An Examination of a Mesoscale Snow Event across Southeast South Carolina and Southeast Georgia

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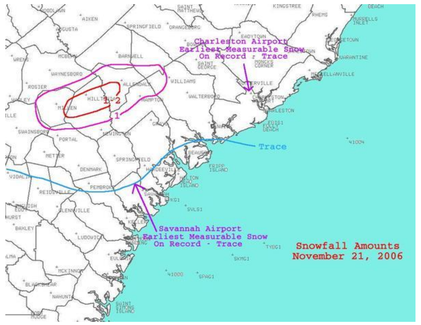
EVENT OVERVIEW

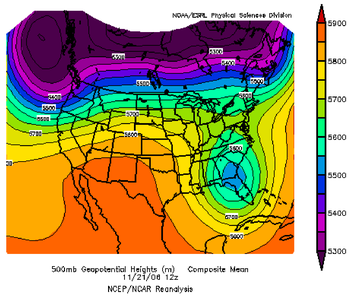


Rare, accumulating snows fell across portions of southeast South Carolina and southeast Georgia on 21 November 2006, as a strong coastal storm meandered off the Southeast United States and a highly anomalously cold upper low drifted across Georgia. Moderate to heavy snows fell during a three hour period resulting in brief accumulations of snow on grassy areas, trees as well as roadways. Snowfall amounts of 1 to 2 inches were common within a distinct mesoscale snow band that developed across the region from Jenkins County, GA through northern Colleton County, SC. Snow of this magnitude is rare for the region any time of year and its occurrence in late November was likely the earliest on record. Earlier in morning of 21 November, both Charleston, SC (KCHS) and Savannah, GA (KSAV) observed a trace of snow, which was the earliest snowfall on record at both sites. Thunder snow was also observed for the first time at KCHS since record began.

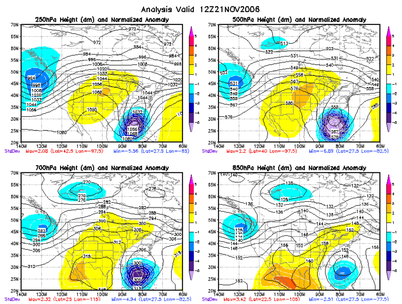
GOAL

This study will examine the kinematic and thermodynamic processes that likely contributed to the development of the band of moderate to heavy snow. An examination of the conditions that favored the development of conditional symmetric instability (CSI) will be presented as the resulting enhanced precipitation rates were likely a major contributor to brief, heavy snowfalls in a highly conditional thermodynamic enviornment.

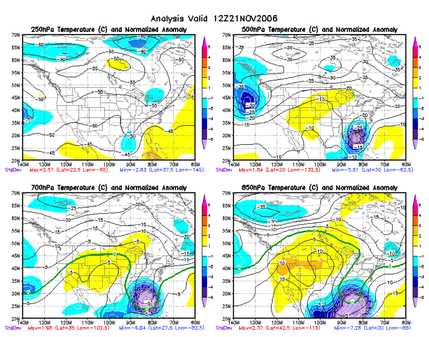
SYNOPTIC SETUP

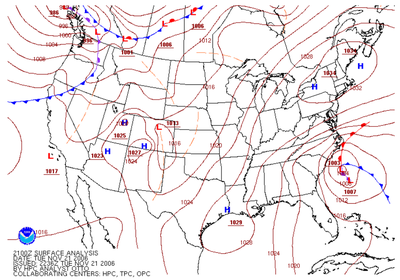


The upper air pattern across the Southeast U.S. was dominated by a large and strong upper level cyclone, which was positioned well south of the polar jet stream. Mid-level heights across region were anomalously low for late November, ranging from 3000 m at 700 hPa with 5400 m at 500 hPa.



NCEP analysis data generated by The Pennsylvania State University (http://hart.met.psu.edu/meteo497/patternmap.html) suggest 700 hPa heights were as much as 2 to 4 standard deviations below normal and as much as 3 to 6 standard deviations below normal at 500 hPa. Temperature anomalies at 850 hPa, 700 hPa and 500 hPa showed similar trends.





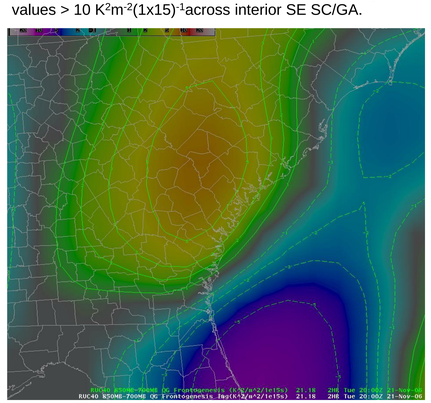
At the surface, a strong coastal storm meandered off the Southeast U.S. coast, approximately 140 miles east of Savannah, GA (SAV). By 21 UTC on 21 November, the coastal low had a pressure as low as 1003 hPa and was producing a number of hazards along the South Carolina and Georgia coasts including heavy precipitation, high surf, coastal erosion, high winds and extremely dangerous marine conditions. The combination of anonymously cold atmospheric temperatures, heavy rainfall and extensive cloud cover yielded chilly temperatures for late November. High temperatures struggled to reach the mid 40s at both KCHS and KSAV, which is about 15 ºF below climatological normals.

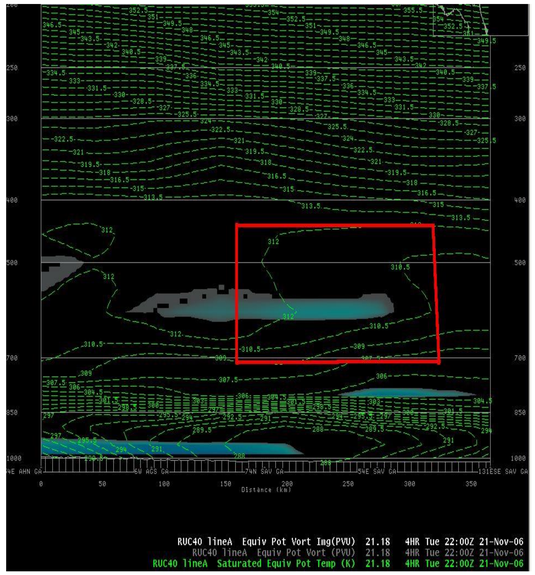
KINEMATIC REVIEW

This event was extremely difficult to forecast. However, a a review of RUC model data, showed that were several factors present for the development of accumulating, convective snows.

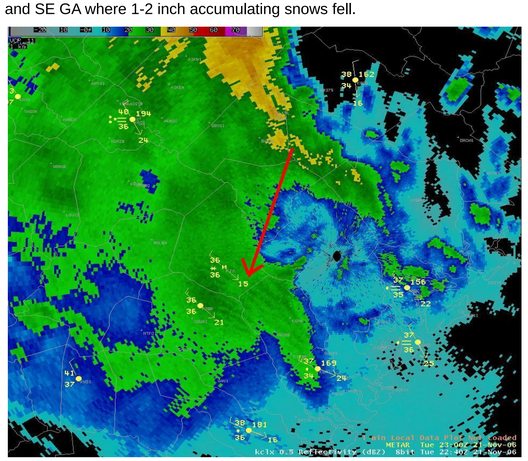
Slant-wise Convection (CSI)

Slant-wise convection, also known as Conditional Symmetric Instability (CSI), is almost unheard of in coastal South Carolina and Georgia. However, a look at the RUC 850-700 hPa Quasi-geostrophic Frontogenesis fields suggest strong veritical motion was occurring during the late afternoon hours due to the presence of an indirect ageostrophic circulation. This upward motion aided in the development of a large precipitation field across much of interior SE SC and SE GA. CSI is generally found in areas of strong Frontogenesis. Note the bulls eye of values > 10 $K^2m^{-2}(1x15)^{-1}$across interior SE SC/GA.



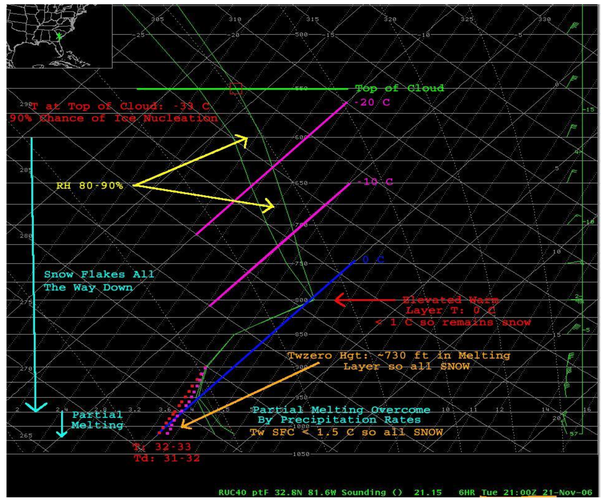


A RUC cross section of equivalent potential vorticity (EPV) and saturated equivalent potential temperature at 21 UTC appears to verify that the potential for CSI did exist where accumulating snows fell. Notice the area where values of saturated potential decreased slightly with height align perfectly with areas of negative equivalent potential vorticity. This suggests the atmosphere was unstable with respect to slant-wise convection when saturated. In the figure above, shaded areas are where EPV values are < 0 PVU. The red box depicts where saturated equivalent potential temperature decreases with height and is located across interior SE SC and SE GA where 1-2 inch accumulating snows fell.



KCLX 0.5º base reflectivity at 22 UTC also suggested the presence of CSI convective rolls. Notice the convective role feature near KJYL where the 22 UTC AWOS observation depicted snow with a visibility of 2.5 sm. These convective rolls likely contributed to the presence of locally enhanced snow rates, especially where localized wet-bulbing was maximized.

THERMODYNAMIC REVIEW



Top Down Method

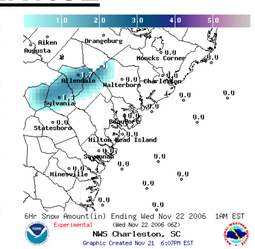
Applying the Top Down Method to the 21 UTC RUC forecast sounding at Sylvania, GA (KJYL) yielded some interesting results. Based on RH cross sections, the top of the cloud layer was located around 550 mb, where temperatures were forecasted to be aroun -33 ºC with RH values between 80-90%. These conditions typically yield a 90% chance of ice nucleation at the top of the cloud layer.

Farther down the sounding, temperatures between -10 ºC and -20 ºC were located between 675 hPa and 725 hPa with similar RH values of 80-90%. As flakes began to fall into this saturated region, the presence of ice and super cooled water droplets produced ideal conditions for large dendritic growth. An elevated warm layer with a temperature near 0 ºC was forecasted to occur near 800 hPa, but this is usually cold enough for flakes to survive, since the Top Down Method allows flakes to survive with temperatures less than 1 ºC.

An initial glance at the surface layer suggested conditions were too warm for flakes to survive all the way to the surface as ground temperatures were forecast to be in the upper 30s with a WBZ height near 2000 ft. Ideally, for measurable snow to occur, WBZ heights need to be less than 1500 ft for flakes to survive. However, spotter reports during the period of heaviest snow, suggested surface temperatures were considerably colder—between -1 ºC and 0 ºC. There modifying the surface layer to match the colder than expected surface temperatures, the sounding would have been sufficiently cold enough to support snow flakes all the way to the surface.

CUSTOMER SERVICE

WFO Charleston advertised the potential for a large coastal storm to develop off the SC/GA coast for many days. A number of impacts were addressed in routine forecast products, including high surf, coastal erosion and heavy rain. The potential for winter weather was occasionally discussed in Area Forecast Discussions, but the potential was downplayed given the various thermal profiles offered by the numerical models and the climatological rarity of snow across the region. Accumulating snows did eventually fall with KCHS and KSAV observing their earlier snowfalls on record.



High situational awareness in the hours preceding and during the event allowed forecasters to issue Snow Advisories to highlight the potential for a short-fuse 1-2 snow event. This was the first time the WFO submitted non-zero Snow Amount grid to the National Digital Forecast Database.