

# Overview of the December 20, 2004 NWS MHX Winter Weather Event

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## 1. INTRODUCTION

On Monday, December 20, 2004 portions of eastern North Carolina received locally heavy snowfall and experienced some of the coldest temperatures of the year. High temperatures in most areas struggled to make it out of the mid 20s, with low temperatures Monday night plummeting into the low to mid teens. Most areas received 1-3" of snow, although, locally heavy snowfall totals of 4-7" were experienced in several counties (**Figure 1**).

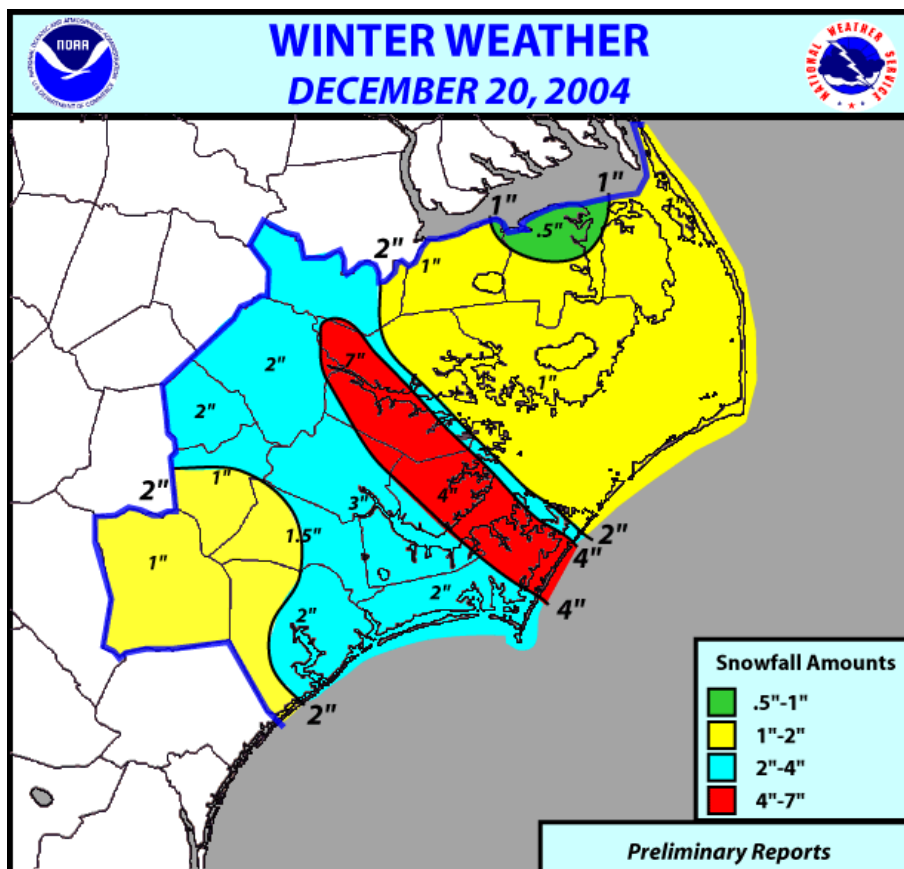
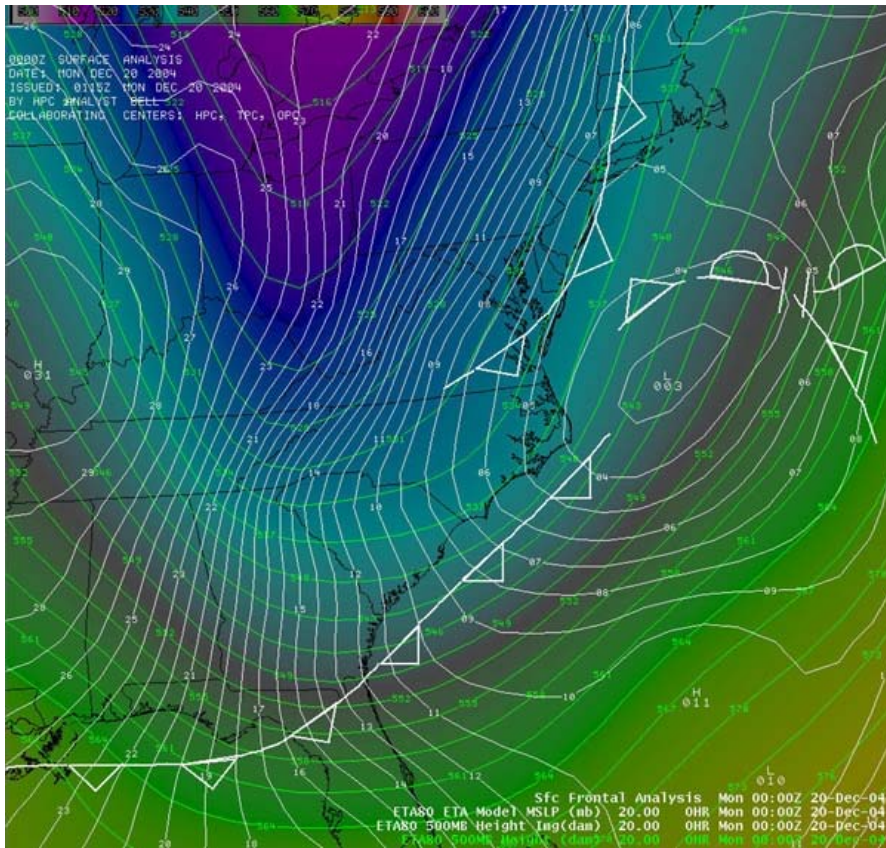


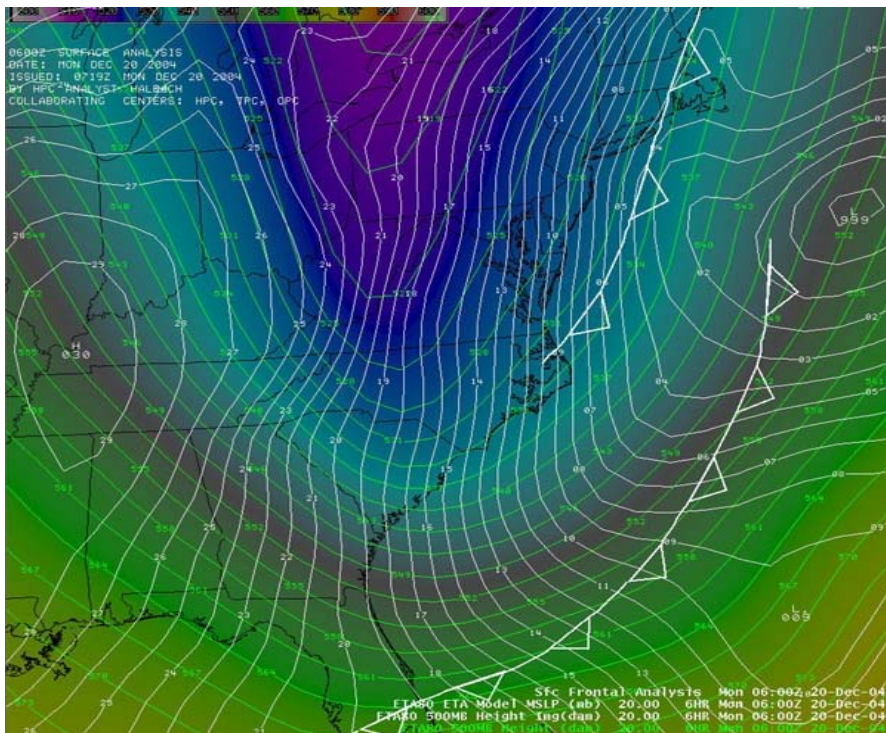
Figure 1. Preliminary Snowfall Totals in NWS MHX's County Warning Area.

## 2. SYNOPTIC OVERVIEW

The upper-air pattern over the eastern U.S. on 00 UTC December 20, 2004 was characterized by a deep neutral or slightly negatively tilted 500 mb trough approaching the Mid-Atlantic region (**Figure 2**). At the surface and to the east (downstream) of the 500 mb trough, a 1003 mb low was located about 100 miles ENE of Cape Hatteras. At the surface and west (upstream) of the 500 mb trough a 1031 mb high was located over IL, MO and KY (**Figure 2**). By 06 UTC on Monday, December 20, 2004, the 500 mb trough had moved into western VA and NC and had also become more negatively tilted (**Figure 3**). The surface low near Cape Hatteras at 00 UTC was 999 mb and located several hundred miles NE of Cape Hatteras by 06 UTC (**Figure 3**).



**Figure 2.** 00Z 12/20/2004 500 mb Heights (green lines), Mean Sea Level Pressure (white lines) and HPC Surface Frontal Analysis (thick white lines).

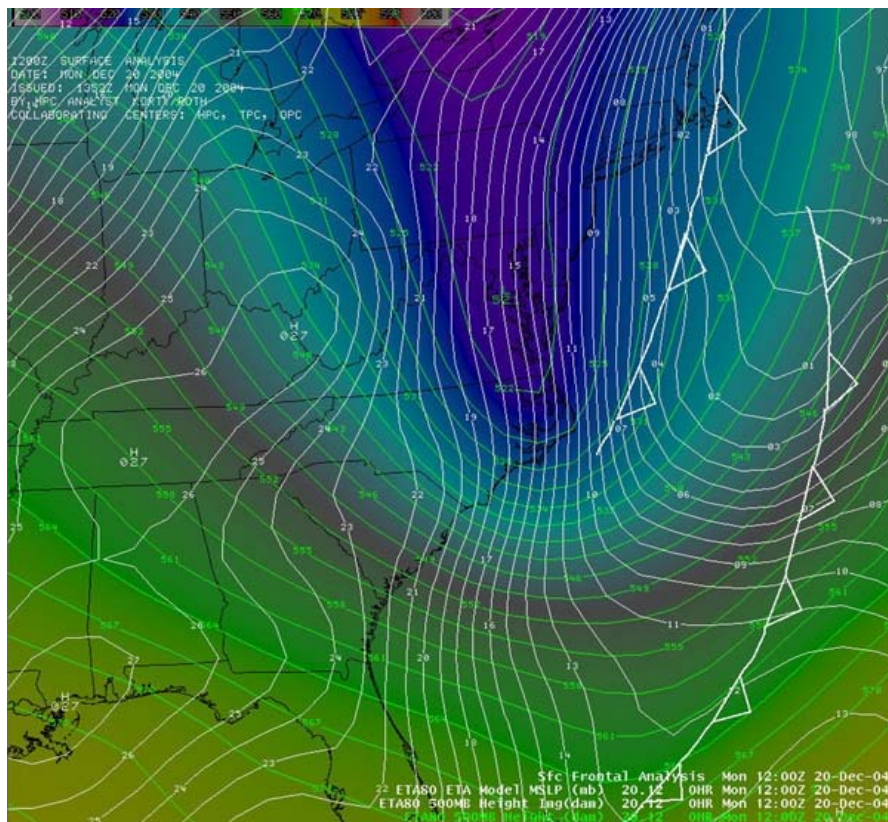


**Figure 3.** 06Z 12/20/2004 500 mb Heights (green lines), Mean Sea Level Pressure (white lines) and HPC Surface Frontal Analysis (thick white lines).

Also, at the surface, a very tight pressure gradient was present over eastern NC, with a 7-8 mb pressure difference between Raleigh, NC and Cape Hatteras, NC (**Figure 3**). This large pressure difference created strong winds over eastern NC on the morning of December 20<sup>th</sup> (**Table 1**). By 12 UTC December 20, 2004, the base of the negatively tilted 500 mb trough was located over eastern NC and VA (**Figure 4**). Even though the event occurred in late December, this trough was exceptionally deep for this latitude, boasting 500 mb pressure surface heights over eastern NC of only 5220 meters!

**Table 1.** Wind Gusts in knots (mph) for eastern NC locations on the morning of December 20, 2004.

Location	Wind Gusts in knots (mph)
Beaufort, NC (MRH)	34 (39)
Cape Hatteras, NC (HSE)	32 (37)
Cherry Point, NC (NKT)	33 (38)
Manteo, NC (MQI)	32 (37)
New River, NC (NCA)	29 (33)
Jacksonville, NC (OAJ)	26 (30)
Diamond Buoy (41025)	45 (52)
Duck Buoy (DUCN7)	40 (46)

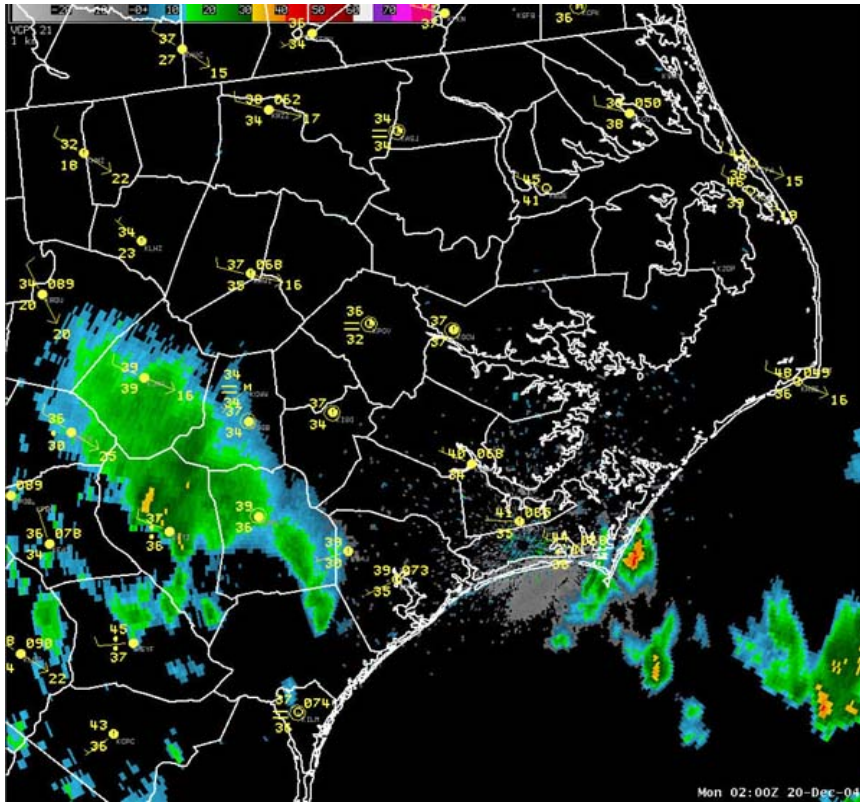


**Figure 4.** 12Z 12/20/2004 500 mb Heights (green lines), Mean Sea Level Pressure (white lines) and HPC Surface Frontal Analysis (thick white lines).

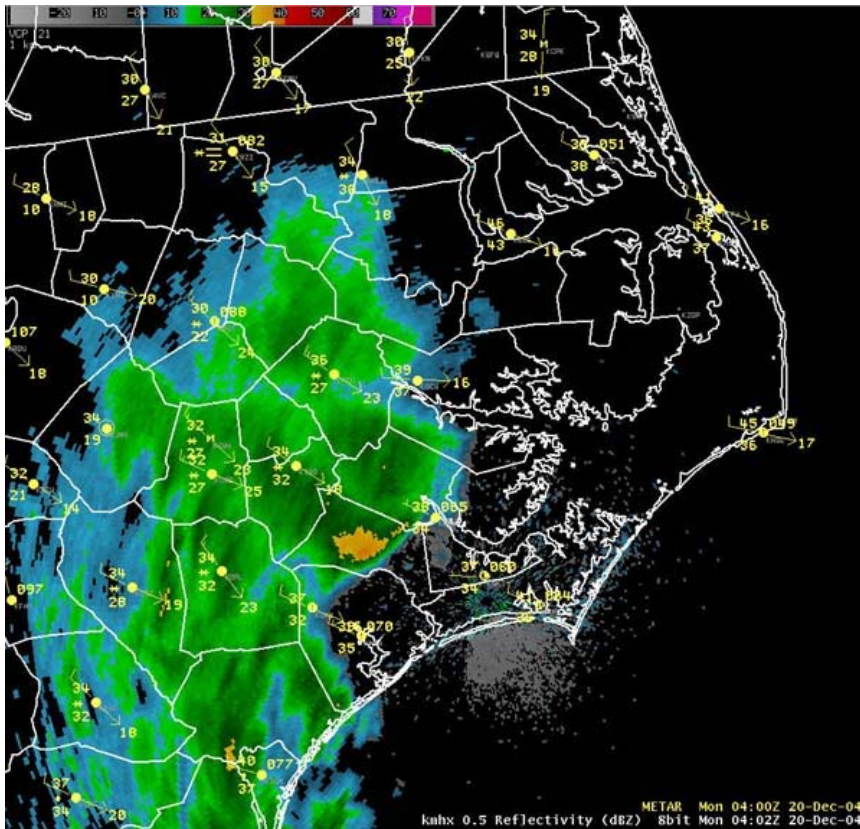
By 12 UTC December 20, 2004 the surface low downstream of the 500 mb trough was well out to sea. After 12 UTC, as the upper trough over eastern NC and VA began to lift northeast out into the Atlantic, the upstream surface high over TN and KY subsequently spilled into the Mid-Atlantic and finally began to clear out the skies over eastern NC.

### 3. MESOSCALE OVERVIEW

Precipitation began over eastern NC in the form of rain around 02 UTC on Monday, December 20 (9:00 pm EST Sunday, December 19) (**Figure 5**). Temperatures over eastern NC ranged from the mid 30s inland to the mid

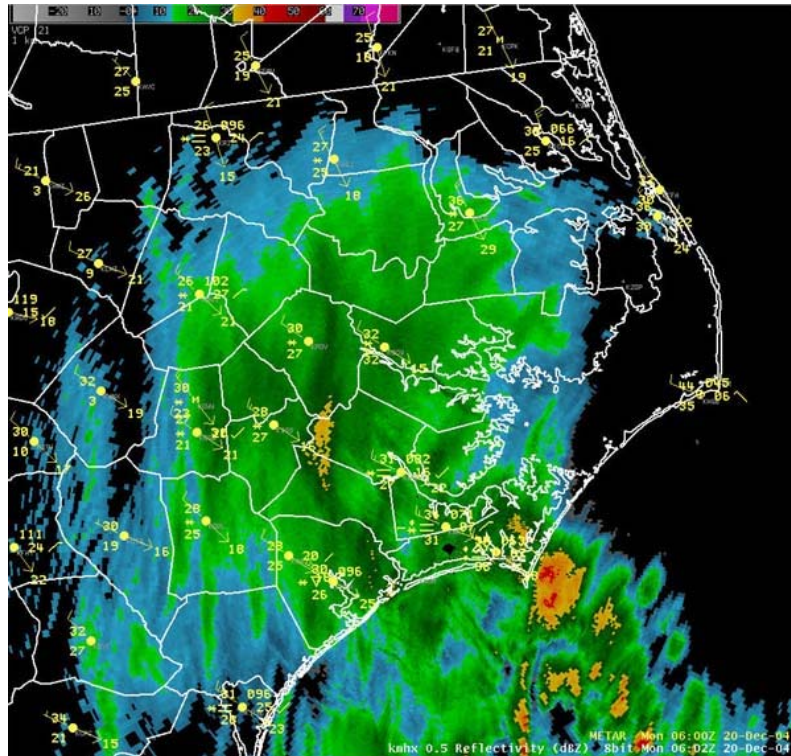


**Figure 5.** 02Z 12/20/2004 0.5 Degree Reflectivity and Surface Observations Showing Rain Beginning in the NWS MHX CWA in Duplin County.

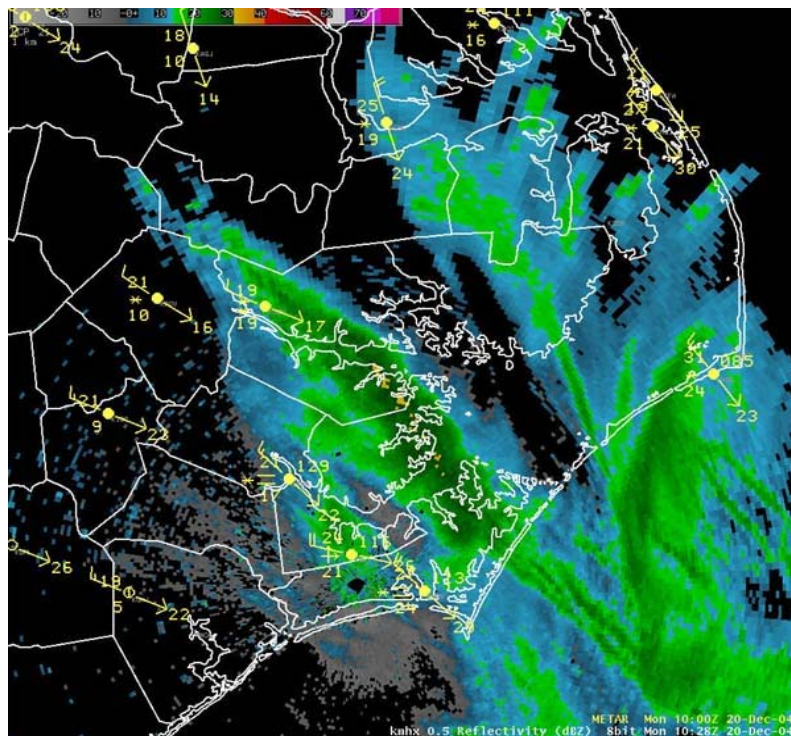


**Figure 6.** 04Z 12/20/2004 0.5 Degree Reflectivity and Surface Observations Showing Snow in Duplin, Lenoir, Greene and Pitt Counties and rain in Onslow, Jones, Craven and Beaufort Counties.

40s along the coast and Outer Banks. As the night progressed, the precipitation increased in coverage and intensity and temperatures began to fall as the deep 500 mb trough approached eastern NC. By 04 UTC on Monday, December 20, the precipitation had changed over to snow in Duplin, Lenoir, Greene and Pitt counties and rain had spread into Onslow, Jones, Craven and Beaufort counties (**Figure 6**). By 06 UTC December 20, precipitation in advance of the upper trough had overspread much of eastern NC. Temperatures inland had fallen to the upper 20s and lower 30s with snow falling in Duplin, Greene, Lenoir, Pitt, Onslow, Jones, Craven, Martin, Beaufort, Pamlico and Washington counties (**Figure 7**).



**Figure 7.** 06Z 12/20/2004 0.5 Degree Reflectivity and Surface Observations Showing Snow over most of eastern North Carolina.

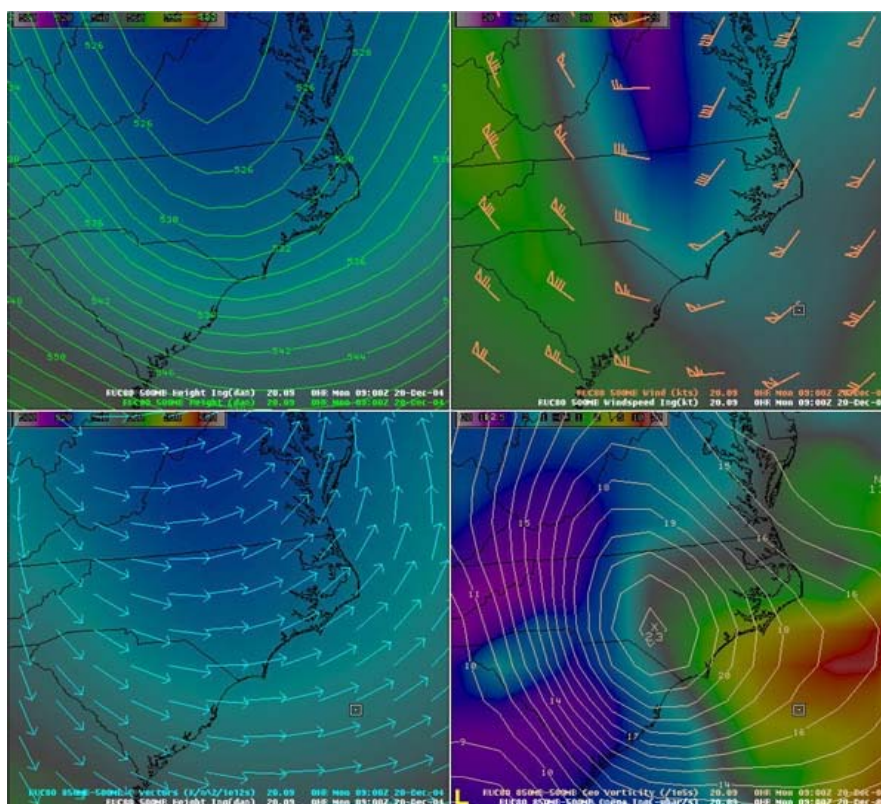


**Figure 8.** 10Z 12/20/2004 0.5 Degree Reflectivity and Surface Observations Showing Heavy Snow Band over Martin, Beaufort, Pamlico and Carteret Counties.

As the morning progressed, the precipitation continued to move east and temperatures continued to drop as the upper trough lifted over eastern NC. Even the Outer Banks dropped below freezing and reported light snow for several hours. By 10 UTC December 20, an interesting feature developed over eastern NC. A band of snow approximately 20-25 miles wide and 80-100 miles long trained over Martin, Beaufort, Pamlico and downeast Carteret counties for 6 hours between 10 and 14 UTC December 20 (**Figure 8**). The band contained moderate to occasionally heavy snow. After training over the before mentioned counties for several hours, the band of snow began to move southeast and dissipate at 13 UTC, finally exiting off the coast of Carteret county between Cape Lookout and Cedar Island at 14 UTC. The narrow zone of heavy snowfall totals (4-7") shown in **Figure 1** is a direct result of this persistent band of snow. Locally heavy bands of snow such as this are difficult to predict because of their small spatial scale. Possible explanations for this snow band will be reviewed in the discussion section.

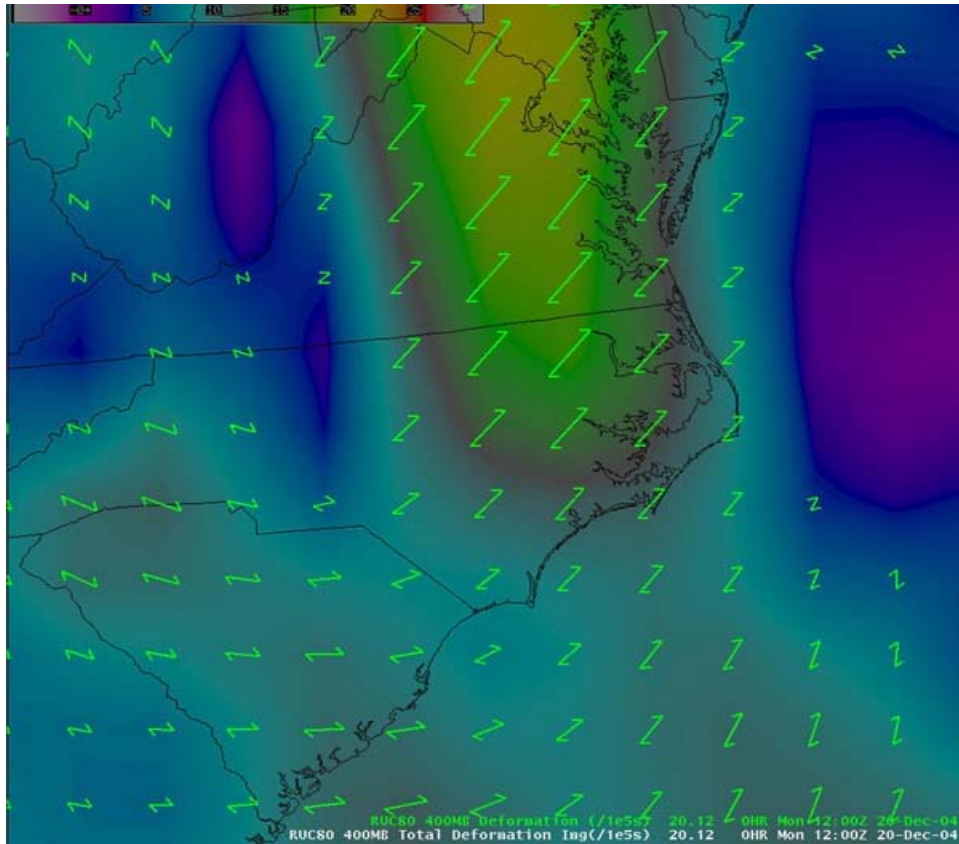
#### 4. DISCUSSION

It is difficult to determine why the heavy band of snow developed and trained over Martin, Beaufort, Pamlico and downeast Carteret counties between 10-14 UTC December 20. An analysis of 500 mb heights, winds and geostrophic relative vorticity showed that a strong vorticity maximum was approaching eastern NC at 09 UTC December 20 (**Figure 9**). As the deep, negatively tilted 500 mb trough approached eastern NC, the deep-layer lift



**Figure 9.** 09Z 12/20/2004 RUC Model Analysis. Upper Left panel (500 mb heights), Upper Right panel (500 mb winds), Lower Left Panel (850-500mb Q-Vectors), Lower Right Panel (850-500 mb Geostrophic Relative Vorticity and 850-500 mb Omega).

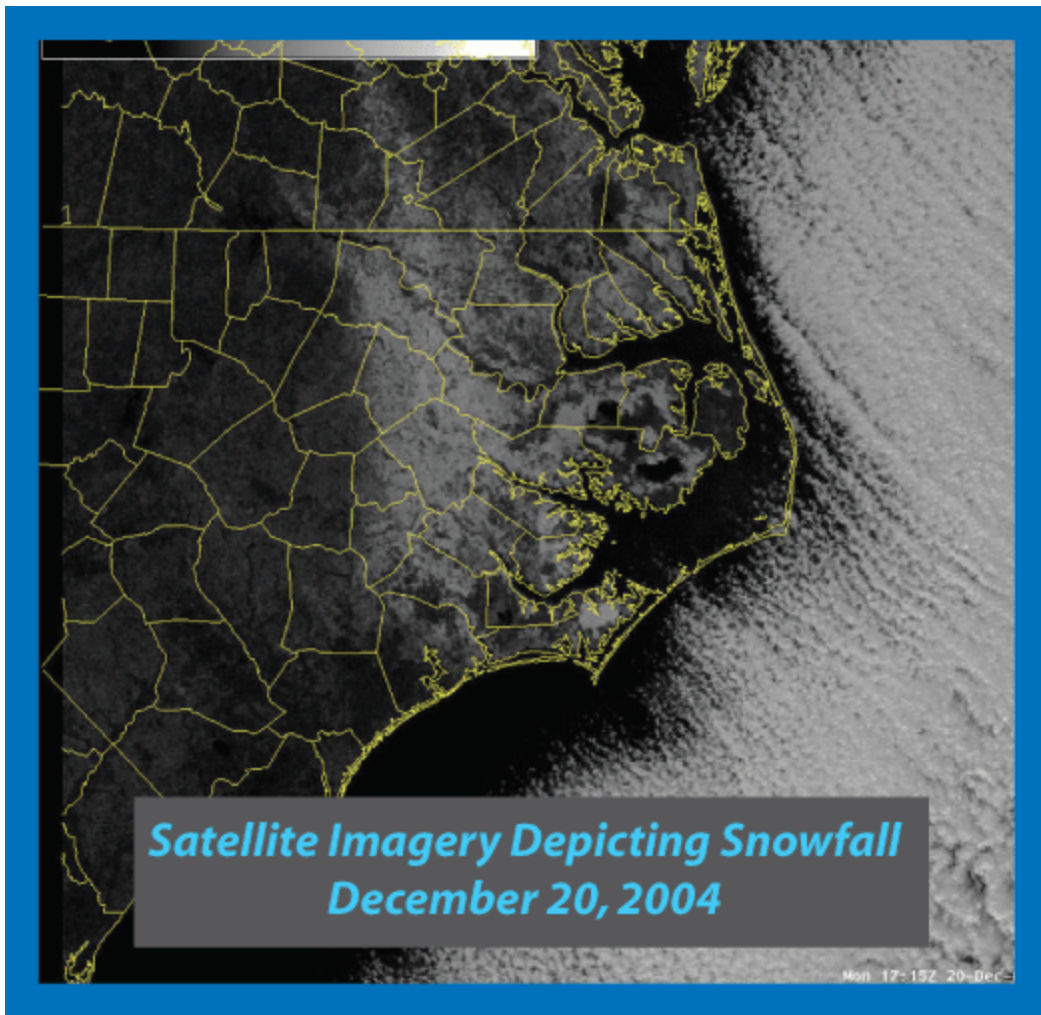
associated with the trough was responsible for the swath of precipitation over eastern NC on the morning of the 20<sup>th</sup>. One possible explanation for the narrow swath of heavy snow was hypothesized. Between 10 and 14 UTC a strong, narrow deformation zone crossed eastern NC (**Figure 10**). It is possible that this narrow area of large stretching/shearing deformation aloft stretched the preexisting surface precipitation along the dilatation axis, which was oriented northwest to southeast (also the same direction as the mean 1000-850 mb flow). The heavy snow band in **Figure 8** does indeed show the band is parallel to the mean 1000-850 mb flow (northwest to southeast) and that the band is aligned parallel with the axis of dilatation aloft (northwest to southeast). Therefore, the narrow band of heavy snow was possibly the result of strong stretching/shearing deformation aloft acting upon an area of preexisting precipitation with the net result of concentrating the precipitation into a narrow zone that corresponds with the orientation of the dilatation axis and the mean flow in the 1000-850 mb layer.



**Figure 10.** 12Z RUC 400 mb Deformation Vectors and Total Deformation as Image. Note: Axis of Dilatation is perpendicular to the Deformation Vectors, so the Axis of Dilatation is oriented northwest to southeast over eastern NC.



**Figure 11.** Picture of NWS MHX in Newport, NC on the morning of December 20, 2004. Snowfall accumulation at the office was between 1-2". Picture taken by Brandon Vincent.



**Figure 12.** 1715 UTC December 20, 2004 Visible Satellite Image Showing Snowfall over Eastern NC.