

Rockies to Southeastern U.S. Winter Storm

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Overview:

The second week of February 2011 was highlighted by a strong winter storm that dropped southeastward through the northern and central Rockies before continuing eastward across the central and southern Plains into the southeastern U.S. Heavy snows were recorded early in the week across the northern into the central Rockies (Figs 1a, b) before extending eastward across the Texas and Oklahoma Panhandles and western Kansas (Fig 1b). Heavy snows continued into eastern sections of Oklahoma where the state set an all-time record for 24-hour snowfall accumulation when 27 inches fell in Spavinaw on February 9th. By midweek heavy snows had reached southern Missouri and northern Arkansas (Fig 1c). As the storm continued eastward, lighter amounts were reported across portions of the Tennessee and lower Ohio Valleys to the North Carolina and Virginia coasts (Fig 1d).

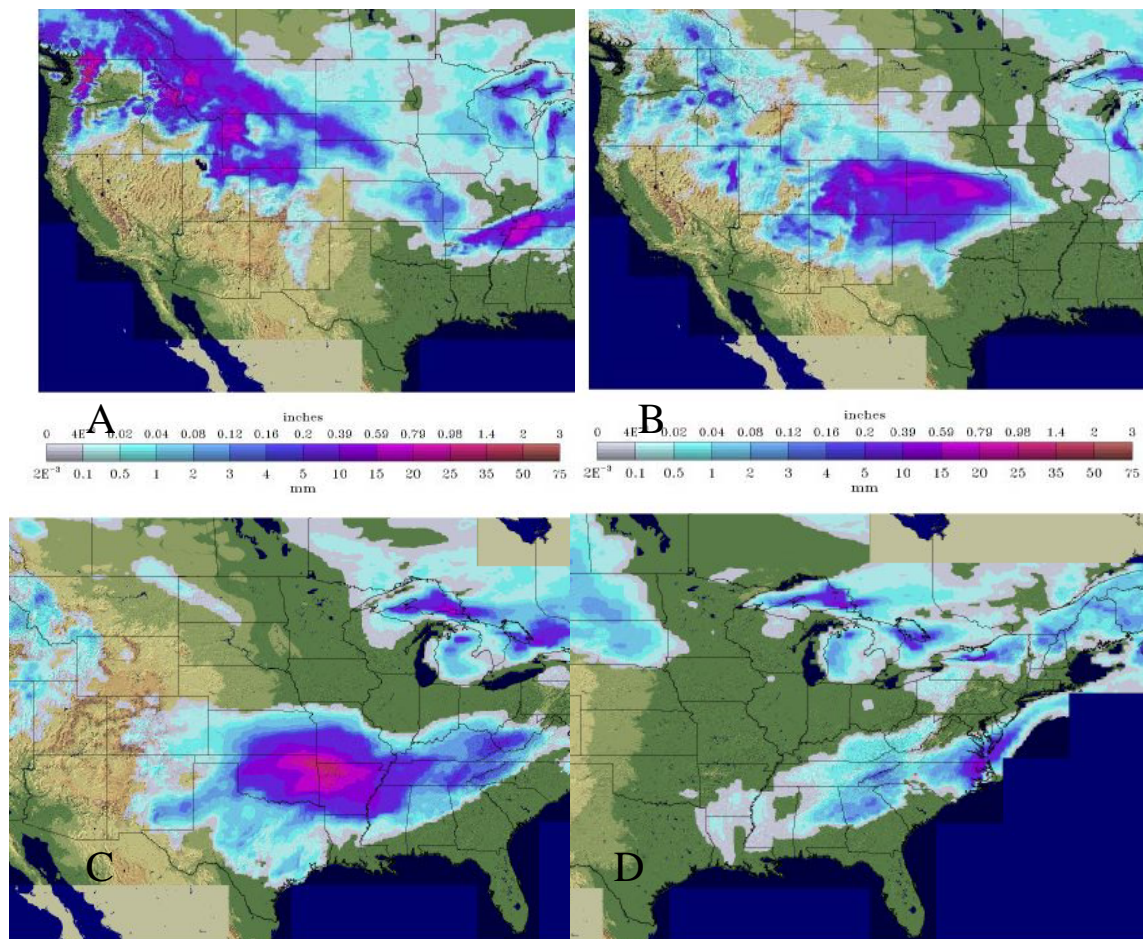


Figure 1: Scaled snow precipitation from 06 UTC on (a) 8 Feb 2011, (b) 9 Feb 2011, (c) 10 Feb 2011 and (d) 11 Feb 2011 (SPC).

Synoptic Pattern:

At 12 UTC on 7 February 2011 a shortwave trough and strong upper jet were noted moving into the Pacific Northwest (Fig. 2a) with an associated cold front extending from northern Idaho back into southeastern Oregon (Fig. 3a). Over the next 12-hours analyses showed this 500 hPa shortwave and the upper jet digging south into the central Great Basin, placing southern Wyoming under the left-exit region of the jet. Strong upslope flow in the low to mid levels across the Nebraska and the Dakotas into the northern and central Rockies, along with high mean relative humidity in the 700-500 hPa layer, further contributed to the snows reported across the region. By the evening of the 7th, 10-14 inches of snow had been reported across parts of the central and northern Rockies, with 6-8 inches across southwestern South Dakota and western Nebraska (Fig.1a).

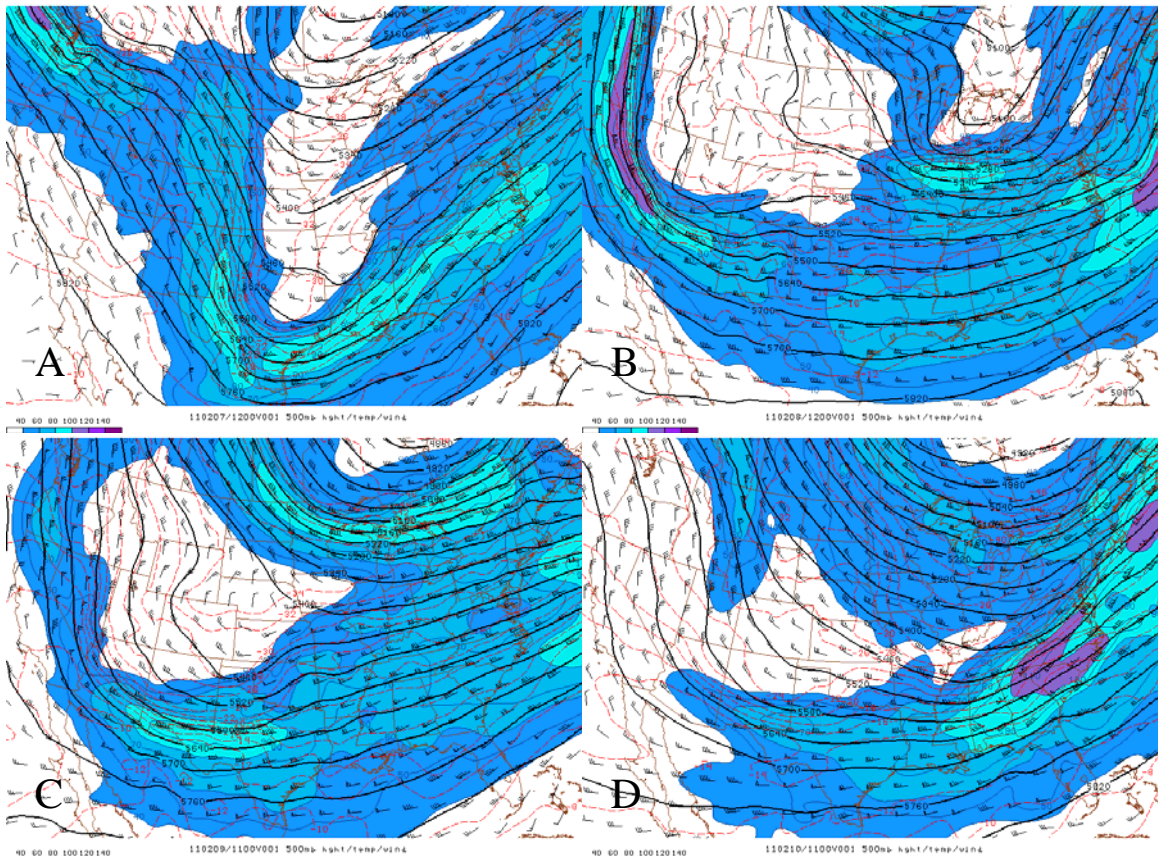


Figure 2: 500 hPa analysis, wind bards, wind speed (shaded) from 12 UTC on (a) 7 Feb 2011, (b) 8 Feb 2011, (c) 9 Feb 2011 and (d) 10 Feb 2011 (NOHRSC).

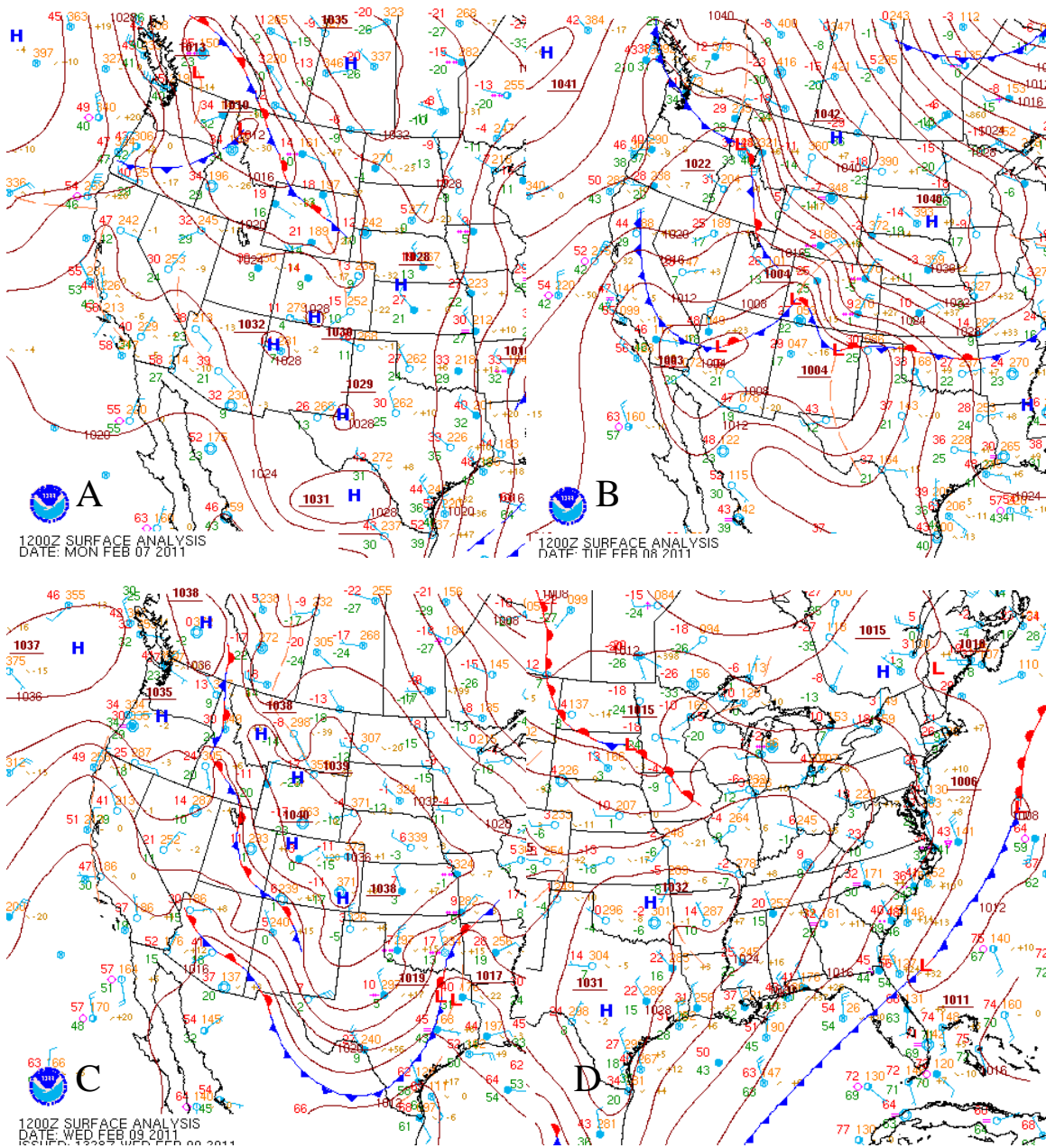


Figure 3: Surface analysis from 12 UTC on (a) 7 Feb 2011, (b) 8 Feb 2011, (c) 9 Feb 2011 and (d) 10 Feb 2011 (HPC).

During the overnight hours the aforementioned shortwave continued to dig to the south through the Great Basin. An Arctic surface boundary analyzed along the front range of the northern Rockies a day prior (Fig. 3a) had filtered across the mountains as a strong Arctic high nosed southeastward through the north central U.S (Fig. 3b). By the morning of the 8th a 700 hPa low had developed across western Colorado. The high mean relative humidity and upslope flow previously across the northern Plains into the Rockies had by this point dropped further to the south across Kansas and Colorado (Fig. 4a). During the day the shortwave trough began to swing more eastward toward the central Rockies with

a strong upper jet extending out across the Texas Panhandle, through Oklahoma into southwestern Missouri (Fig. 2b). Heavy snows began to fall across northern New Mexico, Kansas and northern Oklahoma. By that evening, with snow still falling, 10-15 inches of snow had been reported across portions of western Kansas, with up to a foot over parts of northern New Mexico (Fig. 1b).

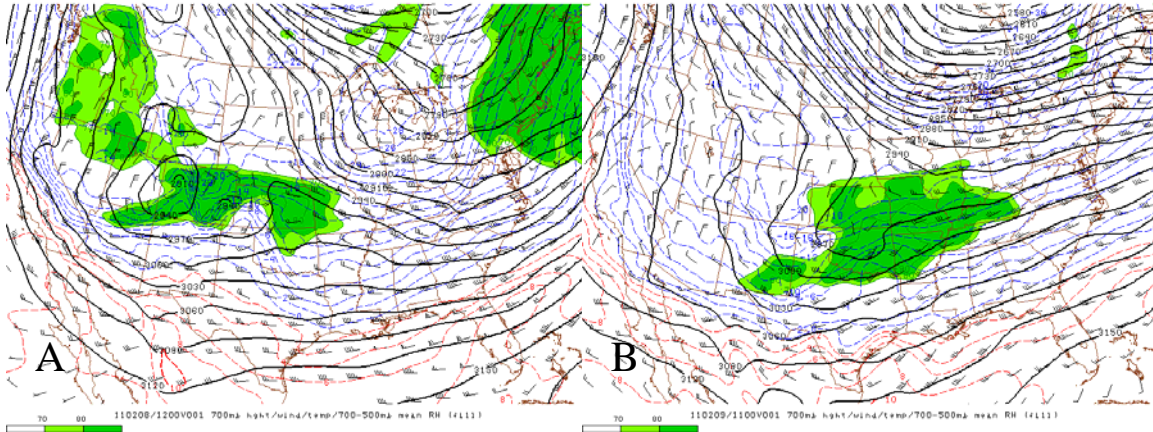


Figure 4: 700 hPa analysis, wind, temperature and 700-500 hPa mean relative humidity (fill) on 12 UTC (a) 8 Feb 2011 and (b) 9 Feb 2011 (SPC).

By the morning of the 9th, the shortwave trough had reached the central High Plains (Fig. 2c) and there was now evidence of upper jet couplet positioned near the Ozarks. The 700 hPa wave was now moving across Oklahoma. Deeper moisture and warm advection afforded by strong southwesterly flow ahead of the wave was noted across Oklahoma into Missouri, Arkansas and the lower Ohio Valley (Fig. 4b). Heavy Snow was reported across eastern Oklahoma and western Arkansas. Snow totals of 6-8 inches were reported across parts of the Texas Panhandle. Heavier amounts of 10-20 inches were observed across northeastern Oklahoma and 10-14 over northwestern Arkansas. Totals of over 2 feet would be observed across this region before the snows ended (Fig. 1c).

Meanwhile the Arctic surface boundary had plunged southeastward across Texas (Fig 3c). Single digits to subzero Fahrenheit temperatures were recorded across much of the Plains. The following morning, numerous record cold temperatures were set across the central and southern Rockies and Plains as an Arctic high pressure continued to build into the region in the wake of this storm. Bartlesville, Oklahoma set their all time record low with a reading of -28°F , while temperatures in locations as far south as Corpus Christi, Texas dipped below freezing.

During the day on the 9th, the 500 hPa shortwave trough continued to track east across the central Plains toward the mid Mississippi Valley, while the Arctic surface front pressed into the southeastern U.S. and through the western Gulf of Mexico. Surface temperatures fell below freezing and snow was reported across northern and central Alabama and Mississippi, as well as western Tennessee. These regions would receive up to 4-6 inches before the storm ended (Fig. 1d).

Meanwhile, a surface low was beginning to form near the South Carolina coast. As the shortwave over the Plains began to phase into the broader trough over the eastern U.S. (Fig. 2d), this surface low advanced northeastward off of the Mid Atlantic coast, with the trailing Arctic front now pressing southeastward across the Florida peninsula. Up to 4 inches of snow fell across eastern North Carolina and southeastern Virginia before the low moved well offshore and its associated precipitation over the U.S. came to an end.

An Arctic air mass remained entrenched across the central and southern Rockies and Plains while spreading eastward into the lower Mississippi, Tennessee and Ohio Valleys where many low temperature records continued to be set through the latter part of the week.

Mesoscale:

The heaviest snow totals from this event were observed across northeastern Oklahoma and northwestern Arkansas where snow accumulations of 18-23 inches were recorded (Fig 5). Radar imagery from Tulsa, Oklahoma indicated an intense narrow band of snow extending across northeastern Oklahoma into northwestern Arkansas the morning of the 9th (Fig 6). Mesoanalysis that morning revealed an axis of strong 700 hPa frontogenesis centered over northeastern Oklahoma and northwestern Arkansas (Fig 7). Overlying this area was a narrow swath of negative geostrophic Equivalent Potential Vorticity (EPV_g^*), as noted by the red and green shadings. Negative values suggest a symmetrically unstable atmosphere. It has been shown that in the presence of ample moisture, areas of strong lift due to frontogenetic forcing, collated with a symmetrically unstable air mass above the frontal boundary, increases the development potential of intense snowfall bands.

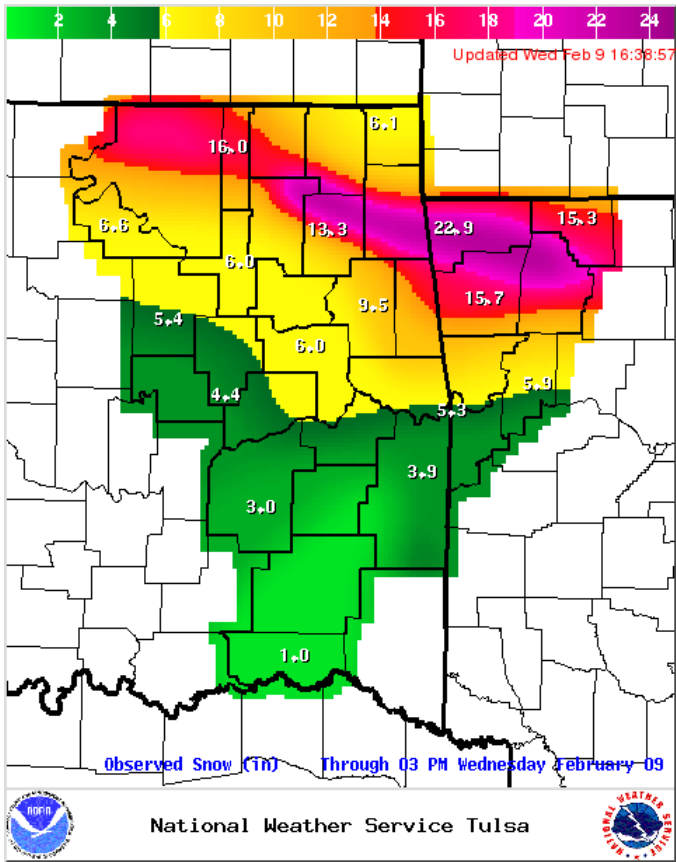


Figure 5: Observed snowfall ending 3 PM CST 9Feb 2011 (WFO-Tulsa).

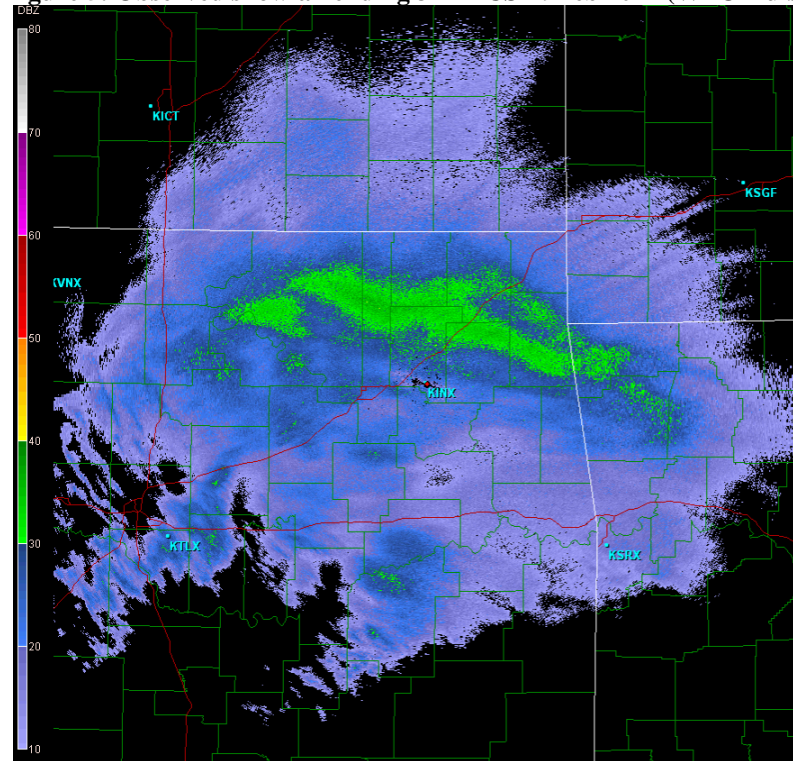


Figure 6: KINX radar 10 UTC 9 Feb 2011 (WFO-Tulsa).

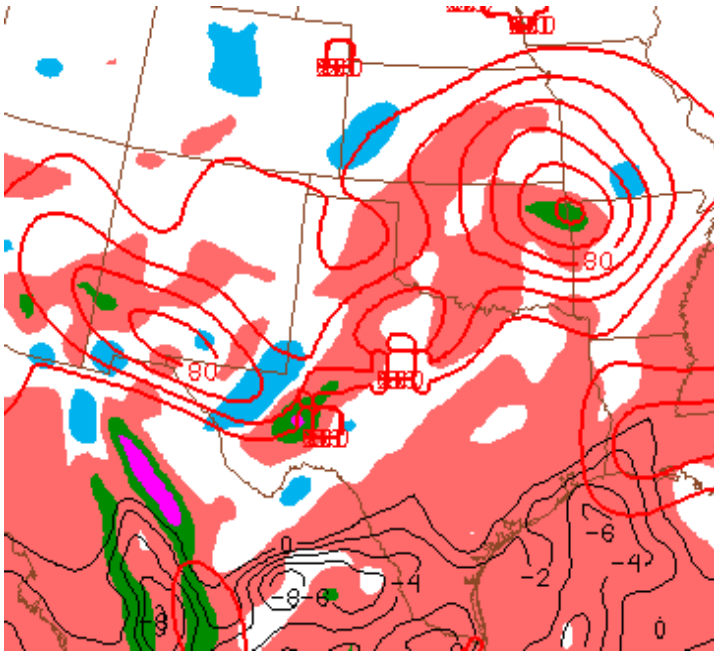


Figure 7: 700 hPa frontogenesis (red), 650-500 hPa EPVg* (shaded) and conditional instability on 12 UTC 9 Feb 2011 (SPC).

Summary:

A storm associated with a shortwave trough that dropped from the northwestern U.S. through the northern and central Rockies and into the Plains, brought heavy snows to portions the region. Strong frontogenetic forcing and a symmetrically unstable air mass contributed to an intense narrow snowband that produced record amounts over northeastern Oklahoma and northwestern Arkansas. The storm continued eastward across the southeastern U.S., producing low-latitude snows across parts of the Tennessee Valley, Gulf coast and southeastern states. In addition to widespread snow, record cold temperatures were observed from the Rockies to the lower Mississippi, Tennessee and Ohio Valleys.