A WES ANALYSIS OF THE GREAT BASIN NATIONAL PARK NEVADA HEAVY SNOW EVENT, JANUARY 30-31, 2004

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Introduction

Overnight on Friday, 30 January, 2004 and on the morning of Saturday, 31 January, 2004 heavy snow fell over east central Nevada at Great Basin National Park (GBNP). GBNP is located in White Pine County 40 miles southeast of Ely (68 mile drive) (Fig. 1). The visitor center is at 6825 ft msl, with nearby Wheeler Peak at 13,063 ft msl. Light snow showers were forecast with no significant accumulation expected for White Pine County. However, snowfall amounts of 10 inches were reported at the GBNP visitor center on Saturday morning, with no other accumulations reported across White Pine County. While this type of snow event is not unusual for GBNP, it presents a challenge to established forecast techniques. The Weather Event Simulator (WES) was used in a post mortem analysis to help increase Situation Awareness (SA) and aid in proper decision making during isolated high terrain heavy snow events.

Synoptic Overview

At 0600 UTC, 31 January 2004, a 500 mb shortwave trough with strong vorticity maxima was located 250 miles southwest of Great Basin National Park (GBNP) in White Pine County, NV (Fig. 2). The MesoEta (Eta40) 0600 UTC analysis indicated a 700 mb trough axis across central Nevada west of GBNP with the surface-700 mb frontal boundary located across southern Nevada and Utah (Fig. 2). The KLRX (Elko) and KICX (Cedar City) WSR-88D radars indicated only a few weak reflectivity echoes across southern White Pine county, since both radars were scanning above the low topped stratiform precipitation. (Fig. 2). Surface observations were sparse across the area since GBNP did not have active staff at night, and only the Ely, Nevada ASOS had reported light snow since 0415 UTC. Due to the speed of the ejecting shortwave trough to the southeast of GBNP, the frontal boundary was expected to shift the main thermal gradient and upper dynamics south of GBNP.

Fn Vector Divergence

Heavy snow events for the high terrain in east central Nevada often involve 700 mb convergence or mid-level 700-500 mb frontogenesis to help enhance vertical motion along the thermal gradient axis (Apfel 2003). The conceptual model identified at the time of the event supported a progressive shift of the 700 mb convergence axis and the mid level frontogenesis south of White Pine County into southern Nevada. To examine where the strongest frontogenetic component was located, a MesoEta cross section of the Fn Vector Divergence field was constructed from the 0000 UTC model run for the 0600 UTC forecast. Fn vector divergence is the component of frontogenesis that is normal to the potential temperature gradient with negative values indicating convergence and enhanced vertical motion potential. The cross section was taken directly over GBNP from southwest to northeast along the 700 mb thermal gradient (Fig. 3). Very large negative values of > 40 units were seen over GBNP from 700-650 mb to support strong mid level frontogenesis at 0600 UTC.

To track the movement of the Fn vector divergence field, a MesoEta plan view of the 0900 UTC forecast from the 0600 UTC model run was selected (Fig. 4). The Fn vector divergence axis was seen to have shifted south of GBNP with positive values (+10) over GBNP and weaker negative values (-14) south. This did support a continued shift of the mid level frontogenesis axis south rapidly as the 500 mb shortwave ejected southeast. Snow showers with little or no accumulation remained in the forecast for White Pine County during the overnight period, but no updates were made.

The Upslope Heavy Snow Event

On Saturday morning at 1545 UTC, 31 January, 2004, a report was received by WFO Elko, NV from the GBNP staff of 10 inches of new snowfall overnight. GBNP did have a NWS cooperative network station at the visitor center, and some staff were trained to take snowfall measurements. In addition to the report, a web cam view of the GBNP did support the heavy snowfall overnight. This obviously did not fit the forecast and the conceptual model of fast moving frontogenesis with limited snowfall potential, but it did support possible upslope flow and heavy snow due to orographic lift.

Hourly observations were not available at the GBNP visitor center, but a Remote Automated Weather Station (RAWS), Baker Flat (BKFN2), was located just 0.5 miles south of the visitor center at 6841 ft msl. The AWIPS hourly data plots for BKFN2 were reviewed in 4-panel groupings with the terrain map overlayed to view potential upslope wind flow (Fig. 5). The 0430 UTC plot showed southeast upslope flow ahead of the frontal boundary with relative humidity (rh) values of 94%. BKFN2 had no present weather sensor or precipitation accumulation indications, but the high rh values did support possible snowfall.

The 0630 UTC showed a windshift to northeast upslope flow, more favorable for orographic snow across GBNP. This also indicated that the frontal boundary had shifted south of the visitor center, and showed some continuity with the MesoEta model surface and 700mb fields. The relative humidity increased to 98% with the air temperature decreasing, supporting continued snowfall in GBNP. Subsequent observational plots from 0830 UTC through 1330 UTC continued to indicate northeast upslope flow and relative humidity values near 100%. This trend continued until 1530 UTC when the GBNP staff reported that the heavy snowfall had ended.

Discussion and Conclusion

Heavy snow events are not uncommon over the high terrain of GBNP, but this event was likely not forecast due to failed aspects of proper Situation Awareness (SA). There appeared to be a failure of the first level of SA involving perception of the data. In addition to lack of nighttime staff observations at GBNP, some forecasters did not realize that the BKFN2 RAWS site was available. Use of BKFN2 could have implied snowfall with high relative humidity, despite the lack of precipitation data. Furthermore, the radar data was inconclusive due to the overshooting of the radar beam. There was also a failure in the second level of SA involving comprehension of the data. It was apparent that forecasters became locked into the conceptual model of fast moving upper support shifting the frontogenesis south, and therefore little snow accumulation was expected. This overshadowed the possible upslope flow component favoring heavy orographic snowfall after a frontal passage. It is difficult to determine whether lack of experience, workload distractions on a midnight shift, or maybe both played a part in this event as well, however, it did ultimately lead to a lack of a proper warning decision, since a heavy snow warning was not issued.

Great Basin National Park remains a challenge for operational forecasters as radar coverage is fair at best. Observations from park employees can only be obtained during normal park hours, or via the daytime webcam. The complex nature of the terrain with orientation of mountains and valleys complicates matters. This WES post-mortem analysis was used to aid forecasters in recognizing SA failures with a goal of improving SA skills in order to make a proper warning decision. There are many distractions in the forecast environment, ranging from data issues, to shift work issues, to experience and lack of proper conceptual models. Continued training with the WES, improved forecast research and better observational data sets will help forecasters maintain and improve SA for the future.

References

Apfel, Steven L., 2003: Analysis of a Heavy Snow Event over East Central Nevada Using the Weather Event Simulator (WES) October 1, 2002. Western Region Technical Attachment 03-04.

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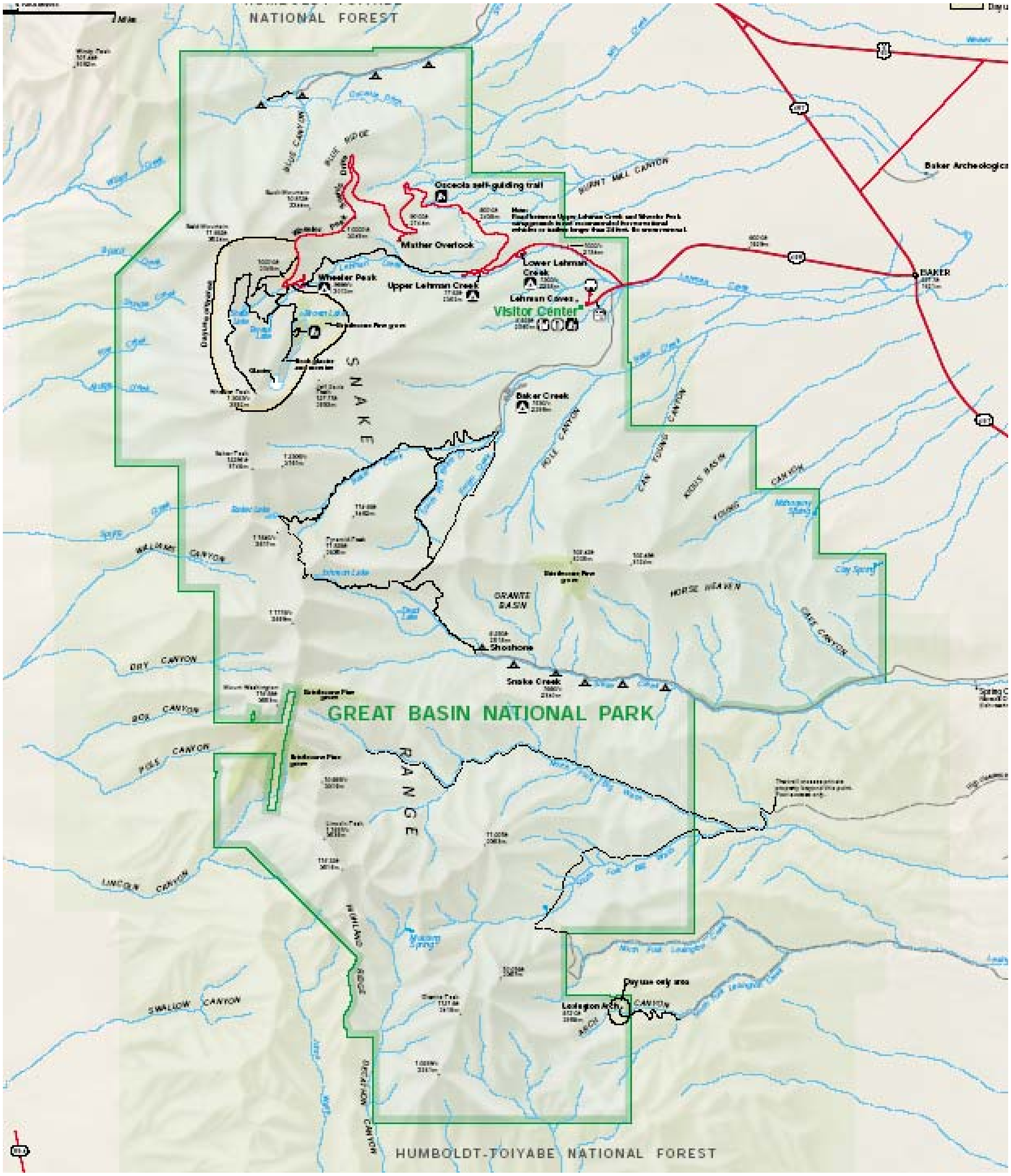

Fig. 1. Department of Interior, National Park Service map of Great Basin National Park in southeast White Pine County, Nevada.

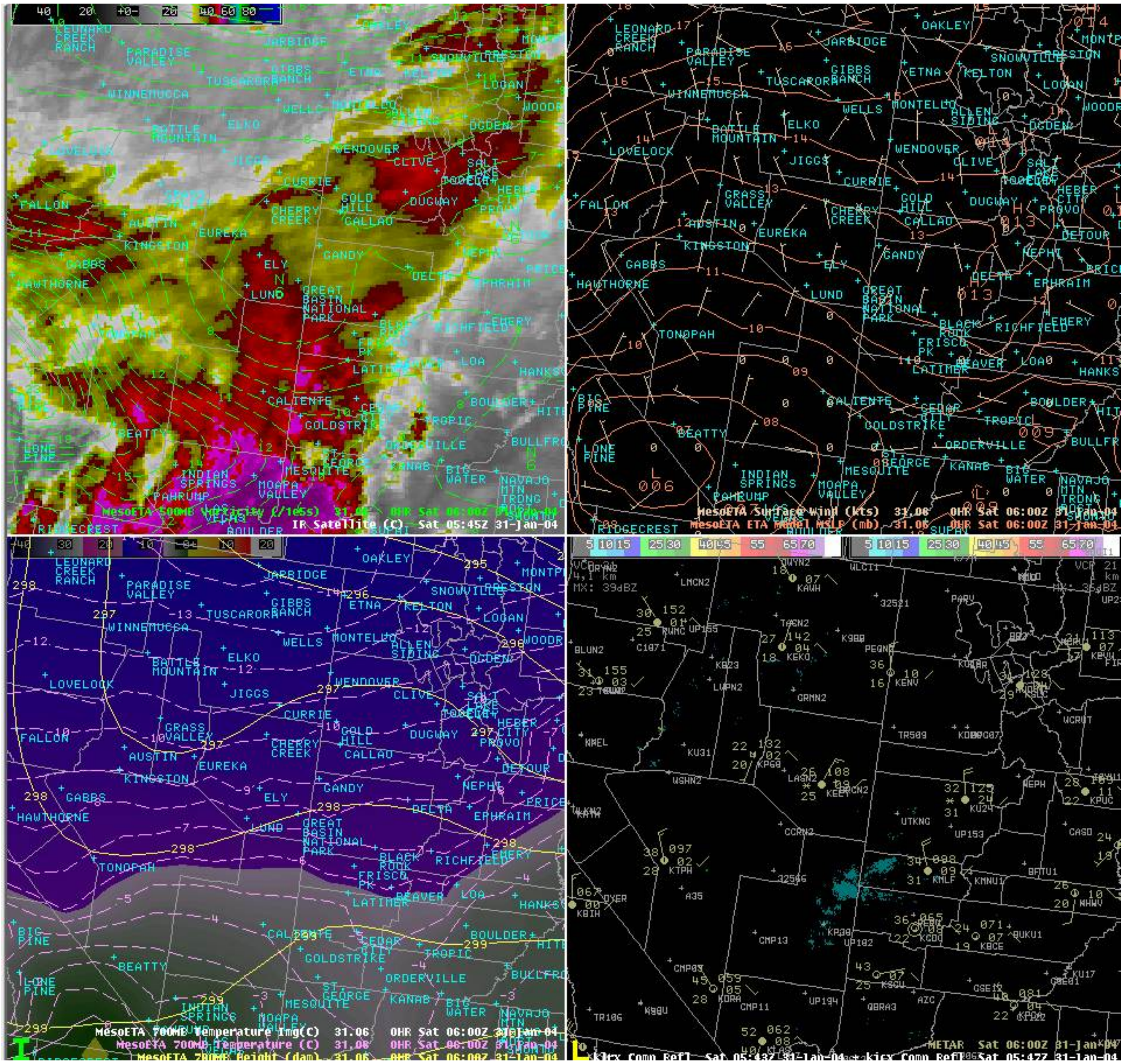

Fig. 2. MesoEta (Eta40) 4-panel at 0600 UTC, 31 January, 2004. Displayed panels are 500 mb Vorticity/IR Satelllite, 700 mb Heights/Temperature, MSLP/Surface Wind, and KLRX/KICX WSR-88D radar reflectivity with METAR observations.

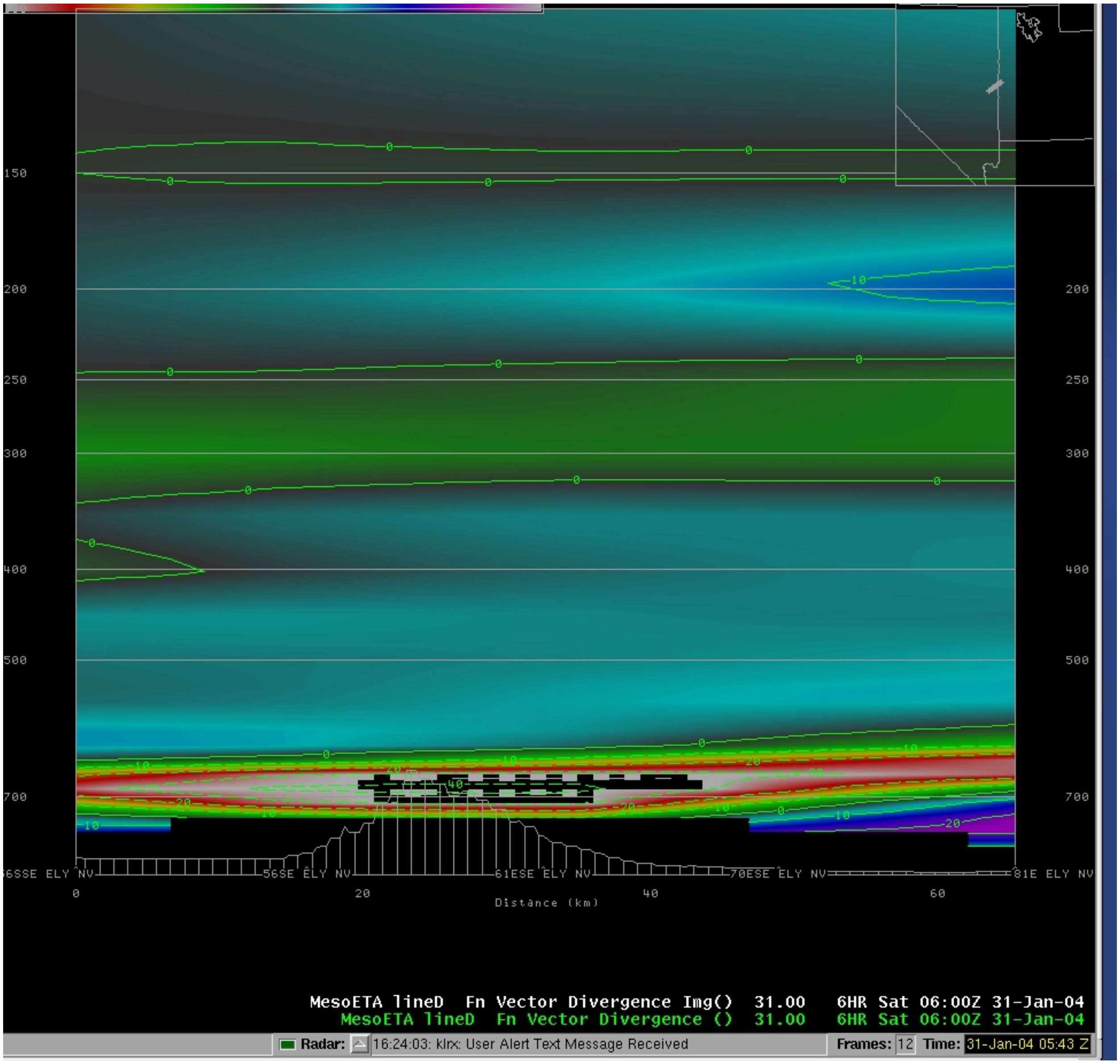

Fig. 3. MesoEta (Eta40) cross section of Fn Vector Divergence from the 0000 UTC model run for the 0600 UTC, 31 January, 2004 forecast over GBNP.

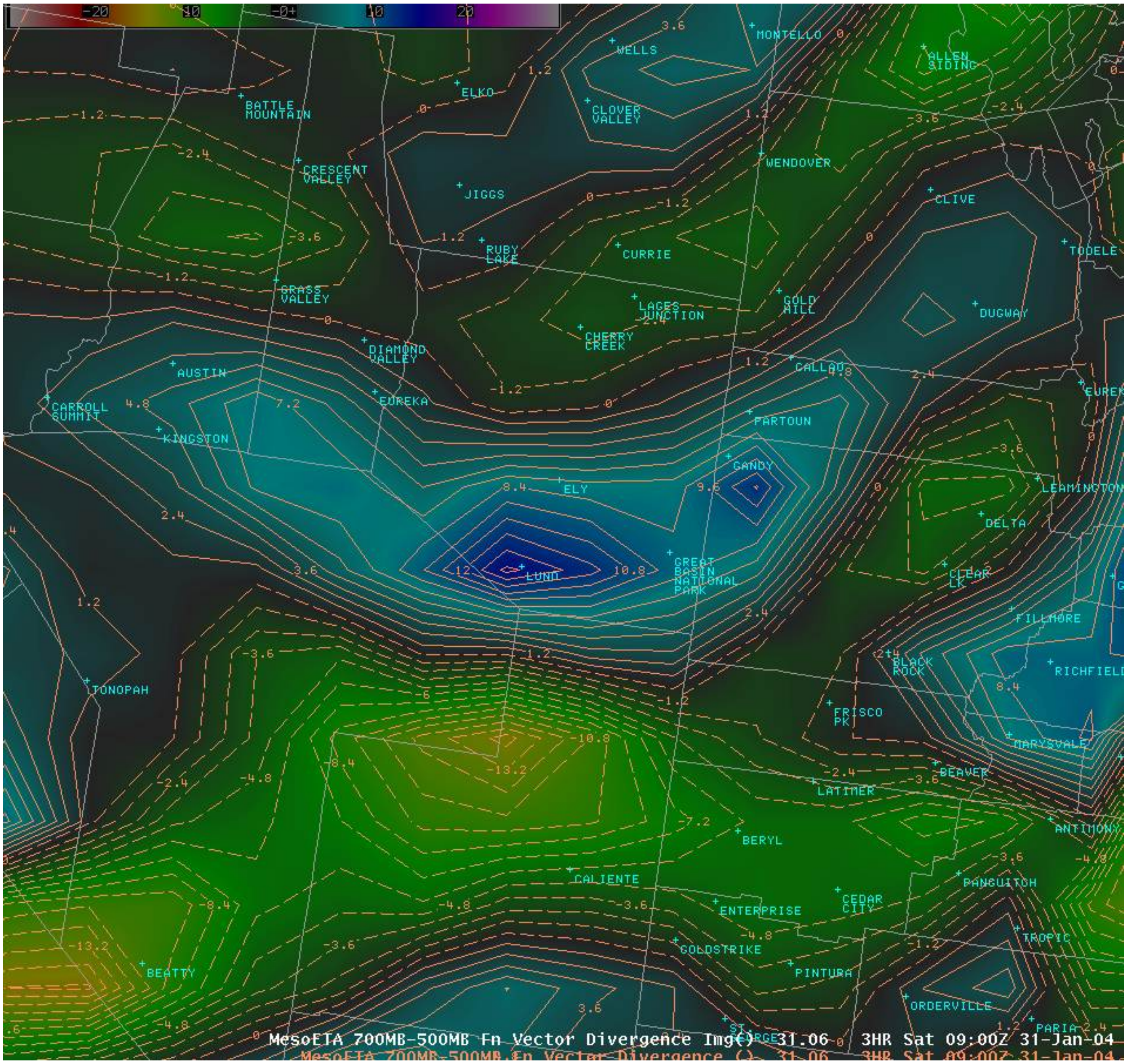

Fig. 4. MesoEta (Eta40) plan view of Fn Vector Divergence from the 0600 UTC model run for the 0900 UTC forecast, 31 January, 2004.

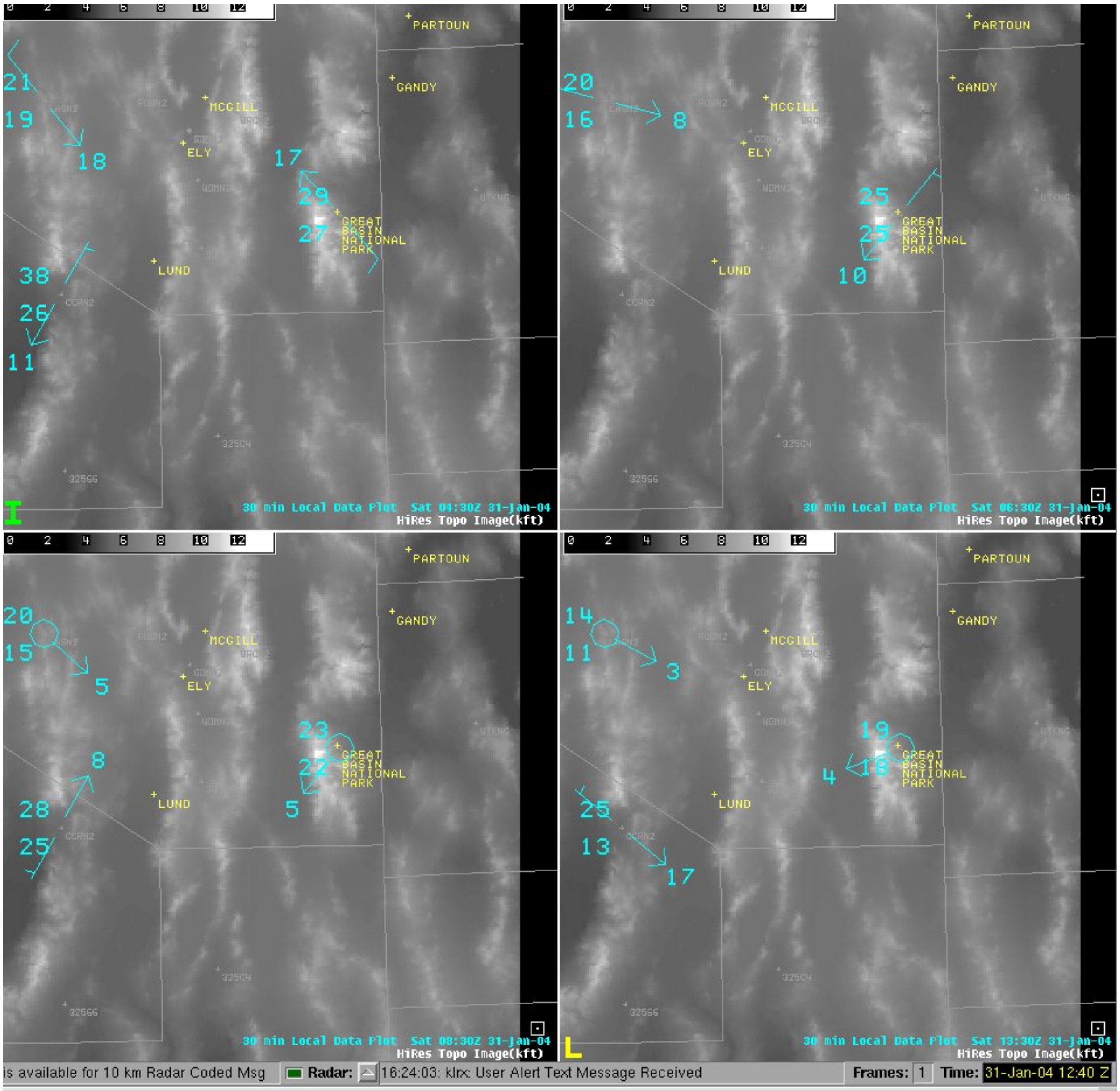

Fig. 5. Local data plot of hourly RAWS surface observations overlayed on terrain map from 0430 UTC to 1330 UTC, 31 January, 2004.