Central and Eastern U.S. Winter Storm (Mar. 23-26, 2013)

WPC meteorologist: Kwan-yin Kong

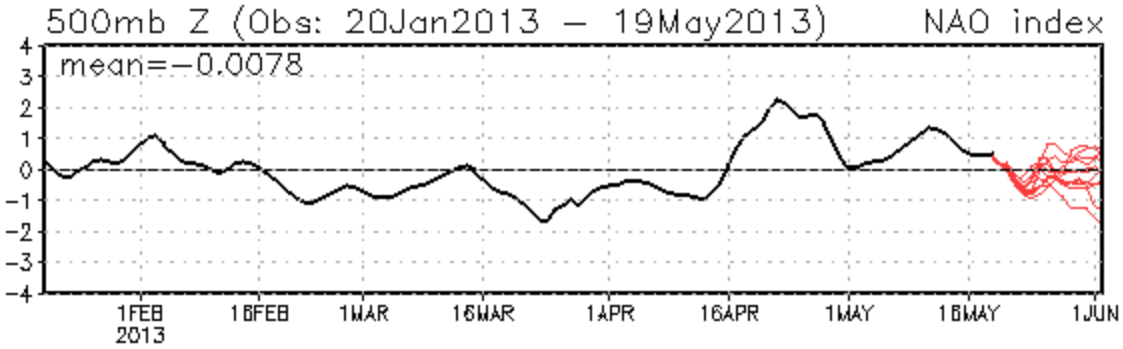

Figure 1 Observed North Atlantic Oscillation (NAO) index from Jan. 20 through May 19, 2013

Synoptic overview: This late-March snow event occurred during a period of anomalously low negative North Atlantic Oscillation index (fig. 1) when a large upper-level low remained anchored in southeastern Canada (fig. 2a). On March 22, a shortwave embedded within a broad trough in western Canada began to amplify and move southward into the western U.S. (fig. 2a). The best lifting mechanism began to set up over the central Rockies where a surface low pressure center formed in the foothills of central Colorado. On March 23, snow developed quickly during the evening in northeastern Colorado (fig. 2b) and expanded in coverage across Nebraska and Kansas. Meanwhile, lower-level cold air continued to advect southward into Colorado. Replenishing shortwave energy associated with the broad upper-level trough acted to sustain the heavy snow in Colorado throughout much of the day on the 23rd (fig. 2c, d). Snow finally tapered off in the evening of March 23 after dumping accumulations of 10 to 20 inches in northeastern Colorado (fig. 2e). Late on the 24th, the last piece of shortwave energy began to move around the base of the upper-level trough and exited the central Rockies (fig. 2f). In response, the surface low and associated precipitation accelerated eastward across the central Plains (fig. 2e, g). By early on the 24th, upper-level divergence ahead of the system began to induce the formation of a secondary surface low pressure center near the border of Missouri and Arkansas. An area of light to

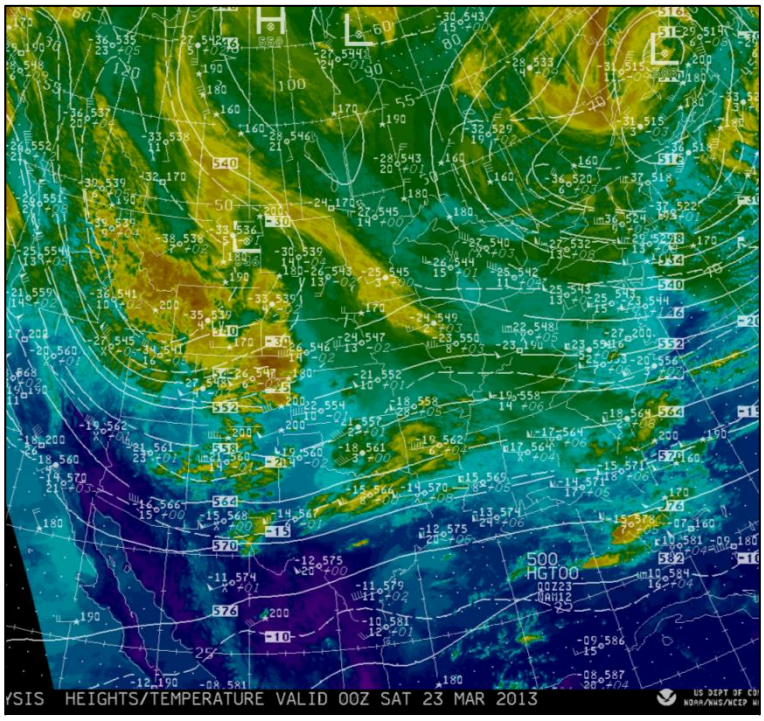

Figure 2a—500mb analysis overlaid on enhanced GOES-E infrared image at 00Z March 23, 2013

moderate snow developed and remained anchored to the northwest of the low center (fig. 2g). Meanwhile, the primary low pressure center over the central Gulf coast moved eastward along the warm front. Widespread showers and thunderstorms developed as southerly flow advected moisture from the Gulf of Mexico and instability increased in the vicinity of the warm front. (fig. 2e, g). As a result, widespread heavy rain and thunderstorms swept across the Southeast in the morning of the 24th. The moisture also spread northward over the cold air in Virginia where a period of moderate snow fell in the afternoon over the central Appalachians. By the evening hours, snow was exiting Virginia while mixed snow and sleet overspread the Mid-Atlantic States (fig. 2i). As the wide swath of precipitation swept across the Eastern Seaboard, the secondary low in the central Mississippi Valley intensified quite rapidly and became the main low pressure center later on the 24th (fig. 2 i, j). The area of moderate to heavy snow on the northwestern quadrant of the low expanded across the Midwest and into the Ohio Valley. The heaviest snow fell near a surface inverted trough located to the northwest of the low center (i.e. under the "Trowal"). Thundersnow was also observed during the height of the storm. The high snowfall rates broke 24-hour snowfall records in central Illinois.

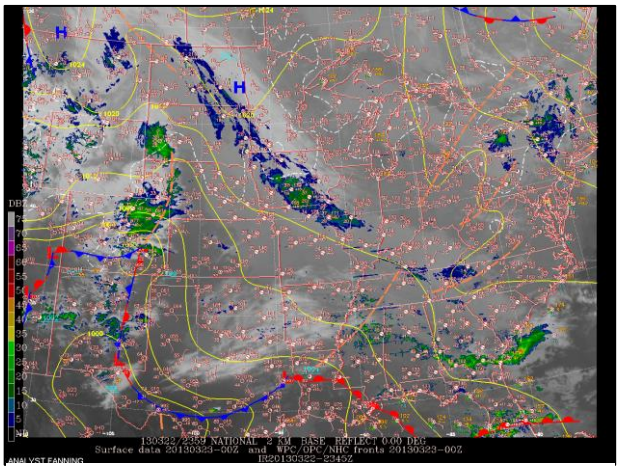

Figure 2b—Surface analysis overlaid on radar and GOES-E infrared images at 00Z March 23, 2013

The intensification of this low was rather unusual, as it occurred within the polar air mass without a preexisting surface frontal zone (fig. 2g). It appeared that cyclogenesis commenced as an upper-level front associated with the energized shortwave trough began to work its way down to the surface. Surface analyses (fig. 2i) show that frontogenesis was most apparent to the south of the intensifying surface low as the upper-low approached from the west.

The anomalous intensification of the secondary low was relatively short-lived as the surface low center suddenly tracked northward into Ohio whereas the upper low center continued to track eastward towards the Mid-Atlantic States during the night on the 24th (fig. 5). The sudden change of vertical tilt of the storm led to its rapid dissipation during the morning on the 25th. Meanwhile, the upper low continued to move eastward into the Mid-Atlantic region and began to tap into Atlantic moisture. The antecedent primary surface low in the Southeast began to intensify off the coast of North Carolina in the night of the 24th and early on the 25th as the Ohio Valley low weakened (Fig. 3a). As this transfer of energy occurred, wet snow started to develop in the Mid-Atlantic region before sunrise on the 24th with temperatures hovering at or slightly above freezing under northwesterly winds. The snow then spread farther north into New Jersey and Long Island during the day (fig. 3b) and into the evening hours before tapering off during the overnight hours as the storm deepened just off the Mid-Atlantic coast (fig. 2m and fig. 5). This burst of wet snow represented the last attempt of the lackluster winter of 2012-13 to deliver accumulating snow to the Mid-Atlantic region. Reagan National Airport received its first and final full inch of storm total snowfall on March 25th for the entire 2012-13 winter season.

Impacts: The storm brought widespread significant snowfall across the country from the Rockies eastward through the East Coast with three distinct snowfall maxima (Fig. 4 and 5). In northeastern

Colorado, near-blizzard conditions prompted highway closures during the height of the storm. To the north of Denver, a fiery crash on Interstate 25 resulted in a pile-up with as many as 50 vehicles involved. One positive aspect with the snow was that it brought much-needed precipitation to a drought-stricken Colorado. Snow accumulations of more than 20 inches were observed in the Foothills; up to about 18 inches were measured in the High Plains of northeastern Colorado. In central Illinois, 18.5 inches of snow fell in Springfield, establishing a new 24-hour snowfall record for the city. Schools were closed for the first time in two years due to snow. Over extreme western Maryland and nearby West Virginia, a total of 16 inches were observed on the western slopes of the central Appalachians. Lastly, Washington D.C. received its first one inch snowfall on March 25th in the entire winter with 1.4 inches measured at Reagan National Airport. This ended a streak of a recording-breaking 788 days without an inch of snow on the ground at the airport.

A radar/satellite animation of the event can be found at the WPC Facebook page at https://www.facebook.com/photo.php?v=491404567593131&set=vb.158734987526759&type=3&theater

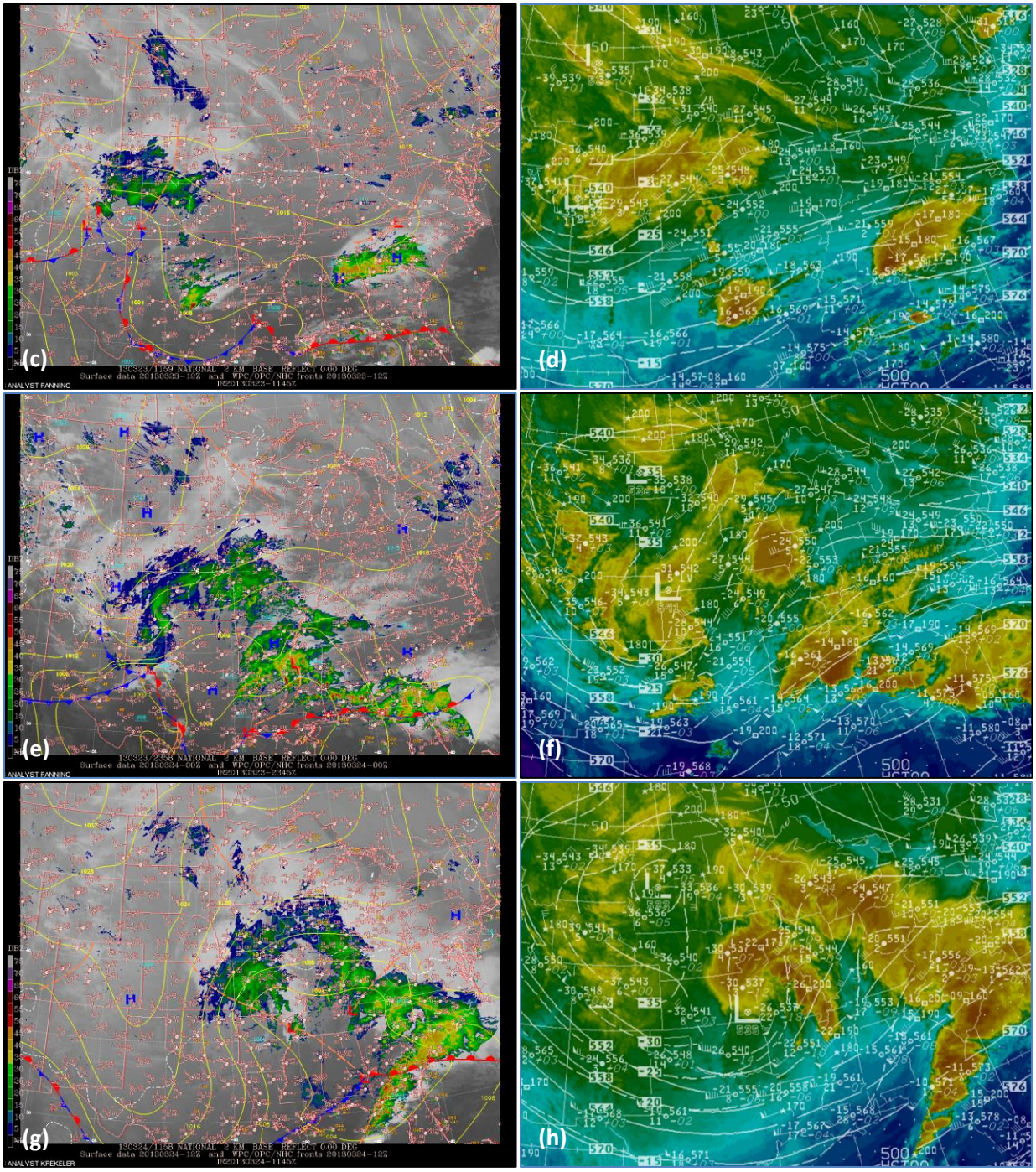

Figure 2c, d—Surface analysis overlaid on radar and GOES-E infrared images (left) and 500mb analysis overlaid on enhanced GOES-E infrared image (right) at 12Z March 23, 2013; fig. 2e, f—at 00Z March 24, 2013; fig. 2g, h—at 12Z March 24, 2013.

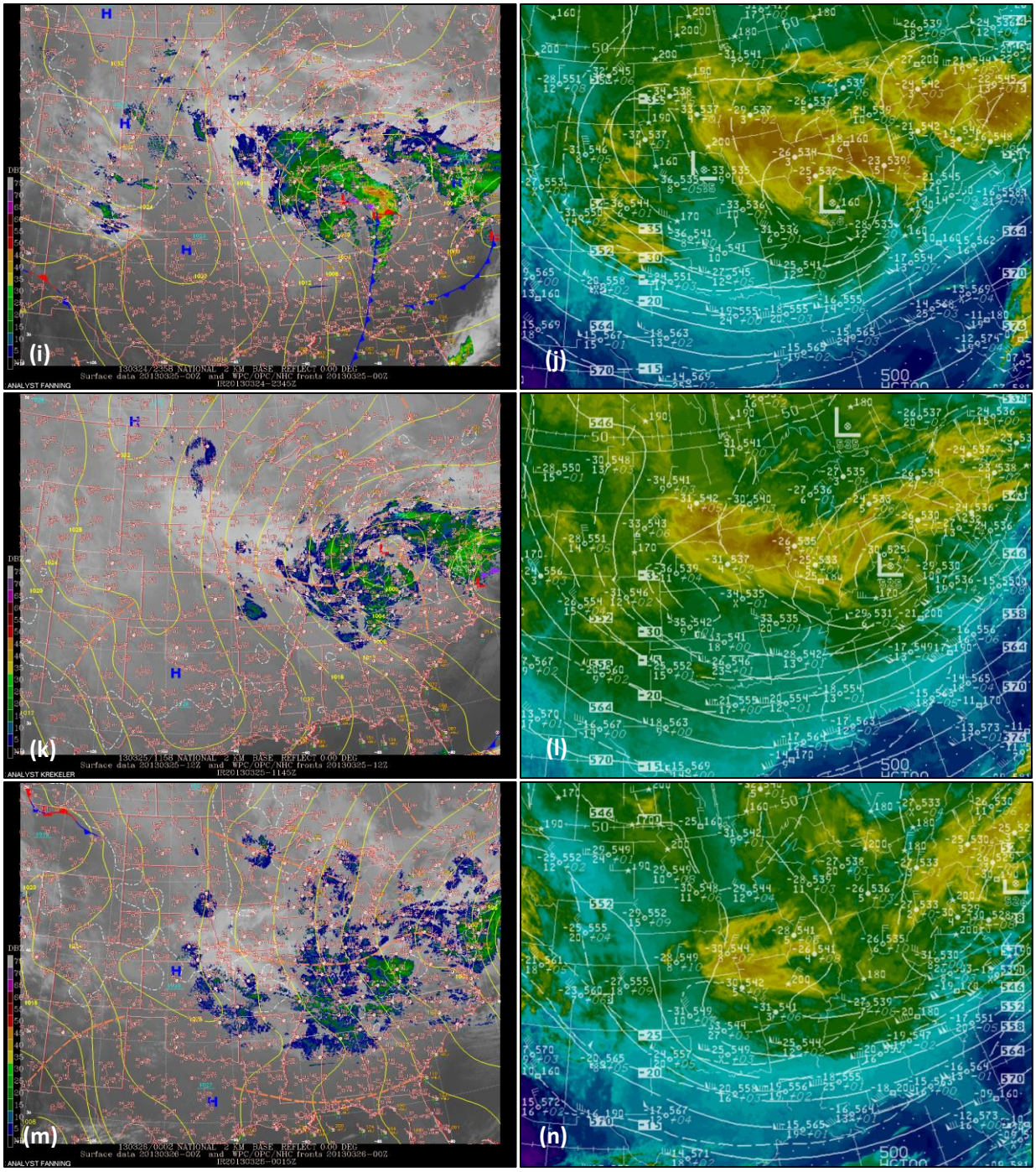

Figure 2i, j—Surface analysis overlaid on radar and GOES-E infrared images (left) and 500mb analysis overlaid on enhanced GOES-E infrared image (right) at 00Z March 25, 2013; fig. 2k, l—at 12Z March 25, 2013; fig. 2m, n—at 00Z March 26, 2013.

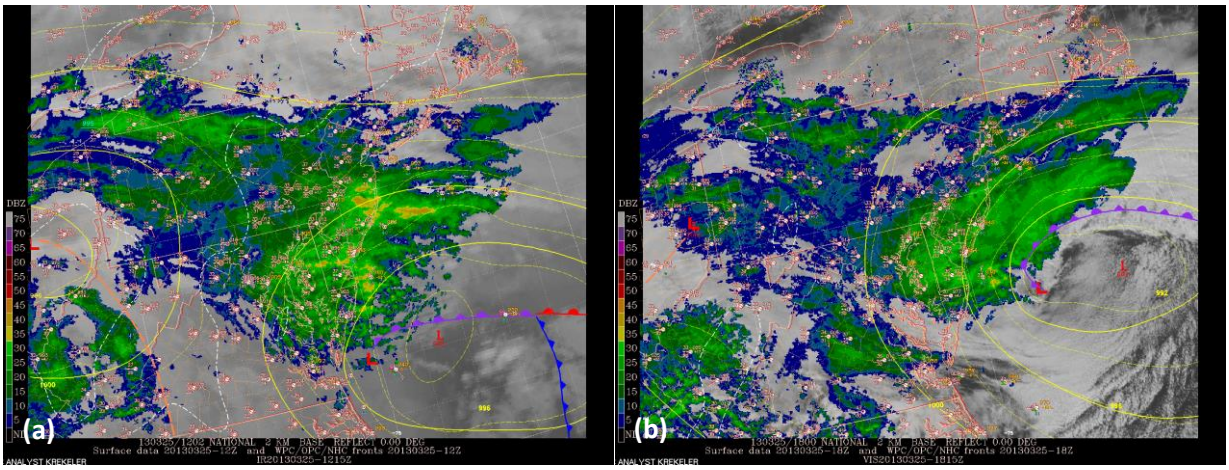

Fig. 3. WPC surface analyses overlaid on radar and GOES-E infrared images at around 12Z March 25, 2013, and (b) radar and GOES-E visible image at around 18Z March 25, 2013 for the Mid-Atlantic region.

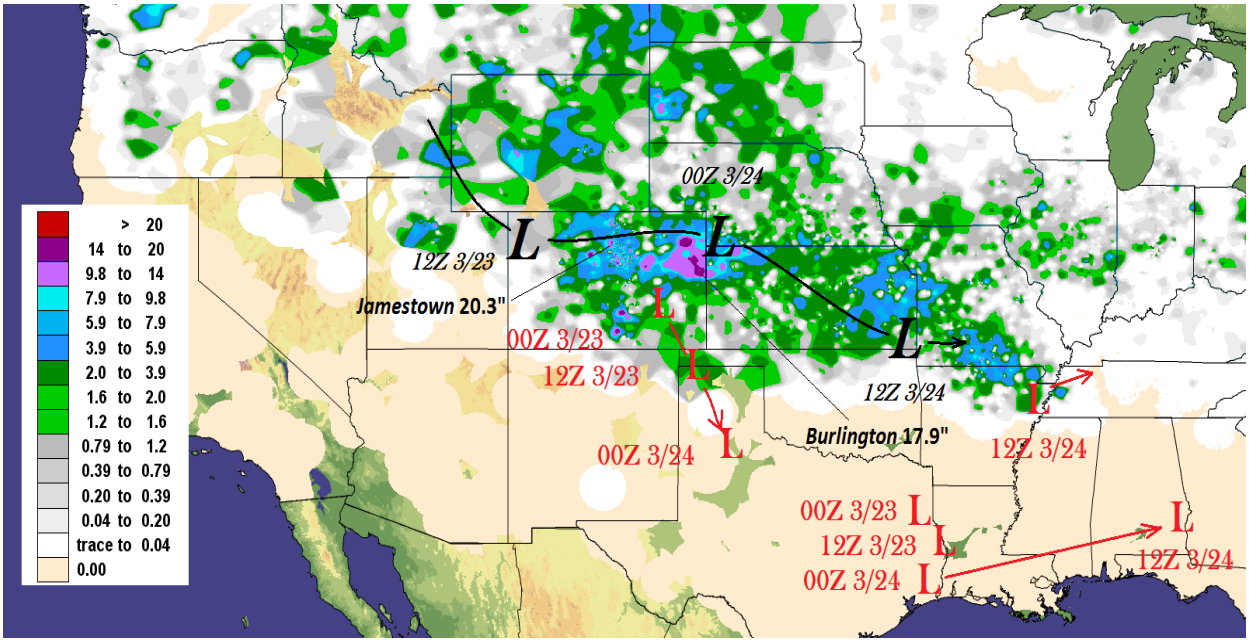

Figure 4 72-hour snowfall accumulations ending at 12Z on March 24, 2013 along with total observed snowfall at Jamestown and Burlington, CO. The tracks of 500mb low centers (black) and surface low pressure centers (red) are also shown.

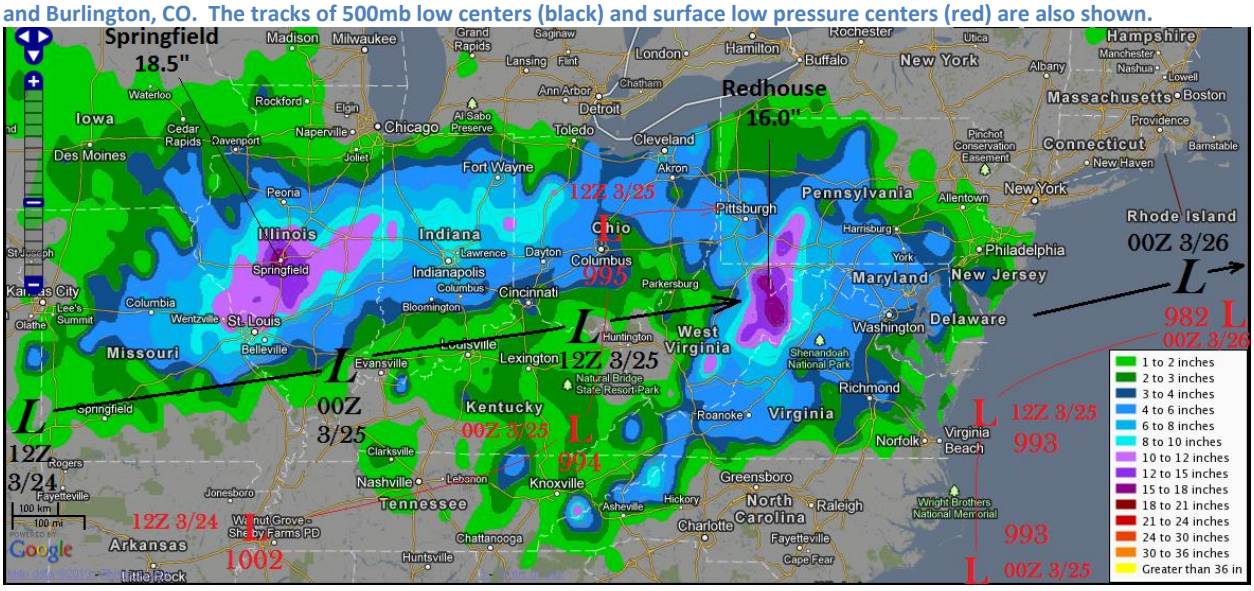

Figure 5 72-hour snowfall accumulations ending at 12Z on March 27, 2013 along with total observed snowfall at Springfield, Il and Redhouse, WV. The tracks of 500mb low centers (black), surface low pressure centers and their estimated central pressures (red) are also shown.