCoRaHS	8.30	4
Isle of Palms 0.1 E	Charleston	CoCoRaHS	8.17	10
Loris 5.3 W	Horry	CoCoRaHS	8.04	4
Murrells Inlet 1.0 NW	Georgetown	CoCoRaHS	8.02	10
Hilton Head Island 4.7 NW	Beaufort	CoCoRaHS	7.15	20
Conway 10.4 ENE	Horry	CoCoRaHS	6.96	10
Port Royal .01 W	Beaufort	CoCoRaHS	6.74	20
Bluffton 2.9 ENE	Beaufort	CoCoRaHS	6.60	20
Longs 1.3 NW	Horry	CoCoRaHS	6.48	20
Surfside Beach 2.0 N	Horry	CoCoRaHS	6.40	20
Charleston 4.8 SE	Charleston	CoCoRaHS	6.18	20
Okatie 7.6 NE	Beaufort	CoCoRaHS	6.14	20
Hampton 0.2 SW	Hampton	CoCoRaHS	5.84	20
Mullins 4.9 ESE	Marion	CoCoRaHS	5.71	20
Folly Beach 1.3 SSW	Charleston	CoCoRaHS	5.47	50
Daniel Island 1.4 S	Berkeley	CoCoRaHS	5.07	20
Huger 7.7 S	Berkeley	CoCoRaHS	5.05	20
Edisto Beach 0.7 NE	Colleton	CoCoRaHS	4.62	100
Ridgeland 9.9 SSE	Jasper	CoCoRaHS	4.60	50
Varnville 6.7 SW	Hampton	CoCoRaHS	4.51	50
Lodge 3.4 SW	Colleton	CoCoRaHS	4.46	100
Summerville 2.0 SW	Dorchester	CoCoRaHS	4.40	100

Annual Exceedance Probability (AEP): Percent chance that an event will happen in any given year.