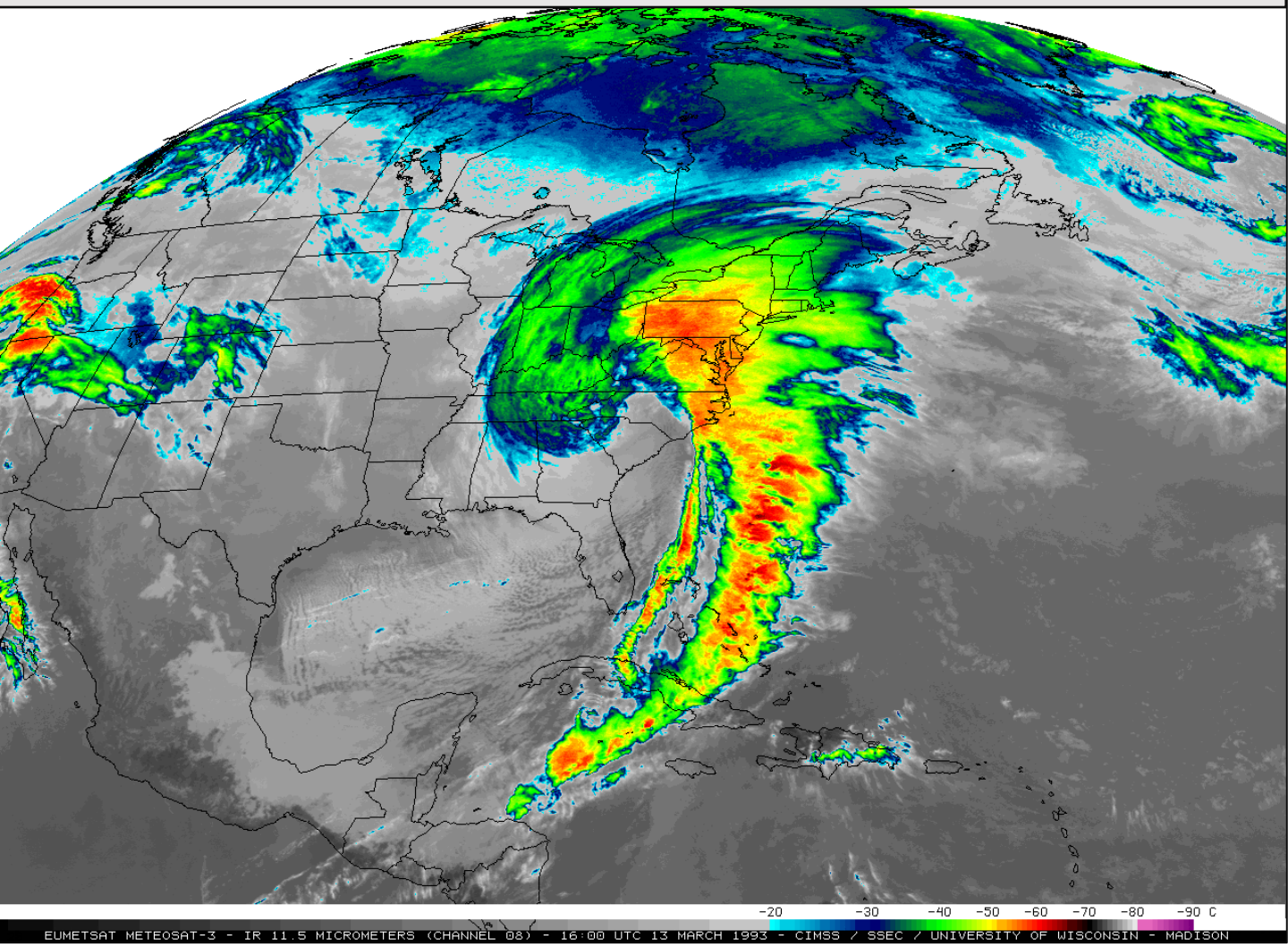
Winter Storms Of South Carolina: A Summary



Infrared satellite image of the March 1993 winter storm while centered near Columbia. This storm set several snowfall, wind and barometric pressure records for locations in South Carolina. Image from the University of Wisconsin CIMMS Satellite Blog

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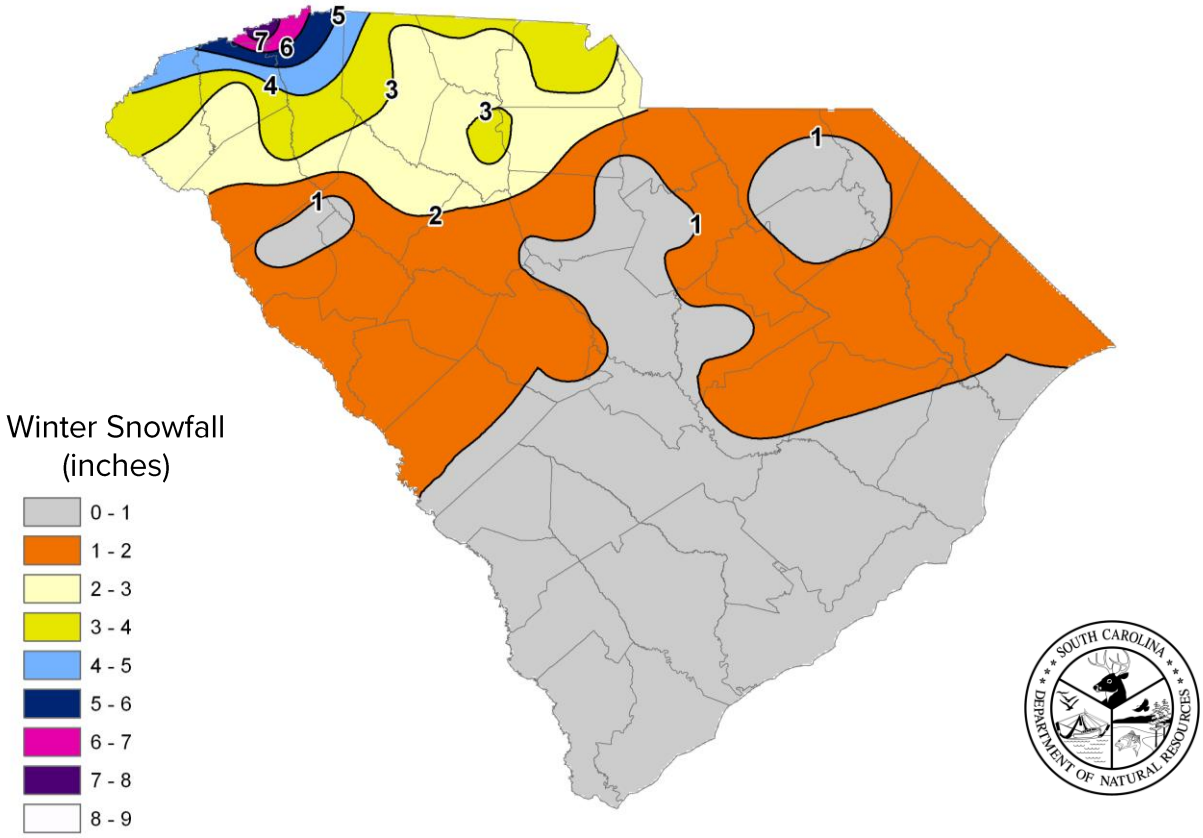
South Carolina's Winter Storm Climatology

Winter precipitation events in South Carolina are usually high-impact situations because of their rarity. In the Upstate, two or three winter storms with snow or ice accumulation or freezing rain accretion typically occur per winter season. The Midlands and Pee Dee average about one winter precipitation event per season, whereas it may be a couple of years between winter events in the Lowcountry. Most of the state averages two inches or less of snowfall each year. The annual snowfall average increases as you move from the Piedmont to the mountains, with a mean annual snowfall of 5 to 7 inches at the State's highest elevations. Many of the winter weather events that impact SC include a combination of snow, sleet, and freezing rain.

South Carolina Average Winter Snowfall 1950 - 2020



Due to the state's low-latitude location, winter storms are quite rare in South Carolina outside of the coldest months of the year. Nearly all the winter storms in the state's recorded history have occurred between the last week of December and the first week of March. The earliest accumulating snow ever recorded in the state occurred on November 1 (of 2014, in Lexington County and some surrounding areas). The latest measurable snow on record occurred on May 7 (of 1992, at Caesars Head).

South Carolina's Winter Storm Climatology Extremes

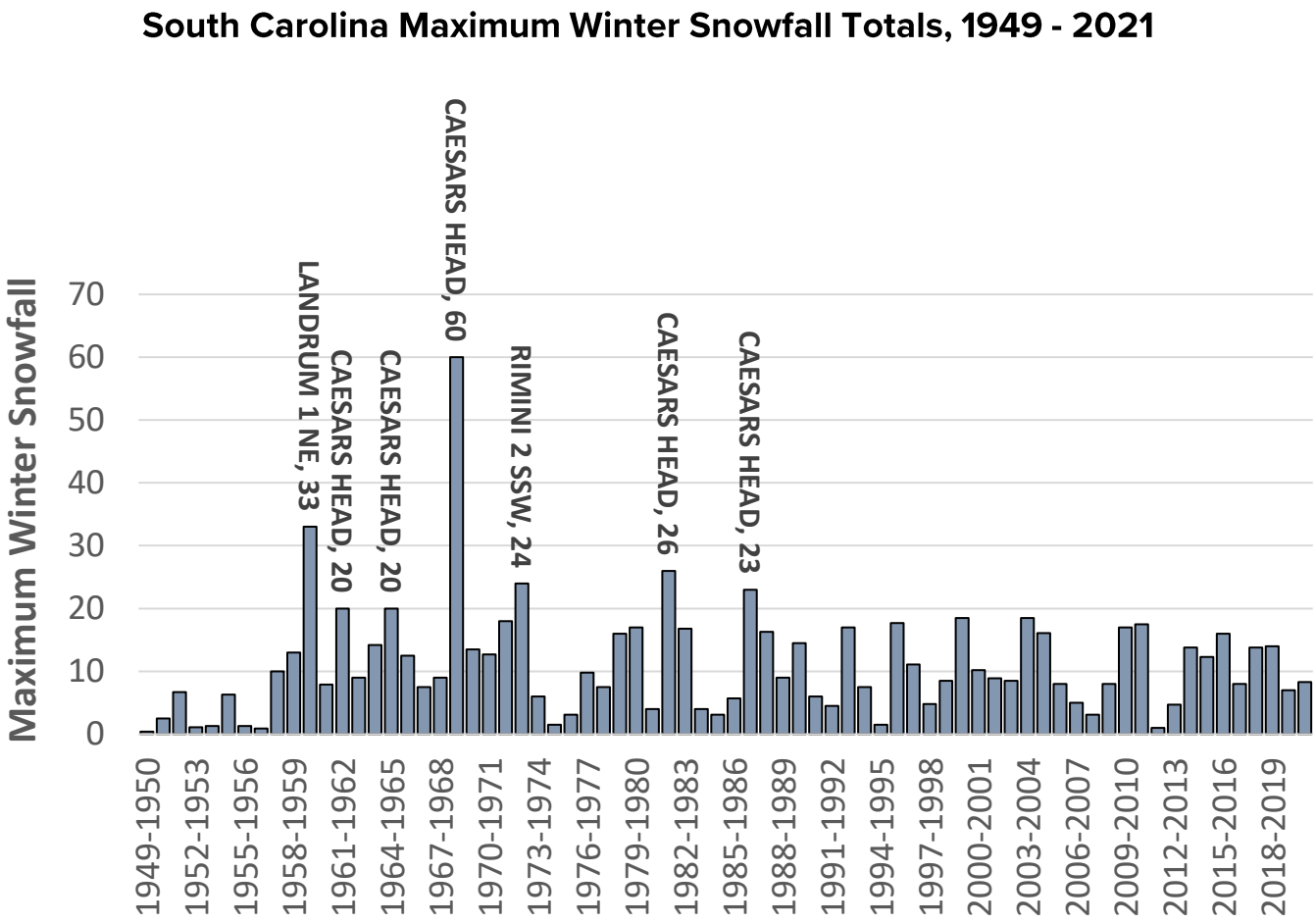
While South Carolina is not known for deep snow cover and subzero temperatures, both have occurred in the state's reliable recorded weather history, dating back to the 1890s. Many winter storms have left over a foot of snow ,and several cold waves have caused temperatures to fall below zero. The best-known snowstorm occurred in February 1973, when 1-2 feet of snow fell over a large part of the state. Two cold waves stand out in the historical record: February 1899 and January 1985.

South Carolina's Coldest Low Temperatures

Location	Low, °F	Date
Caesars Head	-19	January 21, 1985
Santuc	-11	February 14, 1899
Shaws Fork	-11	February 14, 1899
Caesars Head	-11	January 9, 1970
Caesars Head	-10	January 30, 1966
Cheraw	-9	February 14, 1899
Landrum	-9	December 31, 1917
Long Creek	-8	January 21, 1985
Newberry	-8	February 14, 1899
Clemson	-7	February 14, 1899
Anderson Airport	-6	January 21, 1985
Greer (GSP Airport)	-6	January 30, 1966
Mountain Rest	-6	December 30, 1917
Caesars Head	-6	January 8, 1970

Dozens of other locations in South Carolina have recorded temperatures at or below zero, the farthest south being Yemassee, which reached zero on January 21, 1985.

South Carolina's Winter Storm Climatology Extremes



The graph and table are based on the maximum total winter snowfall reported each season.

Range of Maximum Winter Snowfall Totals	Number of Winters
0 to 4"	17
5" to 9"	22
10" to 14"	13
15" to 19"	13
>= 20"	7

7 Snowiest Winters

Winters with Maximum Snowfall >= 20"

Season	Location	Snowfall Total
1968 – 1969	Caesars Head	60.3"
1959 – 1960	Landrum	33.0"
1981 – 1982	Caesars Head	26.5"
1972 – 1973	Rimini	24.0"
1986 – 1987	Caesars Head	23.7"
1964 – 1965	Caesars Head	20.8"
1961 – 1962	Caesars Head	20.4"

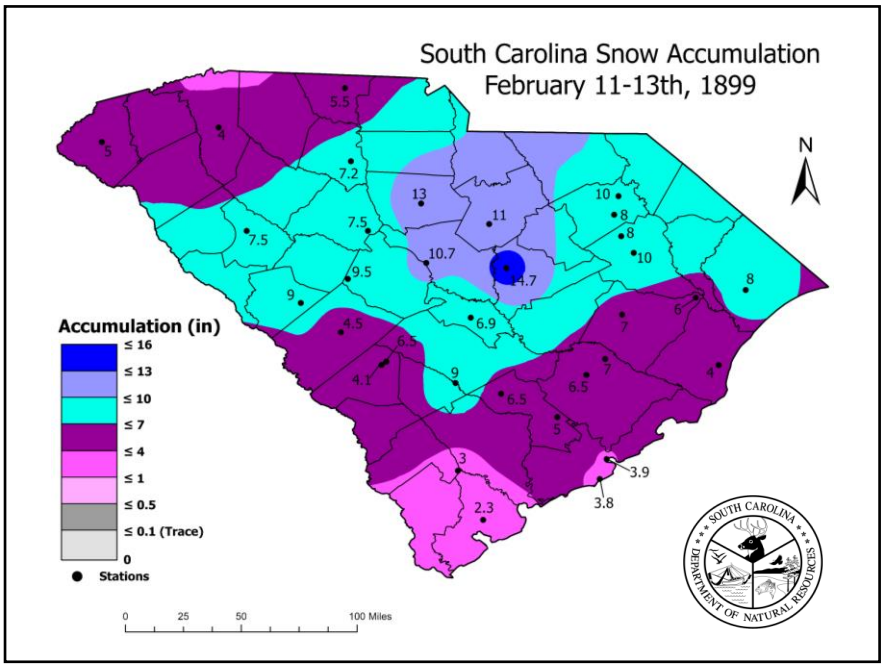
South Carolina's Winter Storm Climatology Extremes

It is difficult to say which South Carolina winter storms should be considered the state's 'biggest.' The snowstorm of February 1973 is undoubtedly a top contender and producer of the state's largest 24-hour snowfall (at Rimini). The 28.9 inches at Caesar's Head in 1969 was higher but occurred over three days. Several other snowstorms, such as the February 12-13, 2010, winter storm, caused accumulations over most of the state. The winter storms of February 26-27, 2004, and January 7-8, 1988, also caused widespread heavy snowfall.

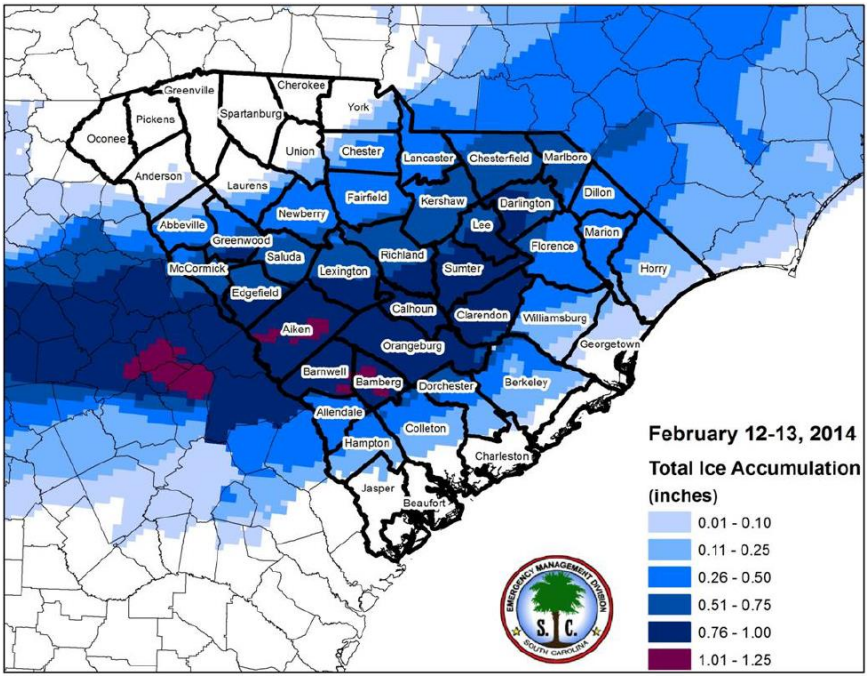
There could be an argument that the worst winter storms are where extreme cold occurs during and after the storm, putting the winter storm of January 7-8, 1988, into contention because it was followed by ten days of unusual cold. As a result, there were travel difficulties long after the storm. However, using this metric, the worst winter weather event for South Carolina was likely the mid-February 1899 snowstorm and extreme cold. This event featured statewide snow accumulations followed by the coldest temperatures ever recorded.

South Carolina's Largest Snow Reports (events lasting up to three days)

Location	Snow, Inches	Ending Date
Caesars Head	28.9	February 18, 1969
Rimini	24.0	February 11, 1973
Bamberg	22.0	February 11, 1973
Manning	21.0	February 11, 1973
Branchville 6 SW	19.0	February 11, 1973
Chesnee 7 WSW	18.1	March 4, 1942
Lake City 2 SE	17.5	February 11, 1973
Rock Hill (Winthrop)	17.3	February 27, 2004
Florence Airport	17.0	February 11, 1973
Blackville 3 W	17.0	February 11, 1973
Caesars Head	16.5	January 8, 1988
Cheraw	16.0	February 27, 1914
Columbia Metro Airport	16.0	February 11, 1973



South Carolina's Winter Storm Climatology Extremes



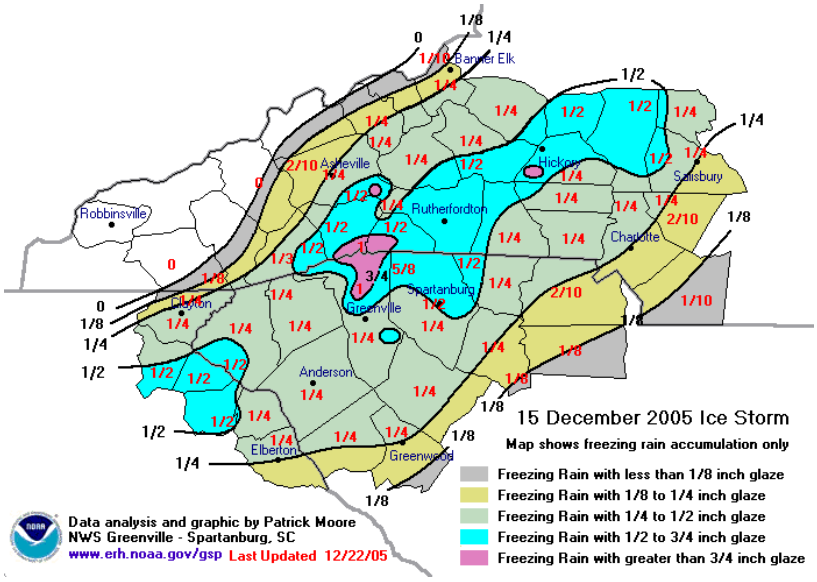
Ice accretion caused by the winter storm of February 11-13, 2014. Most of the Midlands and Central Savannah River Area saw three-quarters of an inch or more of ice accretion, causing severe tree damage and widespread power outages. Map courtesy of SCEMD.

It is even more challenging to declare any ice storm the worst in state history due to a lack of historical information. Few databases contain ice accretion reports, and none are easily searchable, and most of the accounts of ice accretion are sparse before 1990.

However, good data can be found about recent storms. In recent memory, South Carolina's worst ice storm would be one which occurred in February 2014. One inch or more of ice accretion was reported in parts of Aiken, Barnwell and Bamberg Counties. The storm also generated heavy snowfall in the Upstate and up to a foot in York County. The ice caused an estimated total of $430 million in losses, including $360 million in timber losses in the state, 346,000 power outages and five deaths.

A federal disaster declaration was issued in the wake of this storm. It would be in the running for one of South Carolina's worst winter storms due to the amount of damage it caused with its widespread heavy ice and snow, though the ice and snow melted quickly with temperatures rising to the 50s and 60s within a few days behind the storm.

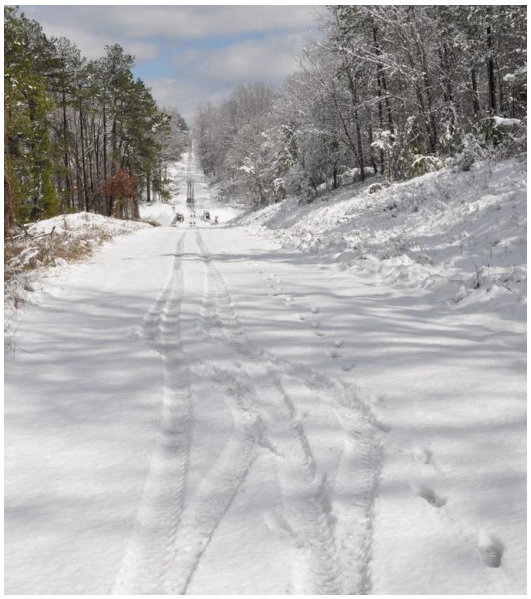
Another recent ice storm which caused significant ice accretion occurred on December 15, 2005, primarily affecting the Upstate but with some effects into the Midlands as well as York, Chester, Lancaster and Chesterfield Counties. Damage was mostly to trees and power lines, with travel impacts minor. The damage, was, however, widespread enough for a federal disaster declaration in the wake of the storm which included seven Upstate counties.



Wintertime Hazards

Travel

It is well known that snow will lead to slippery road conditions, but winter driving isn't only about dealing with snow; ice on the road is a real threat. Black ice is hazardous because it is transparent and difficult to see. It is a glaze that forms on surfaces such as roads, sidewalks, and driveways from light freezing rain, freezing of lingering rainwater, or refreezing melted snow or ice on surfaces. It's called "black ice" because it tends to look like the pavement. Black ice forms most commonly at night or in the early morning when it's below freezing and when the sun isn't around to warm the roads. Shady areas can be prone to black ice during the daytime. It will also form more frequently on roads that are less traveled. Black ice forms readily on bridges, overpasses, and the road beneath overpasses. This is because the bridge will have the same temperature as surrounding air, while a road, at least in South Carolina, is atop the warmer ground. However, while very rare in South Carolina, black ice sometimes forms even with air temperatures above freezing if rain falls on roads that remain below freezing in the wake of prolonged unusual cold.



SCDNR photo by Stewart Grinton, of a snowy road following a winter storm in 2009.

Tree Damage and Power Outages

A photo of tree damage from an ice storm which occurred on February 11, 2014, in northern Colleton County, where there was about a half inch of ice accretion. Photo courtesy of the South Carolina Forestry Commission.

Snow accumulations and ice accretions lead to tree damage and power line damage during more significant storms. In general, this begins to occur in ice storms once ice accretions reach a quarter inch. Ice accretions over a half-inch result in more widespread damage and the potential for prolonged power outages. Snow can also lead to tree and power line damage if the snow is wet and enough of it falls. Fortunately for South Carolinians, it is rare for snow and ice to occur in the state so early or late that trees still have foliage, but when it does, it increases the potential for tree and power line damage. Further exacerbating the risks is when extreme cold occurs with the storm or when a lengthy cold wave follows a storm. This increases the potential for damage when there is an electrical system failure due to the storm, as a lack of home heating can result in water damage from bursting pipes.

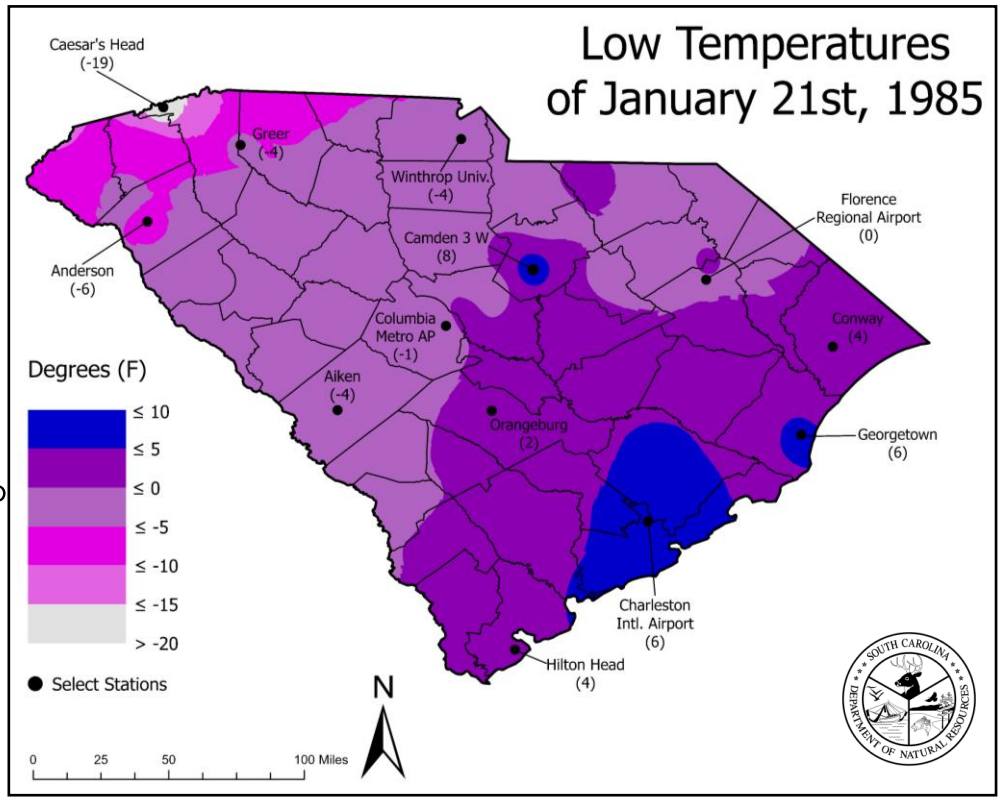
Wintertime Hazards

The Risk of Extreme Cold

In South Carolina, any period of extreme cold is potentially damaging. While the entire state will experience subfreezing temperatures several times per winter, it is unusual for temperatures to fall to the teens or colder, except in the Upstate, and temperatures near zero or colder are infrequent. With such an extended return period between times of cold weather extremes, there is time for memories to fade and things that are vulnerable to extreme cold to fall into disrepair. There is also the potential for agricultural losses, even in midwinter. For example, the January 1985 cold wave, likely the second-worst in the state's recorded history, nearly wiped out the state's peach crop along with truck crops such as turnips and collards. In addition, the cold wave caused 15 deaths due to hypothermia.

Frozen Pipes

One of the main types of damage observed in South Carolina during extreme cold is frozen pipes. This is most common in mobile homes and recreational vehicles, where the pipes are more exposed to the outside. Older homes can also be at risk where the insulation protecting their pipes has aged or fallen into disrepair, or the structure has become damaged in such a way that outside air quickly intrudes under the home. Frozen pipe damage can be costly; in addition to the cost of replacing the pipes, water leakage can damage other parts of a home.



South Carolina's lows on January 21, 1985, showcasing some of coldest temperatures ever observed in the state.

Space Heaters and Generators

Improper use of a generator or a supplementary heat source such as a kerosene heater during a cold wave can cause damage, injury, or death. Heaters that burn fuel will generate carbon monoxide, which is toxic because it displaces oxygen in the bloodstream. They also consume oxygen in the air and produce carbon dioxide; improper ventilation can result in a room lacking sufficient oxygen to sustain life. Space heaters and generators become very hot and can start a fire when placed too close to flammable materials such as draperies or most types of furniture. Fires can also be started when either is caused to tip over.

South Carolina's Winter Storm Climatology

South Carolina is located at a low enough latitude that seasonal temperatures are not cold enough to result in winter precipitation even during the coldest time of the year (mid-January). The coldest part of the state, the Upstate, sees average daily temperatures of around 42°F in January. The warmest part of the state, near the mouth of the Savannah River, sees average daily January temperatures around 52°F.

Because of its geographic location, the primary ingredient for a winter storm is colder than average air, and it needs to be in place in advance of an approaching storm system or arriving with the storm. In general, the colder the air, the more likely a storm moving into it will cause wintry precipitation. The adage "it's too cold to snow" does not hold up to scientific scrutiny, but very cold weather patterns can indeed cause storms to bypass South Carolina to the south. A favorable storm track is another vital ingredient to create an environment cold enough to produce snow, sleet, or freezing rain.

Jet Streams

Jet streams are fast-moving currents of air that circulate above the Earth. The winds blow from west to east in jet streams, but the flow often buckles northward and southward, forming ridges and troughs in the flow of air. Ridges tend to promote calm and warm weather beneath them, while the weather is usually colder and stormier beneath a trough. Jet streams are stronger in winter when air temperature differences that drive them tend to be most pronounced.

In this example of a jet stream, a ridge is present over the Intermountain West and Plains, while a trough is present near the East Coast. Photo from Weather World 2010, University of Illinois

Air north of a jet stream is typically colder, while air to the south is usually warmer. As jet streams dip or break off, they move air masses around, creating shifts in global weather patterns.

The availability of cold air and the path that storms follow are governed by the placement of the jet streams. They are largely controlled by oscillations in the atmosphere that have been discovered through research that began in the late 19th Century. These oscillations affect the jet stream's path, which separates cold, arctic air masses from the warmer air masses in the midlatitudes and tropics.

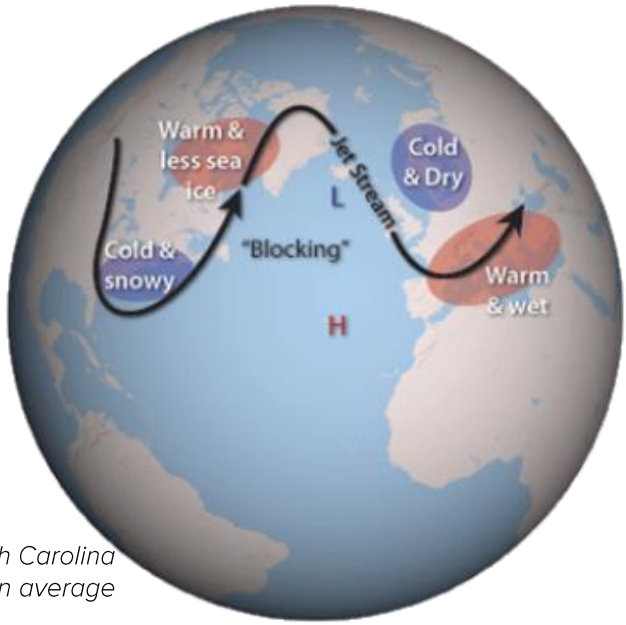
South Carolina's Winter Storm Climatology

The most prominent oscillations impacting South Carolina's weather include:

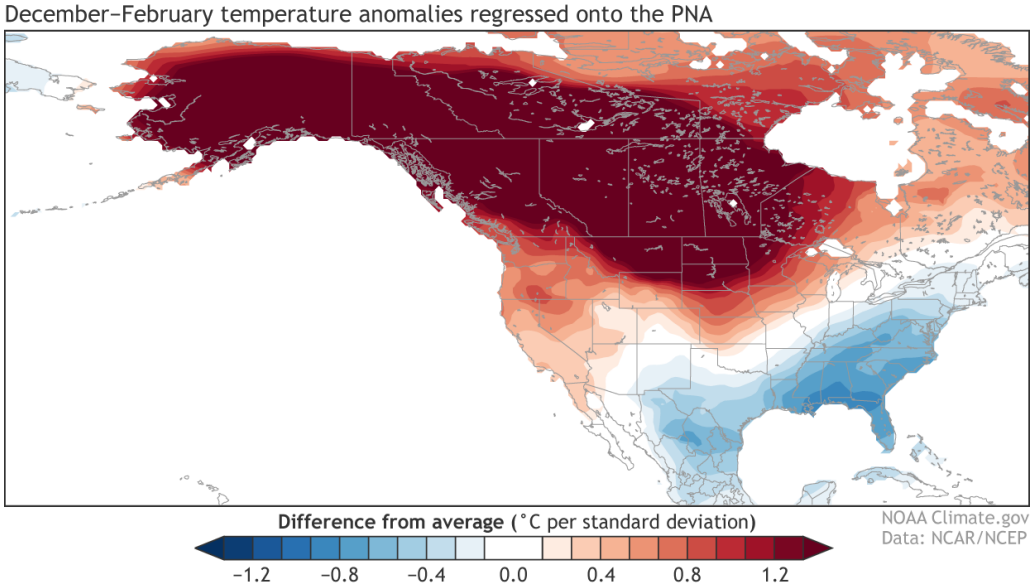
- **North Atlantic Oscillation (NAO)**
- **Pacific N. American Oscillation (PNA)**
- **East Pacific Oscillation (EPO)**
- **Arctic Oscillation (AO)**
- **El Niño Southern Oscillation (ENSO)**
- **Madden-Julian Oscillation (MJO)**

North Atlantic Oscillation (NAO)

- Likely the most important
- Negative phase often causes colder than average temperatures over eastern North America during winter and a storm track near the East Coast



Upper air flow during the NAO's negative phase; South Carolina is usually cooler and wetter than average



December to February temperature anomaly for the PNA's positive phase; South Carolina is usually colder than average

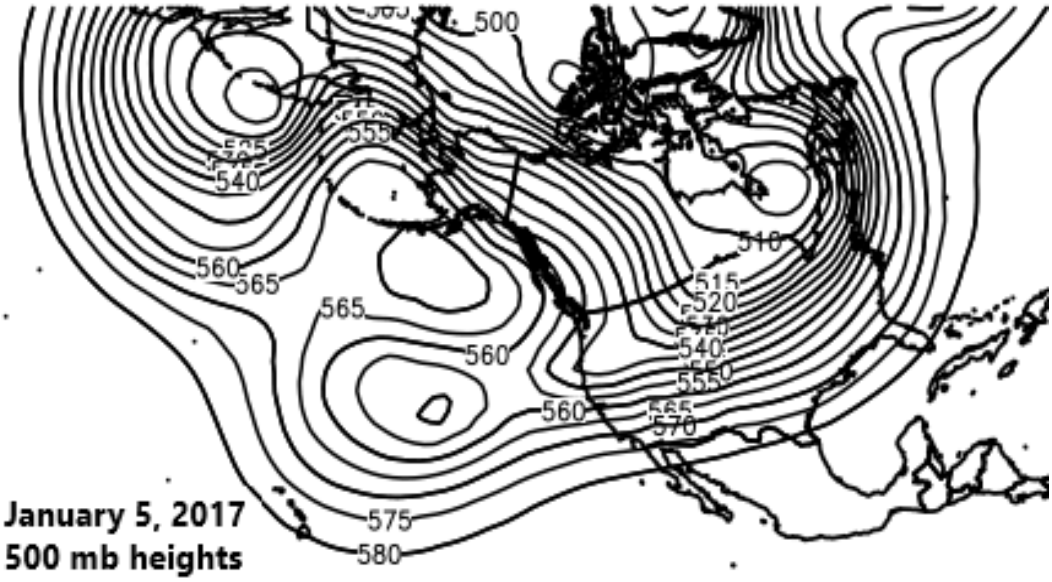
Pacific-North American Pattern (PNA)

- Positive phase tends to send polar air into the Southeastern United States
- Positive phase contributes to a more favorable storm track for winter precipitation in the southeastern United States

South Carolina's Winter Storm Climatology

East Pacific Oscillation (EPO)

Negative phase usually causes colder than average weather in eastern North America

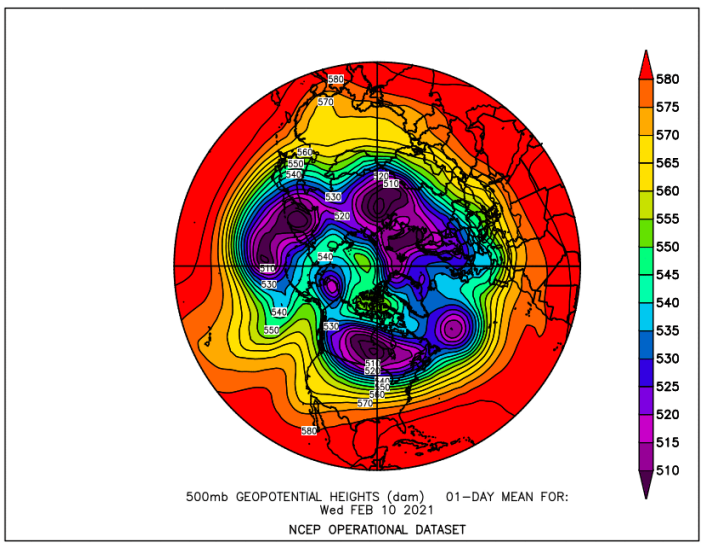


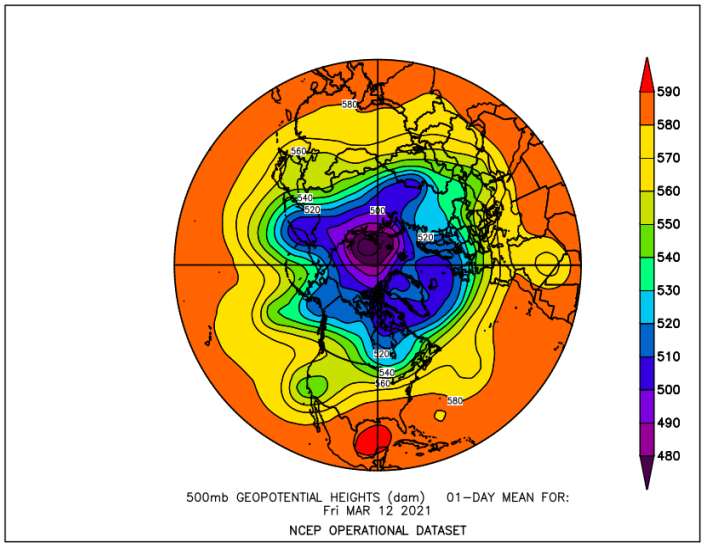
An example of the negative phase of the EPO; an upper ridge over Alaska leads to cross-polar flow, sending arctic air into the continental U. S.

Air flow at this level is parallel to the contours; west-to-east, except around highs and lows

Arctic Oscillation (AO)

Negative phase leads to colder than average temperatures in the midlatitudes in general



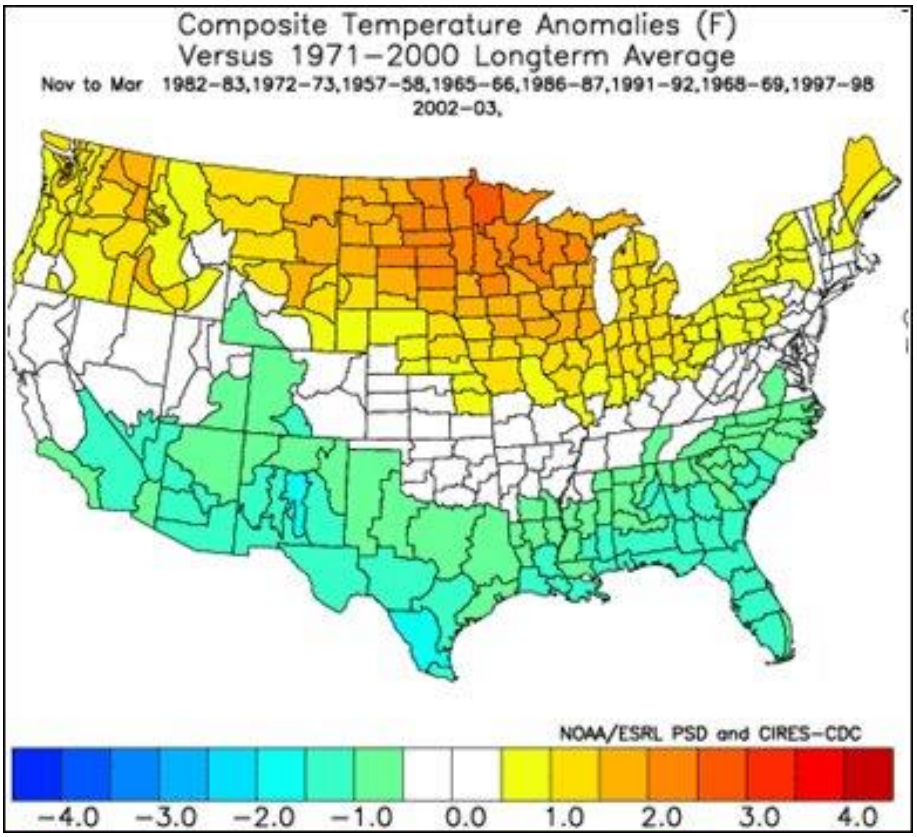


Upper-air (500 mb level) charts showing examples of the AO's negative (left) and positive (right) phases; arctic air intrudes to the south during the AO's negative phase but is held near the North Pole when the AO is in the positive phase.

South Carolina's Winter Storm Climatology

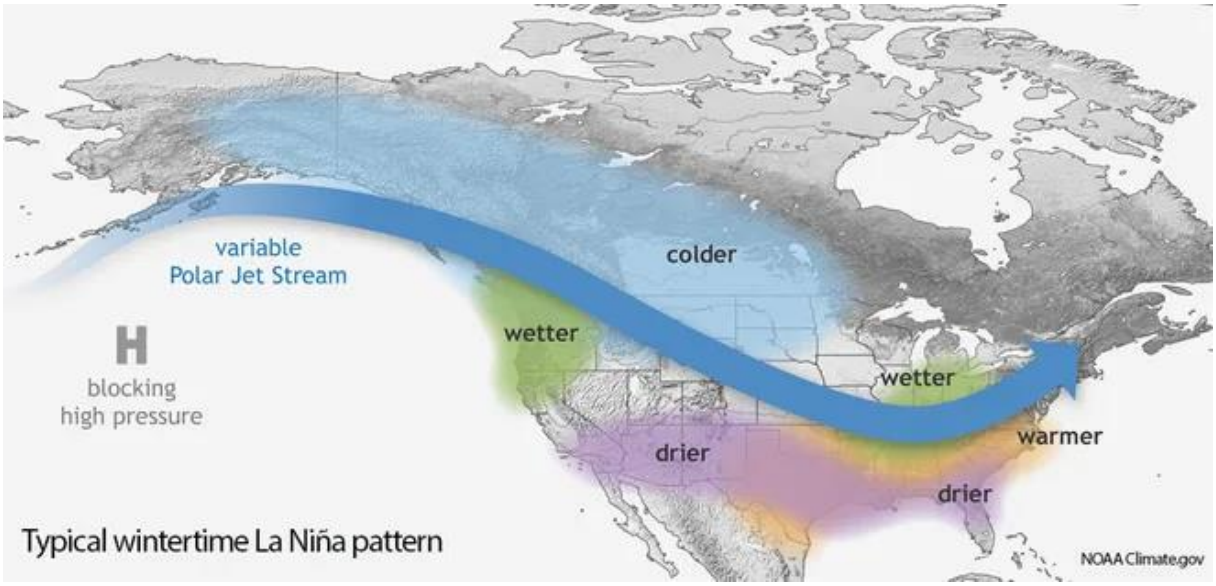
El Niño-Southern Oscillation (ENSO)

Warm phase leads to cooler than average temperatures and potentially stormier weather in South Carolina.



November to March temperature anomalies during El Niño events; South Carolina is typically cooler than average

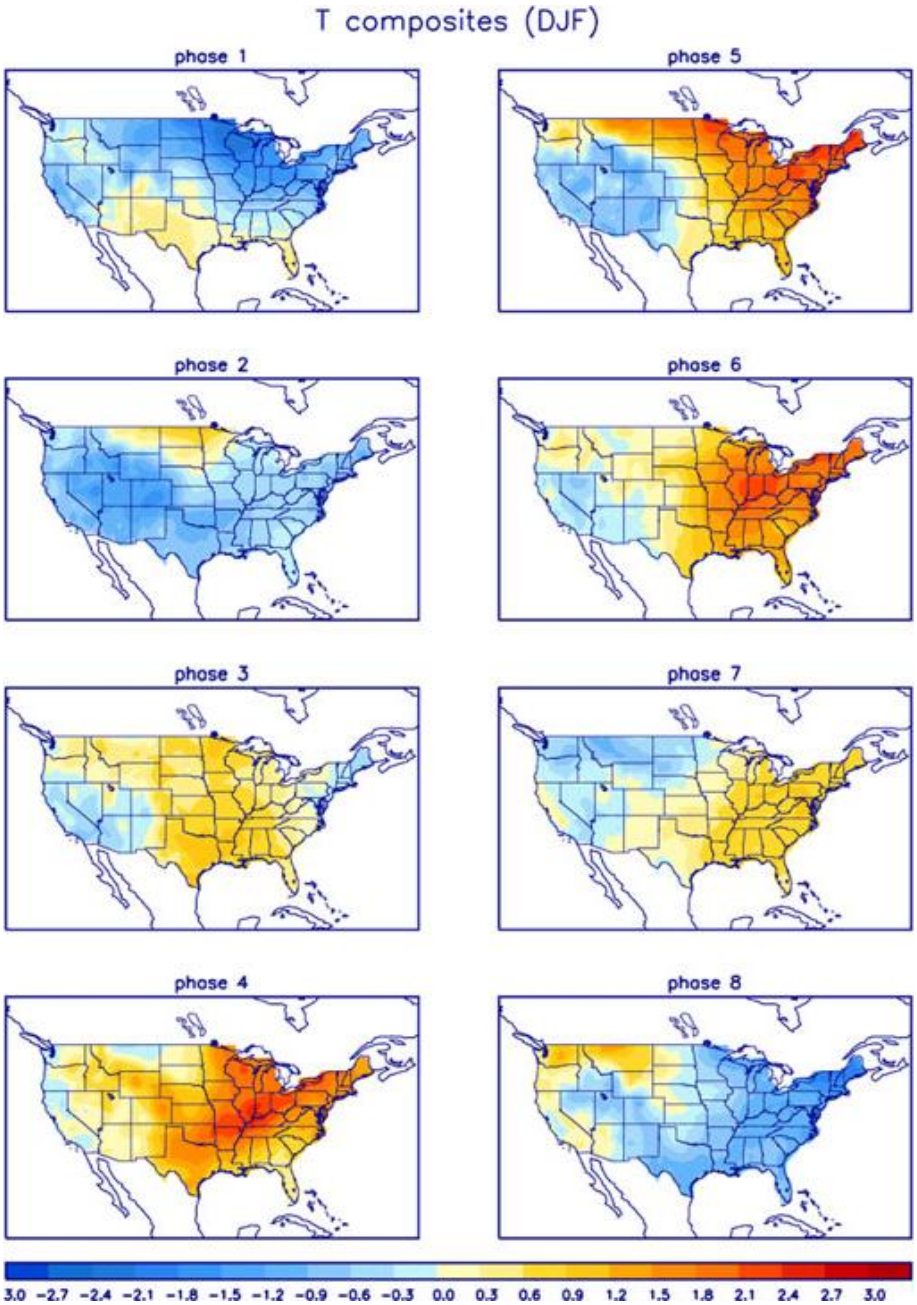
However, a poleward-displaced polar jet stream tends to result in warmer and drier weather than average in South Carolina during La Niña events.



South Carolina's Winter Storm Climatology

Madden-Julian Oscillation (MJO)

- Best known for its role in aiding or suppressing thunderstorm activity in the tropics, but it influences midlatitude weather year-round.
- MJO's Phases 8, 1 and 2 tend to be colder and stormier times during South Carolina winters
- Phase 8 is the most likely to bring South Carolina colder than average temperatures



Composite temperature anomaly for December, January and February for the eight MJO phases. Phases 1, 2 and 8 typically are cooler than average in South Carolina; other phases are usually warmer than average.

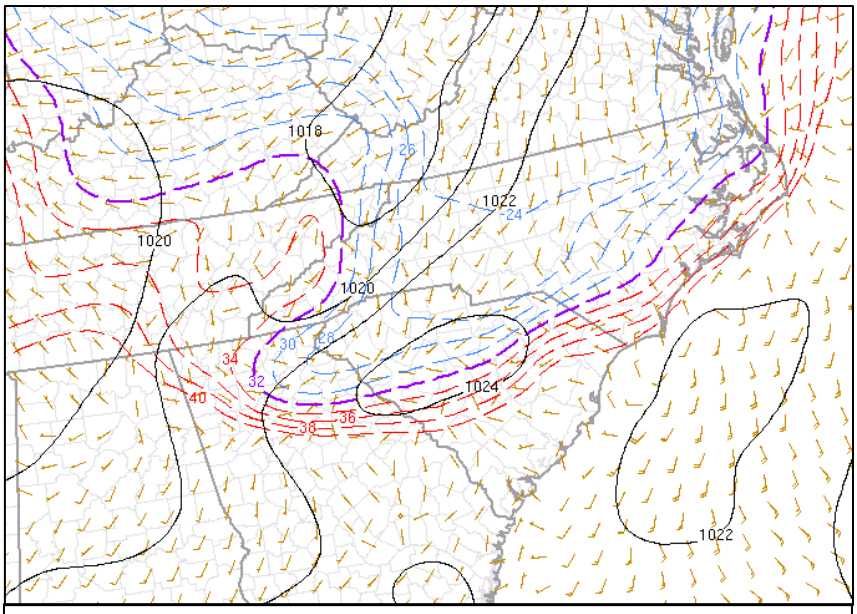
More details on these and other atmospheric oscillations along with their impact on South Carolina's weather during wintertime will be found in our forthcoming report titled *Teleconnections and Their Significance on South Carolina's Winter Weather.*

Cold Air Damming Situations In South Carolina

One common situation that occurs in South Carolina and is most impactful during the cooler part of the year is cold air damming. This term is used to describe a situation where cold air becomes trapped by a mountain range. Meteorologists often describe this situation when it occurs east of the Appalachian Mountains as 'the wedge' because, in three dimensions, the cold air mass is wedge-shaped.

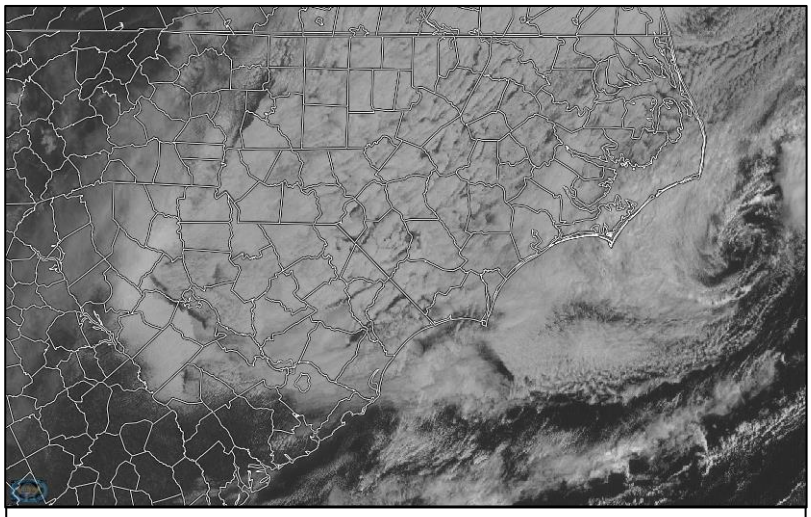
Forecasting cold air damming events present unique challenges. Their onset is usually easy to predict, but it is challenging to indicate when they end because computer models typically predict that the cold air will become dislodged more quickly than will occur. Understanding these events is especially important in winter, resulting in winter precipitation lasting longer than expected. In South Carolina, the challenge is especially tricky because of the state's geography. While the Appalachian mountains extend southwestward into Alabama, the tallest part of the mountains only extend into northern Georgia, resulting in South Carolina often being at the southernmost part of the area experiencing cold air damming. Sometimes this results in a large temperature difference between areas in the wedge of cold air and those outside the wedge. For example, temperatures can be in the 30s and 40s in the Upstate but the 60s and 70s in the Midlands and Lowcountry during times when warmer air moving in ahead of an approaching storm and riding over the cold air wedge. Therefore, an error in forecasting how quickly the cold air wedge erodes can result in significant errors in temperature forecasts and when winter precipitation will end or turn to rain.

Cold air damming occurs next to many mountain ranges worldwide. Still, for South Carolina, the onset is typically caused by strong, cold high pressure moving through the Midwestern states or across the Great Lakes and into the northeastern states or southern Canada. Once wind on the eastern side of the mountains turns to the northeast or east, a barrier jet (a jet of air caused by blocked airflow) forms as cold and stable air are forced into the mountains. In this case, the Appalachians drive the cold air southwestward along the east side of the mountains and into the northern part of South Carolina. The most frigid air affected by cold air damming is usually near the barrier jet just east of the mountains. This is also where the layer of cold air near the surface is usually deepest.



A plot of temperatures and wind barbs from around 5:00 p.m. on January 25, 2013, showing areas most affected by cold air damming with temperatures at or below 40°F. At this time, an ice storm over the Upstate had just ended.

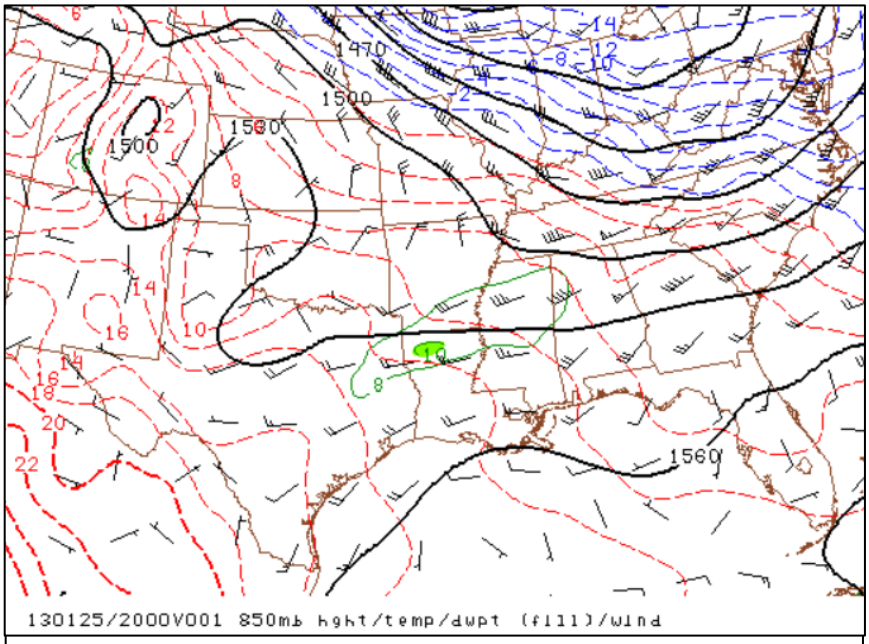
Cold Air Damming Situations In South Carolina



Low cloudiness covered much of South Carolina on October 11, 2021, as northeasterly winds around a storm centered near the Outer Banks of North Carolina pushed a wedge of cool and damp air in from the Atlantic Ocean.

During the winter and occasionally fall and spring, the weather in areas affected by cold air damming is usually cloudy and damp. The northeasterly winds prevalent in the affected area bring in moisture from the Atlantic Ocean. When storm systems move during a cold air damming event, a frequent occurrence for the Carolinas during the winter, warmer air surges into the region from the south. However, the colder air is denser than the warmer air that the approaching storm is bringing to the area. The result is that the warmer air is forced to rise above and over the colder air, making the cold air wedge difficult to dislodge.

The lifting of the warmer air being pushed into the region also generates cloud cover. It enhances precipitation, causing it to be heavier than it would have been with no wedge in place. Also, winter precipitation will occur when temperatures within the wedge of cold air are below freezing near the surface. At times, when cold air damming is a factor at the start of a winter storm, the warmer air moving in and riding above the cold wedge might still be at or below freezing, and snow occurs, but this situation typically does not last long when it happens. This air is usually above freezing, causing snowflakes generated at high altitudes to melt as they fall through the layer of above-freezing air. But, if temperatures are below freezing in the wedge at the surface, the result will be freezing rain and sleet.

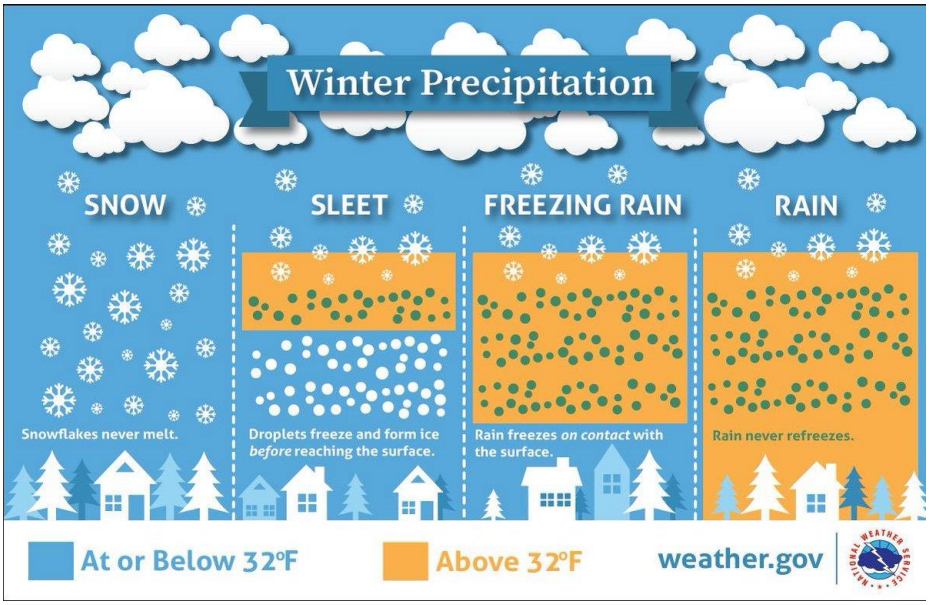


Afternoon of January 25, 2013, 850 mb upper air chart -plotting data at the level where the pressure is 850 mb, approximately 5,000 feet above sea level - shows that temperatures were above freezing aloft with southwesterly winds, while surface temperatures were mostly below freezing in the Upstate.

Precipitation Types and Challenges of Winter Storm Forecasting

South Carolina's winters tend to be mild, but every winter brings a winter storm to at least some state. Each winter storm has a different character, and the dynamic nature of winter storms usually results in varied effects in various places from the same storm.

Ordinarily, temperatures fall as one rises through the troposphere because the air density decreases with height. This drop in temperature with height is called the lapse rate. The lapse rate varies depending on the air's moisture content. In a very dry air mass, the temperature falls by about 5.4 degrees Fahrenheit for every 1000 feet of ascent, called the dry lapse rate. When a storm is passing through, leading to an atmosphere saturated with moisture and precipitation, the temperature will fall by about 3.3 degrees for every 1000 feet of rising, called the moist lapse rate. Scientists usually add the word 'adiabatic' to describe the lapse rate (dry or moist adiabatic lapse rate), meaning no heat is added or removed to cause the temperature change. Cold air damming disrupts the typical drop in temperatures with height.



The different types of precipitation seen in winter weather are described below, and the figure to the left illustrates the atmospheric thermal structure that accompanies each.

Snow

In areas where temperatures are below freezing at every point at or above the surface, precipitation usually falls as snow. Temperatures can be a few degrees above freezing near the surface, and snow can still occur.

Sleet

If the snowflakes encounter a *shallow* layer of above-freezing air, it will melt, but as it falls into a layer of below-freezing air, it will refreeze into sleet before reaching the ground.

Freezing Rain

The situation becomes more complicated when there is a large layer of above-freezing air, often called the warm nose. Any snowflakes will melt completely but fall onto a surface where temperatures are below freezing. The result is freezing rain.

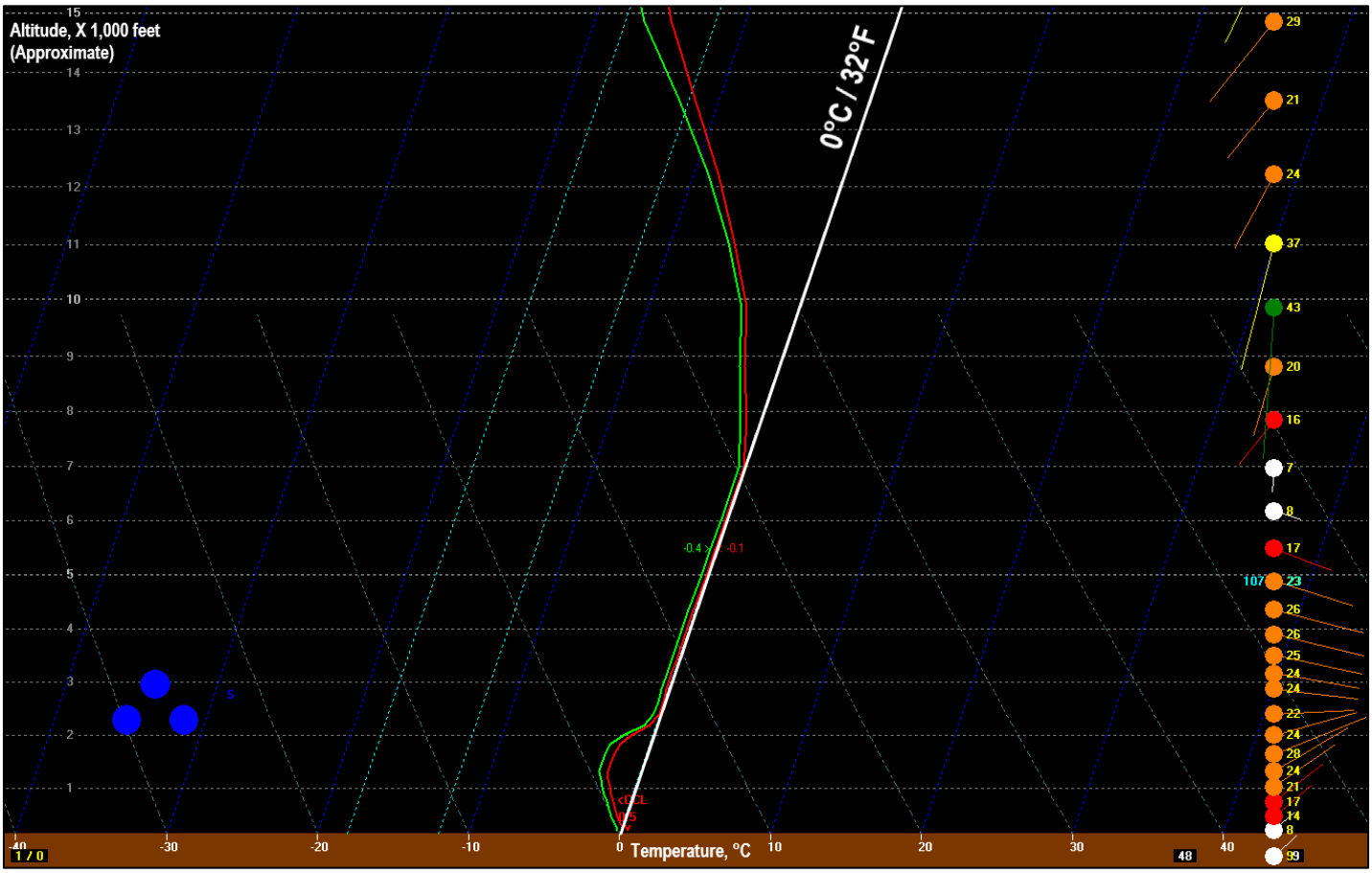
If the temperature in the warm nose is only a bit above freezing, and the warm nose is thin, some snowflakes may melt, but not all of them. In this situation, a mix of snow and sleet or freezing rain, perhaps even all three, occurs at the surface. Therefore, meteorologists sometimes tell you to expect a "mixed bag" of winter precipitation.

Precipitation Types and Challenges of Winter Storm Forecasting

For several different reasons, winter storm forecasting is complicated. Each area has a set of unique challenges that impact the probability of experiencing a winter storm.

Precipitation Type and Temperatures

The first challenge that all weather forecasters deal with is forecasting the precipitation type. Meteorologists must consider many variables, including the temperatures near the surface and aloft. This is a challenging forecast anywhere, but often with winter storms across the South, temperatures can be near freezing from the surface to several thousand feet above the surface. Any error in the temperature forecast at any level could result in a missed precipitation type forecast; what was predicted to be a foot of snow might turn out to be four inches of a slushy snow and sleet mixture or a thick glaze of ice.



A plot of forecast conditions over Raleigh, NC from the NAM computer model, run on the morning of January 6, 2021, for a winter storm to occur there on January 8. The red line is a plot of temperatures. Since temperatures are all forecast to be below freezing, snow is forecast by the model. However, note that there is a layer 5,000 feet thick where temperatures are near freezing. Any error by the model forecasting too-cold temperatures at any point in this layer means that sleet and freezing rain will occur instead.

Precipitation Types and Challenges of Winter Storm Forecasting

Additional Forecast Challenges

Precipitation rates - Heavier snowfall rates can lead to a more rapid accumulation.
Soil Temperatures - The ground usually is not colder than freezing in South Carolina, so it often takes some time with snow or ice falling before it starts to accumulate.
Time of Day - Even when it is overcast in January in South Carolina, enough sunlight reaches the surface to warm it, perhaps above freezing and thus limiting or preventing accumulations.
Date - The sun angle is higher in March or November than it is in January. The days are also longer, leading to warmer surfaces due to more incoming sunlight, making daytime accumulations far less likely.
Strong Wind - Snowflakes falling in windy conditions will fracture into smaller particles, leading to denser snow on the ground with lower snow to liquid ratio.
Snow Ratio - The ratio of snowfall to its melted equivalent of rainfall can vary widely; it can be as low as five to one (5:1) in a warmer storm and can be as high as 20 or more to one (20:1).

The amount of snow can look impressive when it covers the ground, but when the snow melts, you discover that very little water is involved.

Precipitation Types and Challenges of Winter Storm Forecasting

WET SNOW

Wet snow occurs when the air temperature near the surface is above freezing, causing the snowflakes to melt before reaching the surface partially. The wetness of the snowflakes makes them easier to stick together as they fall; thus, the snow will often have larger snowflakes that will easily adhere to and accumulate on outdoor surfaces. Trees and power lines will develop a pasty coating from wet snow, and damage can result from heavier wet snow events. The ratio for wet snow will be less than 10:1. For example, a 5:1 ratio may occur where five inches of snow melts down to one inch of liquid.

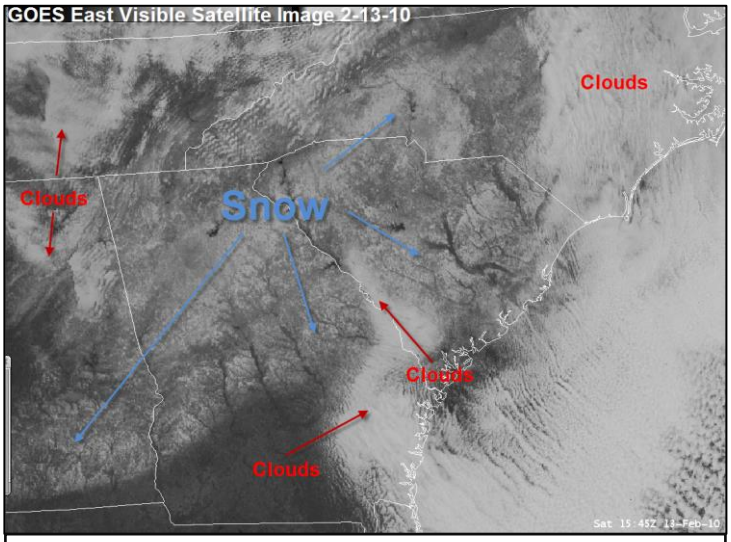
Picture of a snowman in Columbia, SC. Photo courtesy of Wes Tyler.

Picture of snow on the Statehouse Grounds. Photo courtesy of the South Carolina State Climatology Office.

DRY SNOW

Dry snow occurs when the temperatures throughout the troposphere are well below freezing, and the surface temperature is below freezing. Dry snow has a lower liquid water content; this snow will be less dense than wet snow. It is powdery and much more likely to be blown around by the wind than wet snow. The dry snowflakes do not usually clump together as they fall, so dry snow will often be composed of many tiny snowflakes. Dry snow is not sticky and thus unable to hold together for making snowballs. Dry snow tends to accumulate less on trees or power lines and isn't as heavy as the same volume of wet snow, resulting in much less risk for tree and power line damage. Also, dry snow isn't as slippery as wet snow is when it accumulates on roads and sidewalks. The ratio for dry snow will be greater than 10:1. In extreme cases, it can be 20:1 or greater.

Winter Storm Types



A visible satellite image showing snow covering nearly all of South Carolina on February 12, 2010, in the wake of a winter storm that occurred the previous evening.

A particular winter storm track would be another essential ingredient needed in a recipe that yields winter precipitation in South Carolina. Researchers have long studied the weather patterns that lead to winter storms over the eastern part of North America. The earliest research was performed by James E. Miller, published in 1946, which divided the winter storms of eastern North America into two classifications based on storm track. These are now famous among meteorologists: the **Miller A and Miller B storm types**.

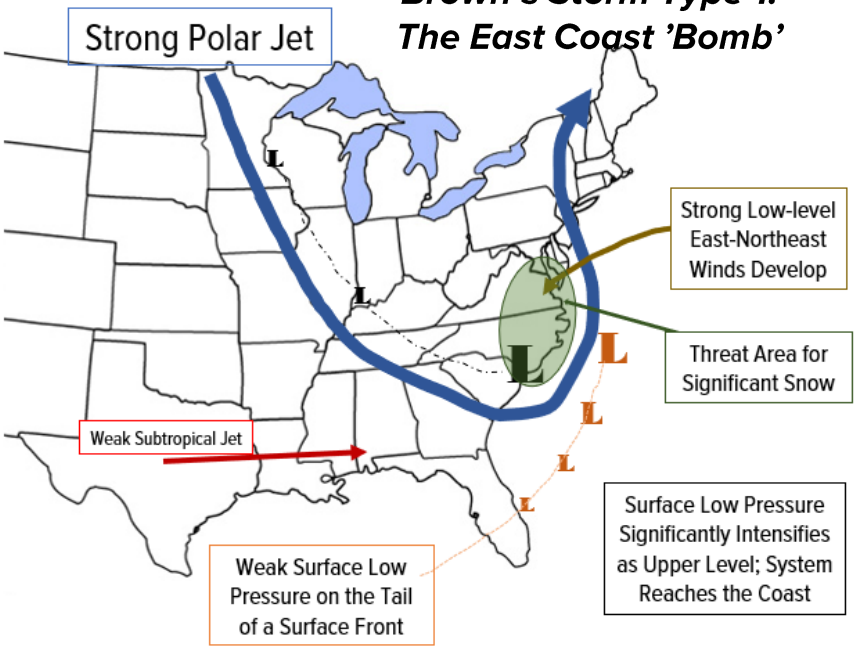
More recently, meteorologists working for the Wakefield, Virginia National Weather Service Office, including Wayne Albright, Hugh Cobb, and Larry Brown, have further studied and classified winter storms into five or six different track types.

Their focus was on storms affecting North Carolina and Virginia, so an additional study is needed to include South Carolina. No good correlation with ENSO can be drawn from Brown's eight storm examples of this type, though half occurred during an ENSO neutral period. The other four types were evenly split between El Niño and La Niña periods. The NAO was positive for five of the eight and negative for the rest. Of the five which occurred during a positive NAO, three occurred during a positive PNA period.

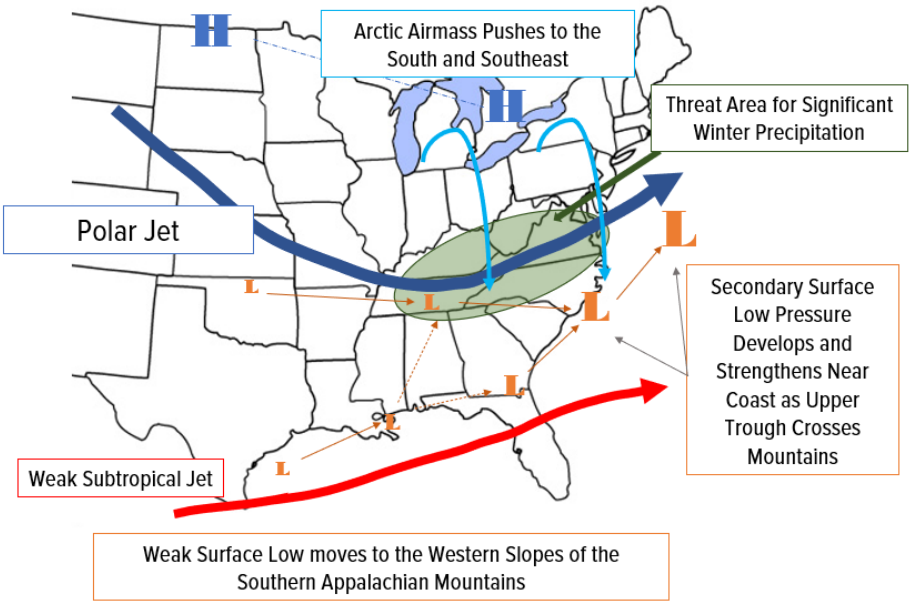
The storm tracks described here will follow the most recently presented research, Brown's, using six different storm track classifications.

Brown's Storm Type 1 (a subset of the Miller B storm) is typified by a storm riding a deep upper-level trough in a strong polar jet stream into the Southeast. This storm gains moisture from a weak subtropical jet over the southern states. Surface low pressure would intensify rapidly upon arriving near the North Carolina Outer Banks and move northward to northeastward. An example of this type of storm would be the December 23-24, 1989, winter storm, which caused heavy snow in coastal South Carolina; locally, over a foot covered the Pee Dee region.

Brown's Storm Type 1: The East Coast 'Bomb'



Winter Storm Types

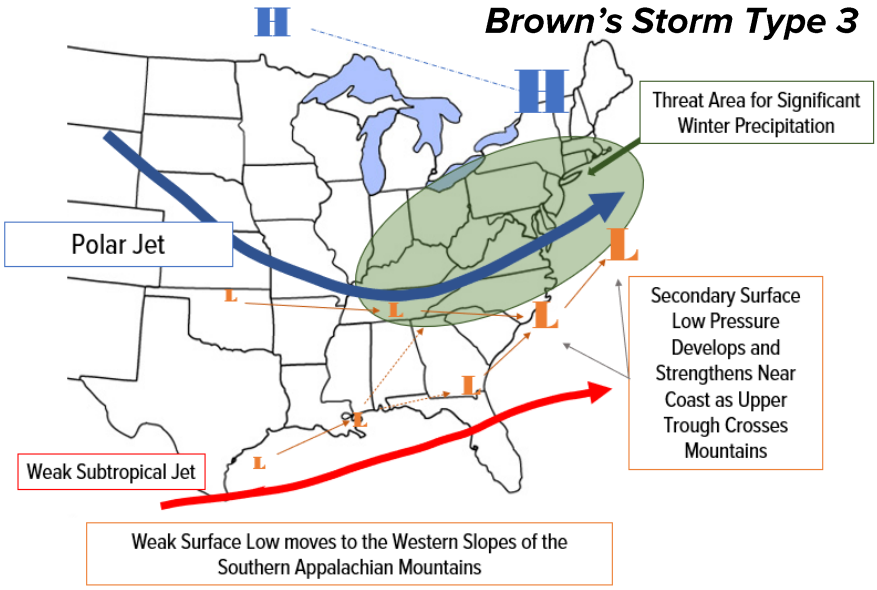


Brown's Storm Type 2

Brown's Type 2 storm (a subset of Miller B, but with a less amplified jet stream) exhibits a surface low-pressure area tracking east from the Plains, which weakens as a new surface storm develops along the Carolina coastline, which then intensifies and tracks to the northeast. The February 25-26, 2004, winter storm, which left over 20 inches of snow in York County, would be an example. Brown found a total of 13 examples of this type of storm. Two occurred during an El Niño, five during ENSO neutral conditions, and six during La Niña. The NAO was negative during seven of these examples and positive with four. Of those four, the PNA was positive for two and negative for two.

Brown's Storm Type 3 (a subset of the Miller B storm type) is like Type 2, except that the original surface low-pressure center remains dominant longer while tracking into the Appalachian Mountains. Cold air damming is strong with this type of storm. A wedge of cold air is firmly entrenched over areas south and east of the Appalachians, including South Carolina and especially the Upstate. While snow can fall during this storm type, sleet and freezing rain are typically dominant at the beginning of the storm.

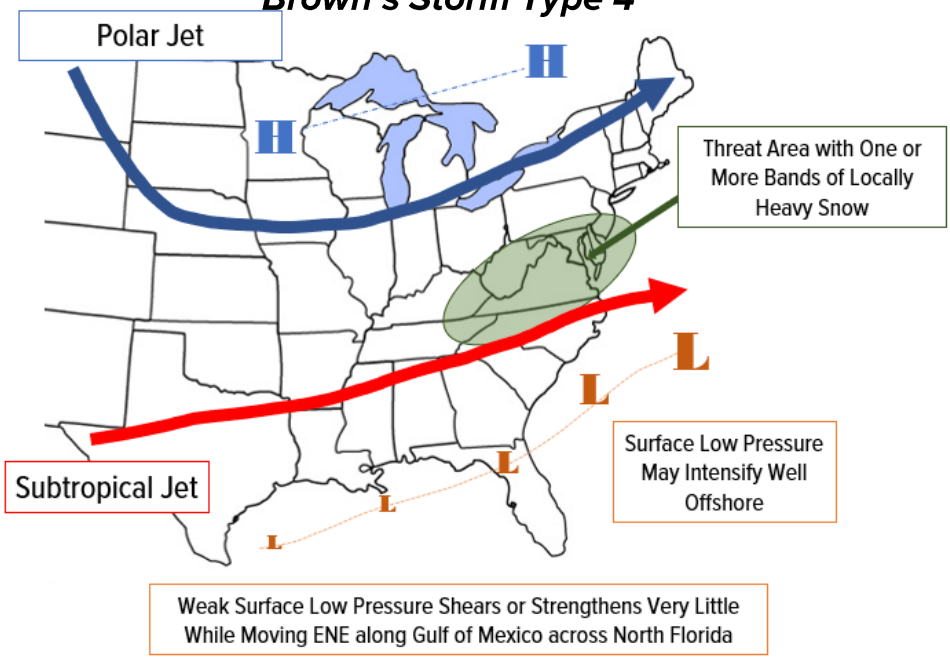
Brown's Storm Type 3



An example of Storm Type 3 would be the January 25-26, 2004, winter storm, which caused severe icing in the Upstate on top of a thin layer of snow. A lesser though still significant ice accretion occurred elsewhere in South Carolina. This storm type is much more common with a negative NAO and during neutral ENSO. Of the 14 storms of this type that Brown studied, only two occurred during a positive NAO, and both occurred when the PNA was positive.

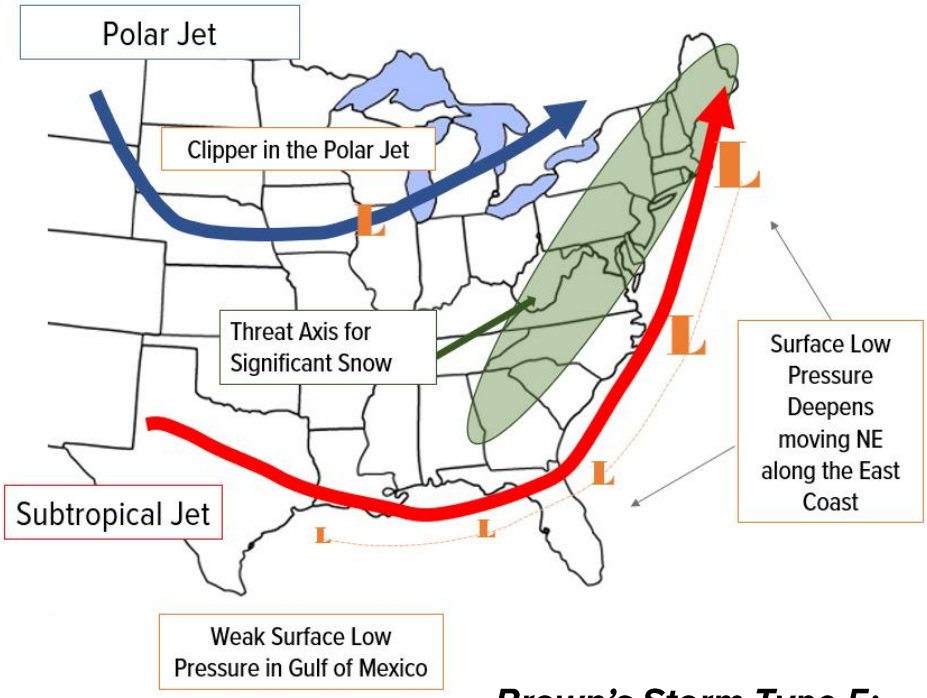
Winter Storm Types

Brown's Storm Type 4



Brown's Storm Type 4 (a subset of the Miller A classification) features a polar jet farther north with a stronger subtropical jet. Surface low pressure tracks farther south and does not reform along the East Coast. In this case, the surface low remains relatively weak but tracks south of South Carolina. While snow is usually the dominant precipitation type, there can be an area seeing sleet and freezing rain just to the south of the area seeing snow. An example of this type of storm is the snowstorm of January 7-8, 1988.

This snowstorm dropped historic snowfall of generally 8-16 inches on the Upstate and 4-8 inches in the Midlands. Freezing rain accretion reached one-half inch in some coastal communities. A negative to neutral NAO is the most common with this type of storm, and three of the four storms that Brown studied of this type that occurred during a positive NAO happened when there was a positive PNA. ENSO was typically neutral, and the same number of this type of storm of the 20 that Brown studied occurred during El Niño conditions as with La Niña.



Brown's Storm Type 5: The Classic East Coast Storm

Brown's Storm Type 5 (subset of the earlier Miller A) is the classic major East Coast storm, featuring the development of low pressure over the northern Gulf of Mexico, which becomes very intense as it moves across Florida toward Cape Hatteras and then into New England. The dominant precipitation type is snow, where winter precipitation occurs, which is usually heavy. In some cases, an Alberta Clipper storm system quickly moves through the Midwest and eventually joins the East Coast storm.

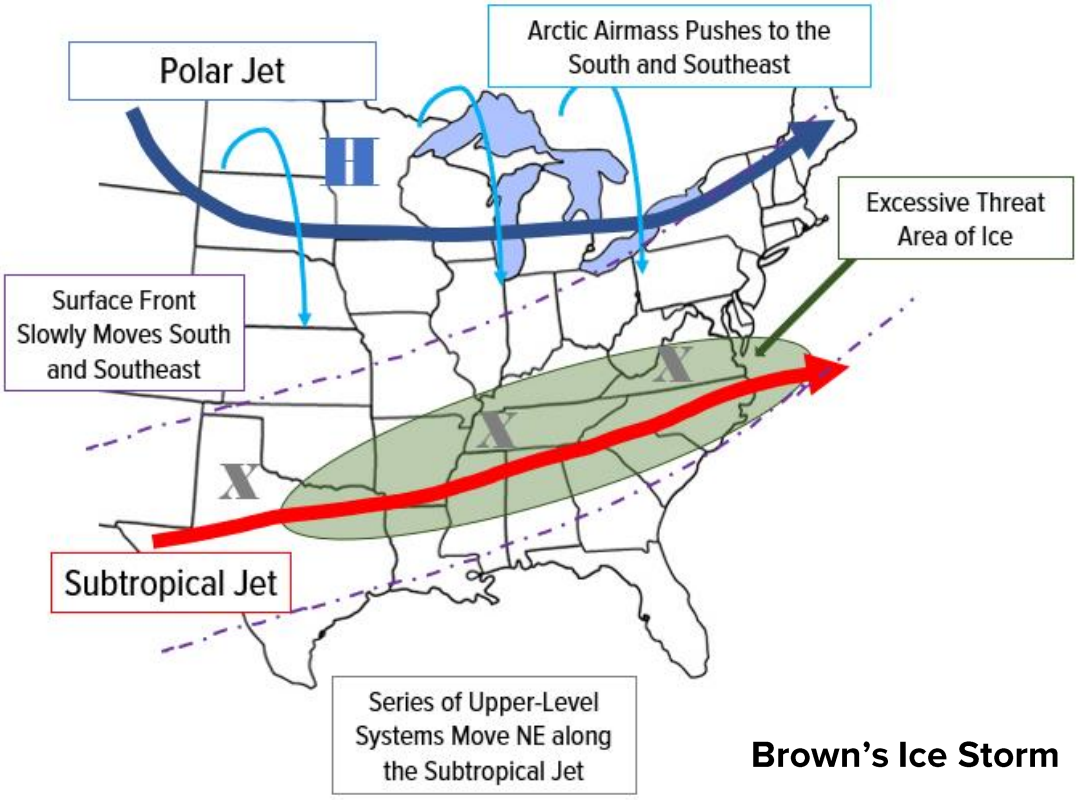
Winter Storm Types

There are several examples of this type of winter storm in South Carolina's history. The most familiar would be the March 1993 'Superstorm,' which brought near-blizzard conditions to Upstate South Carolina and likely true blizzard conditions in South Carolina's mountains. However, because of warmth present in advance of the storm, much of that storm's precipitation in South Carolina fell as rain before colder air arrived. The highest reported snowfall from this storm was 9.8 inches in Greer (at GSP Airport). The dominant winter precipitation type was snow with sleet and freezing rain occurring briefly during the transition between rain and snow.

This storm type is most likely to generate strong wind in South Carolina; the 1993 storm is one of just a few of South Carolina's winter storms to cause truly damaging winds. The highest gust during the 1993 storm in South Carolina was 91 mph at the Springmaid Pier.

These storms are more likely to occur during a negative NAO; 11 of Brown's 21 examples occurred during a negative NAO and six with a positive NAO. Of those six, three occurred with a positive PNA. They are also much more likely to occur during El Niño or ENSO neutral conditions; only four occurred during a La Niña.

Brown's sixth storm type is simply called **'Ice'** because sleet and freezing rain are the predominant precipitation types. In this situation, a strong subtropical jet provides moisture, which overruns a shallow layer of near-surface subfreezing air. The polar jet is weaker and farther to the north than usual in winter but still can provide the needed shallow cold air, usually in a cold air damming situation, to create icy conditions.



Brown's Ice Storm

Surface low pressure will track through Texas, the Gulf of Mexico, or along the Gulf Coast, and across the Coastal Plain in Georgia and the Carolinas. While freezing rain and sleet are predominant with this type of storm, there can be snow on the northern edge of the precipitation shield and for a time at the onset of precipitation. Brown only found five good examples of this type of storm. The best example for South Carolina would be the February 10-11, 1994, winter storm that left a significant ice accretion across Upstate South Carolina and the northern Midlands. Four of Brown's five storm examples occurred during a La Niña winter or with ENSO neutral conditions. The NAO was positive with three of the five and negative with the other two.

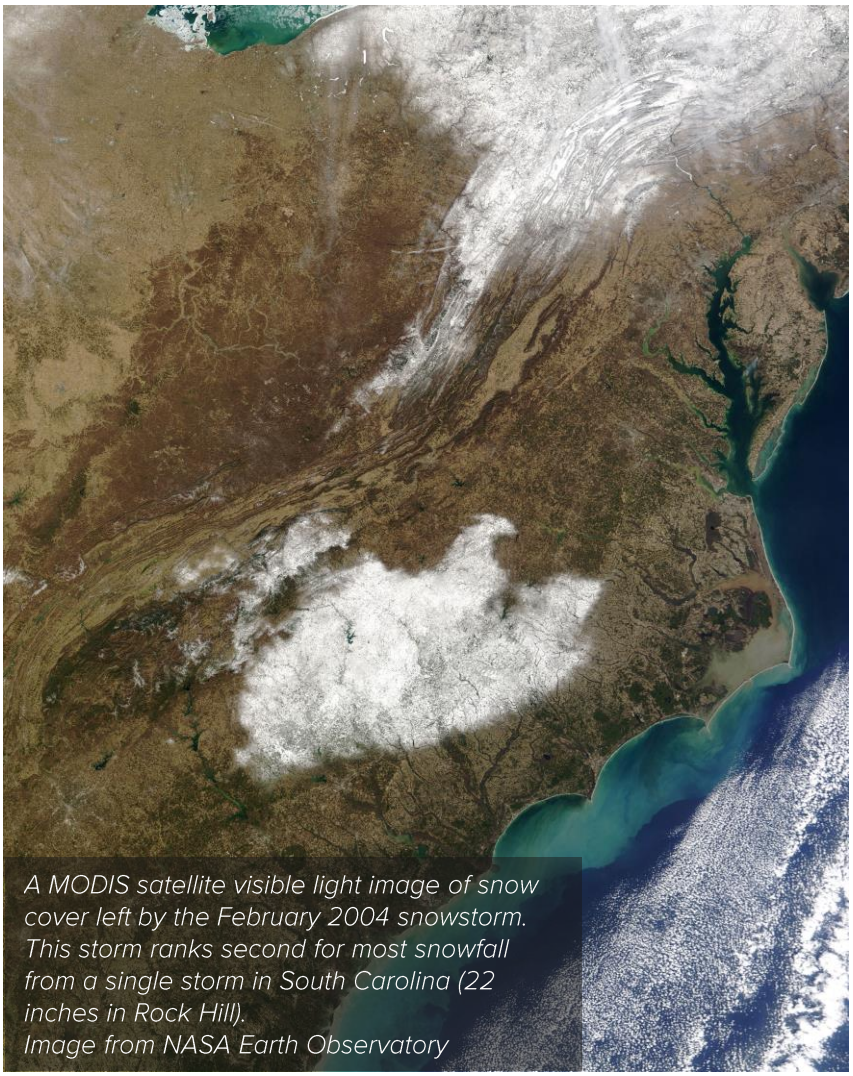
In Conclusion

This summary and the Winter Weather Database is meant to serve many purposes. One is to inform South Carolinians, particularly those who serve as emergency managers in the state, on the risks that winter weather poses by showing what has occurred in the state in the past. Weather forecasters and weather enthusiasts should find this informative and valuable in understanding how winter storms occur in South Carolina and what can occur in the most extreme events which the state has experienced. It should also be a primer for those who are interested in a career in atmospheric science, allowing them to learn more about atmospheric processes and how they lead to winter storms.

How You Can Contribute

We at the South Carolina State Climate Office continue to add storms to the database as we discover them in our research. We realize that some storms, particularly less memorable events, and events before 1958, are not yet included. Should you or someone you know recall a winter storm for which you don't see a summary in our database, we would like you to tell us about it to ensure that it becomes a part of South Carolina's historical record.

If you remember a winter storm that hit South Carolina that you don't see in our database and can recall the date it occurred, please let us know using our "My Extreme Weather Memory" page. Please include the specific date of the storm and recollections of the storm's effect on you, your family, and your community. Make sure to include any measurements you may have made of the snow, ice, or temperatures. We will research your submission by comparing it to past weather maps, weather observations, and local news media accounts for authentication. Once verified, we will include it in the database. We will be unable to research any submitted events that do not have a date of occurrence. Your help in making South Carolina's winter storm database as complete as possible is appreciated.



A MODIS satellite visible light image of snow cover left by the February 2004 snowstorm. This storm ranks second for most snowfall from a single storm in South Carolina (22 inches in Rock Hill).
Image from NASA Earth Observatory

For Further Study

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