An Overview of the Winter Storm of December 4-5, 2002

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1. Introduction

A winter storm produced damaging ice accumulations from freezing rain and several inches of snow and sleet in various parts of the western Carolinas and extreme northeast Georgia on December 4-5, 2002. All 50 NWS Greenville-Spartanburg forecast zones (46 counties) were affected. Winter storm conditions[1] occurred in 47 of the 50 zones.

1. Synoptic Features

A cold front moved south across the area during the night of December 2. By 1200 UTC on the 3rd, the front extended from the Southern Coastal Area of North Carolina west through north Georgia. A large high pressure system (1040 mb) centered over Alberta was building into the central and eastern United States. Figure 1a shows the location of these synoptic scale features.

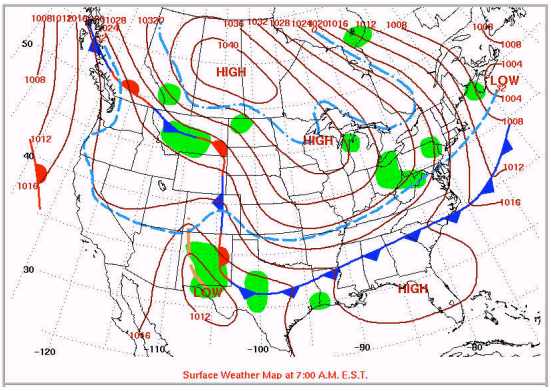

Fig. 1a. NCEP Surface Analysis – 1200 UTC December 3, 2002. Shading denotes precipitation.

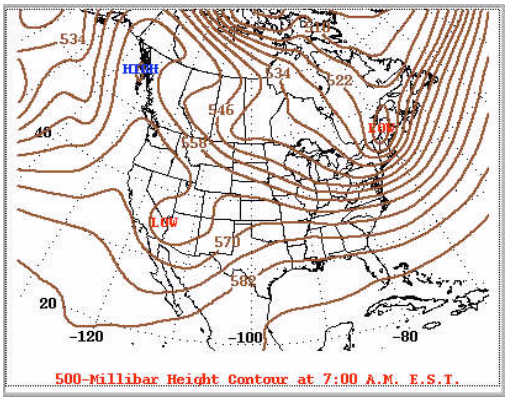

Fig. 1b. NCEP 500 mb Analysis – 1200 UTC December 3, 2002

The 500 mb analysis at 1200 UTC on December 3 (Fig. 1b) showed a split flow pattern

[1] A winter storm is verified in each zone by the occurrence of any of the following: 1) An average snow accumulation of 3 inches in 12 hours, 2) An average snow accumulation of 4 inches in 24 hours, or 3) Ice accumulation of 0.25 inch.

across the United States. A cutoff low height center was over Arizona. The northern branch of the flow extended from the northern Rockies toward the mid-Atlantic coast.

The air mass spreading into the Carolinas on the 3rd was cold and dry. Dew points across North Carolina and much of South Carolina were in the 20s and 30s. Single digit dew points were found over northern Virginia northward into Pennsylvania. Refer to Figure 2.

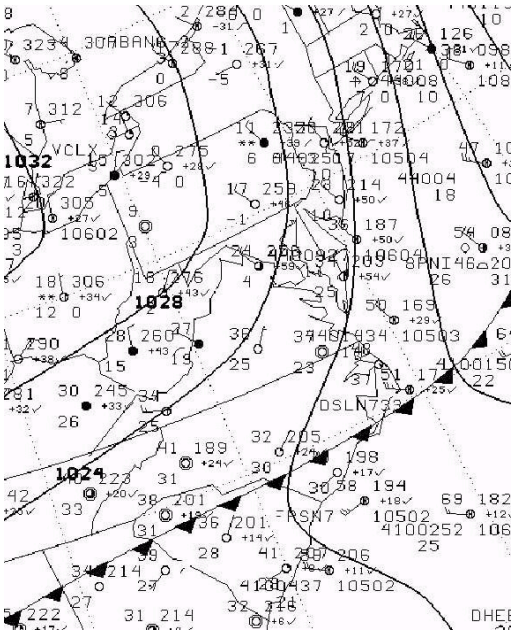

Fig. 2. NCEP Surface Analysis
1200 UTC – December 3, 2002

By 1200 UTC on December 4, a surface low pressure system was developing near the Texas-Louisiana border. The upper low over the southwestern United States had become an open wave moving eastward across the southern Great Plains. These features are displayed in Figures 3a and b.

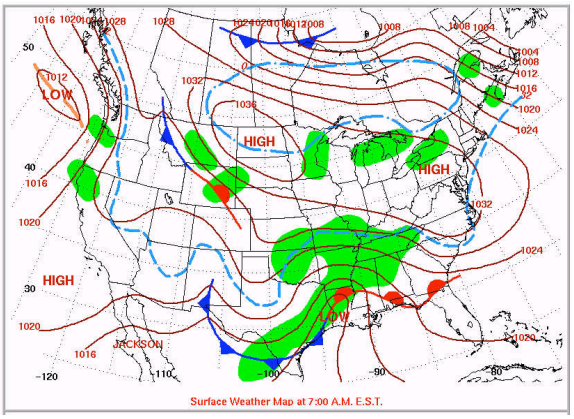

Fig. 3a. NCEP Surface Analysis – 1200 UTC
December 4, 2002

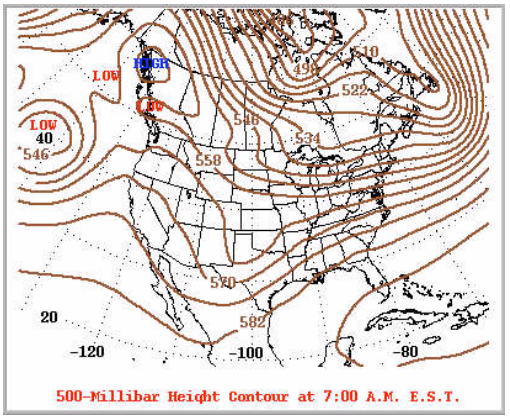

Fig 3b. NCEP 500 mb Analysis – 1200 UTC
December 4, 2002

Figure 4 is a December 4 1200 UTC surface analysis focusing on the mid-Atlantic region. The very dry air with single digit dew points has moved southward into the Carolinas. Figure 5 is a backward trajectory analysis from the EDAS displaying the 24-hour history of air parcels that were 100 m, 500 m, and 1000 m over GSP at 1200 UTC on the 4th. The trajectories indicate the dry air over northern Virginia the previous day surged southward east of the Appalachians as the high pressure system began to assume a cold air damming configuration. The 1200 UTC December 4 sounding from Greensboro, NC (GSO) in Figure 6 shows the cold, dry near the surface.

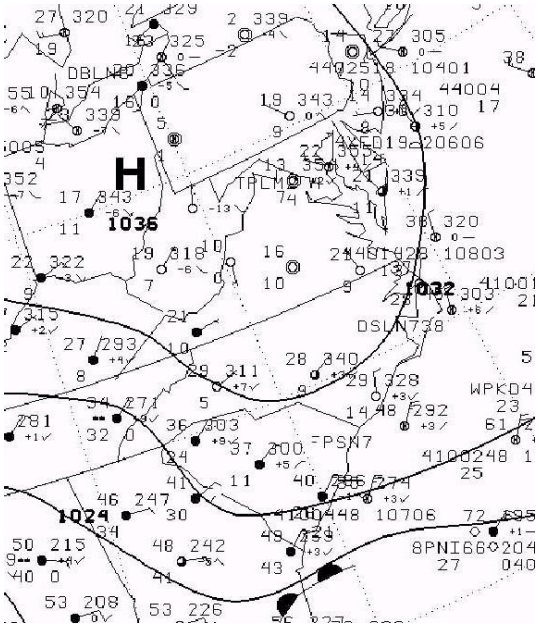

Fig. 4. NCEP Surface Analysis – 1200 UTC for December 4, 2002

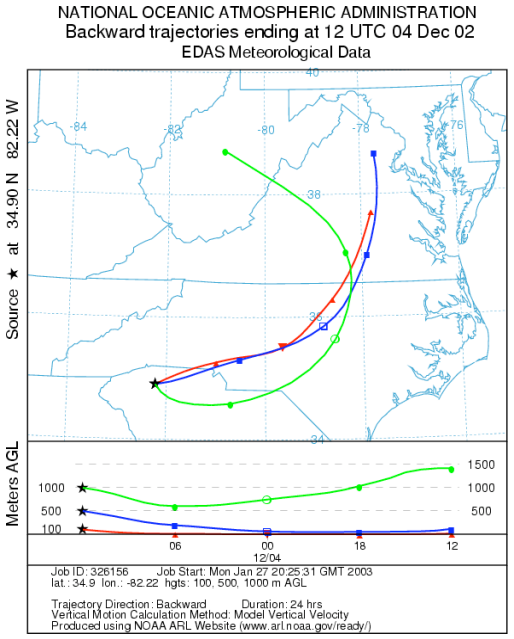

Fig. 5. 24-hour backward trajectories air parcels 100 m, 500 m, and 1000 m over GSP at 1200 UTC December 4, 2002

From NOAA Air Resources Laboratory

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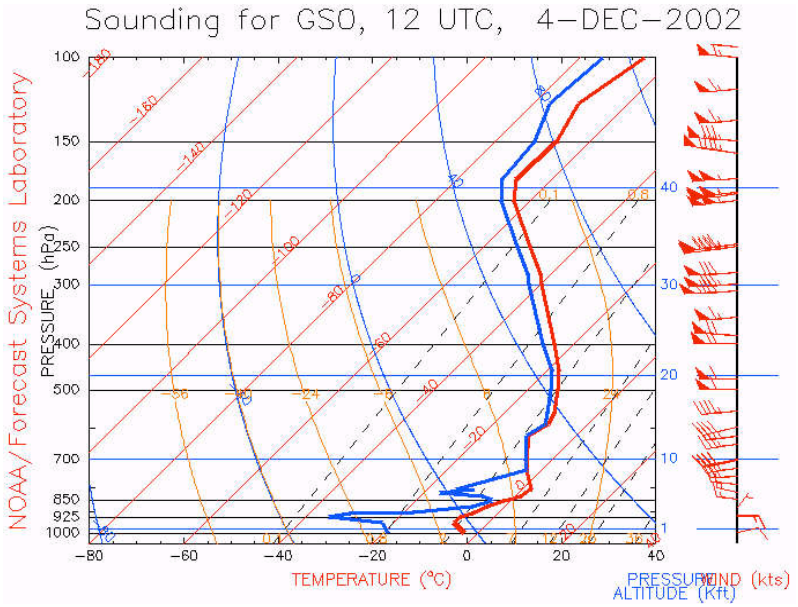

Fig. 6. Greensboro, NC sounding – 1200 UTC December 4, 2002

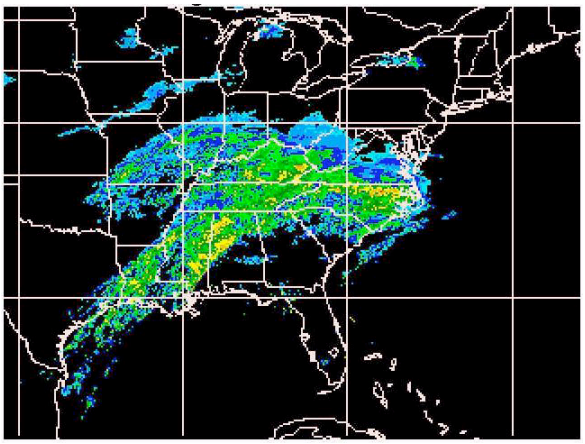

Fig. 7. Radar composite – 0000 UTC December 5, 2002

During Wednesday (December 4), the surface low moved northeast from the central Gulf Coast region toward the southern Appalachians. Precipitation developed over northeast Georgia and the western Carolinas in the morning. By late afternoon, precipitation was occurring across the entire Greenville-Spartanburg CWA. Figure 7 shows the precipitation distribution at 0000 UTC on the 5th.

The 1200 UTC December 4 Greensboro sounding (Fig. 6) had a temperature just above 0^{o}C near 800 mb. A visual inspection of the temperature profile, however, indicates the wet bulb temperature at that time is below 0^{o}C throughout the lower troposphere. Indeed, the precipitation at Greensboro began as snow shortly after noon. Snow continued for approximately seven hours until significant warming occurred near 850 mb. The warm advection above the surface-based cold air created a temperature profile that melted the snow aloft thus producing a favorable freezing rain environment.

The predominant type of precipitation across the southern tier of counties in the GSP CWA was freezing rain. Snow predominated over the northern counties, but some freezing rain also occurred. A band of mixed precipitation stretched through the middle portion of the CWA where significant freezing rain accumulated on top of several inches of snow. The distribution of predominant precipitation types is displayed in Figure 8.

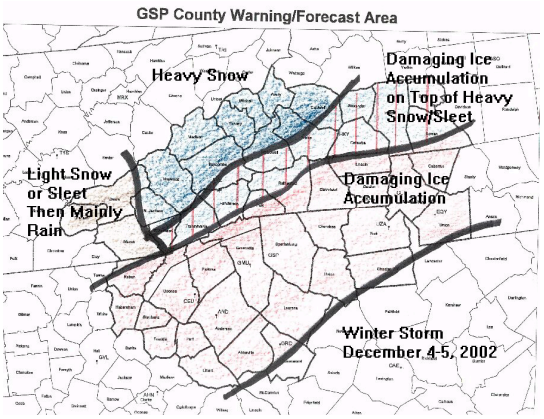

Fig. 8. Distribution of precipitation types across the GSP CWA

By Wednesday evening the low pressure system was over the Mississippi and Alabama border, and another area of low pressure was forming off the South Carolina coast. During the night, the coastal low traveled to the northeast and became the dominant system. The inland low weakened, but remained an identifiable weather system as it moved toward east Tennessee. By 1200 UTC on Thursday (December 5), the primary surface low was near Cape Hatteras (Fig. 10a).[2] The 500 mb analysis in Fig. 10b shows a broad and deep trough over the central United States. The 300 mb analysis in Figure 11 indicates the cyclogenesis occurred in the entrance region of a strong jet maximum extending out over the Atlantic. Widespread precipitation in the western Carolinas at 1200 UTC quickly ended before 1600 UTC on the 5th.

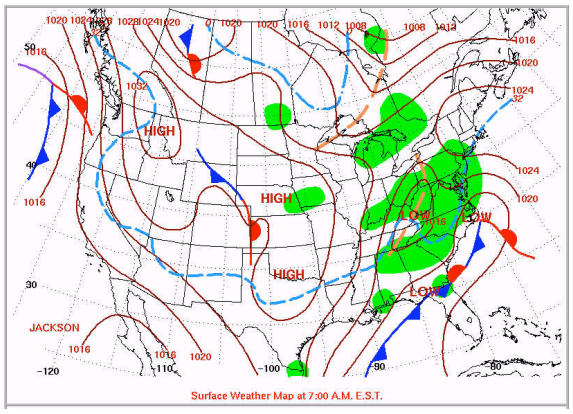

Fig. 10a. NCEP Surface Analysis – 1200 UTC December 5, 2002

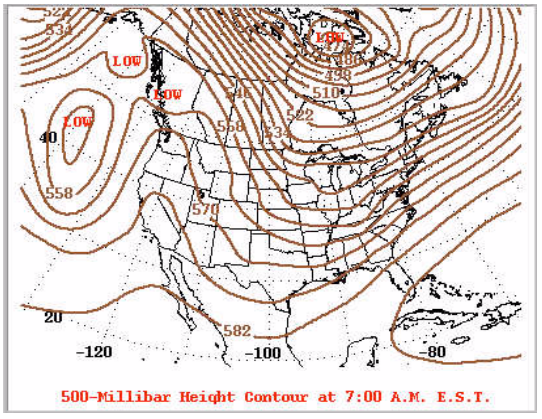

Fig. 10b. NCEP 500 mb Analysis – 1200 UTC December 5, 2002

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2 This cyclogenesis can be categorized as a Miller Type "B."

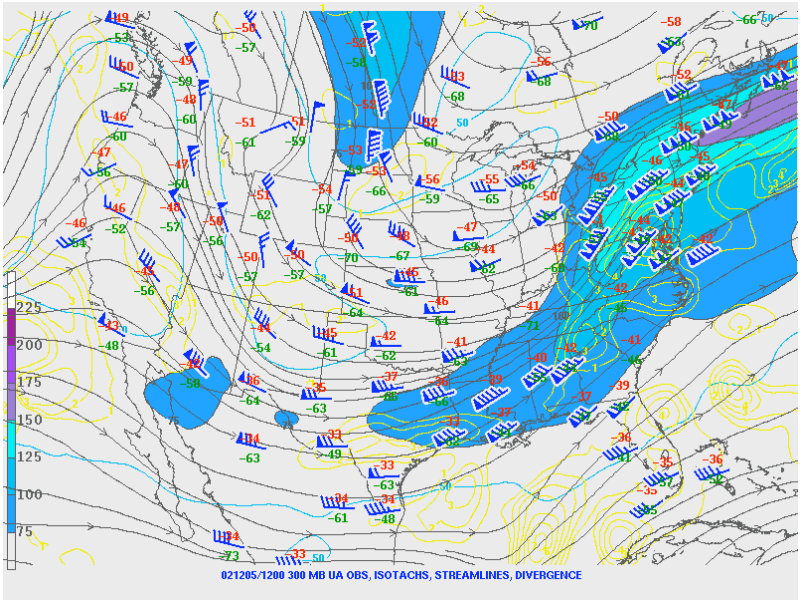

Fig. 11. Storm Prediction Center 300 mb Analysis. Isotachs are shaded According to scale on left.

3. Temperature Characteristics

The vertical temperature profile at GSP is representative of the thermal structure in the zone of significant freezing rain across the southern counties. Figure 12 is the initial hour vertical temperature and moisture profile from the 0000 UTC (December 5) Eta Model displayed in BUFKIT. There was a layer of above freezing air centered around 850 mb (approximately 5000 ft) while the near surface temperature was below freezing. The maximum temperature in the warm nose was around +5^{o}C. This should result in nearly complete melting of snowflakes falling into the layer. The precipitation-type nomogram indicated the predominant form of precipitation during the next six hours would be freezing rain with a trace of sleet. The table below summarizes the precipitation types during that period. (FZRA indicates freezing rain. RA denotes rain.)

Precipitation Types at Greenville-Spartanburg							0000 UTC – 06000 UTC
Time	0000	0100	0200	0300	0400	0500	0600
P-Type	FZRA	FZRA	FZRA	FZRA	FZRA	RA	RA
Unknown precipitation was reported at several intervals between 0300 and 0500 UTC							

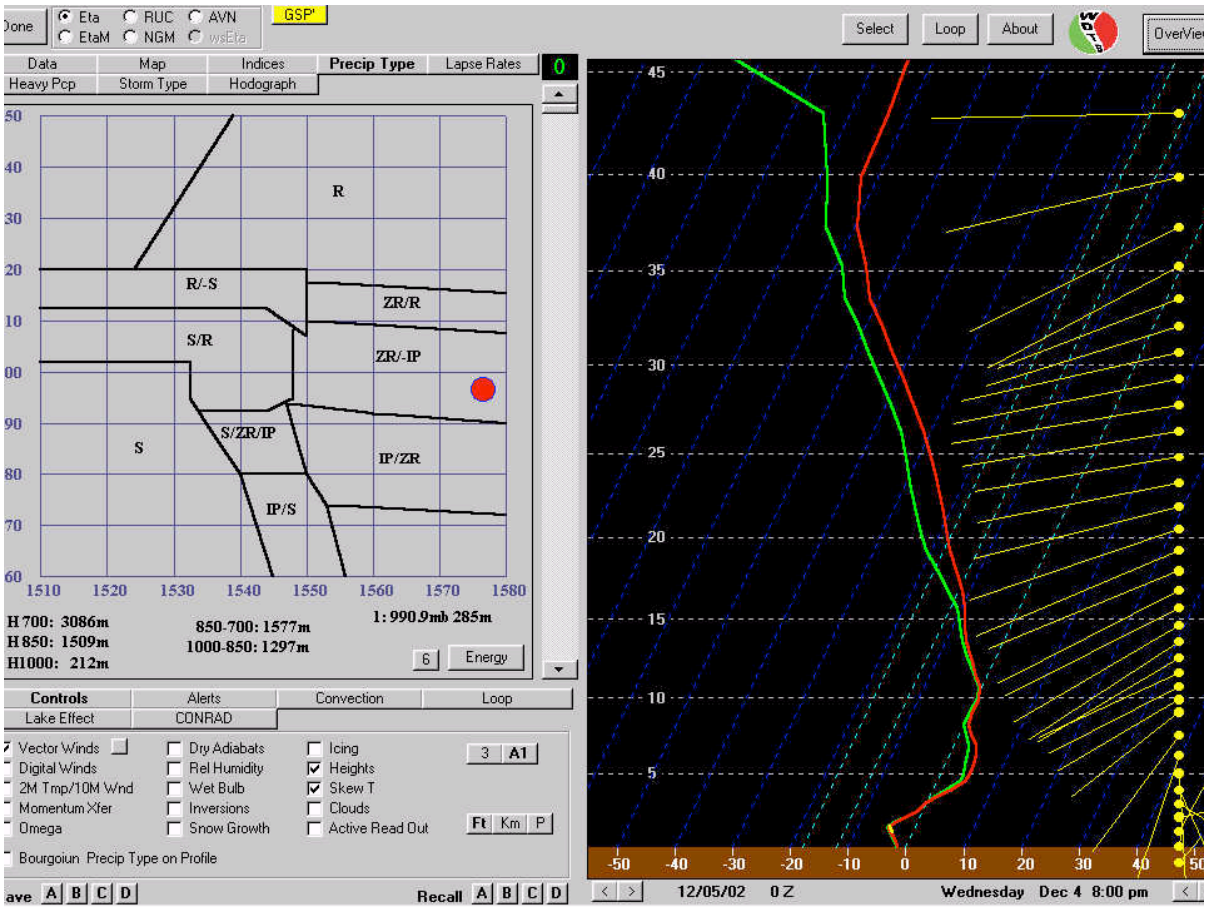

Fig. 2. Initial hour Bufkit display for GSP from the 0000 UTC December 5, 2002 Eta Model. On the right, temperature in red, dewpoint in green. On the left, precipitation-type nomogram.

Figure 13 is the Eta Model initial hour vertical temperature profile valid at 0000 UTC (December 5) for Hickory. This temperature structure is more representative of the northern counties in the GSP CWA. The temperature was just above 0^{o}C (maximum in the layer was +1.4^{o}C) between 850 and 700 mb. The layer was warm enough to melt some of the snow falling into it. Freezing rain was occurring at 0000 UTC, but snow had fallen when the entire temperature profile was below freezing from approximately 1400 UTC until 2200 UTC. The warming trend aloft continued for the duration of the event, but surface temperatures remained below freezing.

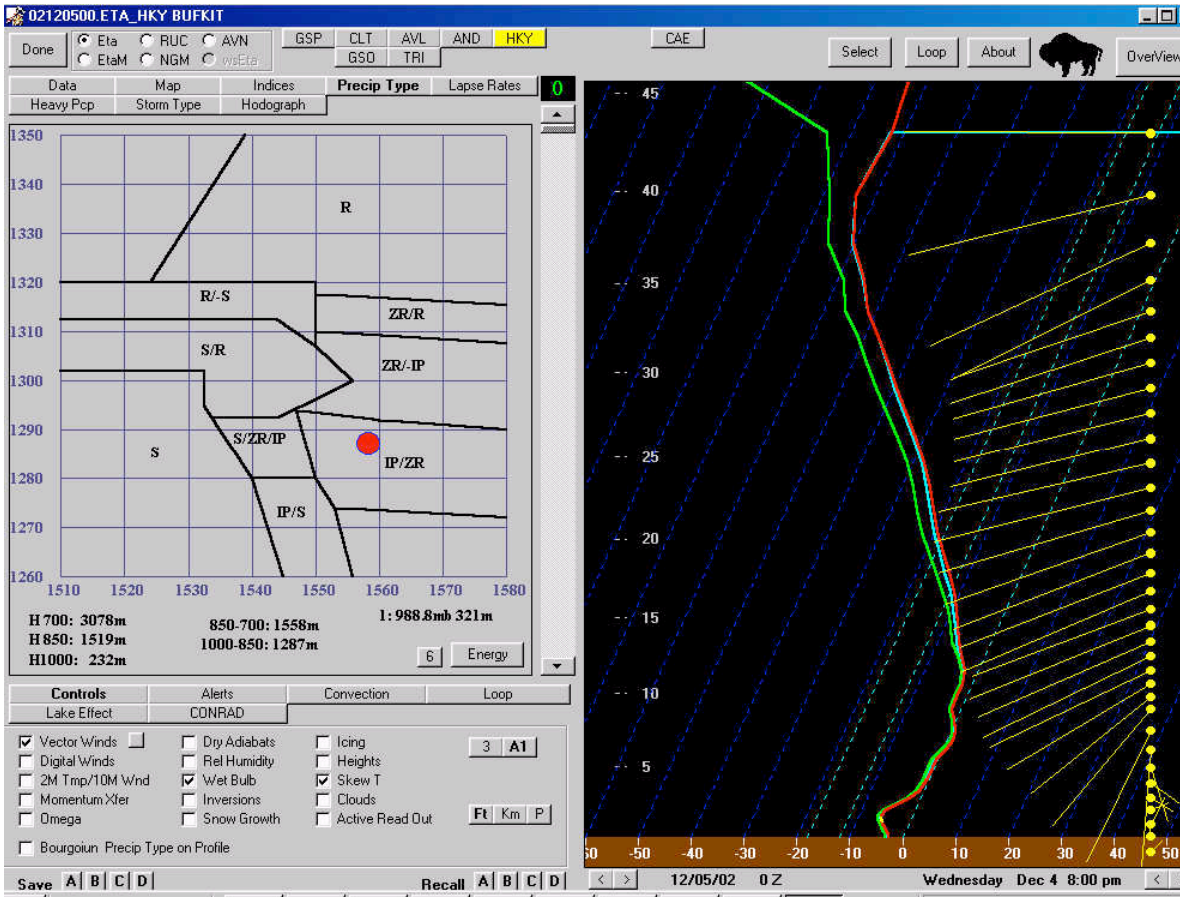

Fig. 13. Initial hour Bufkit display for HKY from the 0000 UTC December 5, 2002 Eta Model

Figure 14 is an Eta Model forecast for HKY valid at 0400 UTC on the 5th. The warm nose has become clearly defined. The temperature was forecast to be +3.5^{o}C at 823 mb which would melt nearly all of the snow. The precipitation type nomogram accurately

forecast the trend from predominant snow through sleet to freezing rain. (It is assumed that the Unknown Precipitation observed during the event was sleet.)

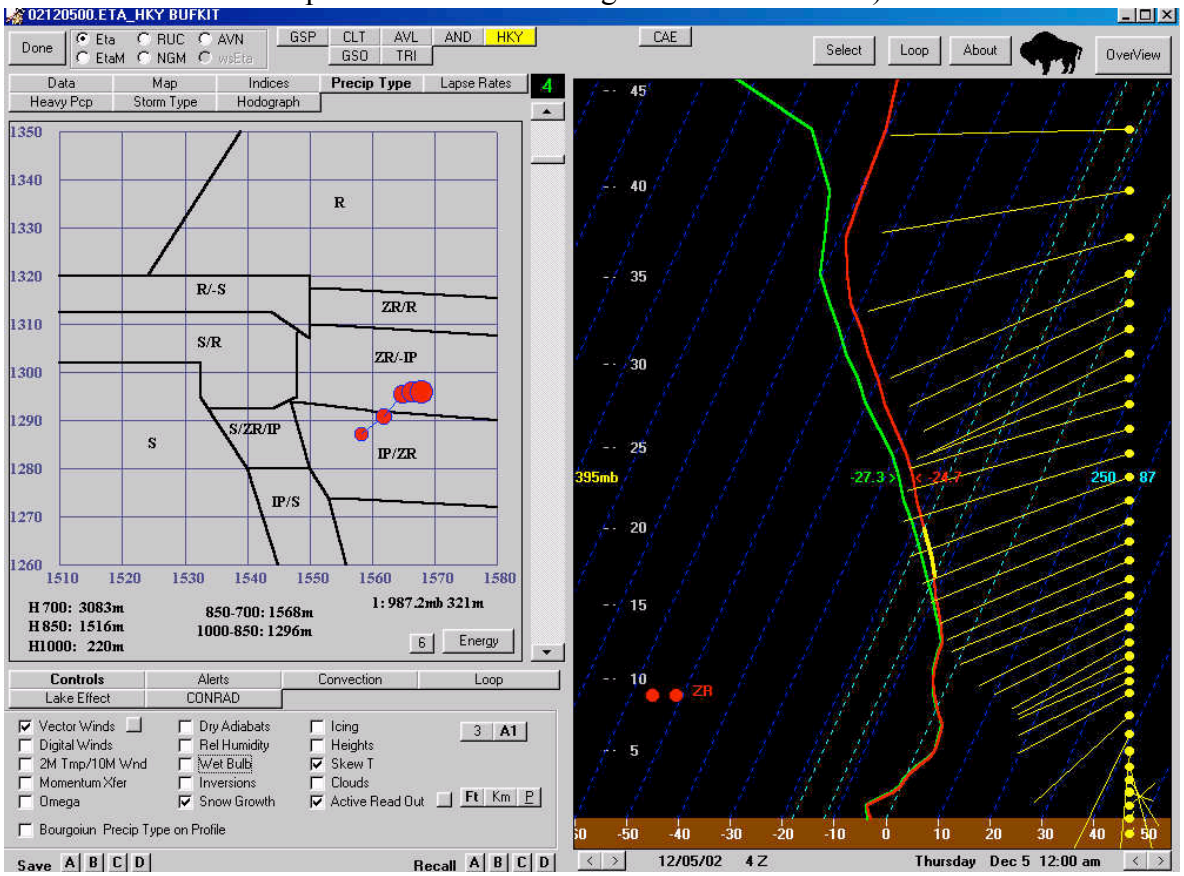

Fig. 14. Bufkit display of 0000 UTC Eta Model forecast at HKY valid at 04000 UTC December 5, 2002

1. Summary

A low pressure system moved from the Gulf Coast states toward the southern Appalachians on December 3, 2002. Freezing rain, sleet, and snow spread across the western Carolinas and extreme northeast Georgia on December 4 and 5. The low moved up the west side of the mountains and weakened while a secondary low formed off the North Carolina coast on the 4th. Precipitation quickly ended on the morning of December 5 when the Carolina coastal low moved north through the mid-Atlantic region.

In its wake, the storm system left extensive damage caused by ice accumulation across the central and southern portions of the Greenville-Spartanburg County Warning Area. Snow, sleet, and freezing rain combined to hamper travel and produce major ice damage in

the northern counties of the GSP CWA.

Forecasts, advisories, watches, and warnings issued by the National Weather Service provided significant notice that a disruptive weather event was going to occur. The first statement (Special Weather Statement) issued by NWS GSP was disseminated on Monday, December 2, at 1016 UTC (516 am EST) mentioning that winter weather was possible. At 2039 (339 pm EST) UTC on December 2, a Winter Storm Outlook indicated that a significant event was expected. The first Winter Storm Watch was issued at 0925 UTC (425 am EST) on December 3. Subsequent watches and warnings followed.

Figure 15 is a forecast map issued by the NWS Hydrometeorological Prediction Center. The area of "Significant Icing Likely" is centered on the western Carolinas.

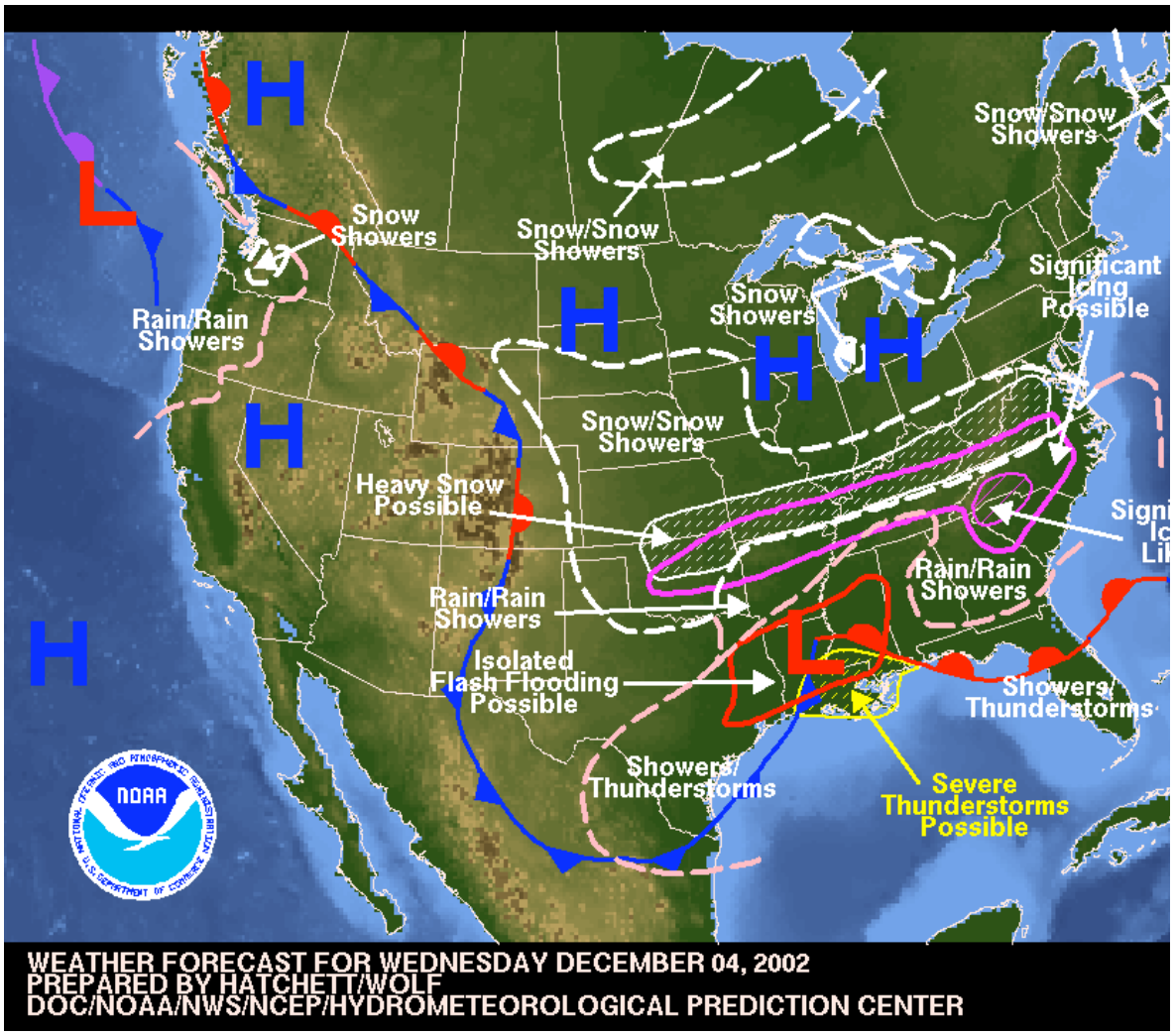

Fig. 15. National Weather Service forecast issued for December 4, 2002

The table below contains verification information for Winter Storm Watches and Winter Storm Warnings issued by NWS Greenville-Spartanburg for the storm of December 4 and 5, 2002. A forecast zone corresponds to a county with the following exceptions: Oconee, Pickens, and Greenville counties (SC) and Jackson County (NC) are split into "north" and "south" sections. A Winter Storm Warning verifies if the forecast zone experiences any of the following: An average snowfall of 3 inches in 12 hours, an average snowfall of 4 inches in 24 hours, or ice accumulation at least .25 inch.

No. of Watches (per Forecast Zone)	No. of Watches with an Event	No. of Events	No. of Events with a Watch	POD	CSI	FAR	Average Lead Time (hours)
50	47	47	47	1.00	0.94	0.06	36.8
No. of Warnings (per Forecast Zone)	No. of Warnings with an Event	No. of Events	No. of Events with a Warning	POD	CSI	FAR	Average Lead Time (hours)
50	47	47	47	1.00	0.94	0.06	24.8

POD (Probability of Detection) = fraction of actual events correctly forecast

Critical Success Index (CSI) = ratio of correct forecasts to the number of events plus the number of incorrect forecasts

False Alarm Ratio (FAR) = fraction of all event forecasts which were incorrect

- End -