A Look at a Rare Winter Mesoscale Convective System

Jeffrey R. Hedges, Senior Meteorologist
National Weather Service
Pocatello, Idaho

On New Year's Day 2004, two periods of heavy snow passed through the WFO Pocatello County Warning Area (CWA). The first episode occurred during the early morning hours, and the second episode during the evening. The second episode was the most unique, and is the subject of this paper. The evening event was convective in nature, but much more characteristic of warm season activity.

A strong, dynamic weather system was moving through the Pacific Northwest on 1 Jan 2004. After a period of warm advection snow early in the day, there was a break in the precipitation as a strong cold front approached from the west. Earlier model runs showed a strong vertical motion field moving through the Snake River Plain late afternoon/early evening, and another significant snowfall was anticipated. The ETA model showed the front left quadrant of a strong upper jet directly over the Pocatello CWA at 02/0000Z (Fig 1), adding more support to the forecast of heavy snow. While the heavy snow did develop, the event turned out to be quite unexpected. The precipitation ahead of the cold front evolved into a linear mesoscale convective system – a classic prefrontal squall line.

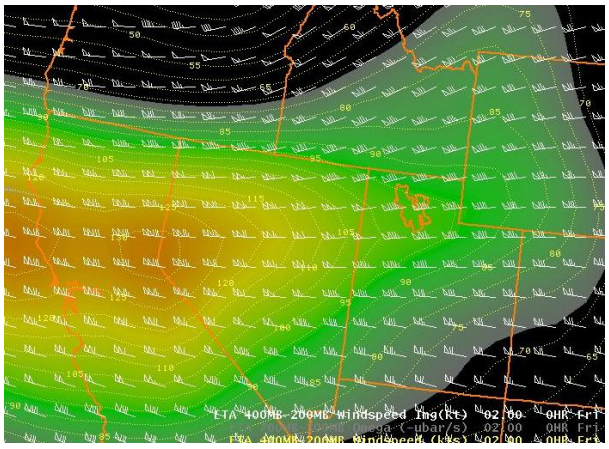

Fig 1. ETA 400-200mb Winds 02/0000Z

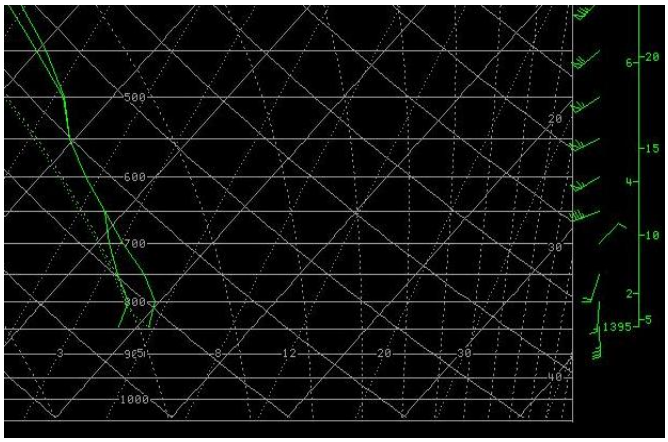
Fig 2. LAPS Sounding 02/0100Z

Thunderstorms in snow events are not uncommon, usually occurring in strong overrunning (warm advection) situations where elevated unstable air is subject to strong synoptic or mesoscale forcing. Rarely, however, does the convection become organized into a mesoscale convective system (MCS). This normally requires much higher moisture contents which can feed the incredible appetite of a MCS, thus requiring a tropical airmass. The ETA model did project less stable air into the Snake River Plain by the early evening of 1 Jan, but Lifted Index (LI) values remained positive. A look a LAPS sounding for Pocatello at 02/0100Z (Fig 2) showed the LI at +5, which would not usually suggest thunderstorms. The wind profile, on the other hand, tells a different story. Strong low level southerly winds which veer and increase with height are very favorable for organized deep convection, and the linear hodograph suggests multicellular development. The LAPS sounding at 02/0000Z showed nearly a 3 point drop in the LI. The Total Totals Index climbed to 51, which is favorable for deep convection.

The squall line moved into the eastern Magic Valley, with some lightning activity and rather unimpressive reflectivities (Fig 3a). The low reflectivities were likely the result of the beam height at that range, as the higher reflectivities would most probably be confined to the lowest levels. As the squall line moved eastward (Fig 3b), it showed some intensification. Reflectivities did increase, but this was at least partly the result of the now lower beam height with respect to the storm. Lightning activity also increased, which would only occur as a result of intensification. Comparing the LAPS

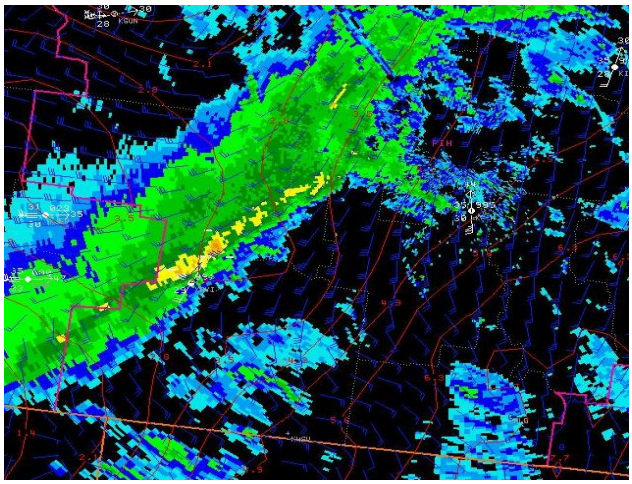

Fig 3a. Base Reflectivity (0.5deg) 02/0125Z

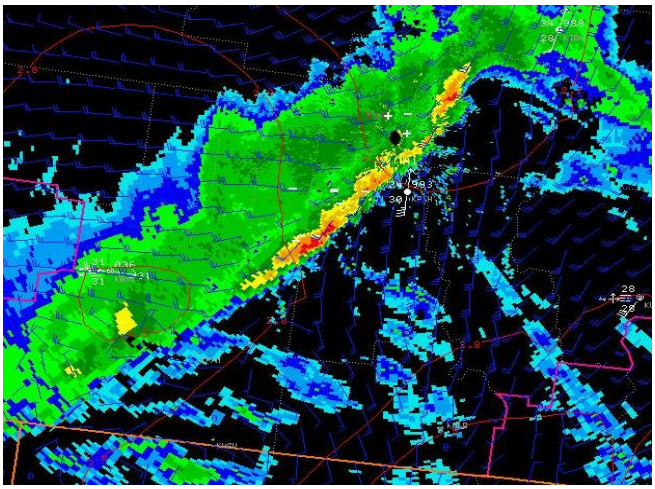

Fig 3b. Base Reflectivity (0.5 deg) 02/0204Z

derived surface wind fields, one can see that the winds ahead of the squall line in the eastern Magic Valley were southwesterly, while the winds were more southerly in the Pocatello area. This would result in an increase in low level convergence, thus an increase in convective intensity with all else being equal. The precipitation with the squall line was all frozen. At Pocatello, the snow became quite heavy with 2 to 4 inches falling in one hour. Hail fell with the intense convection at the leading edge of the squall line. Winds gusting to 65 mph resulted in severe blizzard conditions across the area, resulting in many road closures and stranded travelers.

This squall line was every bit the same as it's the classic warm season relative. The only difference was the state of the precipitation. The horizontal and vertical kinematics, both synoptic and mesoscale, were virtually identical to squall line systems in the Midwest during the warm season. The only real differences were the much lower temperatures and the lack of instability. The fact that a squall line did develop confirms that unstable air was indeed present. In this case it would have been elevated, and not well suited to surface or boundary layer based stability indices such as the LI. Forecasters need to pay attention to the potential for development of deep convection, without regard to the calendar. If the proper conditions are present, so will be the convection.