Central Region Technical Attachment
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January 26-28, 2009 Heavy Snowfall across Southeast Illinois

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1. Introduction

A significant and prolonged winter storm impacted central and southeast Illinois from the evening of January 26 through the morning of January 28, 2009. Two main rounds of precipitation affected the region during this time frame. The first developed during the evening of January 26 and persisted into the early morning hours of January 27. The second took shape by late afternoon on January 27 and eventually tapered off and came to an end by the early morning of January 28. The primary precipitation type for this event was snow: however, enough warming occurred aloft to produce a mixture of freezing rain and sleet at times, mainly along and south of a Flora to Robinson, Illinois line. Once the precipitation came to an end, a widespread accumulating snowfall had occurred across all of central and southeast Illinois. Locations between Interstate 70 and Interstate 64 picked up the highest snowfall totals, where 8–12-inch amounts were common. The snowfall steadily decreased further north, with 2–4-inch totals along the Interstate-72 corridor and 1–2-inch accumulations along and north of a Rushville to Bloomington, Illinois line.

2. Synoptic Overview

An Arctic airmass was in place across the Midwest and Great Lakes region on January 25, 2009. The 0107 UTC 26 January 2009 surface analysis showed a 1032-mb high pressure ridge extending from British Columbia southeastward across the Northern Plains into the Ohio River valley (Fig. 1). Light north to northeast winds were supplying central Illinois with a very cold and dry airmass, characterized by temperatures in the teens (°F) and dewpoints in the single digits (°F). The main synoptic boundary was stalled well to the south along the Gulf Coast arcing northwestward into the southern Rockies.

At upper levels of the atmosphere, a split-flow regime was in place across North America, with the northern branch of the jet stream tracking along the U.S./Canadian border into the Great Lakes and the stronger southern branch flowing from southern California northeastward across the Midwest into the mid-Atlantic states. The 0000 UTC 26 January 500-mb analysis revealed a digging trough in the southern branch of the jet stream across California, with a lead short-wave trough ejecting out of the Rockies across eastern Colorado and western Kansas (Fig. 2). The upper trough across the southwestern U.S. continued to deepen on January 26, allowing the upper flow to become more southwesterly across the Midwest. The increasing southwesterly flow coupled with the approach of a vigorous lead short-wave trough helped bring the first round of precipitation into Illinois by late afternoon.

The 0107 UTC 27 January surface analysis continued to show high pressure extending across the Northern Plains into the Ohio River valley, with the highest pressure increasing to 1036 mb across South Dakota (Fig. 3). A cold and dry airmass was still firmly in place across central Illinois, as evidenced by temperatures hovering in the teens and lower 20s (°F). The primary synoptic frontal boundary was still poised along the Gulf Coast, although it had begun lifting further northward and now stretched from central Alabama westward into central Texas. Widespread precipitation was indicated north of the boundary from northern Texas northeastward into Missouri. This precipitation was being aided by a strong mid-level short-wave trough analyzed at 0000 UTC 27 January across western Kansas into the Texas panhandle (not shown). A 45-kt 850-mb jet streak was present across eastern Texas into northwestern Arkansas (not shown), providing an ample supply of warm, moist air at low levels. Dewpoints between 5 and 10°C at 850 mb were being advected northeastward by this jet. In addition, a strong 850-mb baroclinic zone was indicated by analysis, extending from the Tennessee River valley westward to an area of low pressure over the four-corners region (Fig. 4). Temperatures to the north of this boundary were in the -10 to -15°C range, while readings just south of the front were approximately 20°C warmer. This tight thermal gradient served as the primary focal point for precipitation development, aided by the approaching short-wave trough. In addition, upward vertical motion was further enhanced as this region was located in the right entrance region of a 130–150-kt 300-mb jet streak extending from eastern Nebraska into southern New England.

Radar mosaics from the evening of January 26 showed a rapidly developing area of precipitation extending into south-central Illinois (Fig. 5). The precipitation eventually spread as far north as a Litchfield to Paris, Illinois line; however, it was never able to penetrate any further northward. This was likely due to the continual supply of a dry low-level airmass due to light northeasterly surface winds. The 0000 UTC 27 January upper-air sounding from Lincoln, Illinois (KILX) showed considerable moistening at mid- levels of the atmosphere, but continued to indicate a dry airmass from the surface up to 900 mb (Fig. 6). Meanwhile further south, the 0000 UTC 27 January sounding from Springfield, Missouri (KSGF) indicated a nearly saturated profile from the surface up to 550 mb (Fig. 7).

Light to occasionally moderate snow fell across much of southern and east-central Illinois through the night of January 26. The 1200 UTC 27 January upper-air analysis showed the initial short-wave trough that had ejected from the larger-scale southwest U.S. upper trough had passed to the east and was now located over the Ohio River valley. As a result of synoptic-scale subsidence in the wake of this feature, much of the precipitation had come to an end across southern Illinois. Morning reports from the Cooperative Weather Observer network revealed accumulations generally in the 1- to 4-inch range along and south of a Shelbyville to Mattoon to Paris, Illinois line. The highest totals were observed between Interstate 70 and Interstate 64, where amounts of 3 to 4 inches were common.

The lull in the event proved to be temporary, as additional wintry precipitation spread back into southeast and east-central Illinois by 1800 UTC 27 January. This renewed wave of precipitation was generated by another weak short-wave trough ejecting from the main upper trough across Arizona and New Mexico. The 0000 UTC 28 January upper-air analysis showed a subtle 500-mb wave across southern Illinois and western Kentucky, with the primary northern and southern stream waves attempting to phase as they tracked eastward into the Plains. In response to the approach of these waves, the 850-mb baroclinic zone had shifted northward into the Ohio River valley and now extended from southern Indiana southwestward into northern Oklahoma. The 0000 UTC 28 January upper-air sounding from KILX showed a pronounced warm layer aloft, with a maximum temperature of -4°C at 712 mb (Fig. 8). The profile also revealed that the surface-based cold layer had become shallower, decreasing from a thickness of 3195 m at 1200 UTC 27 January to the current depth of 2832 m. Further south, the depth of the low-level inversion had decreased to 1767 m at KSGF, while a maximum warm-layer temperature of 1°C was observed at 816 mb. Due to the warming conditions aloft, a mixture of freezing rain and sleet occurred for a few hours along and south of a Flora to Robinson, Illinois line during the afternoon and evening of January 27. Further north, snow was the primary precipitation type across the remainder of central Illinois.

Precipitation gradually spread as far north as the Interstate 72 corridor during the evening hours, with the heaviest and steadiest precipitation remaining across east-central and southeast Illinois (Fig. 9). As the northern stream wave approached from the west, two bands of snow developed further north across the Illinois River valley by 0300 UTC 28 January (Fig. 10). As these bands merged and tracked eastward across the area, light to moderate snow was observed along and north of Interstate 72 for approximately 2 to 4 hours. Meanwhile, the heavier snow further south gradually shifted eastward in response to the approaching upper-level waves, with the bulk of the snowfall exiting Illinois between 1200 UTC and 1800 UTC 28 January.

Reports from observers across the area revealed 24-hour snowfall totals of 1 to 2 inches along and north of a Rushville to Bloomington line, 2 to 4 inches along a Springfield to Champaign line, and 5 to 8 inches along and south of a Taylorville to Danville line. A few spots along the Interstate 70 corridor picked up as much as 8 to 9 inches, with totals further south being mitigated somewhat by the period of sleet and freezing rain that had occurred. Total accumulations for the entire event ranged from 1 to 2 inches along and north of a Rushville to Bloomington line, to 2 to 4 inches along the Interstate 72 corridor, to 8 to 12 inches along a Shelbyville to Paris line southward to Interstate 64.

3. Model Discussion

The operational forecast models performed reasonably well during this winter storm event, especially given their usual tendency to struggle with the phasing of northern and southern stream features. The exact speed of the phasing created differences in the timing of the eventual departure of the system. In addition, finer scale details such as the placement of the heaviest precipitation axis, the northern extent of the precipitation shield, and the low-level thermal profile varied from model to model and from run to run. During the course of this event, the Global Forecast System (GFS) model was the most consistent and also regularly represented a compromise between the North American Mesoscale (NAM) model and the European Center for Medium Range Weather Forecasting (ECMWF) model. As a result, the official forecast was weighted heavily toward the GFS solution.

With the initial wave of precipitation that occurred across southeast Illinois during the evening and overnight hours of January 26, the GFS was the first operational model to define the main precipitation axis further north along the Ohio River, including the far southeast KILX County Warning Area (CWA). This solution was first observed with the 0000 UTC 25 January 60-hour forecast ending at 1200 UTC January 27 (Fig. 11). At this time, the NAM was still focusing the primary axis of precipitation further south, mainly south of the Ohio River. The NAM did not latch on to this further north solution until a full 24 hours later with the 0000 UTC 26 January run. Subsequent runs of both the GFS and NAM maintained the precipitation axis along and north of the Ohio River.

Concerning the northward extent of the initial round of precipitation, the NAM outperformed the GFS. The NAM first suggested dry conditions across much of central Illinois along and north of the Interstate 72 corridor with its 0000 UTC 25 January 60-hour forecast for 1200 UTC January 27 (Fig. 12). The GFS did not indicate a dry forecast for the majority of central Illinois until much later during its 1200 UTC 26 January run. The superiority of the NAM in this case is likely due to its higher low-level resolution and thus its better ability to resolve shallow surface-based Arctic airmasses (Jascourt and Bua 2005). It is interesting to note that the NAM 0000 UTC 26 January 36-hour forecast for 1200 UTC January 27 depicted the most accurate snapshot of reality, featuring a tighter precipitation gradient across the KILX CWA, ranging from zero precipitation along and north of Interstate 72 to a maximum of around 0.50 inches in the far southeast (Fig. 13). The NAM provided further evidence to a sharp northern edge to the precipitation shield by suggesting the strongest forcing would be confined to southeastern sections of the KILX CWA in closer proximity to the primary baroclinic zone. The 0000 UTC January 26 NAM 30-hour forecast for 0600 UTC January 27 indicated strong 700–500-mb layer frontogenesis along and south of Interstate 70, with only minimal forcing noted further north (Fig. 14).

After the initial short-wave trough exited to the east and a lull in the precipitation was observed during the early morning of January 27, the next issue to deal with was how fast the northern and southern stream waves would phase as both systems tracked eastward across the Plains. The ECMWF was consistently the most aggressive with developing precipitation further north into the cold airmass during the afternoon of January 27 as the northern stream wave approached from the west. The NAM was the driest, while the GFS represented a more middle-of-the-road solution featuring light precipitation across the entire area, with the main focus for heavier and steadier precipitation along and south of Interstate 70.

The ECMWF was also the first model to indicate a slower departure of the main system as it tracked across the area during the night of January 27. This slowing trend was first noted with the 0000 UTC 27 January run of the ECMWF, which suggested precipitation would linger throughout the entire night of January 27 and perhaps into the morning hours of January 28 across east-central and southeast Illinois (Fig. 15). Prior to this point, all models phased the two upper systems into one and pushed the entire feature east of Illinois much earlier by the evening of January 27. Both the NAM and GFS had begun to slow the system during the 1200 UTC 26 January run; however, neither model slowed it sufficiently and the ECWMF was the first to offer the most accurate glimpse of reality 12 hours later with the 0000 UTC 27 January run. The ECMWF was supported by the 0000 UTC 27 January upper-air analysis (not shown) which showed a 110-kt 300-mb jet streak diving southward along the back side of the main trough across the Desert Southwest. With the trough still digging, a slower ejection eastward and a slower phasing with the northern stream wave was logical.

No operational model offered a perfect solution to this complex and prolonged winter weather event. All models suffered from their own particular biases and changed solutions to some degree with successive runs. The GFS model was closely followed due to its overall consistency and middle-of-the-road solution; however, in retrospect, using the general synoptic pattern and timing of the ECMWF and the mesoscale features of the NAM would likely have yielded the best possible forecast.

4. Watch/Warning Decision Process at National Weather Service Lincoln, Illinois

Projected snowfall graphics created by the Hydrometeorological Prediction Center (HPC) Winter Weather Desk (WWD) proved to be somewhat problematic during this winter storm event. While operational model solutions varied from run to run, the WWD graphics seemed to vary even more widely, with the night shift and day shift forecasters vacillating between a major snowfall and a much less significant event. This lack of consistency among the HPC forecasters led to reduced confidence among National Weather Service Forecast Office (WFO) forecasters and ultimately a delay in the initial issuance of a Winter Storm Watch.

The 0619 UTC 25 January 3-day accumulated snowfall graphic from HPC featured a wide swath of heavy snowfall from central Missouri eastward across central and southern Illinois and Indiana (Fig. 16). The positioning of the heavy snowfall axis seemed to favor both the operational GFS and ECMWF, while rejecting the more southerly emphasis suggested by the NAM. The 6-inch contour from this graphic reached as far north as a Rushville to Bloomington line, while 8-inch amounts extended along and south of the

Interstate 72 corridor. The heaviest snow was forecast to fall along and south of Interstate 70, where greater than 10 inches was indicated.

Despite the hefty snowfall totals projected by HPC, the general thinking among local WFO forecasters was that the amounts were somewhat overdone. Since this was the first outlook that suggested such high snow accumulations and since the event itself was not going to begin until almost 48 hours later, the decision to issue a Winter Storm Watch at both Weather Forecast Office (WFO) Lincoln (KILX) and Indianapolis (KIND) was postponed by the January 25 midnight shifts. Both WFO St. Louis (KLSX) and Paducah (KPAH) decided to issue a watch, while KILX opted to issue a Special Weather Statement (SPS) highlighting the potential for heavy snow across parts of central and southeast Illinois.

The 1655 UTC 25 January issuance of the 3-day accumulated snowfall from HPC offered a radically different opinion than the previous issuance (Fig. 17). The new graphic cut snowfall totals by more than half and now featured 4- to 6-inch amounts along and south of a Mattoon to Shelbyville line, with 2- to 4-inch totals across the remainder of central Illinois. Both the 1200 UTC 25 January NAM and GFS were virtually unchanged from their 0000 UTC 25 January runs, making the extreme shift in projected snowfall amounts seem questionable. After coordination with surrounding WFOs and HPC, the decision to issue a Winter Storm Watch was made by the January 25 KILX day shift. The watch initially covered six counties across the KILX CWA, including Effingham, Jasper, Crawford, Clay, Richland, and Lawrence Counties. The watch was in effect from 0000 UTC 27 January through 0000 UTC 28 January, highlighting the continued thought that the bulk of the snow would occur during the night of January 26 through the day of January 27.

Another major shift in forecast snowfall accumulations occurred with the 0500 UTC 26 January HPC WWD graphics (Fig. 18). The snow totals were increased substantially from the previous chart and almost matched those from the prior midnight shift. In addition, a much tighter snowfall gradient was evident across Illinois, with amounts ranging from less than 1 inch across the far northwest KILX CWA around Galesburg to greater than 10 inches across the far southeast near Lawrenceville. This change followed very closely the changes seen on the 0000 UTC 26 January operational NAM, which showed little or no precipitation across central and northern Illinois with the initial wave and heavier amounts than previously forecast across southern Illinois north of the Ohio River. Given the latest HPC forecast and the northern shift observed by the NAM, confidence was growing that warning criteria snowfall would occur across parts of the KILX CWA. After collaboration with surrounding WFOs, the decision to issue a Winter Storm Warning for heavy snow was made by the January 26 midnight shift. The warning included the original six counties in the watch and was valid from 0000 UTC 27 January through 0600 UTC 28 January. The decision to extend the warning 6 hours longer than the watch was due to a trend that was beginning to emerge on the 0000 UTC 26 January ECMWF model that suggested the precipitation event may last longer than originally expected due to a slower ejection of the main upper trough over the southwest U.S. In addition, a Winter Weather Advisory for snow was issued further north including all areas along and south of Interstate 72. The thought was that borderline advisory criteria snow would occur across these areas, especially further south from Shelbyville to Paris southward. The warnings and advisories were well coordinated with both WFO KLSX and WFO KIND.

By the next issuance of the HPC WWD snowfall graphics, the snowfall event was less than 12 hours from beginning across central and southeast Illinois. Once again, HPC forecasters drastically changed their thinking from the previous shift and slashed snowfall amounts by more than half. The 1723 UTC 26 January graphic featured 4- to 6-inch accumulations along and south of Interstate 70, with 2 to 4 inches as far north as Interstate 72, and 1 to 2 inches further north across the remainder of central Illinois (Fig. 19). The 1200 UTC 26 January GFS had now come into line with the NAM and was suggesting very little or no snow across much of central Illinois with the initial wave of precipitation expected during the night of January 26. Both models continued to feature the heavy precipitation axis setting up along and north of the Ohio River, including the far southeast KILX CWA. Based on HPC forecasts and operational model data, the decision was made to make no changes to the current warning and advisories in effect across the area. Snowfall totals were nudged down a bit, especially across the north given the agreement between the NAM and GFS concerning the tighter precipitation gradient with the initial wave and the expected lull in the precipitation for the morning hours of January 27.

Snow commenced during the evening of January 26, but as satellite and radar trends showed that the bulk of the snow was going to fall across the southeast KILX CWA, the decision was made to drop the northern fringe of the Winter Weather Advisory where little or no snow was occurring (Fig. 5). Further south, the remainder of the advisory and the entire warning would continue unaltered. When the 0556 UTC 27 January HPC snowfall graphics were issued, snowfall totals were again greatly increased. Additional accumulations anticipated between 1200 UTC 27 January and 1200 UTC 29 January ranged from 1 to 2 inches along and north of Interstate 72 to around 8 inches across the far southeast near Lawrenceville. By this point, the main forecast questions revolved around the speed of the ejecting southwest U.S. wave and how fast it would phase with a much weaker northern stream wave tracking across the Northern Plains. The operational models were still in disagreement concerning this process; however, all models were beginning to slow things down. The 0000 UTC 27 January ECMWF was the slowest of all and suggested that precipitation would continue through the night of January 27 into the morning of January 28. Since the ECMWF was not fully supported by any other model, the decision was made to continue the current advisory and warning through 0000 UTC 28 January with no extensions in time or area.

5. Verification and Summary

Once this long-lived winter weather episode came to a conclusion on January 28, all of central and southeast Illinois had experienced an accumulating snowfall. While the original forecasts issued 3 to 4 days prior to the winter storm did not adequately depict the exact length of the event, the overall projected snowfall totals were relatively accurate. Final snowfall amounts from 1200 UTC 26 January through 1200 UTC 29 January ranged from 1 to 2 inches along and north of a Rushville to Bloomington line, to 2 to 4 inches along the Interstate-72 corridor, to 8 to 12 inches along and south of a Shelbyville to Paris line (Fig. 20). The Zone Forecast Product (ZFP) issued at 0946 UTC 26 January highlighted storm total snowfall amounts that verified quite well across much of central Illinois along and north of Interstate 72. Further south, the forecast was underdone, with predicted snowfall along and south of Interstate 70 in the 4- to 7-inch range. In addition, the heavy snowfall area came a bit further north than originally anticipated, with locations across east-central Illinois as far north as Paris and Mattoon picking up between 5 and 8 inches rather than the 2 to 4 inches outlined in the 0946 UTC 26 January ZFP.

Official statistics compiled after the event indicated all six counties in the Winter Storm Warning issued at 0935 UTC 26 January met warning criteria with a lead time of over 43 hours. Due to the heavy snow pushing further north than originally thought, there were four missed events, as Clark, Cumberland, Edgar, and Shelby Counties all received warning criteria snowfall but were not covered by the warning. The missed events reduced the overall lead time of the event to 26.1 hours. There were no false alarms across the KILX CWA with this winter storm.

This was a challenging winter storm to forecast, mainly due to model discrepancies concerning the placement of the heavy precipitation axis and the timing of the final departure of the system. These model issues were echoed in the snowfall guidance provided by the HPC WWD. Despite these difficulties, the overall forecast process went smoothly and all pertinent products were issued in a well-coordinated and timely manner. The public was first alerted to the possibility of accumulating snow across central and southeast Illinois by the Hazardous Weather Outlook issued by WFO KILX at 2100 UTC 20 January, yielding over 6 days of lead time. The Special Weather Statement (SPS) issued at 0902 UTC 25 January provided enhanced information about the developing winter storm 36 hours prior to the start of the event. In addition, an e-mail was sent to the Significant Weather Observation Program (SWOP) network during the evening of January 25, providing detailed information about the storm 24 hours in advance.

While things generally flowed quite well during this winter storm episode, a few areas for improvement should be noted. Better coordination and discussion between WFO and HPC forecasters would be advised, as the conflicting information coming from different forecast shifts at HPC led to reduced forecast confidence in the field. In addition, a more comprehensive analysis of ensemble model data could have potentially improved the initial forecast snowfall amounts and locations. Even though no particular model outperformed another, perhaps a blend of solutions would have yielded a slightly better result. Finally, better understanding of model biases should be sought, as specific knowledge of this subject could have aided forecast staff in better selecting which operational model to trend toward in this particular event.

DISCLAIMER: The views expressed are those of the author and do not necessarily represent those of the National Weather Service.

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Jascourt, S.D., and W.R. Bua, 2005: Forecaster Training on the NCEP North American (NAM) Weather Research and Forecasting (WRF) Model. Preprints, 21st Conference on Weather Analysis and Forecasting/17th Conference on Numerical Weather Prediction, joint with 34th Conference on Broadcast Meteorology, Washington, D.C., Amer. Meteor. Soc. Available online at: http://ams.confex.com/ams/pdfpapers/94811.pdf

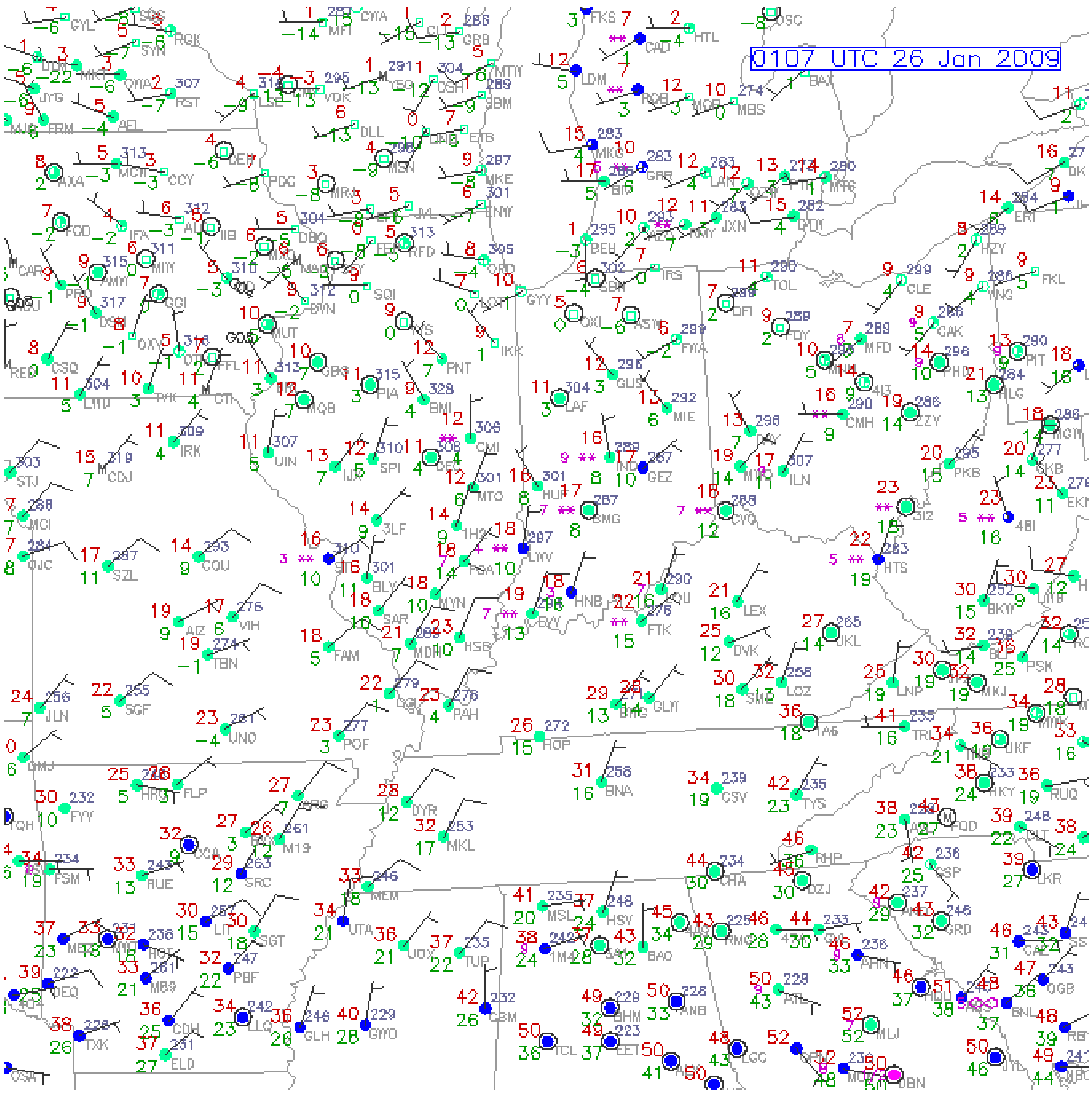

Figure 1: 0107 UTC January 26 surface analysis.

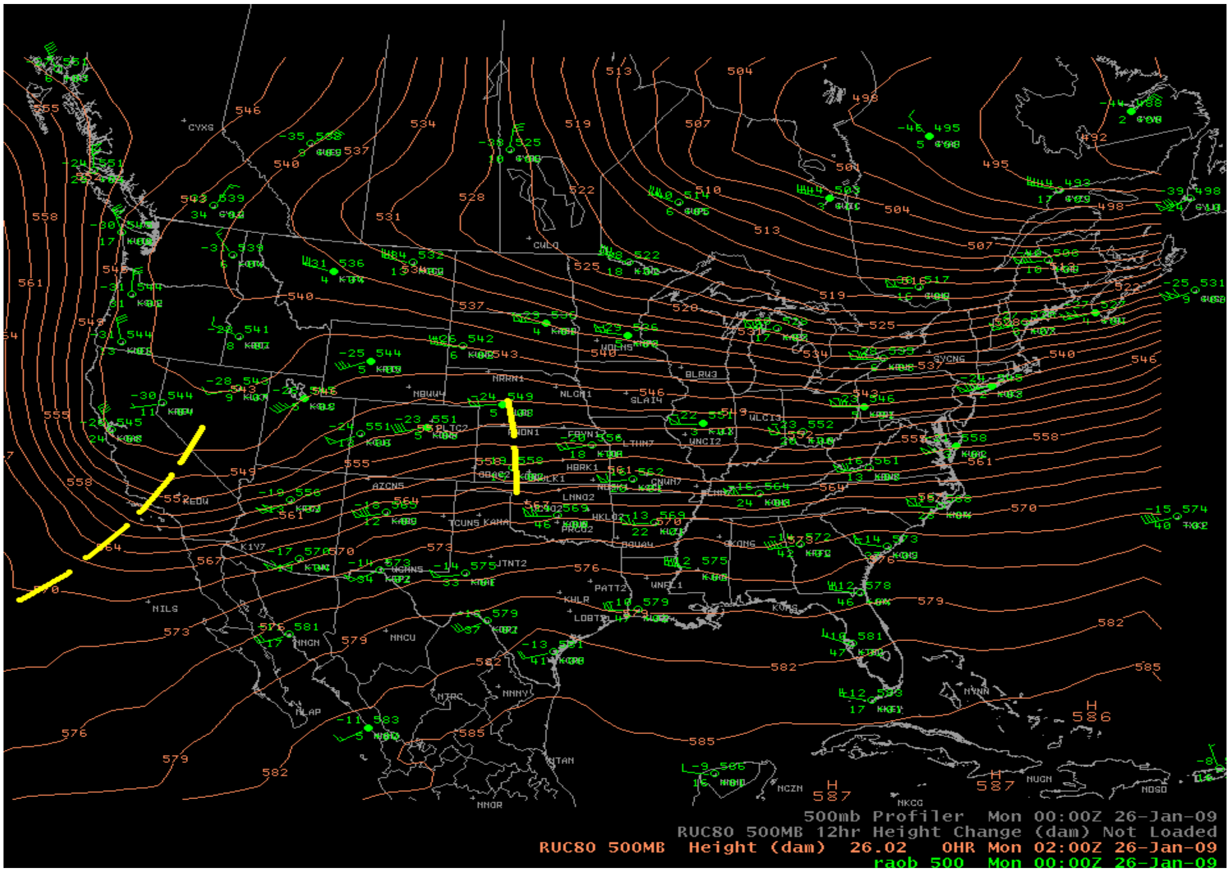

Figure 2: 0000 UTC January 26, 2009 80-km RUC 500-mb height analysis (contour interval is 30 m) and 500-mb upper-air plot (standard convention).

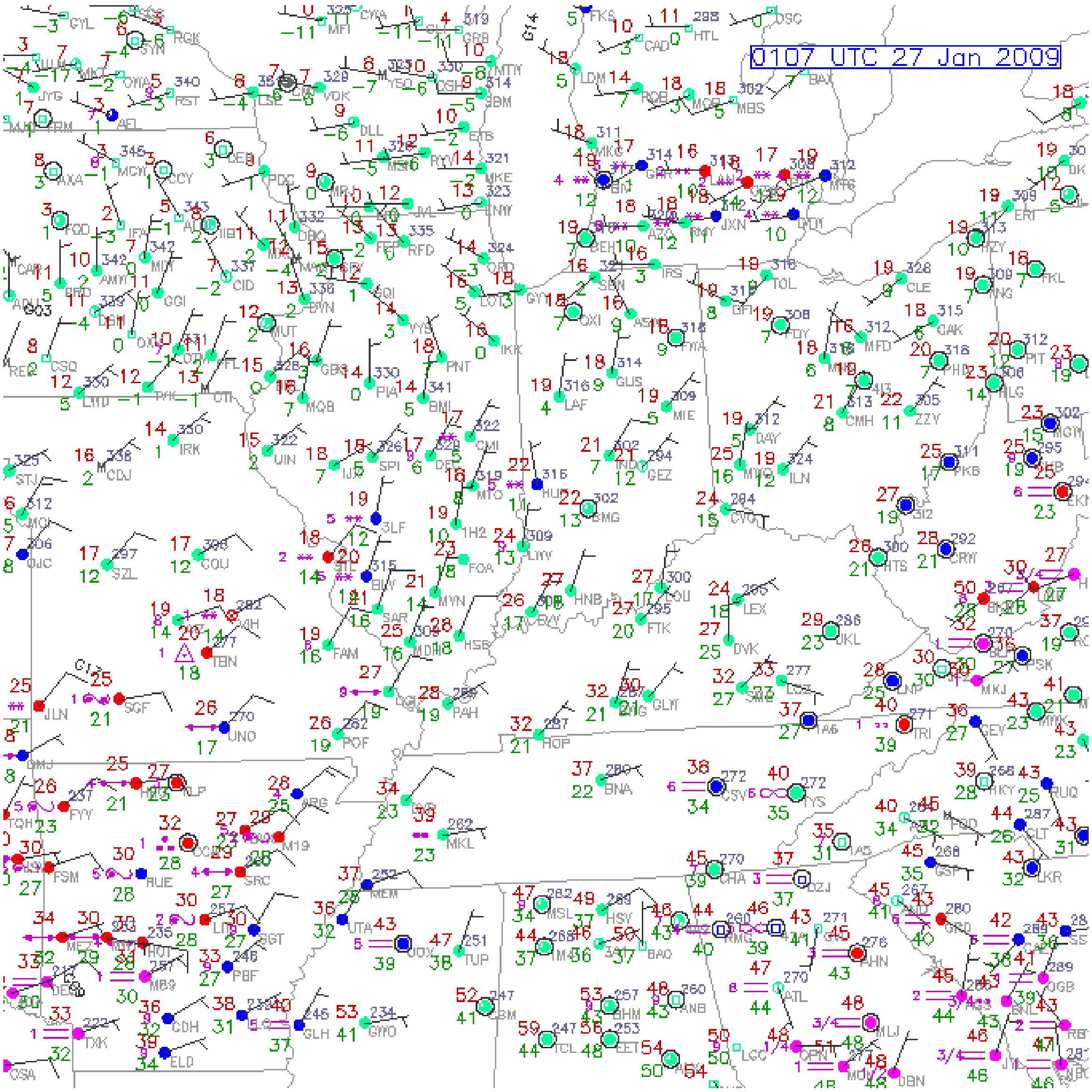

Figure 3: 0107 UTC January 27 surface analysis.

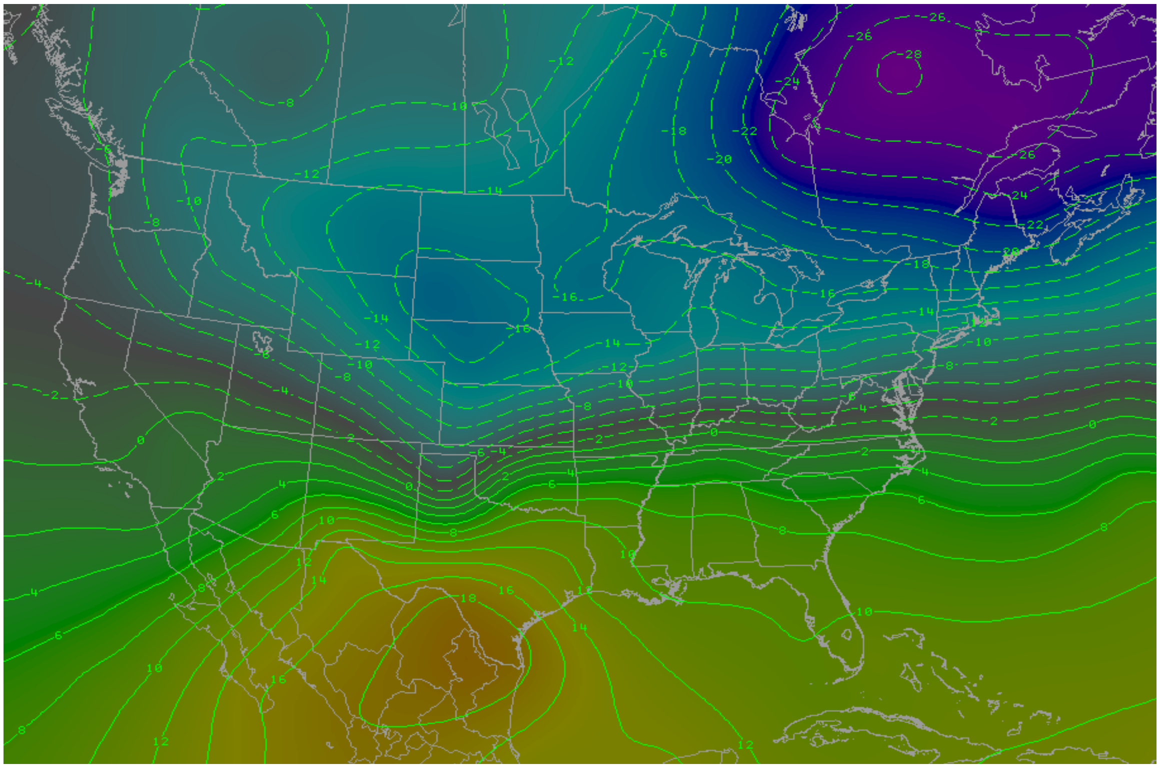

Figure 4: 0000 UTC January 27, 2009 850-mb temperature objective analysis (contour interval is 2°C).

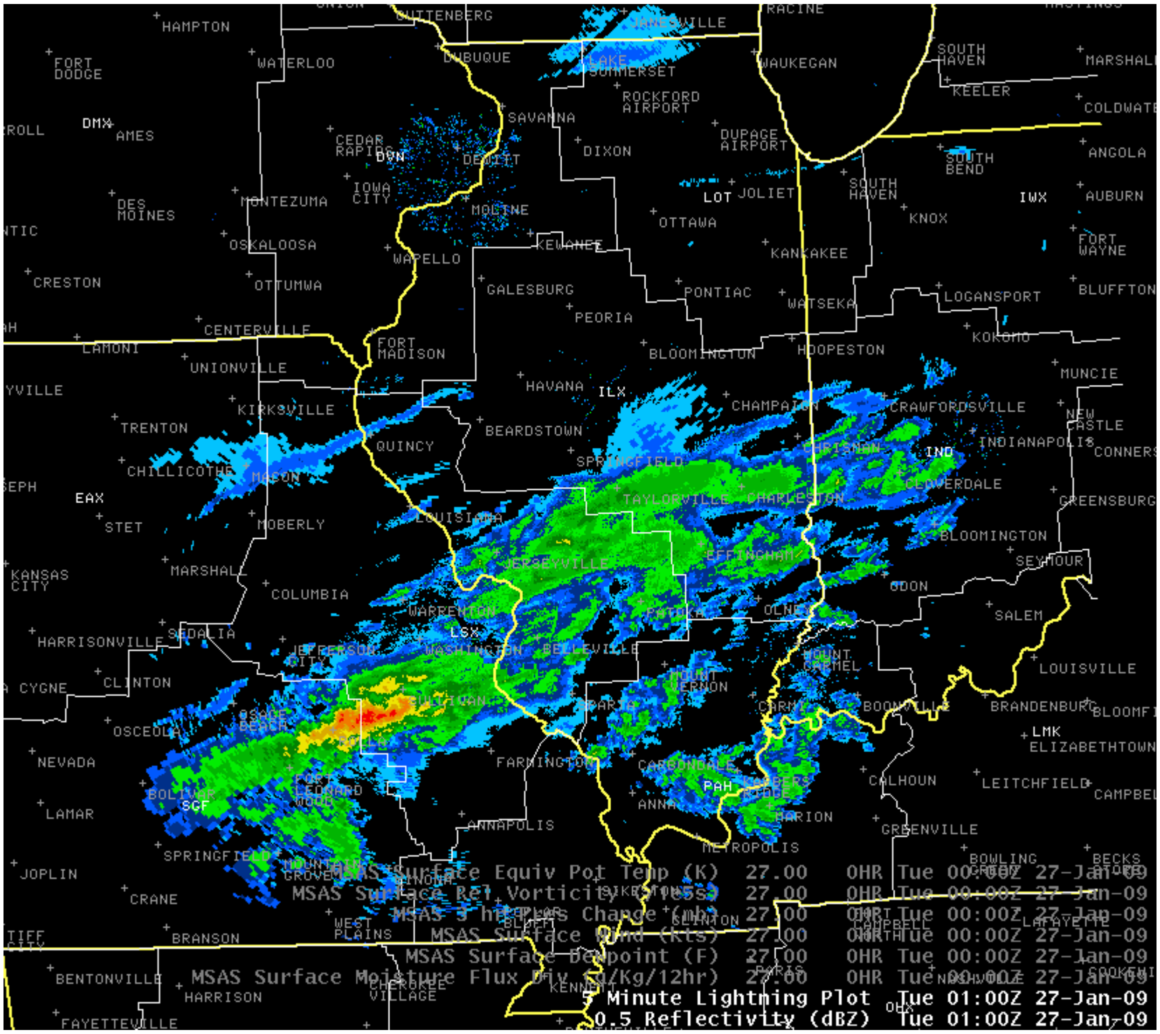

Figure 5: 0100 UTC 27 January 2009 regional radar mosaic (white lines indicate CWA boundaries).

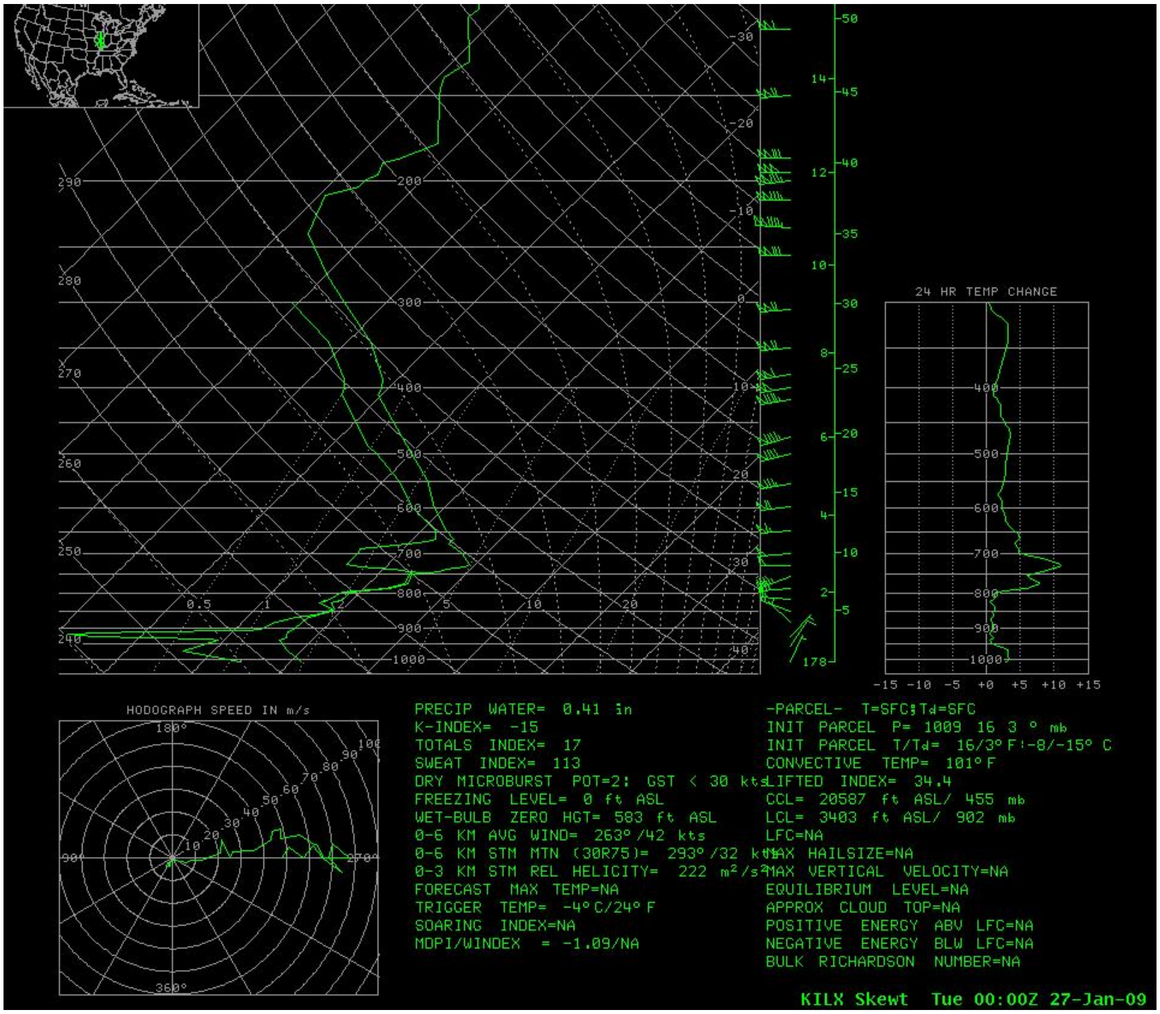

Figure 6: 0000 UTC 27 January 2009 KILX upper-air sounding.

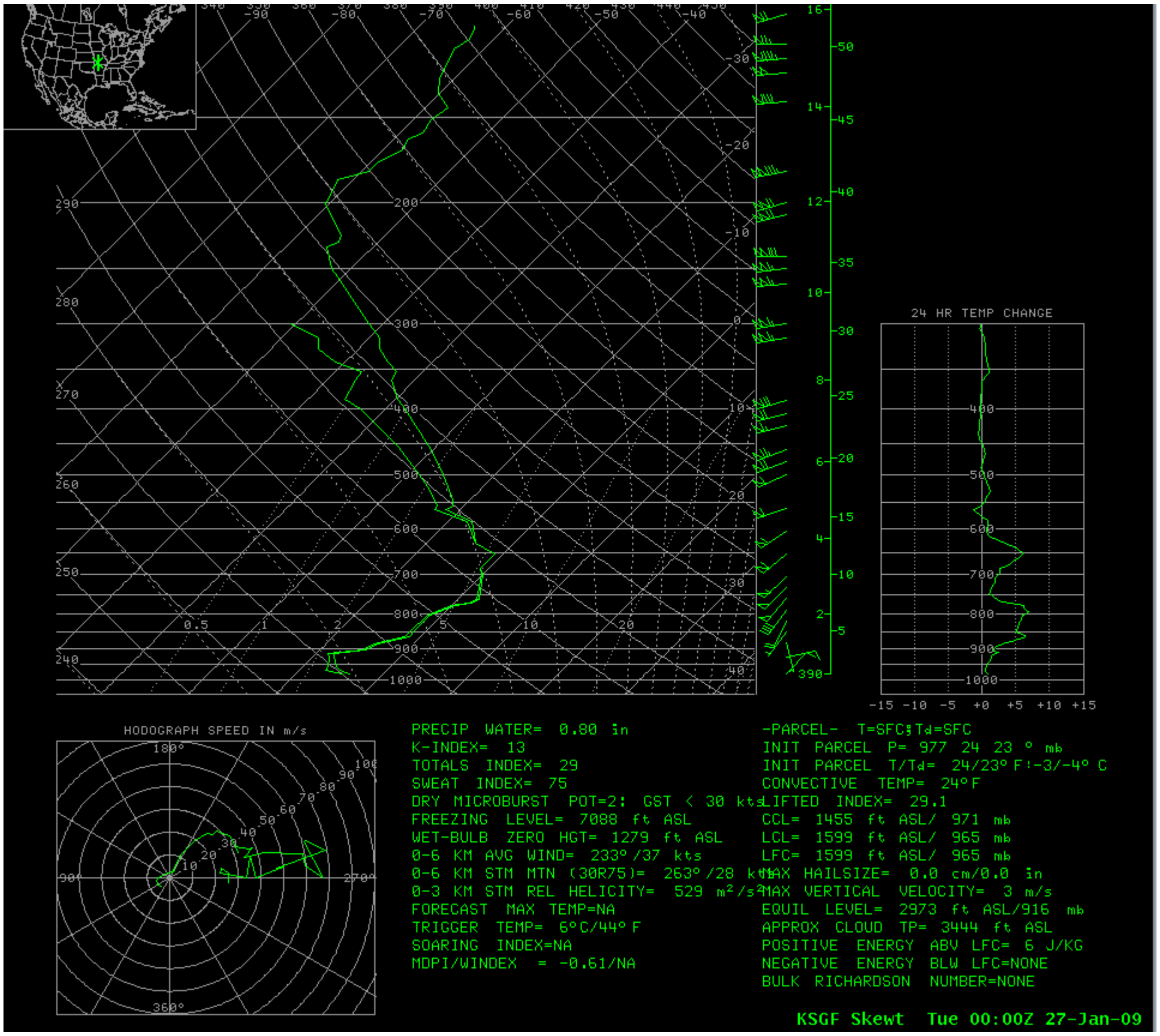

Figure 7: 0000 UTC 27 January 2009 KSGF upper-air sounding.

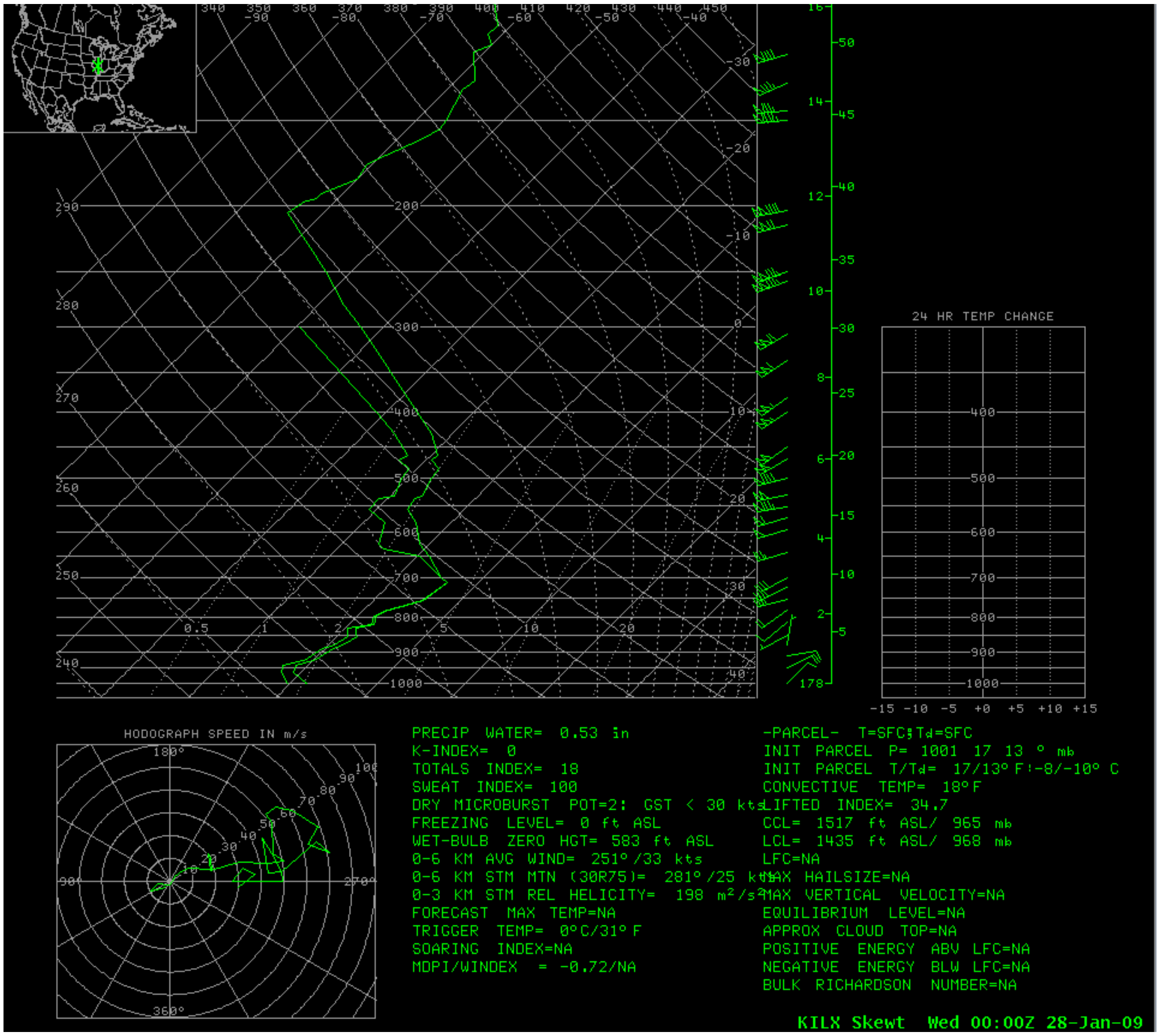

Figure 8: 0000 UTC 28 January 2009 KILX upper-air sounding.

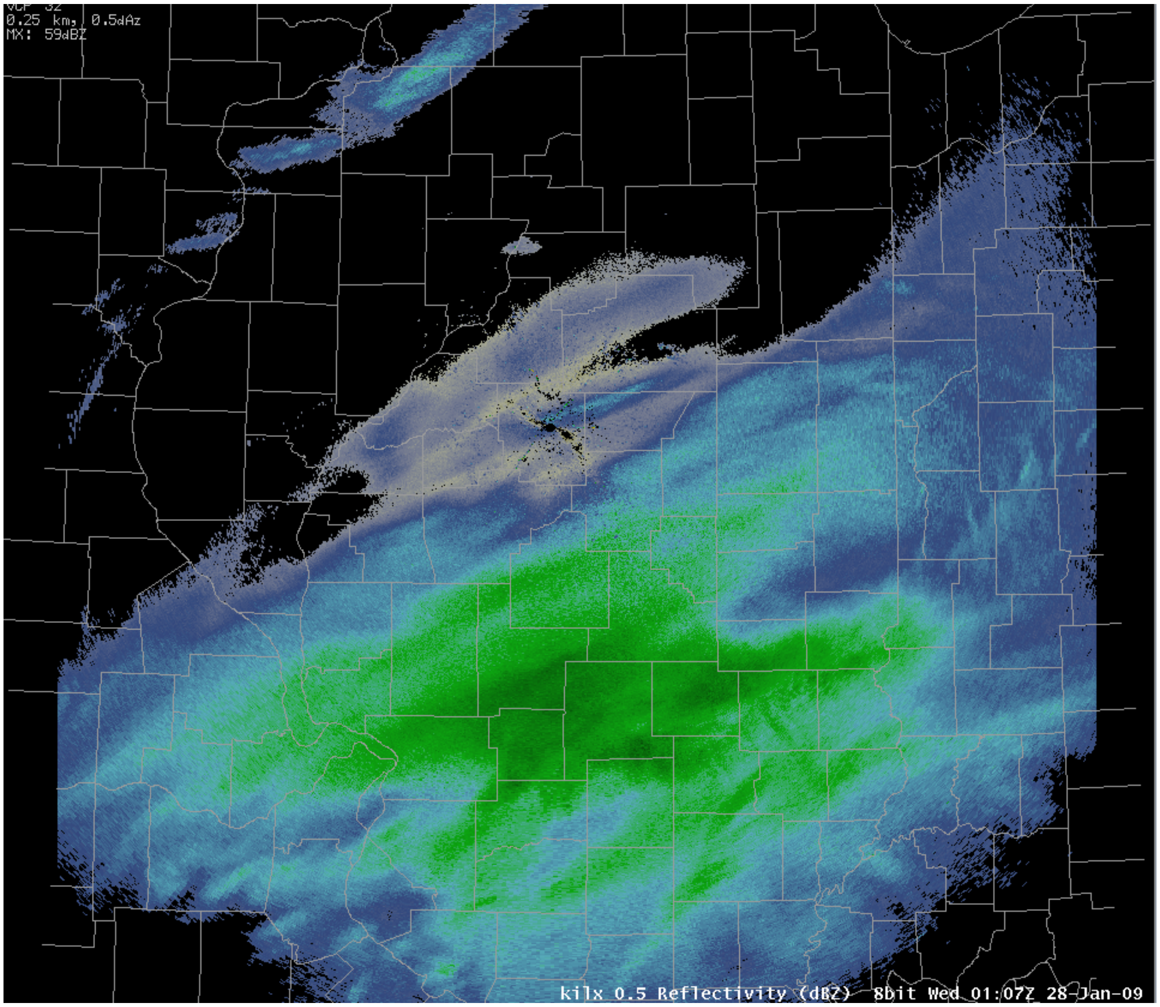

Figure 9: 0107 UTC 28 January 2009 KILX 0.5 reflectivity.

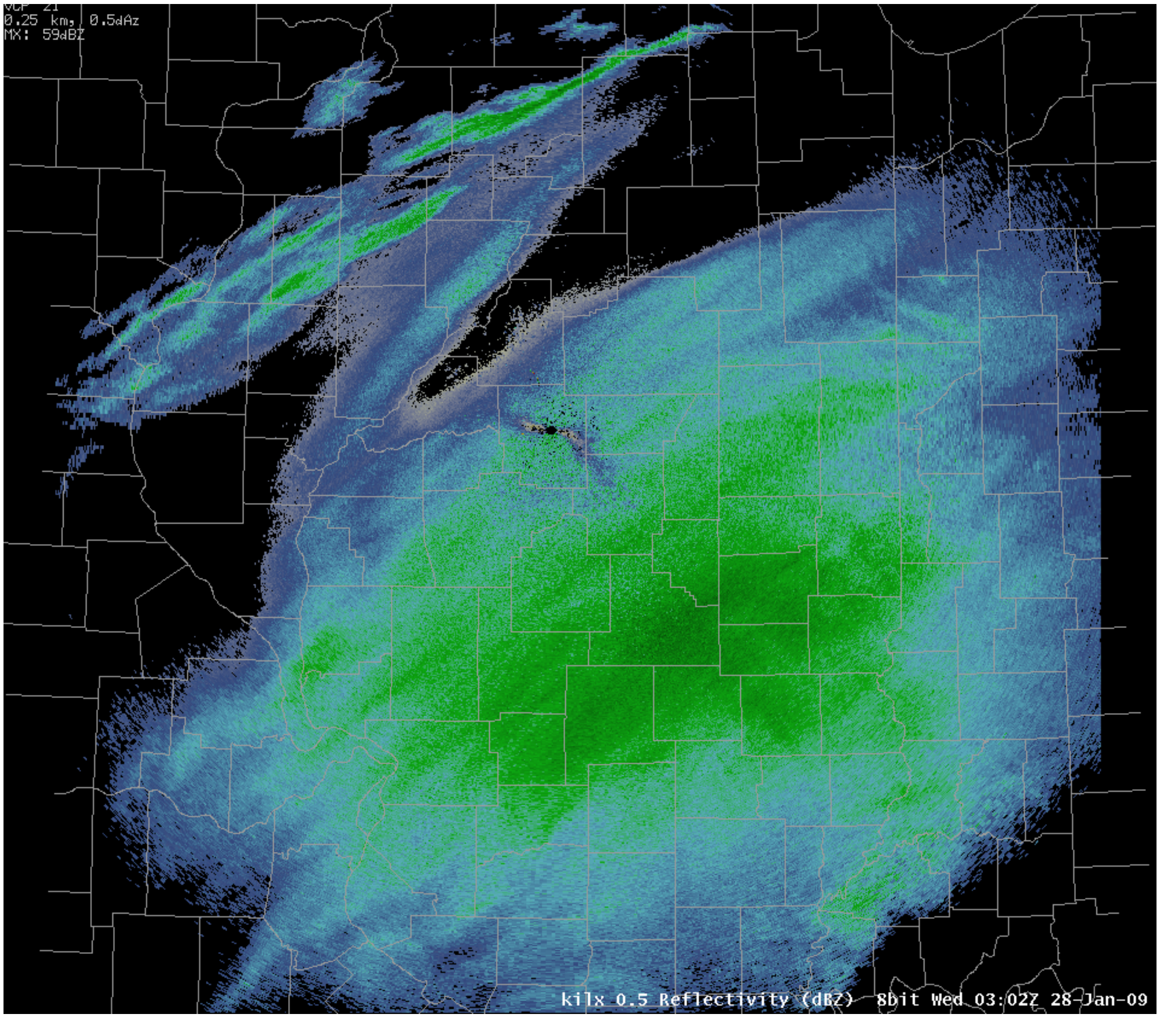

Figure 10: 0302 UTC 28 2009 January KILX 0.5 reflectivity.

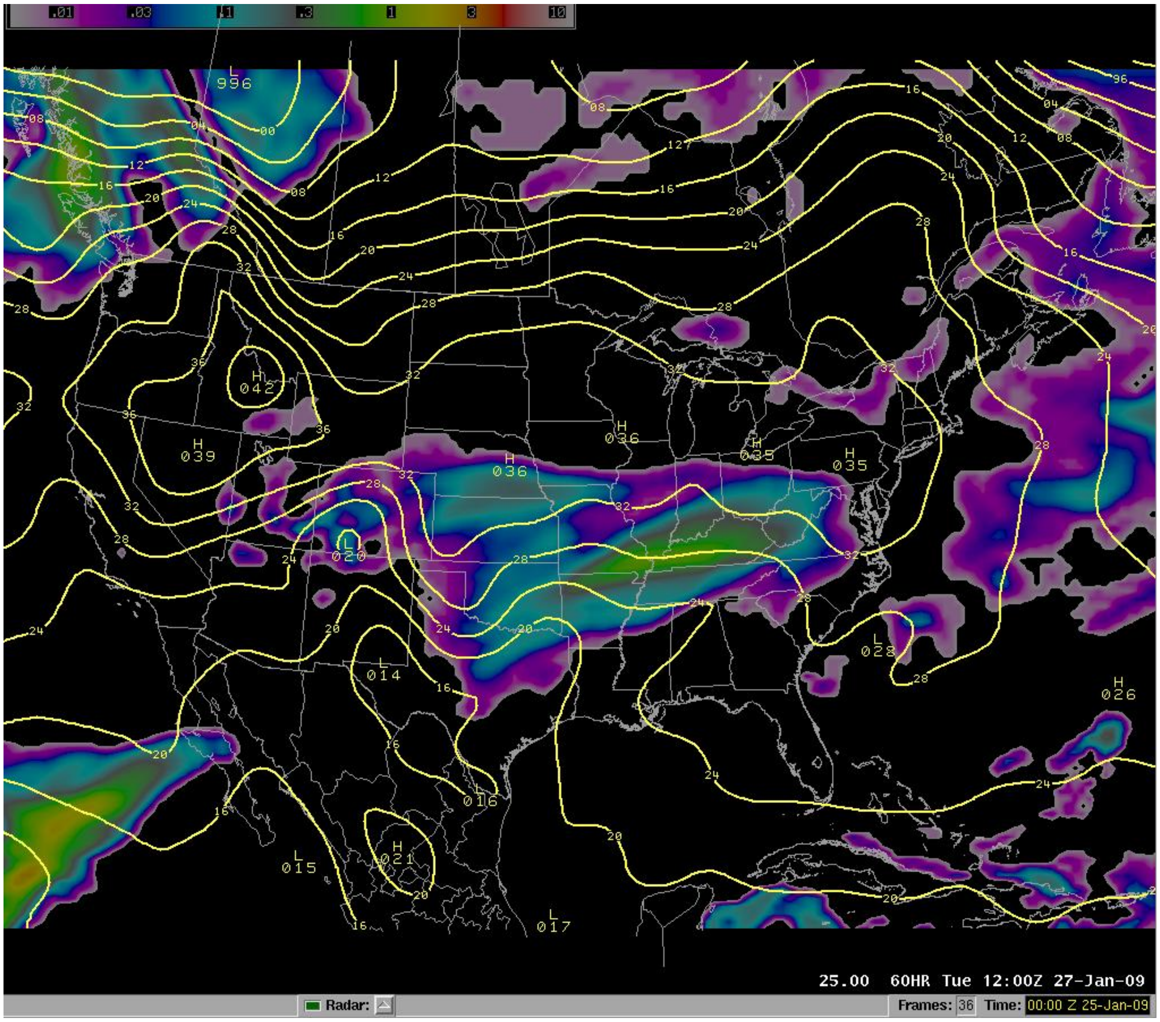

Figure 11: 0000 UTC 25 January GFS 60-hour forecast for 1200 UTC 27 January.

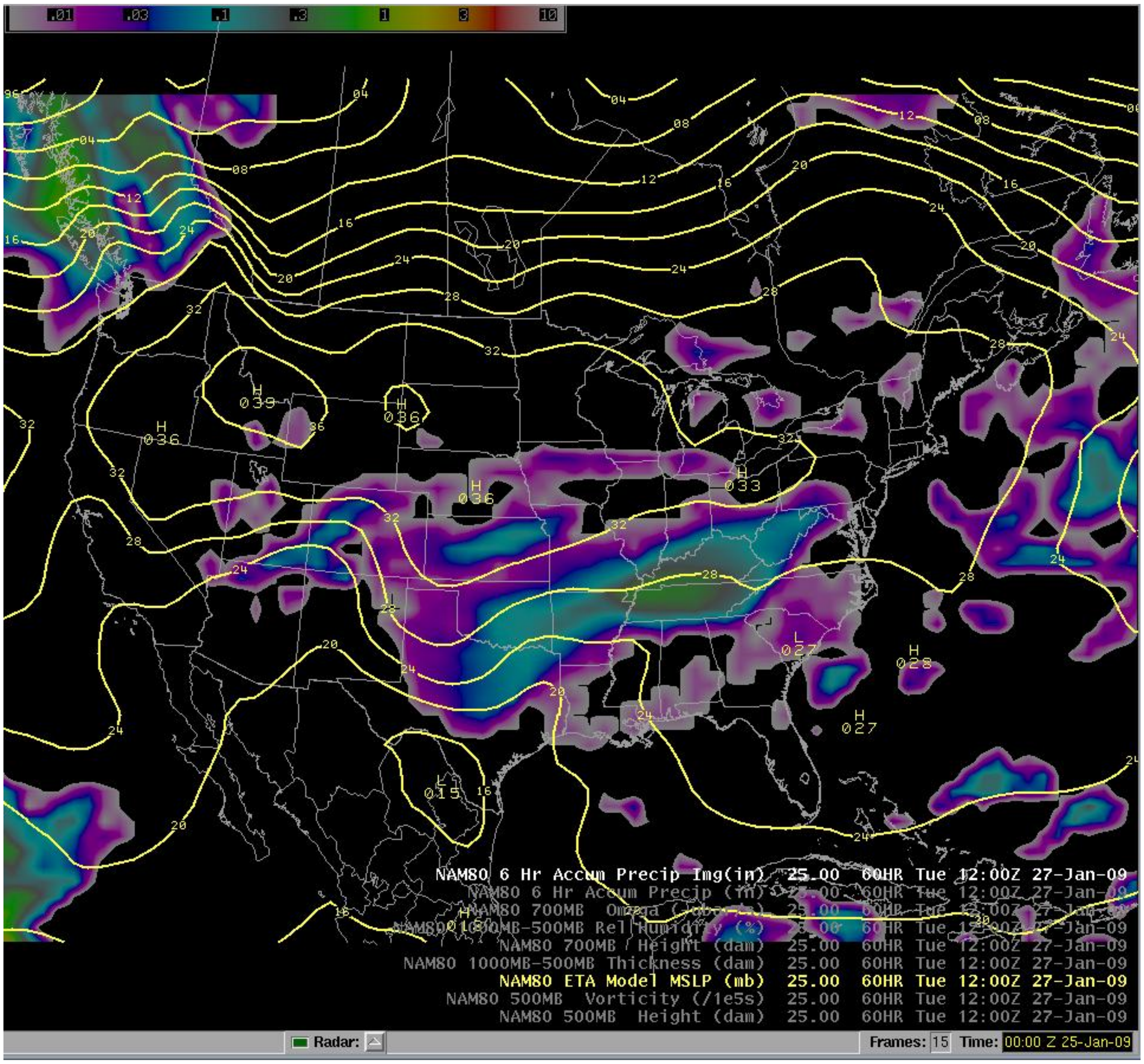

Figure 12: 0000 UTC 25 January NAM 60-hour forecast for 1200 UTC 27 January.

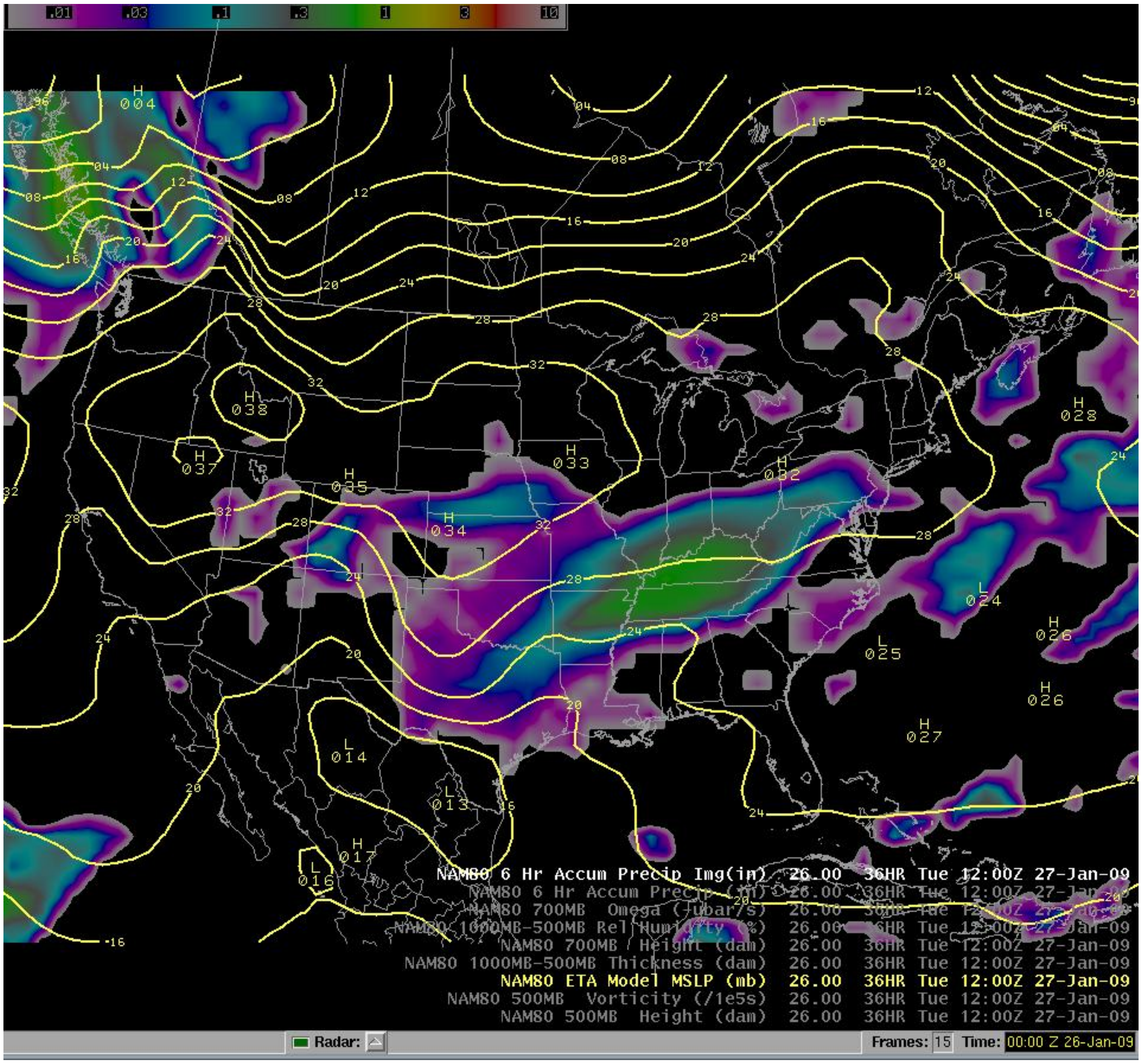

Figure 13: 0000 UTC 26 January NAM 36-hour forecast for 1200 UTC 27 January.

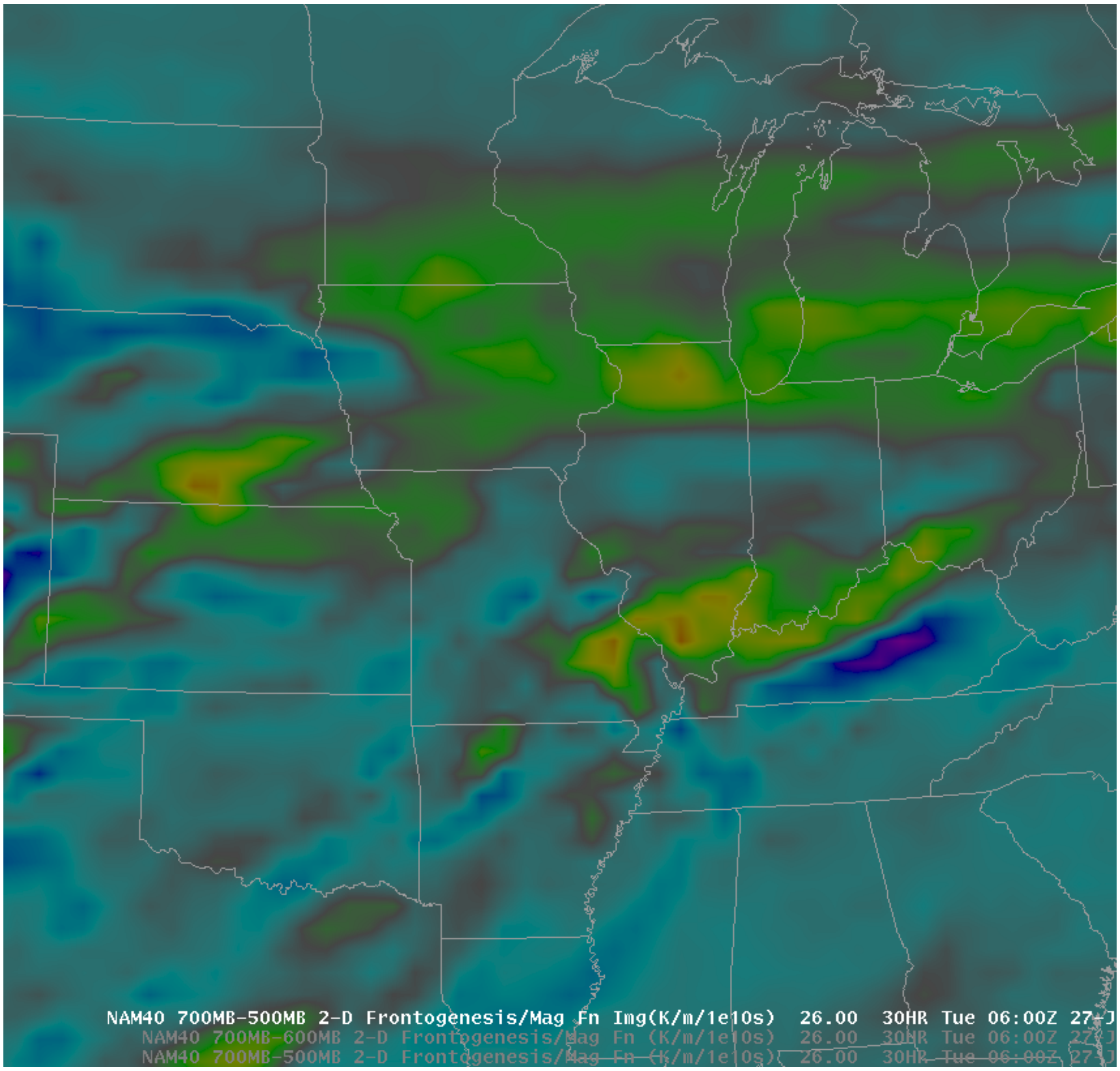

Figure 14: 0000 UTC 26 January 2009 NAM 30-hour 700–500-mb frontogenesis forecast for 0600 UTC 27 January 2009.

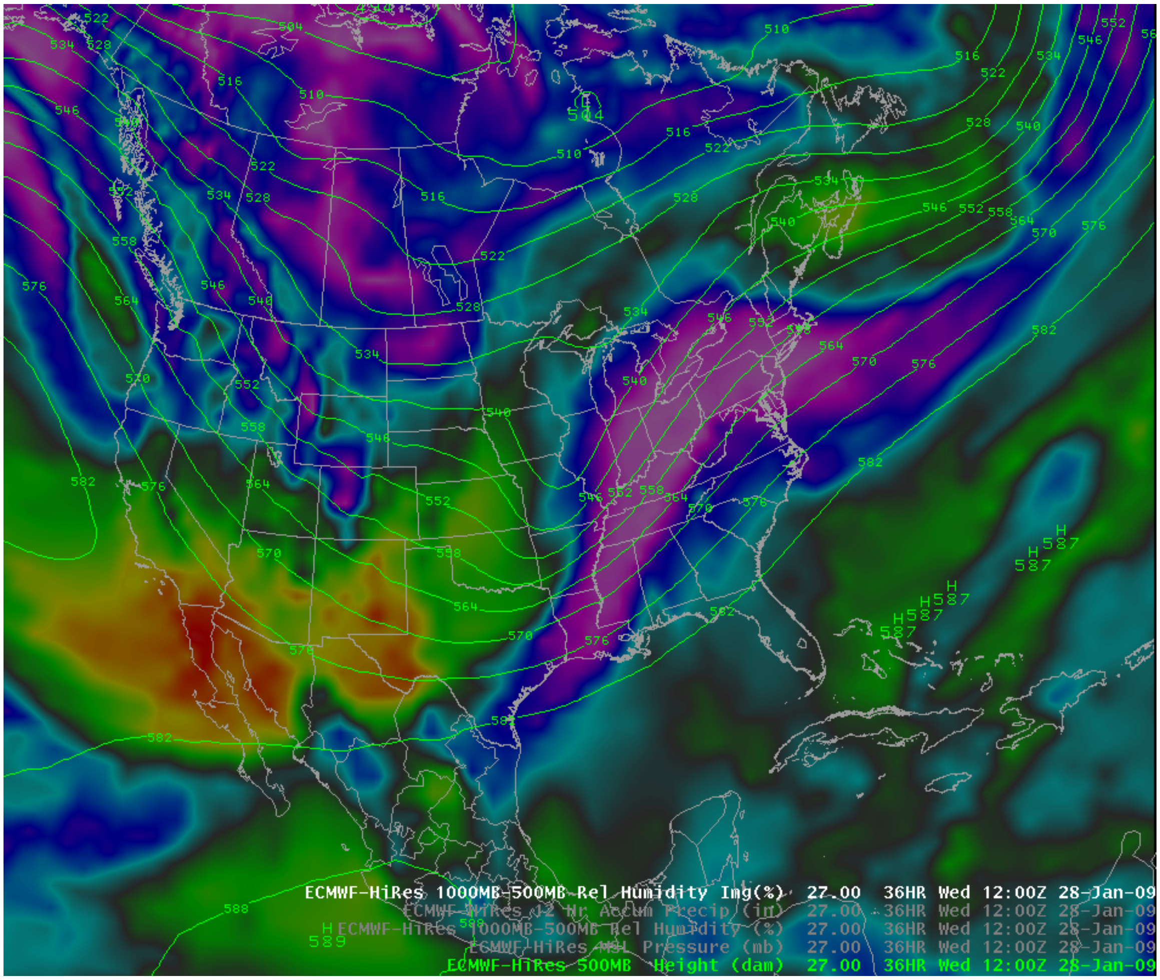

Figure 15: 0000 UTC 27 January 2009 ECMWF 36-hour 500-mb height (contour interval is 60 m) and 1000–500-mb relative humidity (image; values range from 0% over northwest Mexico to 100% across U.S. Midwest) forecast for 1200 UTC 28 January.

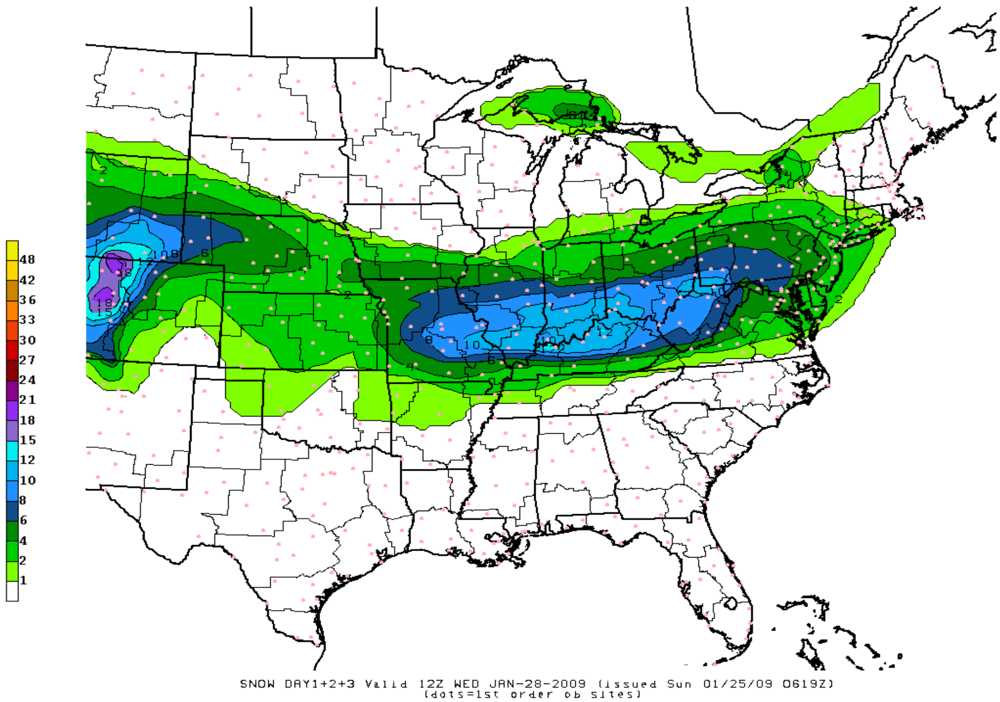

Figure 16: HPC 3-day snowfall graphic issued 0619 UTC 25 January 2009.

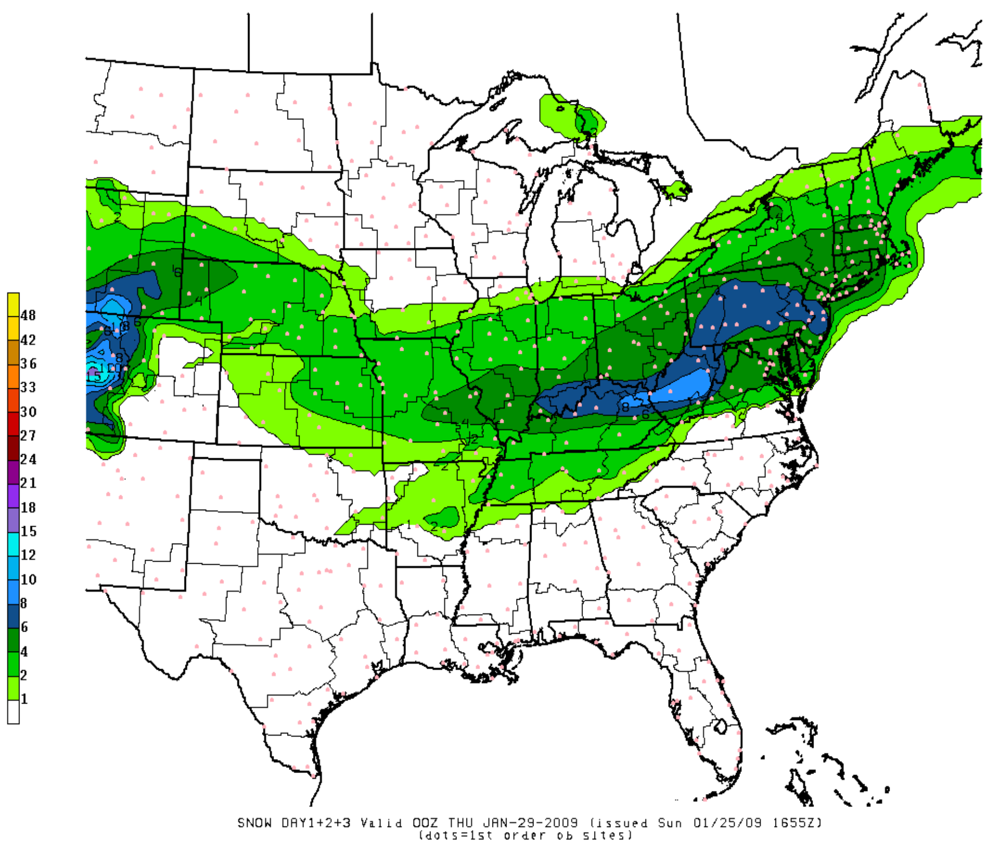

Figure 17: HPC 3-day snowfall graphic issued 1655 UTC 25 January 2009.

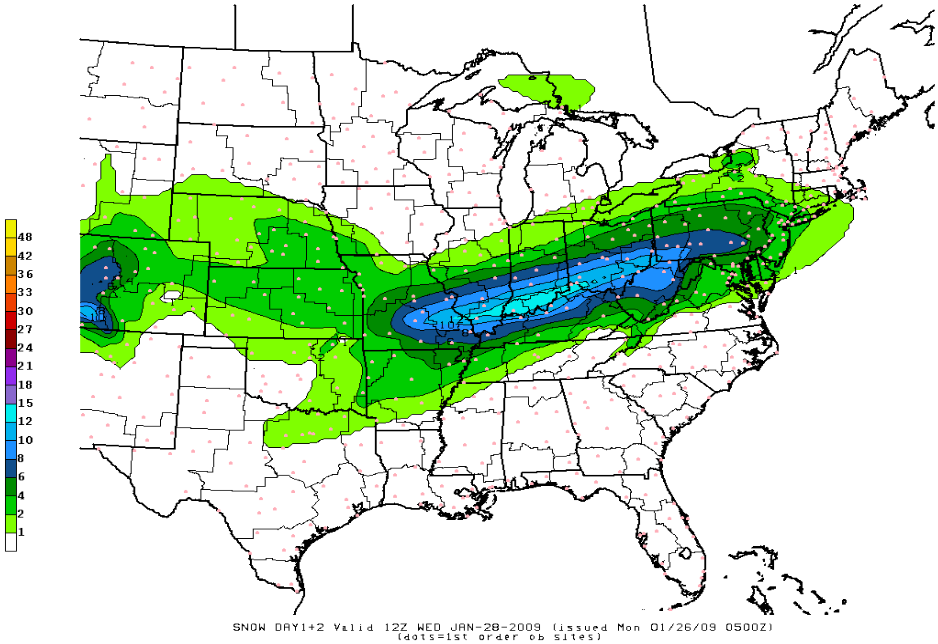

Figure 18: HPC 2-day snowfall graphic issued 0500 UTC 26 January 2009.

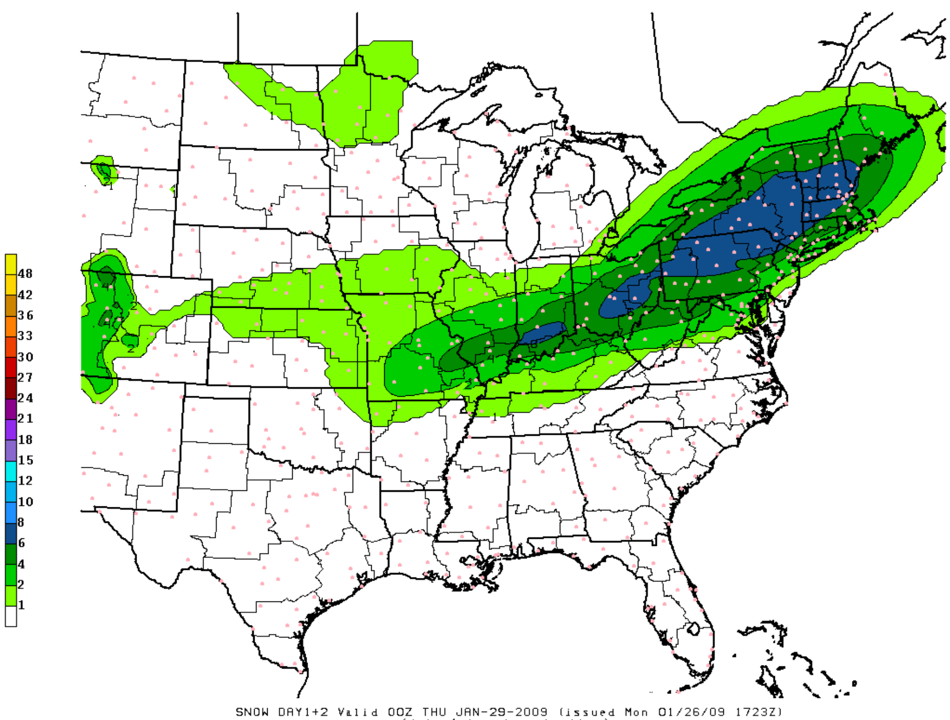

Figure 19: HPC 2-day snowfall graphic issued 1723 UTC 26 January 2009.

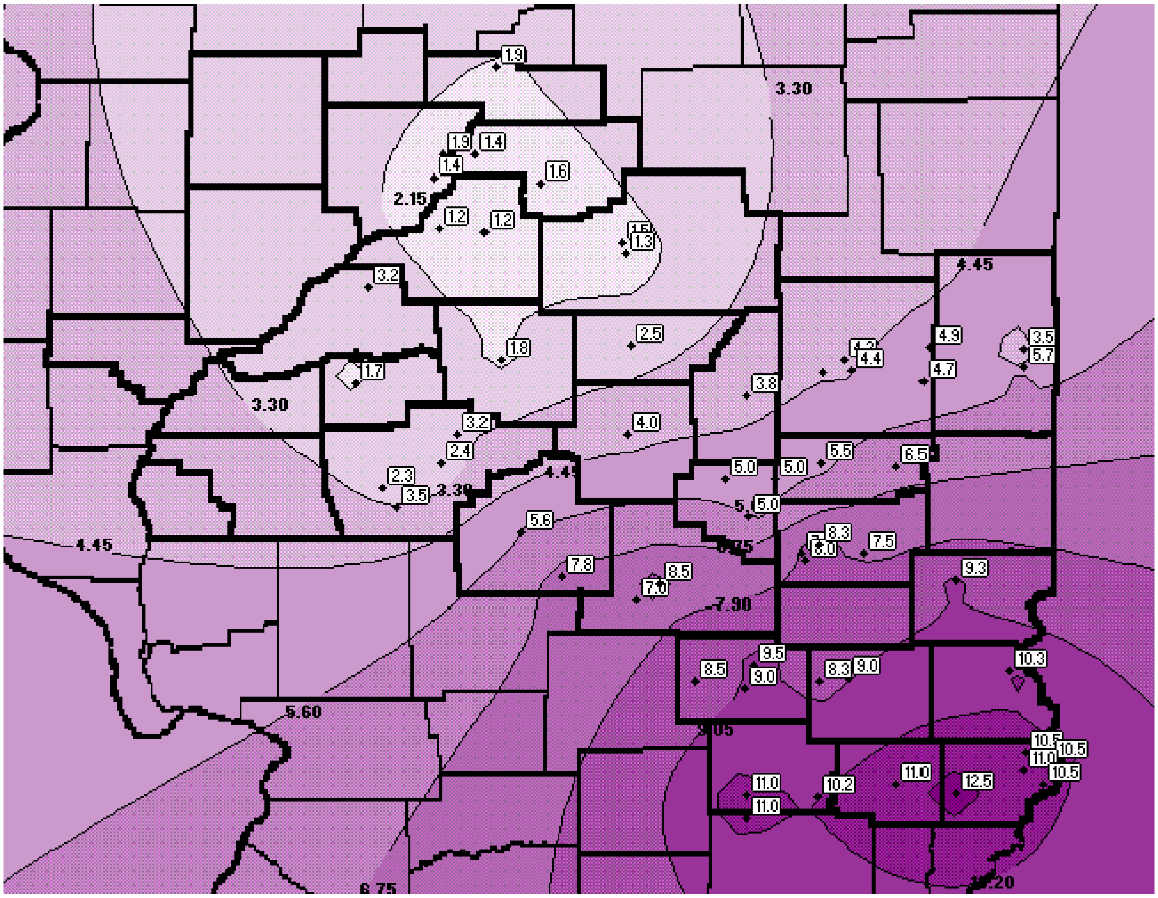

Figure 20: January 26-28 2009 snowfall totals (contour interval is 1.15 inches).