A WES Case Study of a Flash Flood Event in Elko County, Nevada, August 2, 2003

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Introduction

On Saturday, August 2, 2003, Elko County, Nevada experienced a flash flood event which produced nearly an inch of rain in less than one hour. Several forest roads in Elko County were washed out and numerous mudslides were reported. This event was not typical of the normal dry microburst pattern in the Great Basin due to the saturated soil conditions from previous thunderstorms and a moist atmospheric environment. Thunderstorms had moved through Elko County earlier Saturday morning between 1700-1830 UTC, and some areas received 0.50 inches of rainfall. The use of the Weather Event Simulator in this case will help to improve the situational awareness of the forecast staff in flash flood events.

Synoptic and Mesoscale Overview

On 8/02/03, the 1200 UTC water vapor satellite loop and 500 mb GFS height contour analysis revealed several features ideal for a possible heavy rain event (Fig. 1) The first feature was an upper level ridge displaced just east of the four corners region. The second feature was a negatively tilted shortwave trough axis positioned along the California coast. Several embedded vorticity maxes were rotating around the base of the trough into Nevada with a noticeable dry intrusion from a jet max moving into southern Nevada from Arizona. These features were key in helping focus a long southeast moisture fetch into northern Nevada from a plume originating in Mexico. In addition, a small vorticity max was observed on the water vapor loop in Arizona at 0600 UTC moving along the western edge of the moisture plume toward northern Nevada.

Pre-Storm Environment

The 1200 UTC Skew T sounding for Elko, Nevada (KLKN) yielded a very high precipitable water value of 1.26 inches with initial CAPE values of 1744 J/kg and a Lifted Index of -3.9C (Fig. 2). With high moisture values and instability present, the next noticeable parameter was relatively weak southeast speed shear with 0-6km average wind speed of 16 knots. Wet bulb zero heights were also high with 15932 feet ASL. These pre-storm environmental parameters were important for diagnosing potential for heavy rain producing thunderstorms in the Elko County area.

By 1745 UTC, an initial area of convection had moved north through Elko county with the atmosphere remaining moist and unstable. Several rainfall reports of 0.3 to 0.5 inches were reported in areas south and west of Elko. The Eta Bufr analysis sounding for Elko at 1800 UTC indicated a continued trend toward a moist and unstable vertical profile with precipitable water values at 1.13 inches, CAPE at 1747 J/kg and a Lifted Index of -5.5C (Fig. 3). In addition, the wet bulb zero height remained above 15000 ft ASL, and the K-index was 34. The 0-6km average wind speed remained southeast at 15 knots to support a continued trend toward relatively weak moist flow.

GOES Sounder Images

In order to help verify the Skew T sounding trends, the GOES Derived Product Imager (DPI) images were examined at 2000 UTC, at the beginning of thunderstorm development in Elko County. First the GOES DPI Total Precipitable Water (TPW) image ending at 2001 UTC clearly showed TPW values above 1.10 inches over Elko County with a maximum of 1.29 inches just north of Elko (Fig. 4). A decreasing trend in PW values was also observed in Central Nevada with the dry intrusion from the jet max. Next, the GOES DPI Lifted Index image for 2101 UTC, one hour into the thunderstorm event, indicated a maximum of -7.2C just west of Elko (Fig. 5). This image supported a continuing atmospheric profile of high instability to complement the moist atmosphere.

Thunderstorm Development

At 2000 UTC, convection had rapidly developed. The first area of thunderstorms with heavy rain moved across the Elko area by 2030 UTC. At 2100 UTC, a second line of thunderstorms rapidly developed as the approaching 60kt jet max moved into Elko County, shown by the Eta40 300 mb windspeed (Fig. 6). The second line of thunderstorms moved directly across the city of Elko at 2143 UTC, as shown by the 55-60dbz reflectivity cores from the KLRX WSR-88D image (Fig. 7). This prompted a Flash Flood Warning to be issued by WFO Elko, NV valid until 2315 UTC for central Elko County. By 2220 UTC, a third area of thunderstorms moved north across the same area, contributing to additional flash flooding in areas north and directly west of Elko. The KLRX WSR-88D image of one-hour precipitation (OHP) showed a well defined heavy precipitation band of 0.8 to 1.0 inch from 2123 to 2223 UTC (Fig. 8). Storm total amounts of 1.6 to 1.8 inches were common within the area just west and north of Elko.

Discussion and Conclusion

Elko County officials received numerous reports of washed out streets and county roads in Elko and areas north and west after 2200 UTC. Both lanes of Interstate 80 were closed for over one hour nine miles west of Elko due to water running across the highway. Also, State Route 225 (Mountain City Highway) north of Elko was closed due to mudslides below Adobe Summit (6549 ft msl). A large culvert on North 5th Street in Elko had also overflowed, causing damage to the street.

The Weather Event Simulator proved to be a valuable tool for the forecast staff to enhance pattern recognition skills, and more importantly, improve situational awareness in flash flood scenarios. Flash flooding during the Great Basin Monsoon season is not as common as Dry Microburst wind events, but it is equally important in the complex terrain of Northeast Nevada. One goal of the WES convective scenarios was to ensure that all available AWIPS datasets were used to accurately assess severe weather potential. The GOES DPI Sounder images and ETA hourly Bufr soundings did prove to be valuable tools in assessing the proper storm environment for instability and moisture in a flash flood situation. These products helped the forecast staff to utilize near real-time satellite data to enhance the warning decision making process and support the morning KLKN sounding data. Also, the staff learned that very small details, such as minor voriticity maxes embedded in the moist flow, are important trigger mechanisms for summer convection and should not be overlooked.

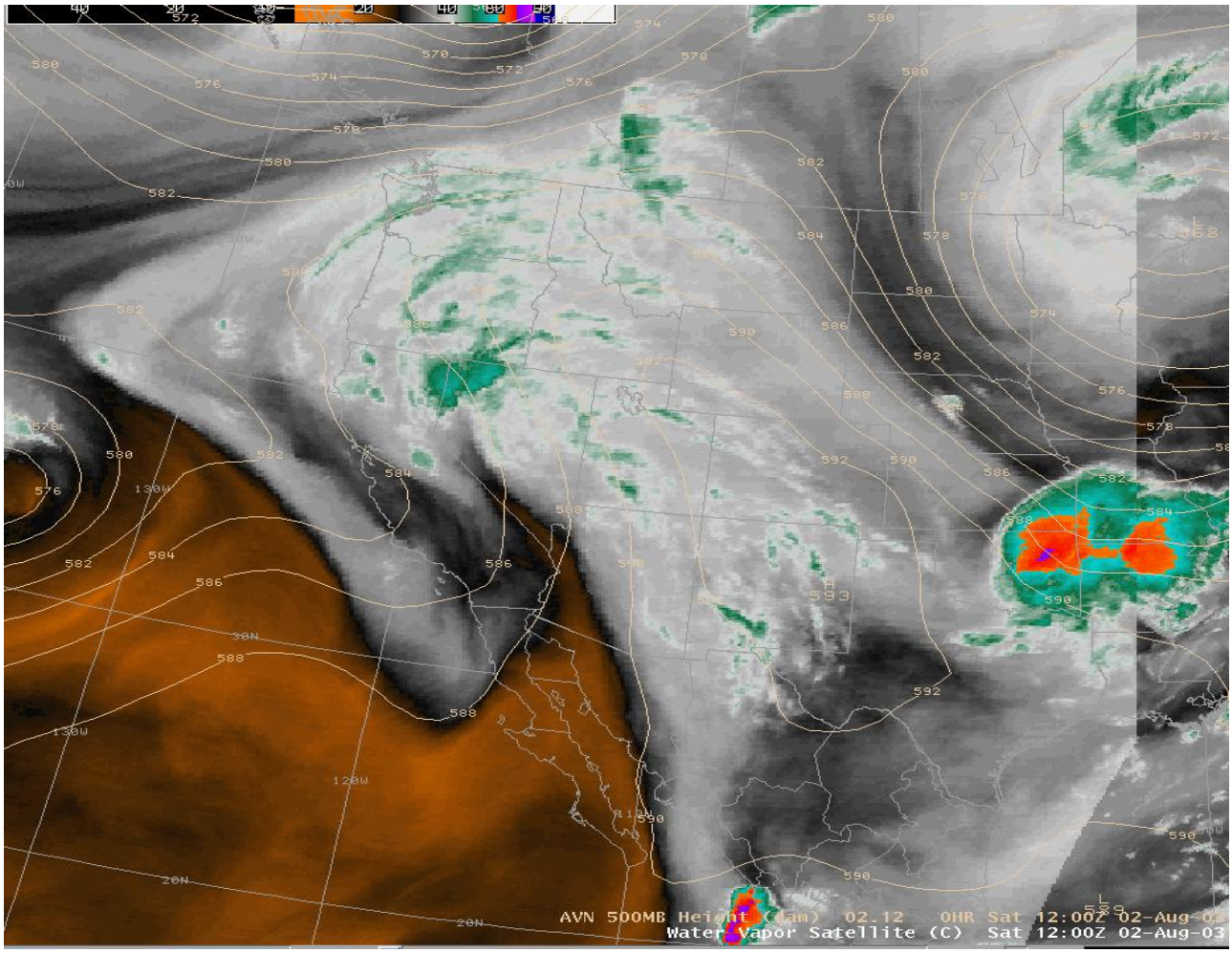

Fig. 1. 1200 UTC water vapor satellite image overlaid with GFS (AVN) 500mb height contours showing main synoptic and mesoscale features.

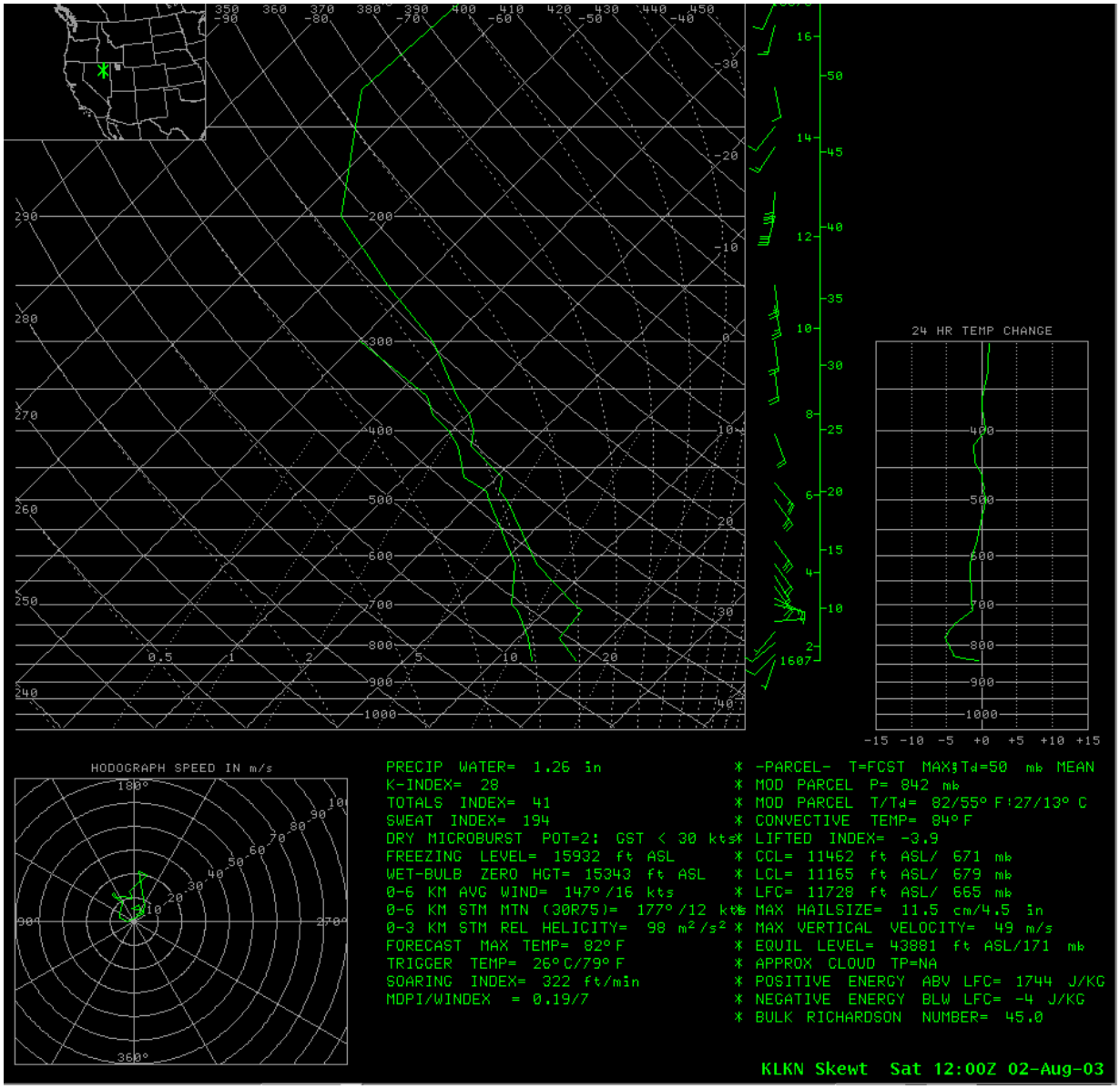

Fig. 2. 1200 UTC KLKN Skew T sounding showing initial moisture, instability and wind shear profile for Elko, Nevada.

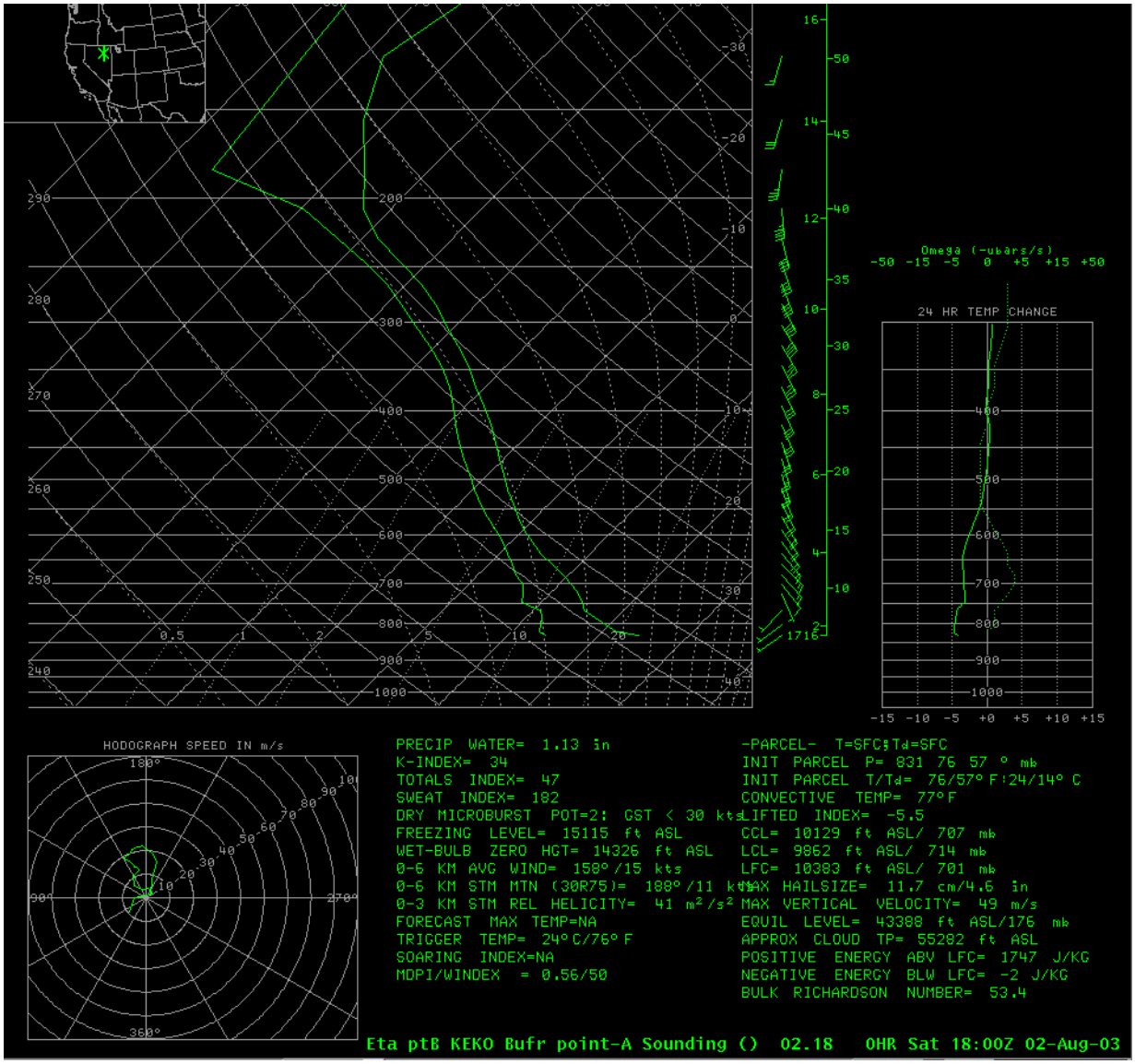

Fig. 3. 1800 UTC Eta Bufr sounding showing continuing trend toward moist and unstable environmental profile with relatively weak shear.

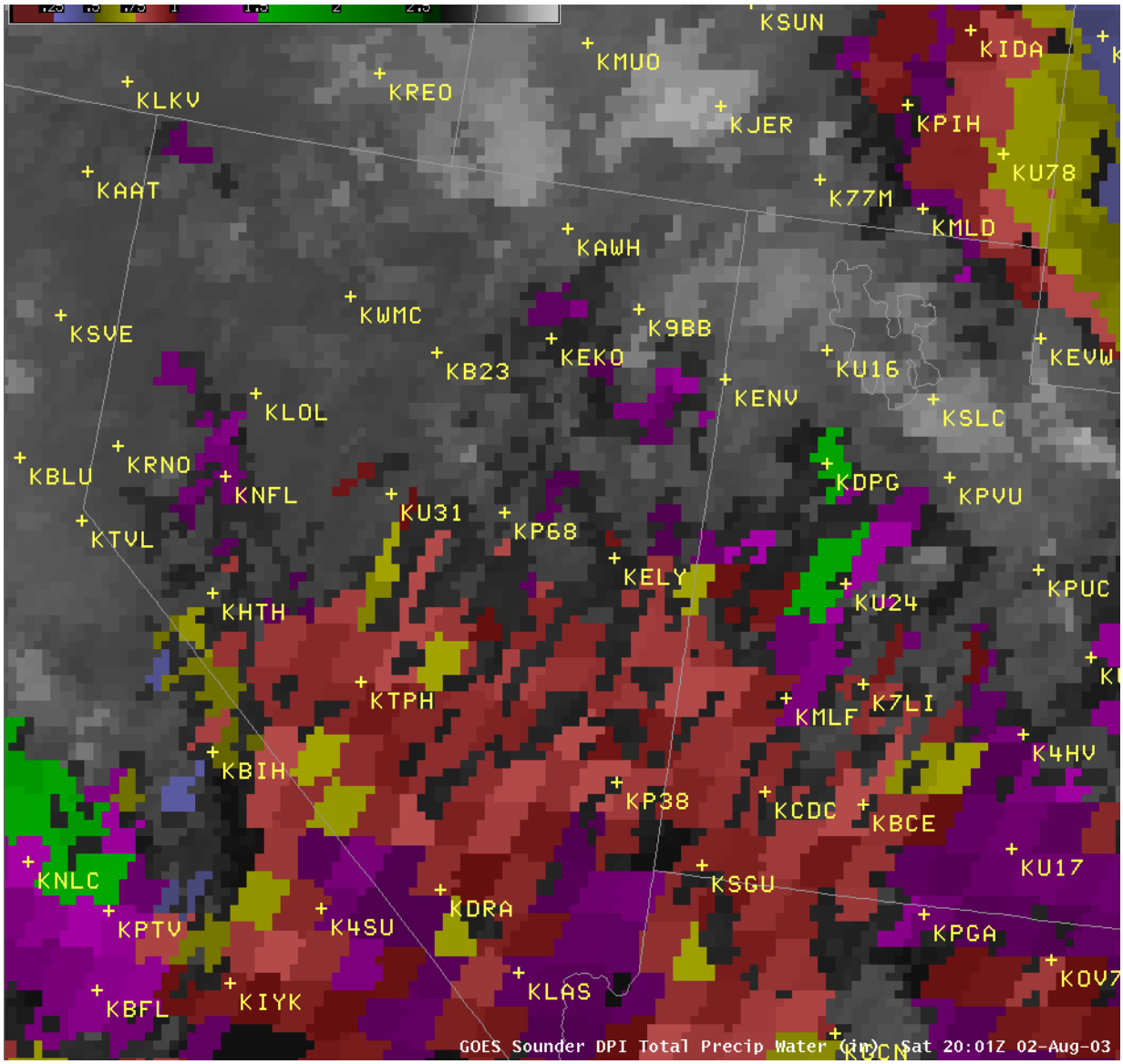

Fig. 4. 2001 UTC GOES Sounder Derived Product Imagery (DPI) showing higher precipitable water values over Elko County and decreasing values south.

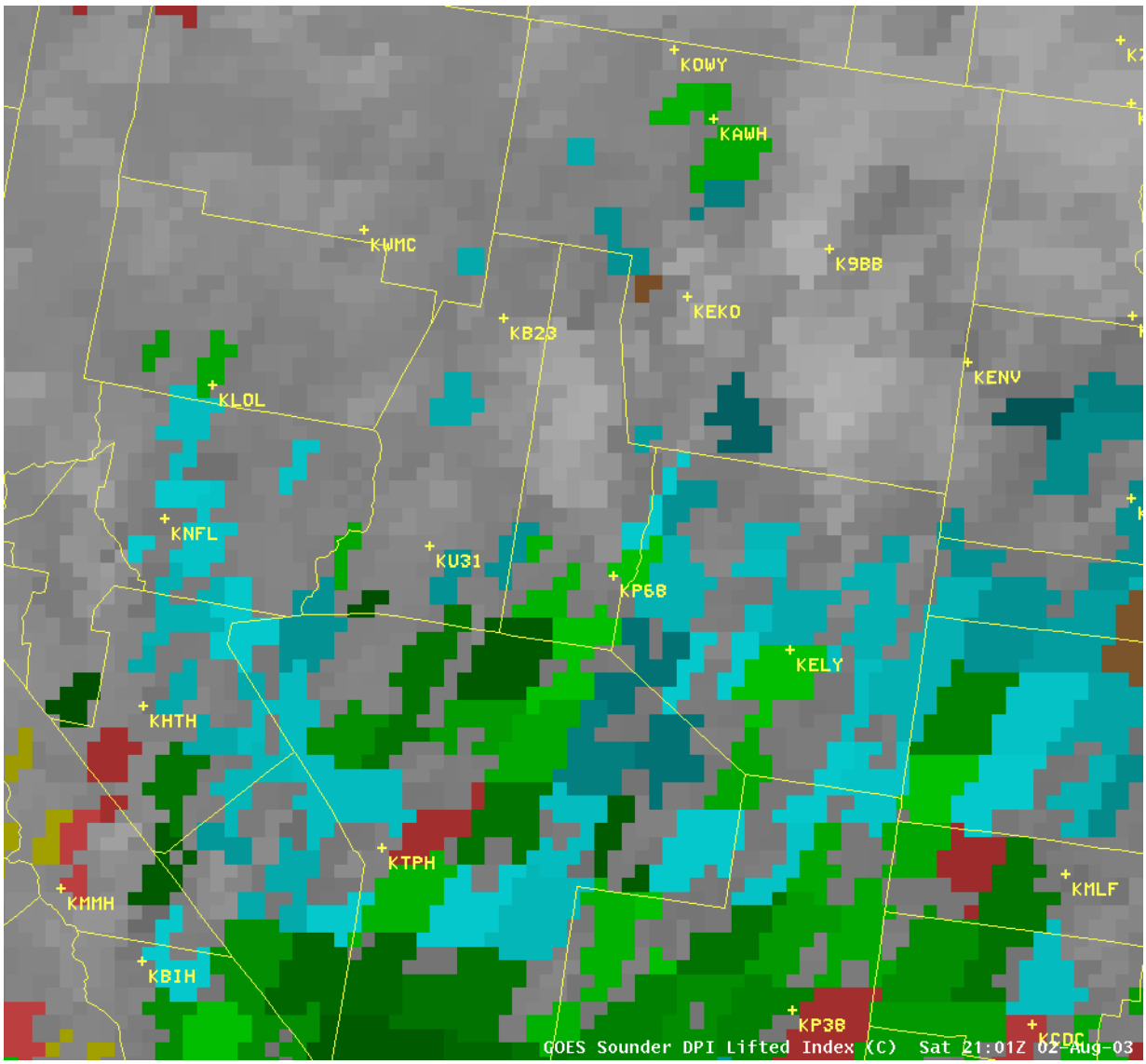

Fig. 5. 2101 UTC GOES Sounder Derived Product Imagery (DPI) showing high Lifted Index values over Elko County during the thunderstorm development.

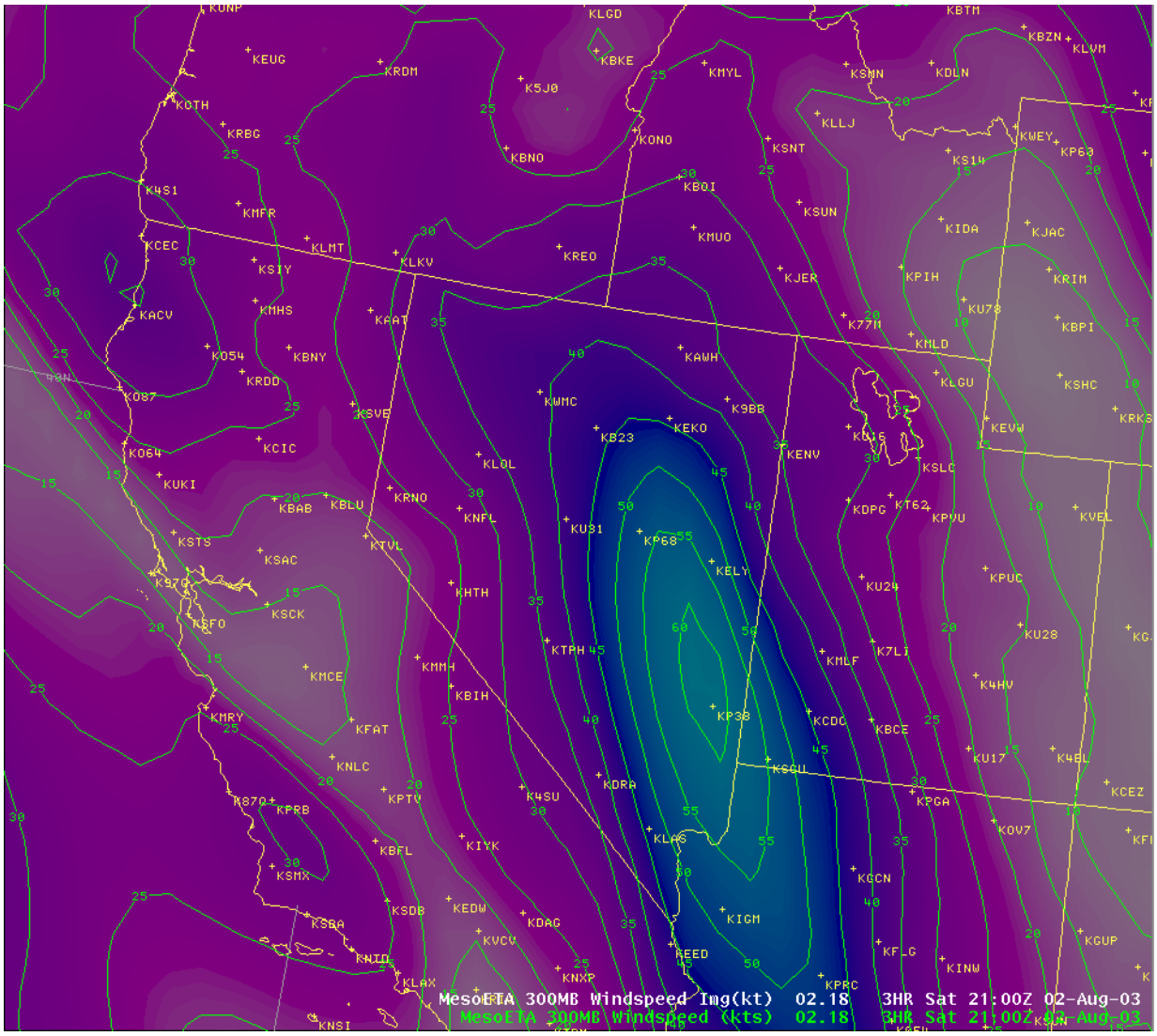

Fig. 6. 2100 UTC ETA40 (MesoEta) forecast of 300mb jet max moving from Central Nevada into Elko County during thunderstorm development.

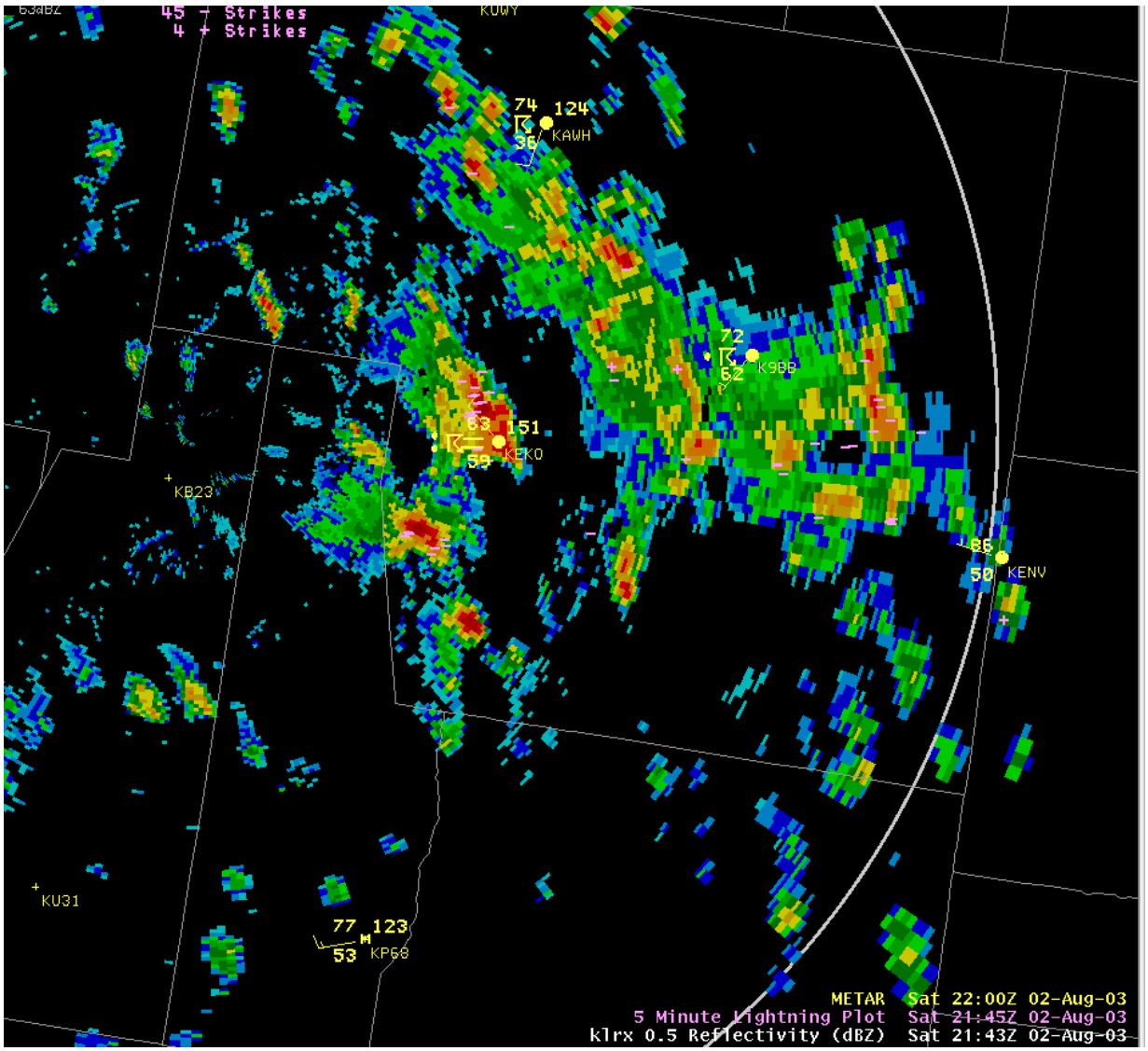

Fig. 7. 2143 UTC KLRX WSR-88D 0.5 degree reflectivity image showing intense 55-60dbz echoes over Elko, Nevada and just to the southwest.

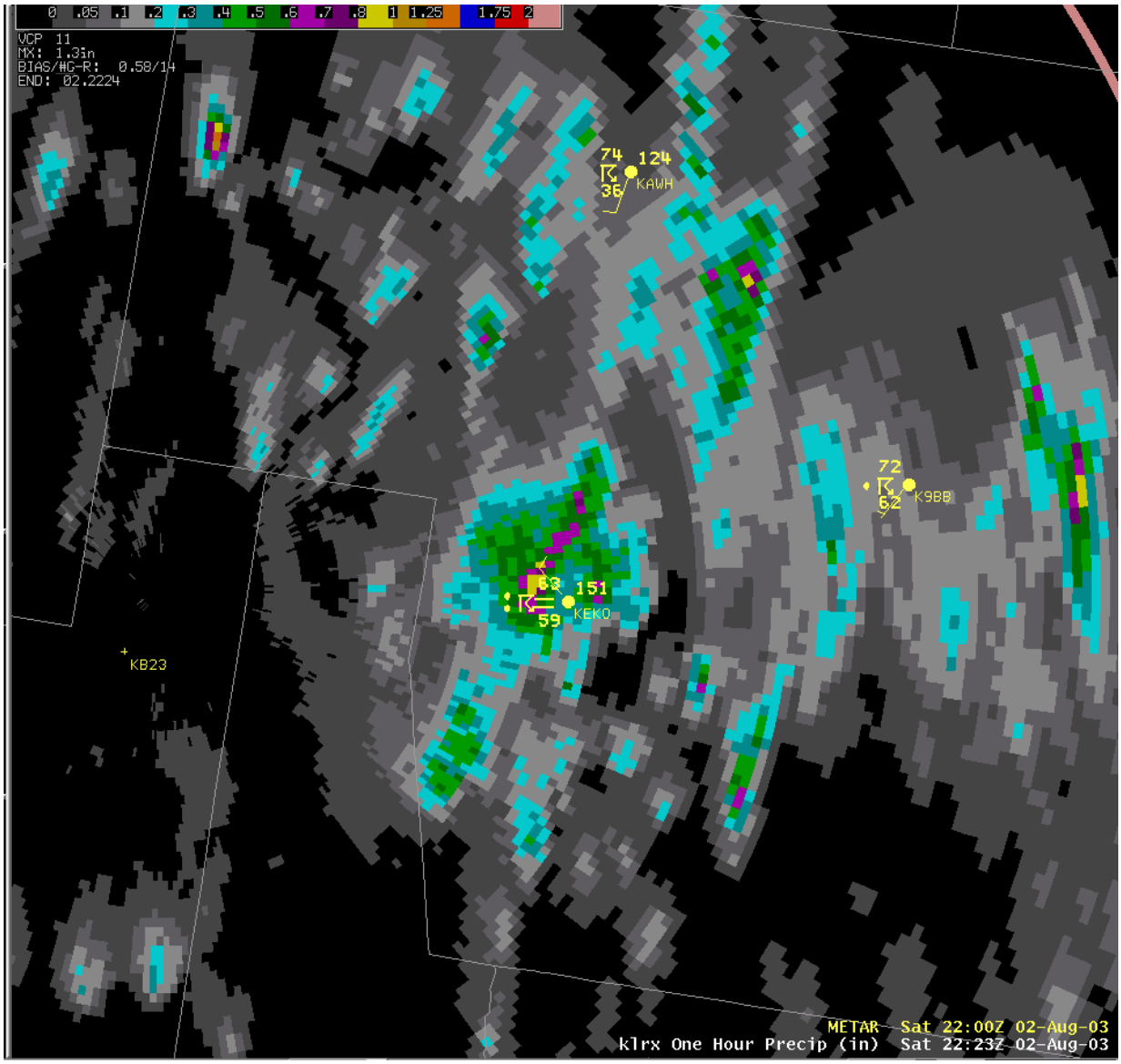

Fig. 8. 2223 UTC KLRX WSR-88D One Hour Precipitation (OHP) image showing 0.8 to 1.0 inch rainfall amounts west and north of Elko, Nevada.