

## **Upper Midwest and Northern Great Lakes Spring Snowstorm – 16-17 April, 2014**

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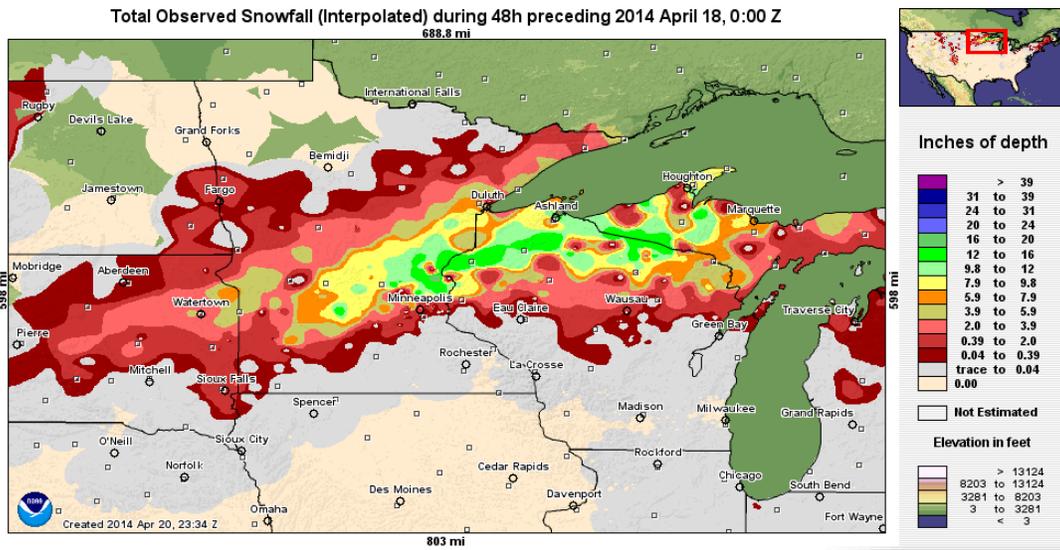
**Meteorological Overview:** A significant snowstorm affected a region stretching from central/eastern Minnesota eastward through northern Wisconsin and into the Upper Peninsula of Michigan. Widespread snowfall amounts over a foot fell during the period with much of it driven by mesoscale banding (Figure 1).

The 500-hPa pattern was of high amplitude featuring a ridge across the East Pacific while a longwave trough stretched from the Intermountain West to the Eastern Seaboard. Between 00-12 UTC on 16 April, a pronounced shortwave raced from the upper Intermountain West to the northern plains while the stronger downstream system lifted into Quebec. Strong warm advection brought a surge of Gulf moisture poleward ahead of this advancing shortwave. The 12 UTC sounding from Omaha, NE (not shown) clearly showed this enhanced low-level flow with 65-70 knots reported in the 880-850 hPa layer. Warm advection driven snows were commonplace during the morning of 16 April but much of it struggled to accumulate given large dewpoint depressions. The atmosphere gradually moistened throughout the day allowing snowfall to stick more readily. With the approach of an 850/700 hPa wave crossing South Dakota by 18 UTC, the thermal gradient sharpened markedly across the Upper Midwest as noted by the increasing 850-700 hPa Petterssen frontogenesis values across eastern Minnesota and northern Wisconsin. This frontogenetical forcing aided in strong upward vertical velocities which was accompanied by a favorable coupled jet structure aloft (Figure 2). Note the maximum in upper divergence across central Minnesota up toward the Upper Peninsula of Michigan where some of the heaviest snow bands set up. In fact, Chisago county which is north of the Twin Cities reported 16-20" of snowfall where hourly rates reached 1-2" during the height of the storm. The 12 UTC sounding that morning at KMPX (Minneapolis/St. Paul, MN) indicated an area of steeper mid-level lapse rates which supports the stronger vertical velocities within the mesoscale bands that afternoon. This comma-head of heavy snowfall gradually shifted eastward into northern Wisconsin with the heaviest reports generally collocated with the maximum in 850-700 hPa convergence.

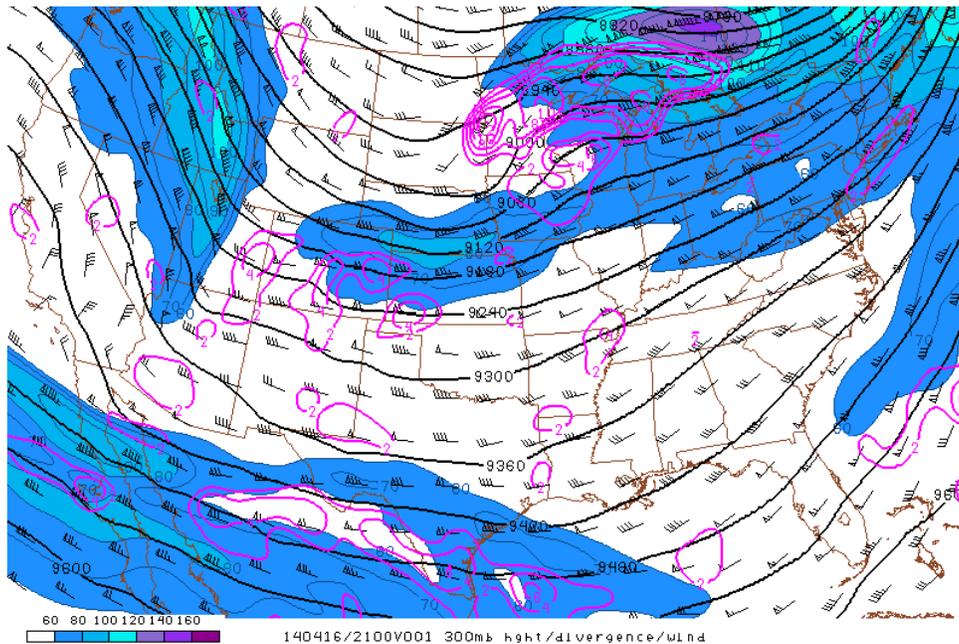
Given the snowstorm unfolded around 15 UTC (10 AM CDT), boundary layer temperatures were still relatively cool from the overnight hours. Broad easterly flow north of an advancing warm front combined with moisture overriding the boundary helped maintain a thick area of cloud cover at the start of the event. This helped maintain near freezing temperatures as precipitation approached from the west. As discussed earlier, dry air at the surface from a previous arctic intrusion initially limited snowfall accumulations. However, increasing omega values within the heavier snow bands helped effectively overcome the initial limitation. The rain/snow line was quite pronounced during the event with upper 20s to low 30s in the cool sector and 50s across the warm sector (Figure 3: surface fronts at 21 UTC on 16 April). This boundary remained nearly stationary leading to impressive snowfall gradients. In fact, North Branch and Isanti, MN recorded nearly 20" of snow while 40 miles to the south at Minneapolis/St. Paul International Airport barely received 0.5". Snow-to-liquid ratios (SLR) throughout the event were generally around 9 to 1 which is on the wetter side relative to the climatological average of 13.5 to 1 for this sector of the country.

**Impacts:** The power of this early spring snowstorm was mainly felt through school closures and travel impacts. Multiple accidents occurred due to compromised road conditions including one fatality in Minnesota. Additionally, while no major airports closed during the storm, there were

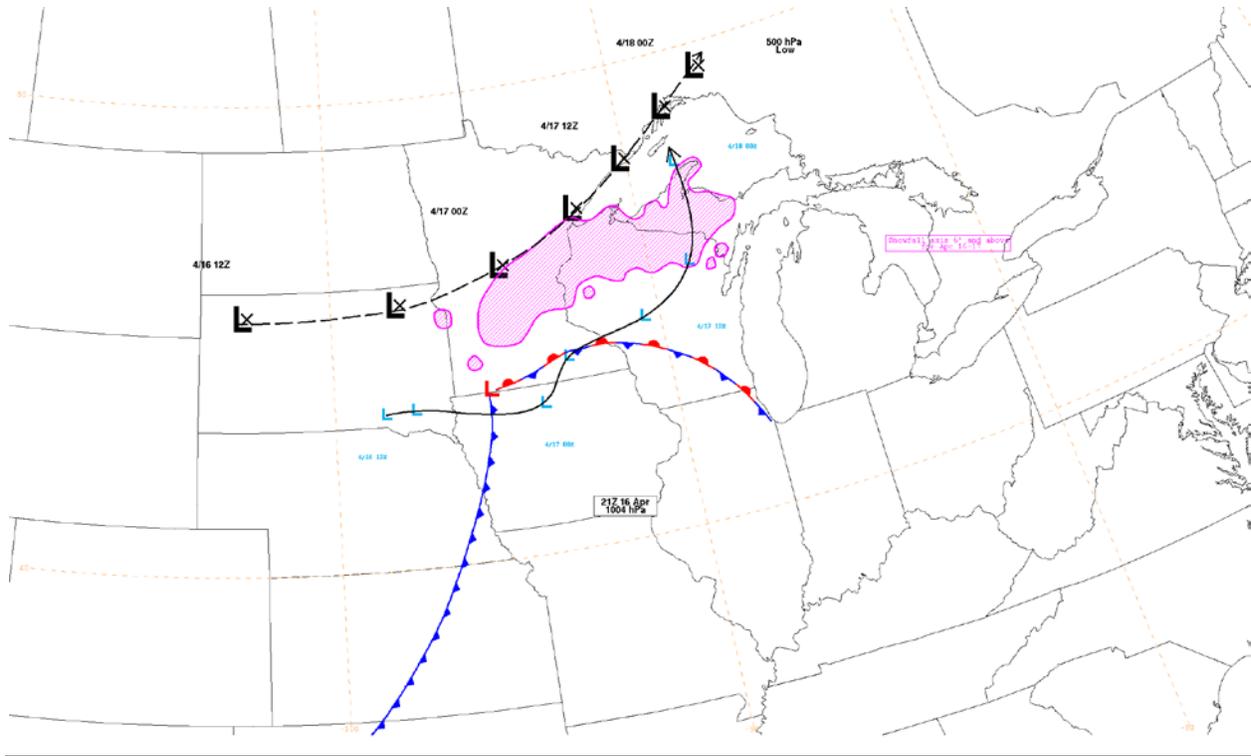
plenty of aviation delays due to reduced visibilities and slick runways. While Minneapolis only saw around an inch of snow, the combination of freezing temperatures and snow cover caused the cancellation of the Twins major league baseball game on 16 April.



**Figure 1:** Total snowfall (inches) during the 16-17 April snowstorm (image from National Operational Hydrologic Remote Sensing Center)



**Figure 2:** 300-mb heights (dm)/wind (kts) (color filled)/divergence (contoured) at 21 UTC on 16 April (courtesy of the Storm Prediction Center mesoscale analysis archive page)



**Figure 3:** 500-hPa low track (black), surface low track (light blue), frontal analysis at 21 UTC on 16 April, snowfall axis 6" and above (pink)