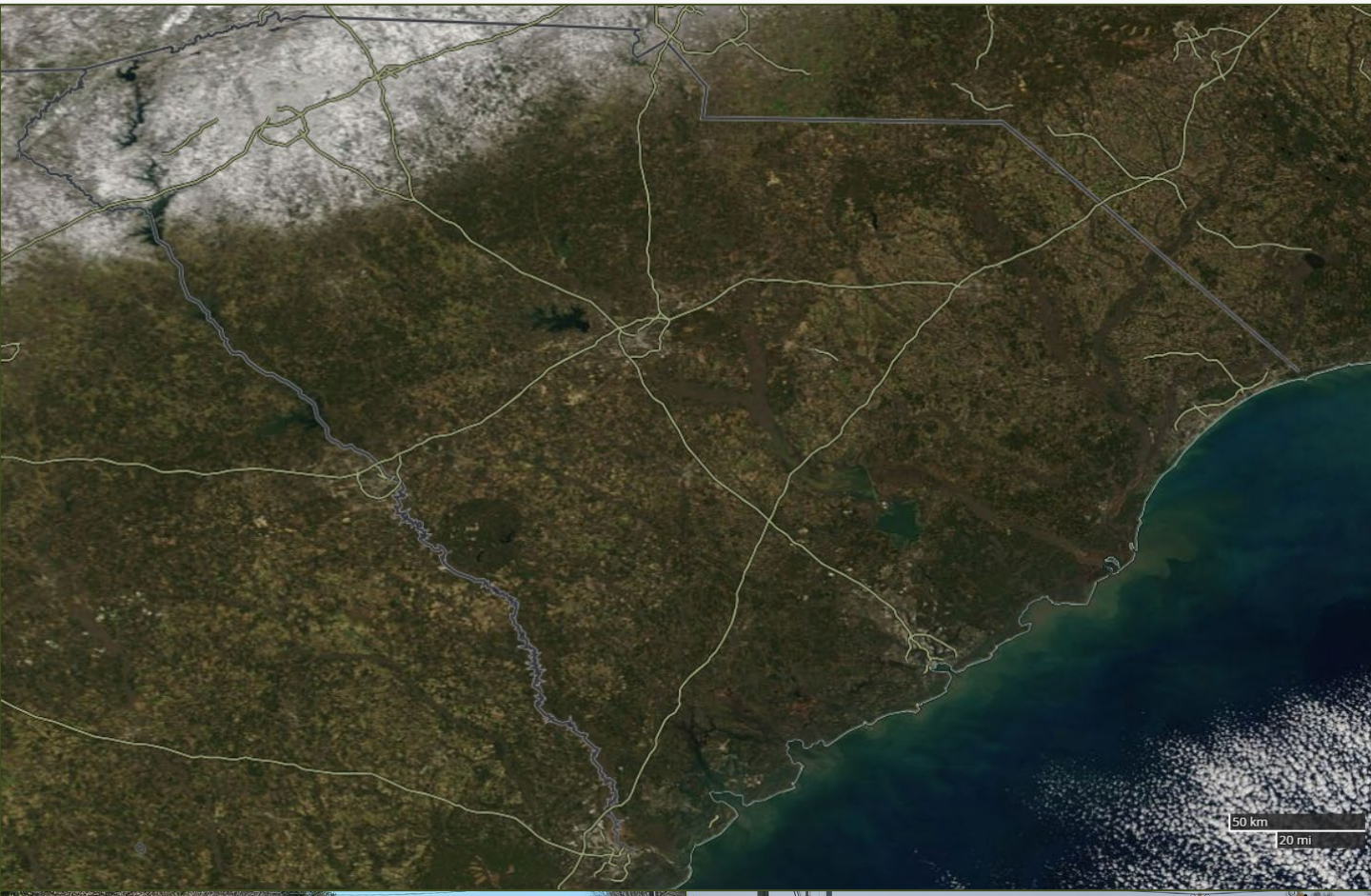
State Climatology Office

Open File Report: Winter Storm of January 16, 2022



South Carolina State Climatology Office
https://www.dnr.sc.gov/climate/sco/
January 12, 2023

This report serves as a preliminary dissemination of information on the impacts of the January 16, 2022, winter storm on the state of South Carolina.

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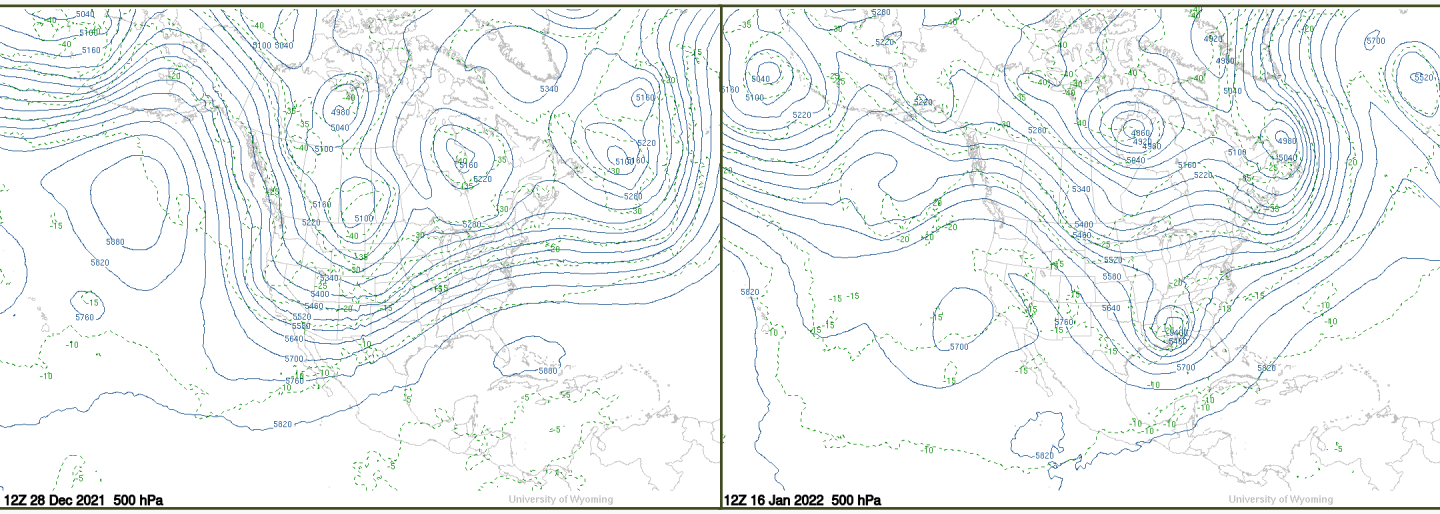
Cover Picture Credits:

Top: A true-color visible satellite picture from the MODIS satellite of South Carolina from the morning of January 18, 2022, showing snow and ice cover lingering over most of the Upstate in the wake of the winter storm of January 16.

Bottom: SCDOT photos showing their plows operating during the storm. On the left is a photo of plows clearing snow from Pelham Road in Greenville. At right is an image showing a plow working to clear S.C. Route 105 in Cherokee County.

After an unseasonably warm December 2021 in South Carolina, there was a major change in the weather pattern around North America in early January 2022. The dominant upper-level ridge over eastern North America that supported the warmth was replaced by an upper-level trough in early January, allowing colder arctic air to invade eastern North America and spread over South Carolina.

The first indication that that a winter storm could occur in the state came from this weather pattern change, which involved the Pacific-North American Pattern (PNA) shifting from its negative phase to its positive phase around January 7. One of the main indicators of the current PNA state is whether an upper ridge (negative phase) or trough (positive phase) is present over the southeastern United States. Another is the presence of an upper ridge (positive phase) or trough (negative phase) over western North America.



Upper-air charts for the 500 hPa (millibar) level showing the weather pattern on December 28, 2021 (left) and January 16, 2022 (right). The weather pattern between these times changed dramatically between one favoring unusual warmth and one favoring below-average temperatures.

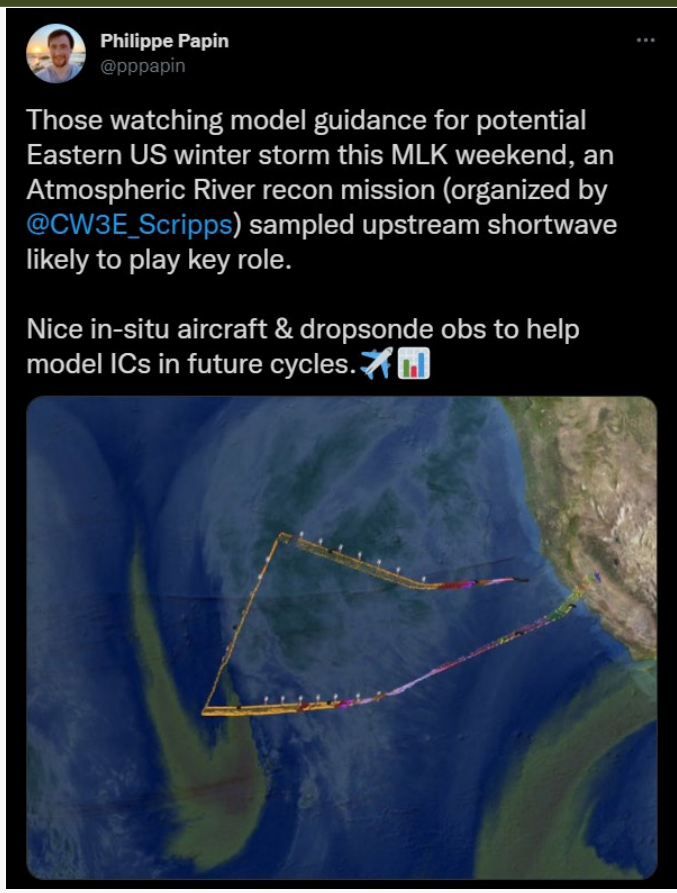
Having an upper-level ridge near western North America and an upper trough over the southeastern United States is a favorable weather pattern for a winter storm to occur in South Carolina. The upper ridge over western North America helps to direct air from Alaska and western Canada southeastward into the eastern two-thirds of the United States. The upper trough over the southeastern United States helps to keep the storm track far enough south that the storm's center will track through or south of the state. This results in the storm's counterclockwise wind circulation bringing northerly or northeasterly winds near the surface during the storm's passage, which will keep colder air flowing into the state during the storm's passage.

Adding to the favorable weather pattern was an upper-level ridge near Greenland, caused by the North Atlantic Oscillation in its negative phase. Having this feature in place tends to produce an upper trough upstream from it over eastern North America. The combination of the negative phase of the North Atlantic Oscillation and the positive phase of the Pacific-North American Pattern is well-known to be favorable for winter storms to occur in the southeastern United States.

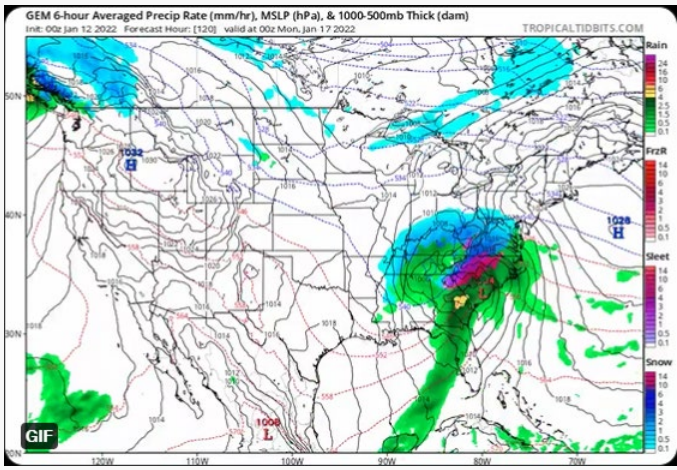
This storm was relatively well forecast several days in advance. Computer model guidance began to show that a winter storm could occur as early as January 10 when the storm was over the Pacific Ocean north of Hawaii. The guidance was likely aided by a research project ongoing at the time over the northeastern Pacific to study 'atmospheric river' phenomena over western North America. Aircraft from the U. S. Air Force 53rd Weather Reconnaissance Squadron, the Hurricane Hunters, were making flights to gather data from storms as they approached western North America. This data gathered by the Hurricane Hunters was fed into the computer models and gave the models better initial conditions around the storm as it approached the coast, leading to better forecasts of the storm.

The January 10 computer model forecasts were already providing strong indication that a winter storm could occur in South Carolina around January 16. This forecast turned out to be better than what would typically be expected at this forecast range. There was good general agreement that near-surface subfreezing air would remain trapped over most of the state in a cold air damming scenario while the storm crossed the region, leading to snow, sleet and freezing rain falling over a large part of the state.

Early indications were that significant snowfall would occur in the Upstate, with hours of freezing rain occurring in an area farther southeast roughly along and north of I-20 leading to a potentially crippling ice accumulation. The early forecasts called for a cold rain along the Coastal Plain with temperatures above freezing for most or all of the event.



A Twitter tweet by South Carolina native Dr. Philippe Papin, now a Hurricane Specialist at the National Hurricane Center, describing how observations from Atmospheric River research were being incorporated into computer models, improving their forecasts.

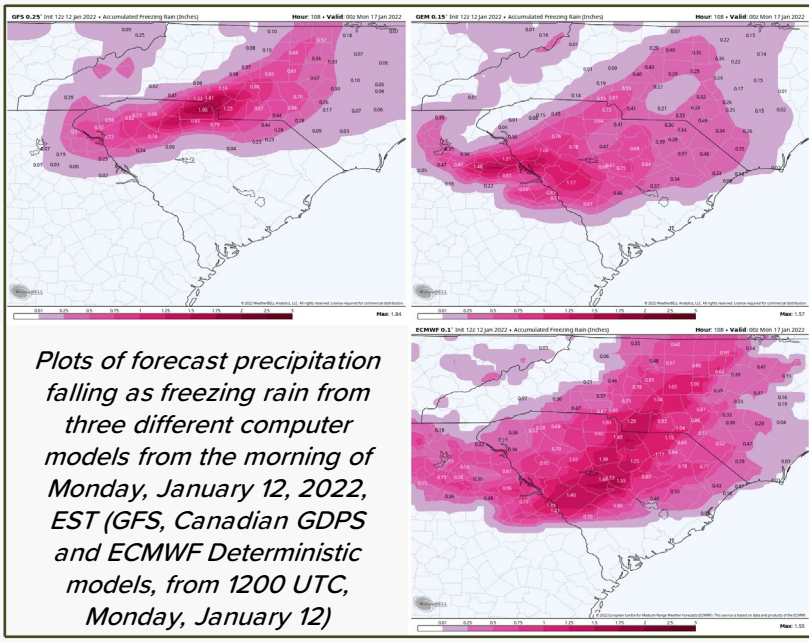


A plot of surface pressure and precipitation categorized by precipitation type from tropicaltidbits.com from the Canadian GDPS model run from 0000 UTC on January 12, 2022, valid for the evening of January 16, 2022.

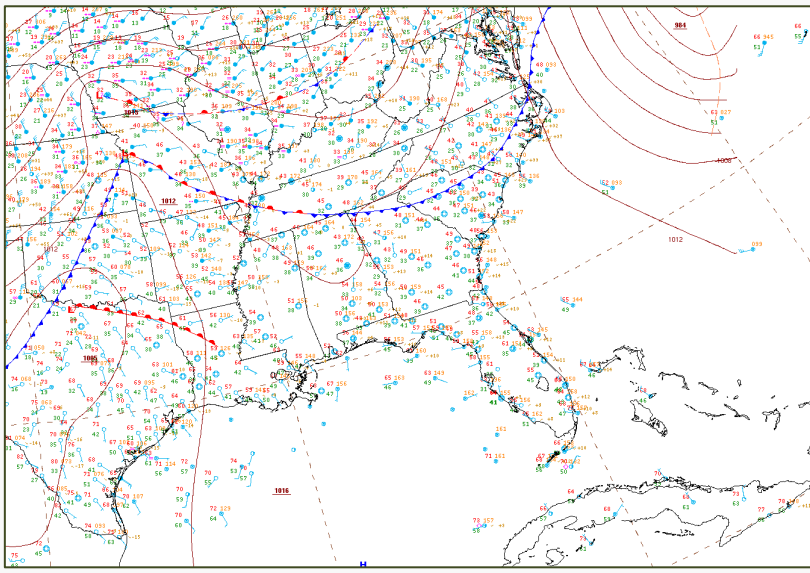
There were, however, differences between the computer models which led to uncertainty about the placement of heaviest snow and worst ice accretion that South Carolina would see. These differences were still present up to the day before the event, adding to the challenge of producing an accurate forecast.

A cold front which moved through South Carolina during the evening of Saturday, January 15 set the stage ushering in a very cold air mass. Under the surface high pressure area passing by to the north, high temperatures this day were in the single digits and teens Fahrenheit over the Midwest, Northeast and southern Ontario, Canada. This air followed northeasterly winds around the high east of the Appalachian Mountains and into South Carolina through Sunday, January 16. This resulted in cold air becoming entrenched in the state ahead of the approaching storm and ensuring that snow, sleet and freezing rain would fall over most of the Upstate.

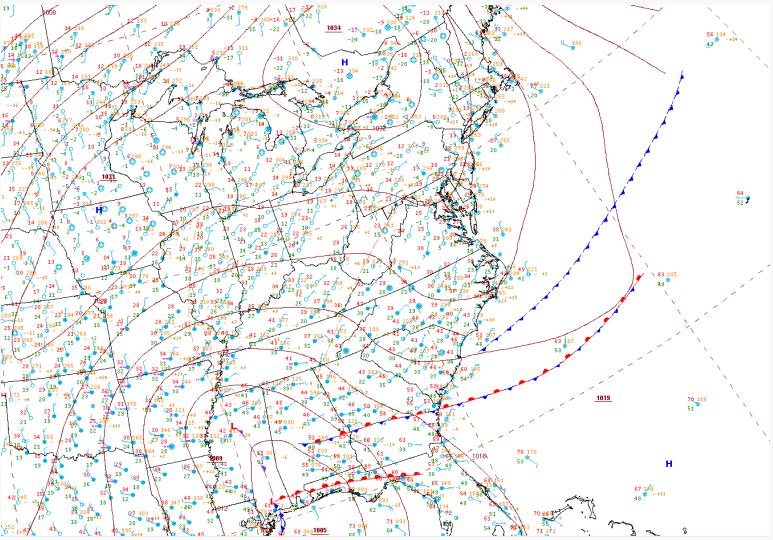
The surface low pressure area tracked from southern Mississippi on the evening of Saturday, January 15 to east-central Alabama early on Sunday morning. From there, the surface low moved to southwestern Virginia and weakened, while a new surface low formed over the lower Savannah River and tracked toward Norfolk, Virginia. At the same time, arctic high pressure muscled into the Carolinas and became dammed by the Appalachian Mountains, forming a ‘wedge’ of subfreezing air over the Upstate, Midlands and Pee Dee regions of South Carolina.



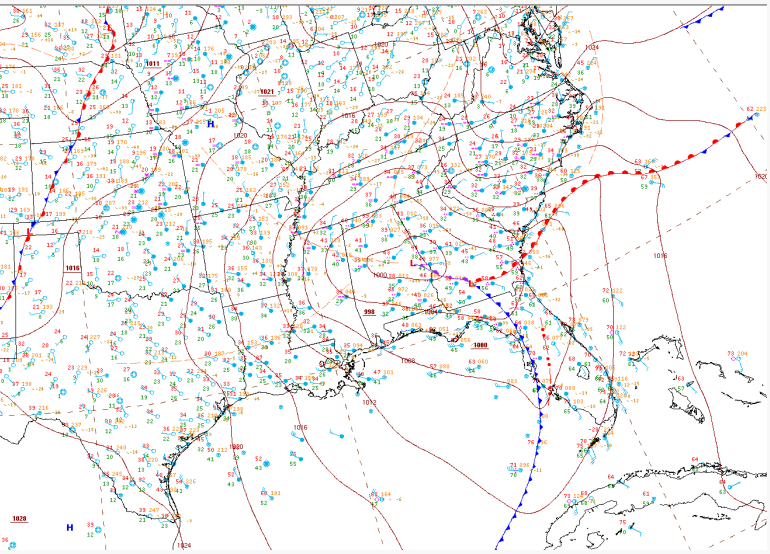
Plots of forecast precipitation falling as freezing rain from three different computer models from the morning of Monday, January 12, 2022, EST (GFS, Canadian GDPS and ECMWF Deterministic models, from 1200 UTC, Monday, January 12)



Above: Surface Analysis from the Weather Prediction Center (WPC) for 0000 UTC, Saturday, January 15 (7 p.m. Friday EST), depicting a cold front crossing South Carolina. Only spotty light rain occurred as this cold front moved through the state. At the time, the approaching storm was centered near Kansas City.



Surface Analysis from WPC for 0000 UTC, Sunday, January 16 (7 p.m. Saturday EST). Strong high pressure was centered over southern Ontario, Canada and the winter storm centered near Gulfport, Mississippi.



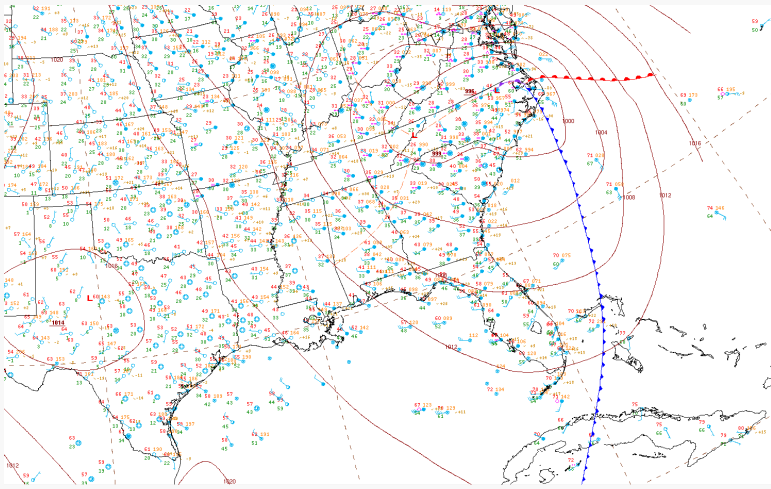
Surface Analysis from WPC for 1200 UTC, Sunday, January 16 (7 a.m. Sunday EST). The storm was centered over east-central Alabama.

The heaviest precipitation affected South Carolina during the morning of Sunday, February 16, starting just after midnight across the Upstate and Central Savannah River Area (CSRA). This was mostly snow and sleet along and north of I-85, where several inches accumulated. Over the rest of the Upstate and the northern Midlands, the precipitation was largely sleet and freezing rain with ice accretion as thick as one-half inch. The CSRA, southern Midlands and southern Pee Dee saw a period of freezing rain which turned to rain as temperatures rose. The heaviest precipitation exited the state during the early afternoon hours of Sunday. However, a second wave of light to moderate precipitation occurred during the late afternoon and evening hours while the upper-level low associated with the storm passed through the region. This was largely snow across the Upstate, leaving generally a trace to two inches. In the Catawba River area, this was the only significant snowfall from this storm, with accumulations also generally a trace to two inches. Farther south, rain fell which ended as snow over the Midlands and Central Savannah River Area. The northern part of this area saw small accumulations of generally one-half inch or less.

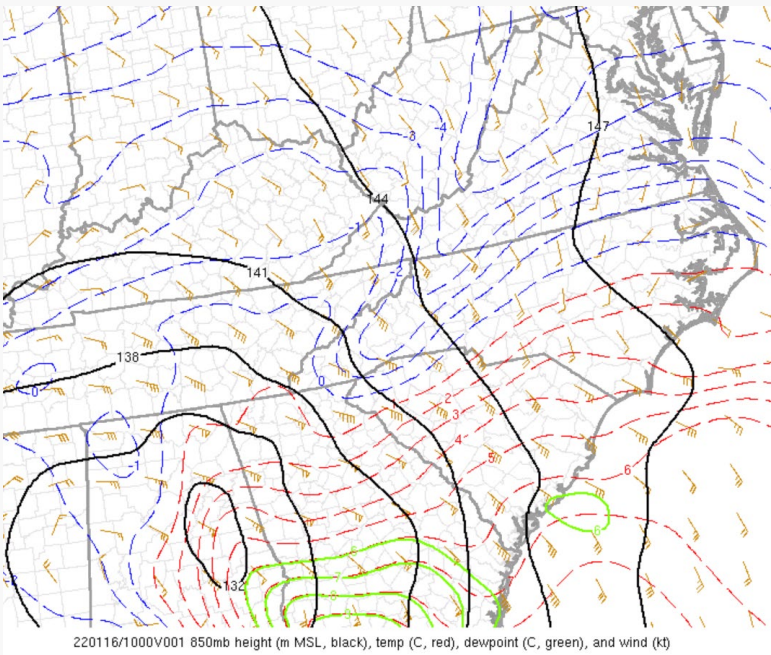
In addition to the wintry precipitation, a period of strong winds occurred on Sunday morning. Highest gusts exceeded 50 mph in a few places around the Upstate and Lowcountry which was about 10 mph stronger than forecast. The winds combined with snow resulted in hazardous travel. As the storm departed, a second period of strong winds began Sunday night and continued through most of Monday, with peak gusts around 40 mph. These gusty winds further stressed trees and power lines already weighted down with snow and ice, contributing to damage from the storm.

As the storm moved toward the East Coast, it exhibited a Miller B type storm track, where the original surface low moves to the southern or central Appalachian Mountains, while a new surface low forms along the coastal areas and tracks northward. This would be a Type 3 storm using the Brown *et. al.* classification scheme. Storms following this type of progression typically cause a variety of precipitation types.

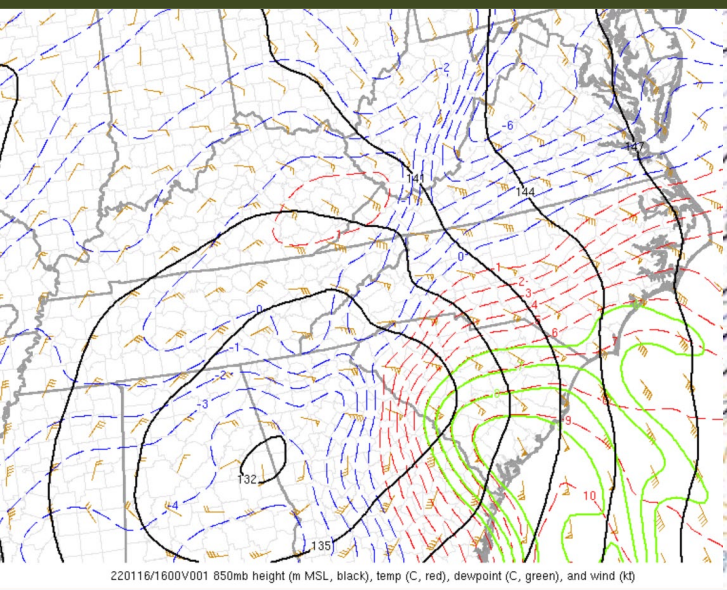
This was the case across South Carolina; most of the state saw more than one precipitation type. Areas south of I-20 saw only a brief period of sleet and freezing rain before a turn to rain occurred. However, most of the Lowcountry say just a cold rain. In the mountains, sleet mixed with the snow for a time. The reason for this was warm air aloft surging into the storm from the southeast while precipitation was ongoing. This created a layer of above-freezing air aloft, often called a 'warm nose' by meteorologists. With this storm, the best visualization of the extent of this layer came from an analysis of the 850 hPa (millibar) level, the height of which varies, but was near 4,500 feet while this storm affected South Carolina. Temperatures were above freezing at this level over nearly the entire state at some point during the storm with temperatures below freezing near the surface. This resulted in much of the state seeing freezing rain and sleet, with only the area northwest of I-85 seeing predominantly snow falling with only a couple of hours of sleet and freezing rain.



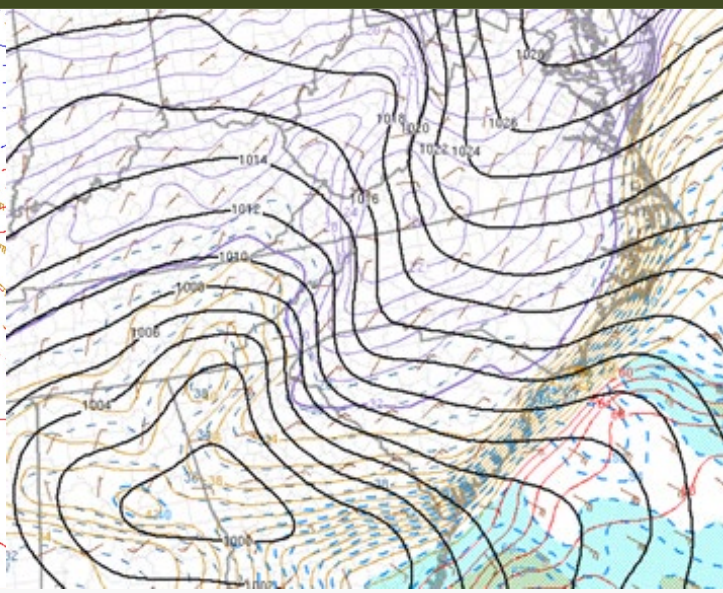
Surface analysis from the WPC for 0000 UTC, Monday, January 17 (7 p.m. Sunday EST). The original surface low was dissipating near the North Carolina-Tennessee state line and a new surface low which had formed near the coast was centered near Roanoke Rapids, NC.



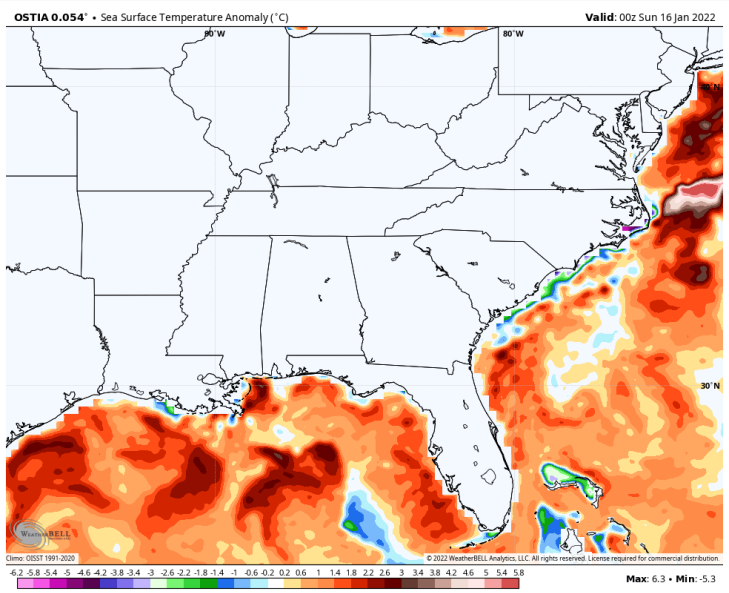
850 hPa analysis from the Storm Prediction Center Mesoanalysis website for 1000 UTC, Sunday, January 16 (5 a.m. Sunday EST), showing temperatures above freezing (red isotherms depicting temperatures at one-degree Celsius intervals) at this level over nearly all of South Carolina as well as strong southeasterly winds at this level.



850 hPa analysis from the Storm Prediction Center Mesoanalysis website for 1600 UTC, Sunday, January 16 (11 a.m. Sunday EST), showing temperatures at this level still above freezing (isotherms at one-degree Celsius intervals; blue isotherms indicate temperatures at or below freezing) over nearly all the state. At the time, nearly all of South Carolina was still seeing precipitation.



Surface analysis from the Storm Prediction Center Mesoanalysis website for 1600 UTC, Sunday, January 16 (11 a.m. Sunday EST), showing surface temperatures at or below freezing (the bold purple isotherm indicates 32°F surface temperatures) roughly along and north of I-20. At the time, rain was falling where surface temperatures were above freezing and freezing rain or sleet was falling in most areas where surface temperatures were at or below freezing. Only the mountain areas of the state were seeing mostly snow at the time.



OSTIA sea surface temperature anomaly plot for Sunday, January 16, 2022, showing above-average water temperatures off the East Coast and over much of the Gulf of Mexico. Image credit: WeatherBELL

Another factor to consider was that sea surface temperatures through most of the Gulf of Mexico and the area off the East Coast of the U. S. beyond the continental shelf were well above normal for January. This can largely be attributed to the well-above-normal temperatures and frequently cloud-free skies of December 2021 throughout this region. These warm waters helped to feed additional moisture and warmth to the storm. It is one reason why the warm layer aloft was as expansive as it was, and a reason why the southern half of the state managed to escape the storm with little or no winter precipitation.

Impacts on South Carolina

As the storm approached South Carolina, Governor Henry McMaster declared a State of Emergency on Friday, January 14, to last for 15 days. The declaration contained the following provisions:

- Activated the South Carolina National Guard to assist with storm preparations and relief efforts
- Allowed state agency directors to suspend regulations that could hinder storm preparations and recovery
- Allowed the Department of Public Safety to suspend enforcement of some transportation regulations for vehicles involved in storm preparation and recovery in South Carolina or a surrounding state
- Allowed other state agency directors to change state business procedures to assist with storm preparation and recovery
- Put restrictions on 'price gouging' into effect

The South Carolina Emergency Management Division partially activated the State Emergency Operations Center on January 14 at OPCON 2.

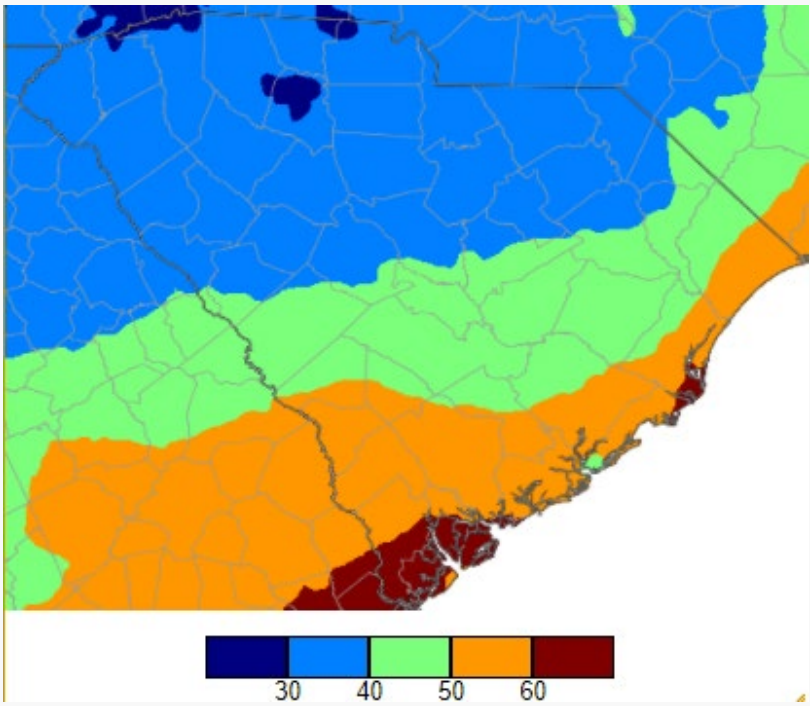
Travel became hazardous across the state on Sunday, January 16. The South Carolina Highway Patrol dealt with 1,124 calls for service, 294 of them for collisions. A 13-mile segment of I-26 in Newberry County was closed for a time due to icy conditions, according to The State newspaper. The State also reported that trees and branches due to ice accretion led to blocked roads at times over the northern Midlands, including stretches of I-77 and I-20.

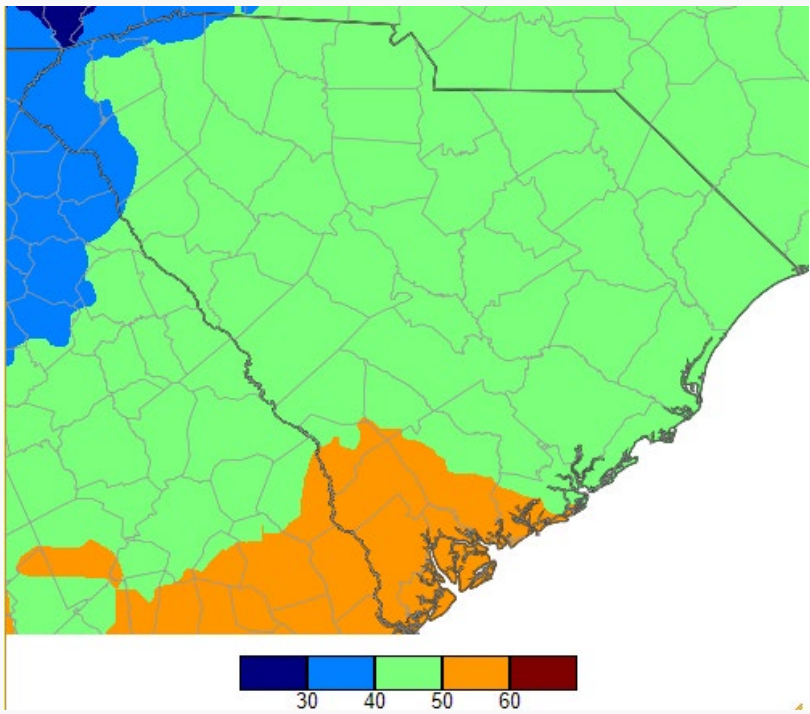
The combination of snow and ice with strong winds led to widespread power outages over the Upstate and northern Midlands. At the height of the storm, an estimated 105,000 homes in South Carolina lost electrical service according to South Carolina Emergency Management Division.

A picture of snowfall from Long Creek, where eight inches fell on January 16. Photo credit: Nicci Hanewald

The snow was slow to melt because a fresh arctic air mass arrived immediately behind the storm. High temperatures across the Upstate were only in the 30s and low 40s the following day with some areas staying below or just barely reaching the freezing mark. Refreezing occurred the night of Monday, January 17 with lows the morning of Tuesday, January 18 across this area ranging from the high teens to middle 20s. Slow snowmelt occurred on Tuesday with highs only in the upper 30s and low 40s. This led to slippery secondary roads for Tuesday night and Wednesday, January 19 with temperatures falling into the 20s again over most of the area. Warmer air arrived on Wednesday afternoon, with faster snowmelt and few travel difficulties past this point.

Having the storm hit on a Sunday followed by the Martin Luther King Day holiday on January 17 meant that school and government office closures were fewer than what would have occurred otherwise. However, due to the cold weather behind the storm and slow melting of the snow and ice, some school districts delayed school on Tuesday and Wednesday, January 17 and 18, or held classes online, and government offices opened late on those days in parts of the Upstate.





High temperatures on January 17, 2022 (above) and January 18, 2022 (below) in degrees Fahrenheit

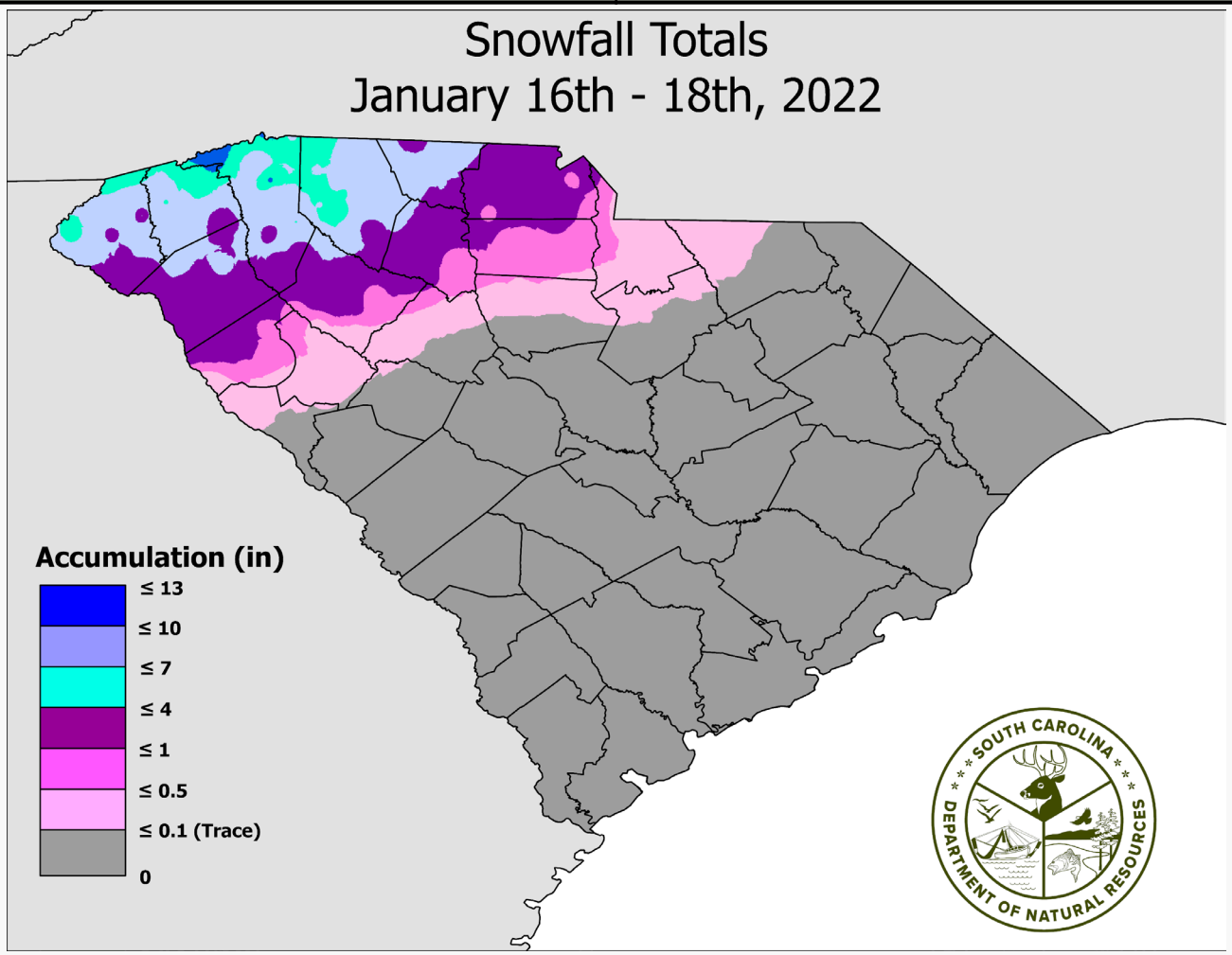
Images from the SC ACIS website

State Climatology Office

Snowfall Reports

Selected Snowfall Reports
January 16-17, 2022

Location	Snow (Inches)	Station Type	Location	Snow (Inches)	Station Type
Caesars Head	12.5	COOP	Pickens	7.0	COOP
Taylors 6.1 NNW	10.6	CoCoRaHS	GSP Int'l Airport	6.5	NOAA
Jocassee 8 WNW	9.0	CoCoRaHS	Blacksburg 3.2 NW	5.3	CoCoRaHS
Duncan 1.6 SSE	8.7	COOP	Clemson University	4.0	COOP
Moore 4.9 NW	8.5	CoCoRaHS	Walhalla	3.0	COOP
Roebuck 3.9 W	8.4	CoCoRaHS	Anderson	3.0	COOP
Long Creek	8.0	COOP	Laurens	2.0	COOP
Travelers Rest 2.4 ESE	8.0	CoCoRaHS	Antreville	2.0	COOP
Table Rock	7.9	COOP	Catawba	0.9	COOP
Spartanburg 5.1 WSW	7.6	CoCoRaHS	Clinton	0.5	COOP

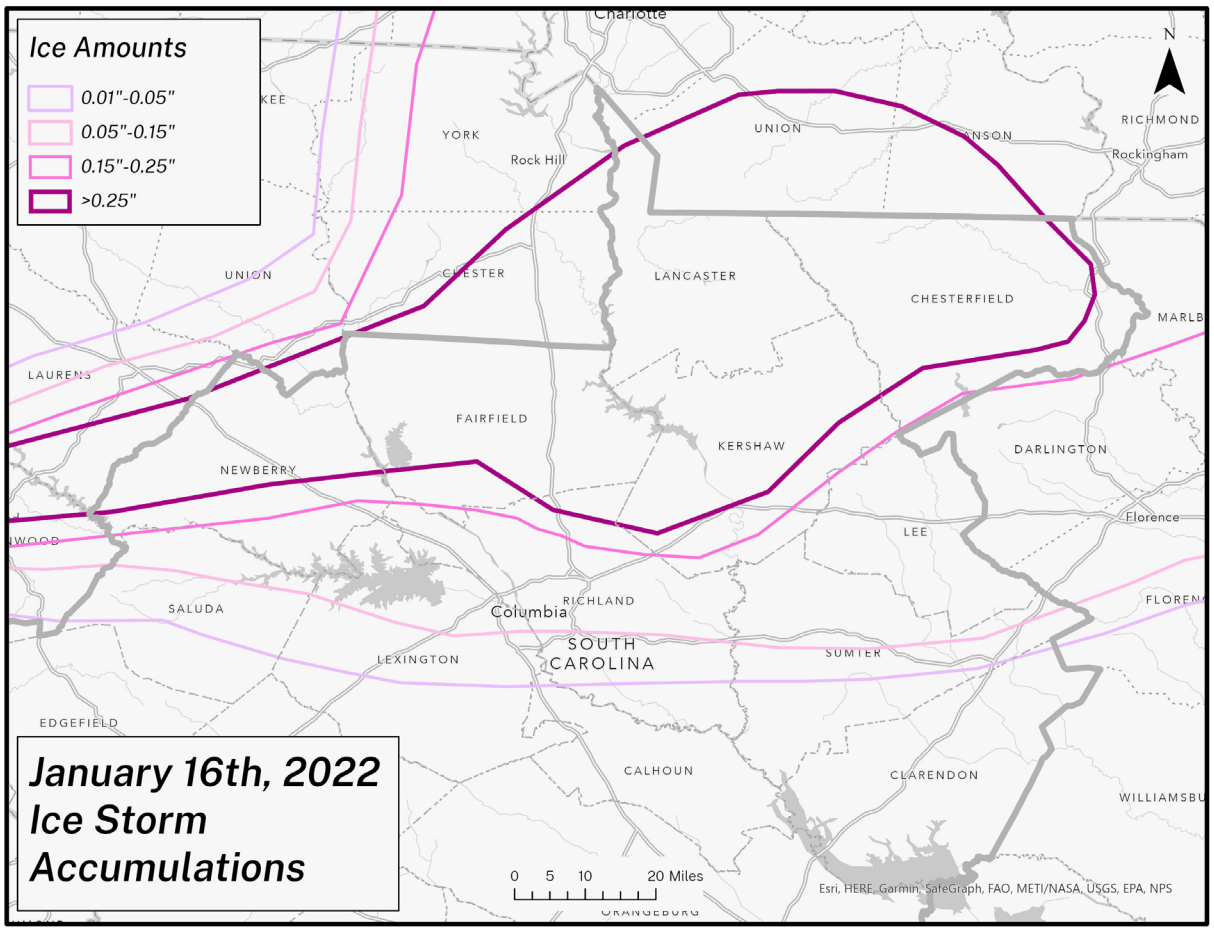


State Climatology Office

Ice Accretion Reports

Selected Ice Accretion Reports
January 16, 2022

Location	Snow (Inches)	Station Type	Location	Snow (Inches)	Station Type
Kershaw	0.50	Spotter	3 SW Bennettsville	0.20	Airplane Pilot
9 W Pageland	0.50	Spotter	N . Hartsville	0.15	Public
Jefferson	0.35	Public	1 NNE Clyde	0.12	Spotter
Lancaster	0.25	Public	Sumter	0.10	Spotter
Blythewood	0.25	Public	Columbia	0.10	Public
Elgin	0.25	Public	West Columbia	0.10	Public
Winnsboro	0.25	Public	Lexington	0.10	Public
5 WNW Pageland	0.25	Public	Latta	0.10	Public
Heath Springs	0.20	Public	2 SE Florence	0.10	Public
7 NE Elgin	0.20	Fire/Rescue	6 ENE Mullins	0.10	Public



Map of ice accretion across north-central South Carolina from the Columbia National Weather Service office

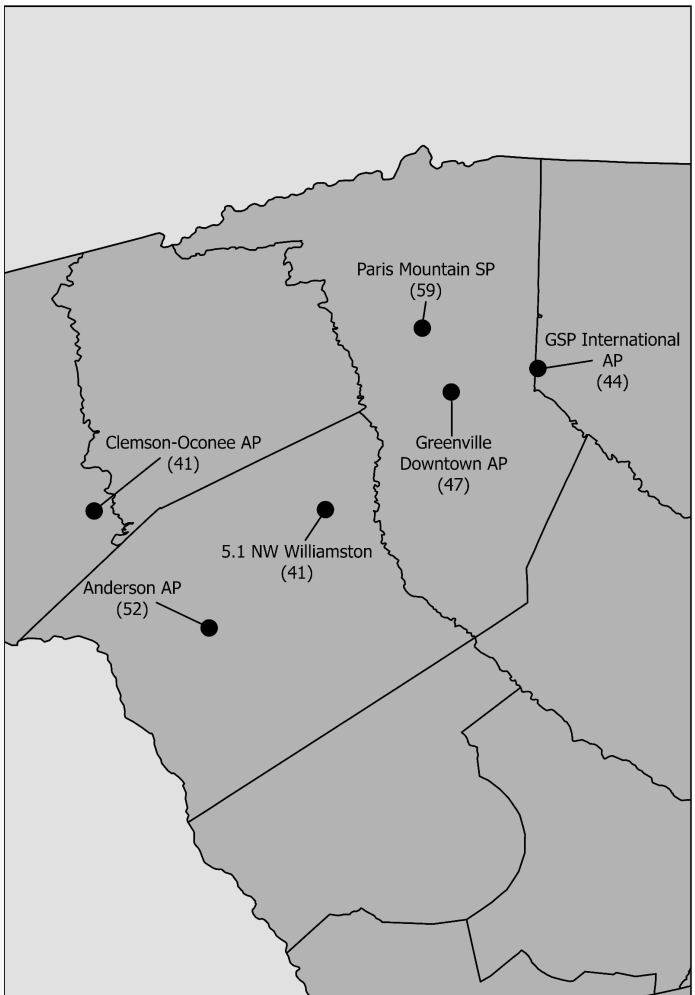
State Climatology Office

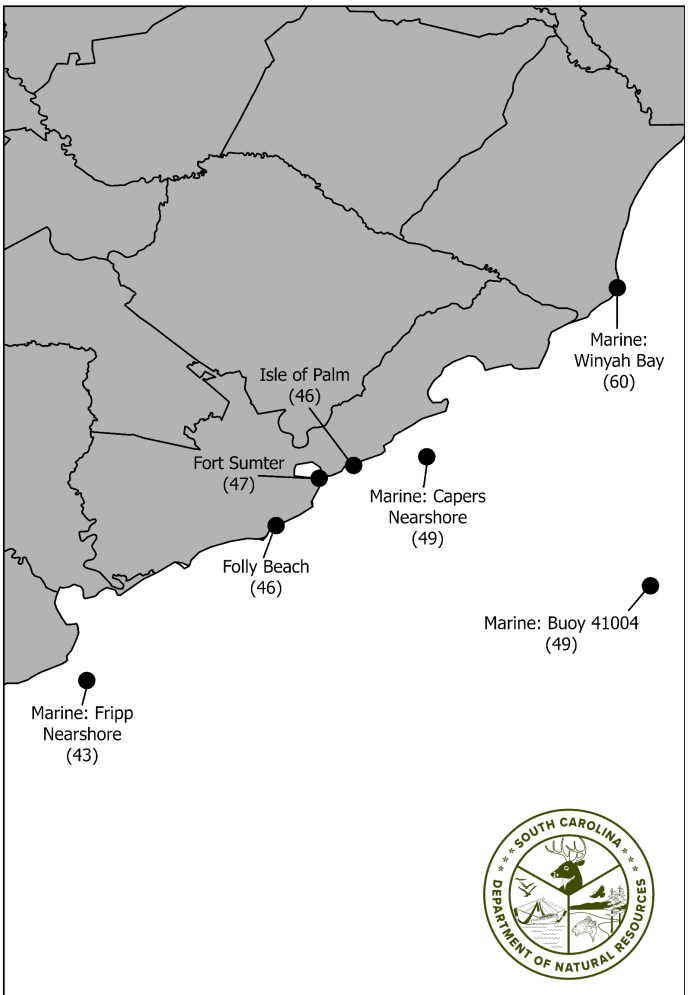
High Wind Reports

High Wind Reports
January 16, 2022

Location	Peak Gust (mph)	Station Type	Location	Peak Gust (mph)	Station Type
Paris Mountain SP	59	WeatherSTEM	5.1 NW Williamston	41	SCDOT
Anderson Airport	52	NOAA	Clemson-Oconee Airport	41	NOAA
Fort Sumter	47	WeatherFlow	Winyah Bay (Marine)	60	WeatherFlow
Folly Beach	46	WeatherFlow	Buoy 41004 (Marine)	54	NOAA
Isle of Palms	46	WeatherFlow	Capers Nearshore (Marine)	49	NOAA
Shutes Folly	46	WeatherFlow	Buoy 41008 (Marine)	45	NOAA
GSP Int'l Airport	44	NOAA	Fripp Nearshore (Marine)	43	NOAA
Greenville Donaldson	41	NOAA	Calibogue Sound (Marine)	43	WeatherFlow

Peak Wind Gusts (MPH) on January 16th, 2022





Acknowledgements

The South Carolina State Climate Office would like to thank the following entities which contributed data or photos for this report:

- The Greenville-Spartanburg, Columbia, Charleston and Wilmington National Weather Service Offices
- NWS Storm Prediction Center
- NOAA Northeast Regional Climate Center's xmACIS website
- South Carolina Emergency Management Division
- South Carolina Department of Public Safety
- South Carolina Department of Transportation
- The University of Wyoming
- The State Newspaper