JP7J.3 **THE 29-30 JANUARY 2005 SOUTHEAST COLORADO SNOWSTORM**

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1. INTRODUCTION

On 29-30 January 2005, a snowstorm struck portions of southeast Colorado with storm total precipitation (figure 1) approaching 100 mm and snowfall totals approaching 85 cm. (Many of the precipitation totals in figure 1 are from CoCoRaHS, which is a network of volunteer precipitation, snowfall, and hail observers. Much more information is available at their website, http://www.cocorahs.org). The heavy precipitation occurred along the east slopes of the Wet Mountains, Spanish Peaks and portions of the southern "Interstate 25 corridor". Heavy snowfall with large water equivalents is not unprecedented in these areas. What makes this event unusual is 1) it occurred during the winter season when snowstorms (and precipitation totals) of this magnitude are rare, and 2) this event had very modest "orographic forcing" (lower tropospheric flow perpendicular to a nearby mountain barrier).

The storm total precipitation at Walsenburg, Colorado indicates the rarity of this event. Walsenburg is an NWS COOP site with observations starting in 1934. This storm has the second largest 3 day precipitation total for the period 1 November to 29 February at Walsenburg since 1934. In addition, the storm total precipitation is about 75% of the average precipitation for the months of November, December, January and February combined. At other COOP sites in this region, the storm ranked as one of the wettest for the months of November through February.

2. SYNOPTC SITUATION

At 0000 UTC 30 January 2005, a 50 hPa low was located over central Arizona (figure 2). During the next 24 hours (see Figure 3) the 50 hPa low slowly moved east reaching east central New Mexico by 0000 UTC 31 January 2005. Heavy precipitation started around 2200 UTC 29 January over portions of the area. At this time, the rapid development of cold topped clouds was evident on the IR satellite image coincident with the locations of heavy precipitation. Cloud top temperatures were near the tropopause temperature. At 70 hPa, the winds at 0000 UTC 30 January (figure 4) were generally from the southeast at around 7.5 ms^{-1}. The winds remained generally at this speed and direction until around 1200 UTC (figure 5), then they gradually backed to the northeast by 2000 UTC 30 January. The winds at 0000 UTC 31 January (figure 6) are similar to the 2000 UTC winds.

The Pueblo radar image, as well as spotter reports, indicated heavy snowfall along the east slopes of the Wet Mountains from 0000 UTC through at least 1400 UTC 30 January 2005. During this period, the winds at 70 hPa and below were from the southeast. Typically, heavy snow along the east slopes of the Wet Mountains is associated with lower troposphere winds from the east to northeast, which is perpendicular to the mountain range.

Since orographic induced lift can not easily explain the heavy snowfall and precipitation at many locations, various fields were examined to try to determine the important factors for the unseasonably heavy precipitation. The surface observations at 0000 UTC 30 January (figure 7) show east to southeast flow at the surface over much of the southeast plains of Colorado. The dew point at Pueblo (KPUB) was around 2-3°C (35 -37°F) from 1800 29 January through 0000 UTC 30 January. These dew points were the highest observed during the month of January at Pueblo from 1997 to 2005. Observations from various mesonets show that the unusually moist low level air was present throughout the east slopes of the eastern mountains and along the southern Interstate 25 corridor.

Another feature of this storm, related to the low level moisture, was the atmospheric stability profile. The RUC sounding for Pueblo at 0000 UTC 30 January (Figure 8) shows the atmosphere was moist throughout the entire troposphere. Lapse rates were relatively steep with 50 hPa to 70 hPa lapse rate of over 7Ckm^{-1}. From 70 hPa to the tropopause (around 35 hPa) the lapse rate was close to the moist adiabatic. The RUC sounding with a surface temperature of 6°C and dew point 3°C (44°F and 37°F, respectively) had convective available potential energy around 400 Jkg^{-1}. The vertical wind profile had east to southeast flow below 70 hPa, and the veering of wind with height suggested warm air advection. Examination of isentropic charts showed very modest isentropic upglide with less upglide on equivalent potential temperature surfaces.

Many upper level fields were examined to identify physical processes to produce synoptic scale lift. From 0000 UTC to 1200 UTC 30 January, a good match was found between the 40 hPa deformation from the RUC initial fields and the colder cloud tops. Figure 9 shows a plot of the 40 hPa deformation and IR image for 0300 UTC 30 January. The colder cloud tops were in a ridge of higher deformation with the ridge of higher deformation extending to the north and west through 1200 UTC. Further evidence of the deformation was seen when the IR images were looped. Over eastern Colorado, the cloud elements were moving toward the

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east while over central Colorado the cloud elements were moving toward the northwest.

It appears that instability played an important role in producing unseasonably high precipitation totals. It is hypothesized that the area of deformation (and likely divergence) aligned over a region of instability. The instability helped produce the deep cloud layer and heavy precipitation. The easterly component upslope flow allowed for the continued advection of the low level moisture into the east slopes of the mountains and Interstate 25 corridor. Orography likely played a role in allowing the moisture to remain pooled along the east slopes of the mountains.

3. NCEP NUMERICAL GUIDANCE

Figure 10 shows the storm total precipitation from the 1200 UTC 29 January 2005 ETA (now called NAM) run and Figure 11 shows the same for the 1800 UTC 29 January 2005 ETA run. The numerical guidance significantly underestimated the total precipitation for this event especially east of the Wet Mountains. The ETA and other models did not identify the heavy snowfall early in the event resulting from the deformation and instability. The ETA did identify some of the orographic precipitation associated with the southeast flow turning to northeast flow later in the event. The 1800 UTC 29 January 2005 ETA run had more precipitation than the 1200 UTC run, which is a trend in the right direction. However, our office (and others) has the impression that the 1800 UTC ETA runs tend to forecast more precipitation than the 1200 UTC runs. The increased precipitation in the 1800 UTC does not often trend the precipitation amounts in the right direction.

4. WSR 88D SNOWFALL ARGORITHM

The 88D snowfall algorithm output has not been received by the due date for the extended abstract. The snowfall algorithm evaluation will appear in the poster.

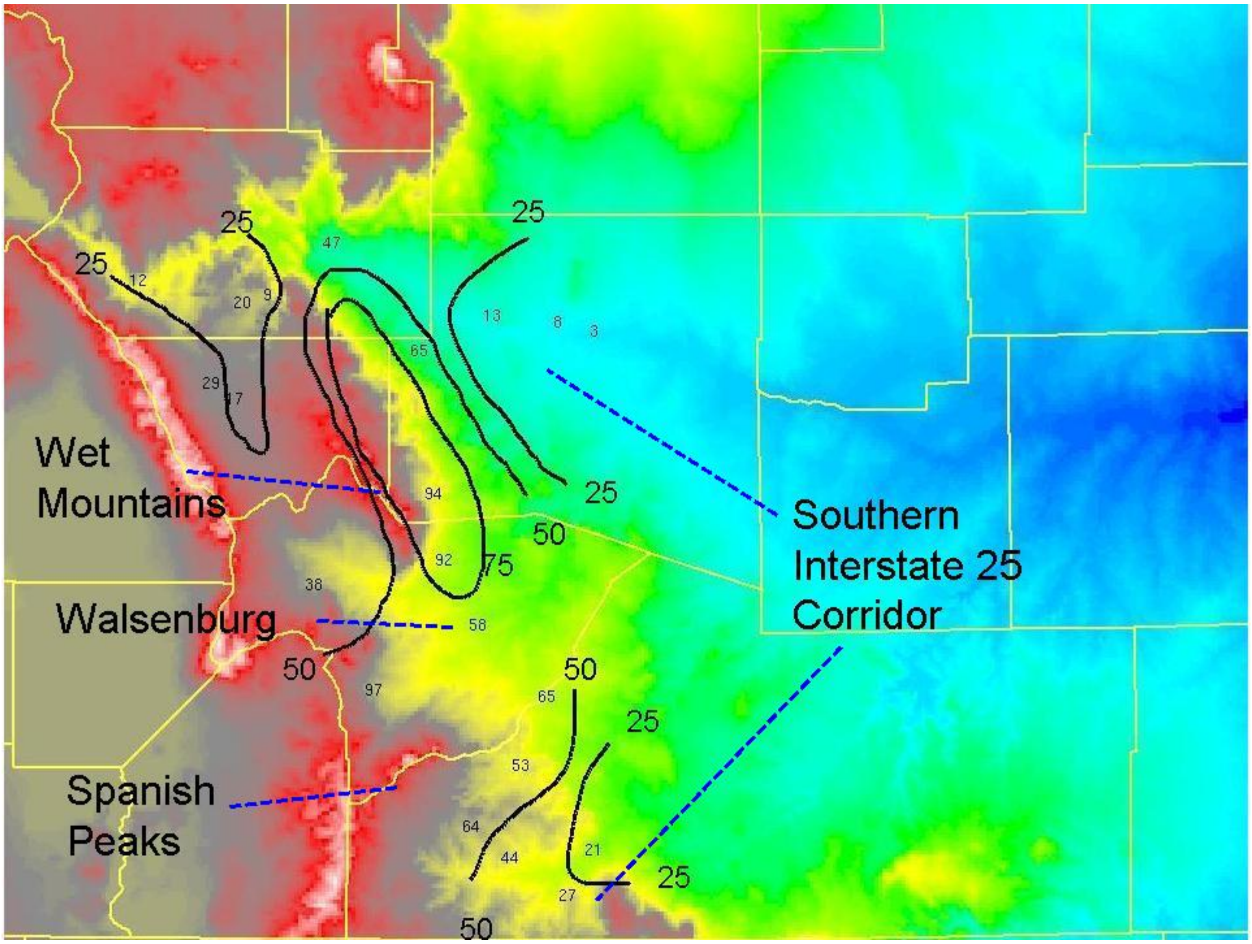

Figure 1. Storm total precipitation (mm). The observations are from NWS COOP sites and CoCoRaHS observers. Background is topography of the region. See figure 4 for elevation key.

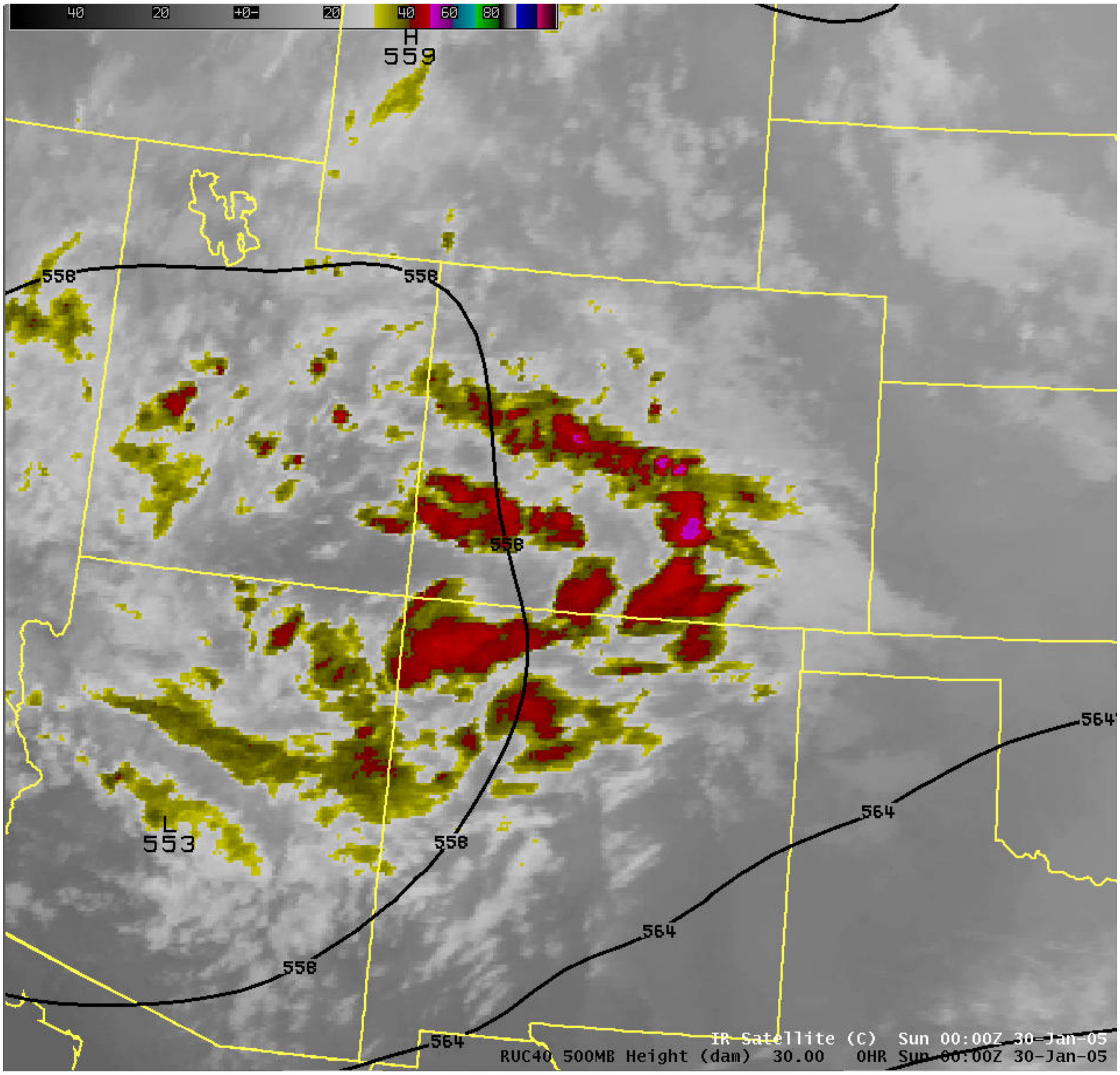

Figure 2. 50hPa height (dm) and IR image at 0000 UTC 30 January 2005

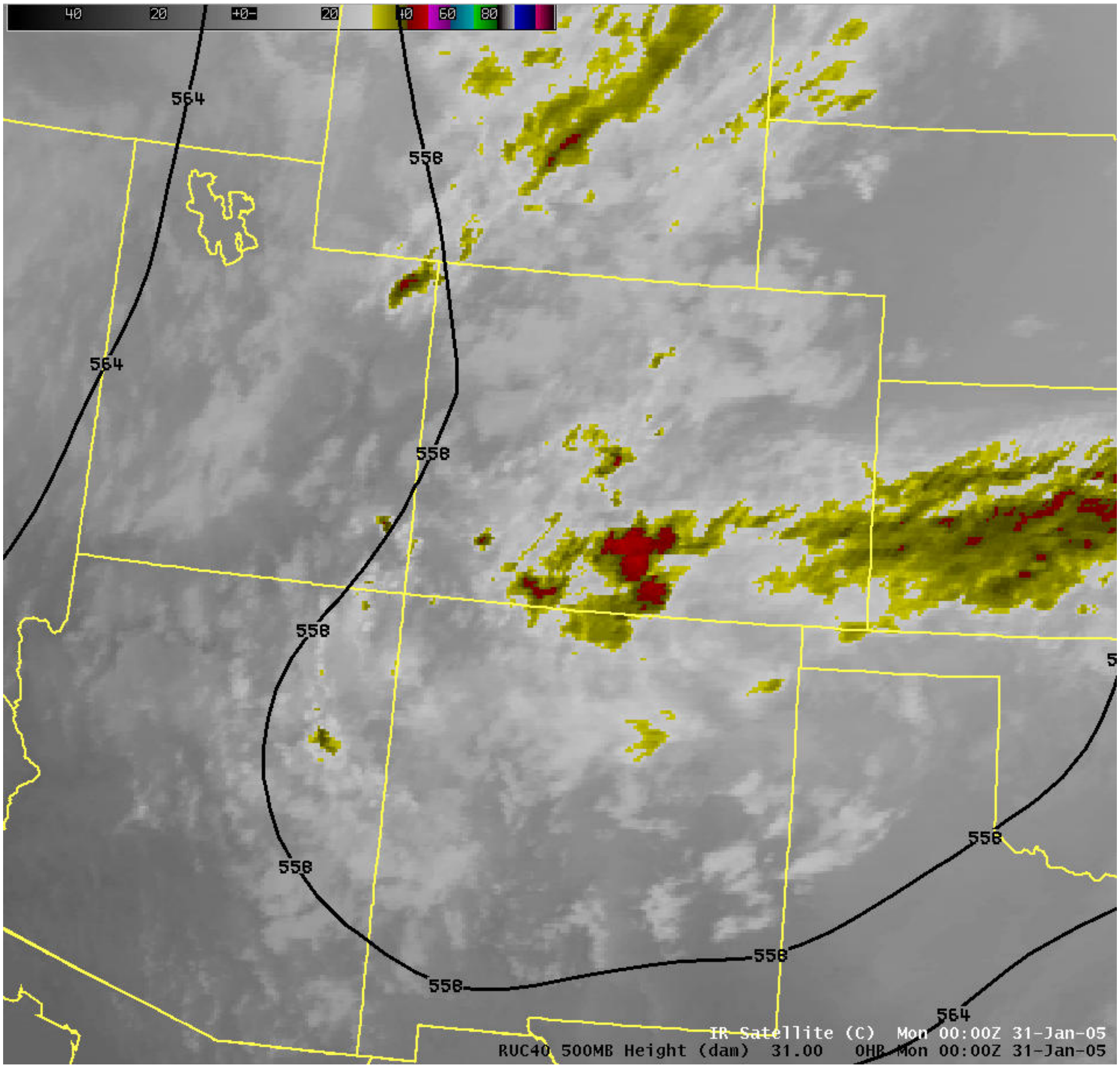

Figure 3. 50hPa height (dm) and IR image at 0000 UTC 31 January 2005

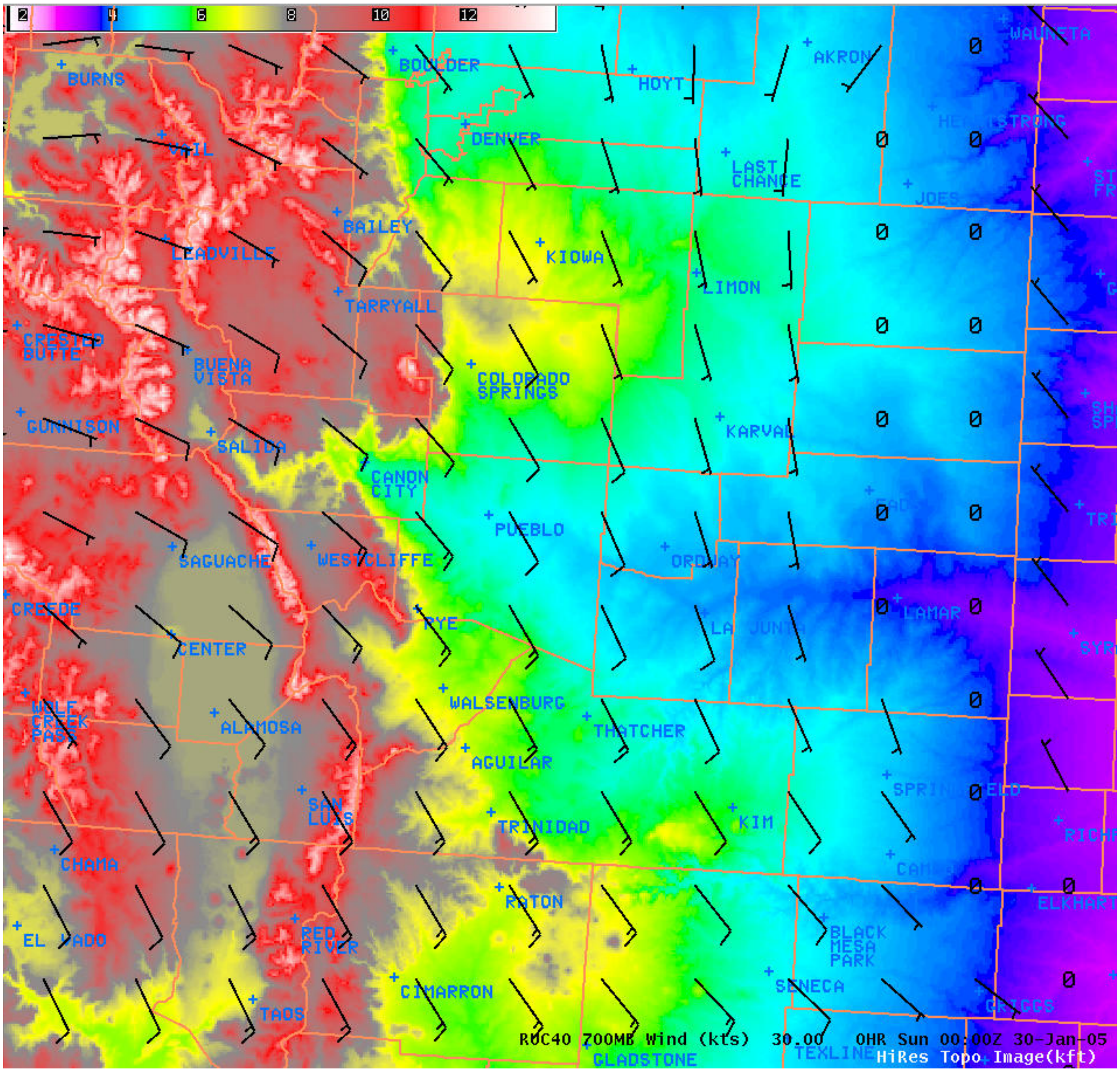

Figure 4. 70 hPa winds at 0000 UTC 30 January 2005. Key lists colors for elevation in thousands of feet.
4000 feet = 1.22km, 6000 feet = 1.83km, 8000 feet = 2.44km, 10000 feet = 3.05km, 12000 feet = 3.66km
For winds, a full barb = $5 ms^{-1}$ and half barb = $2.5 ms^{-1}$.

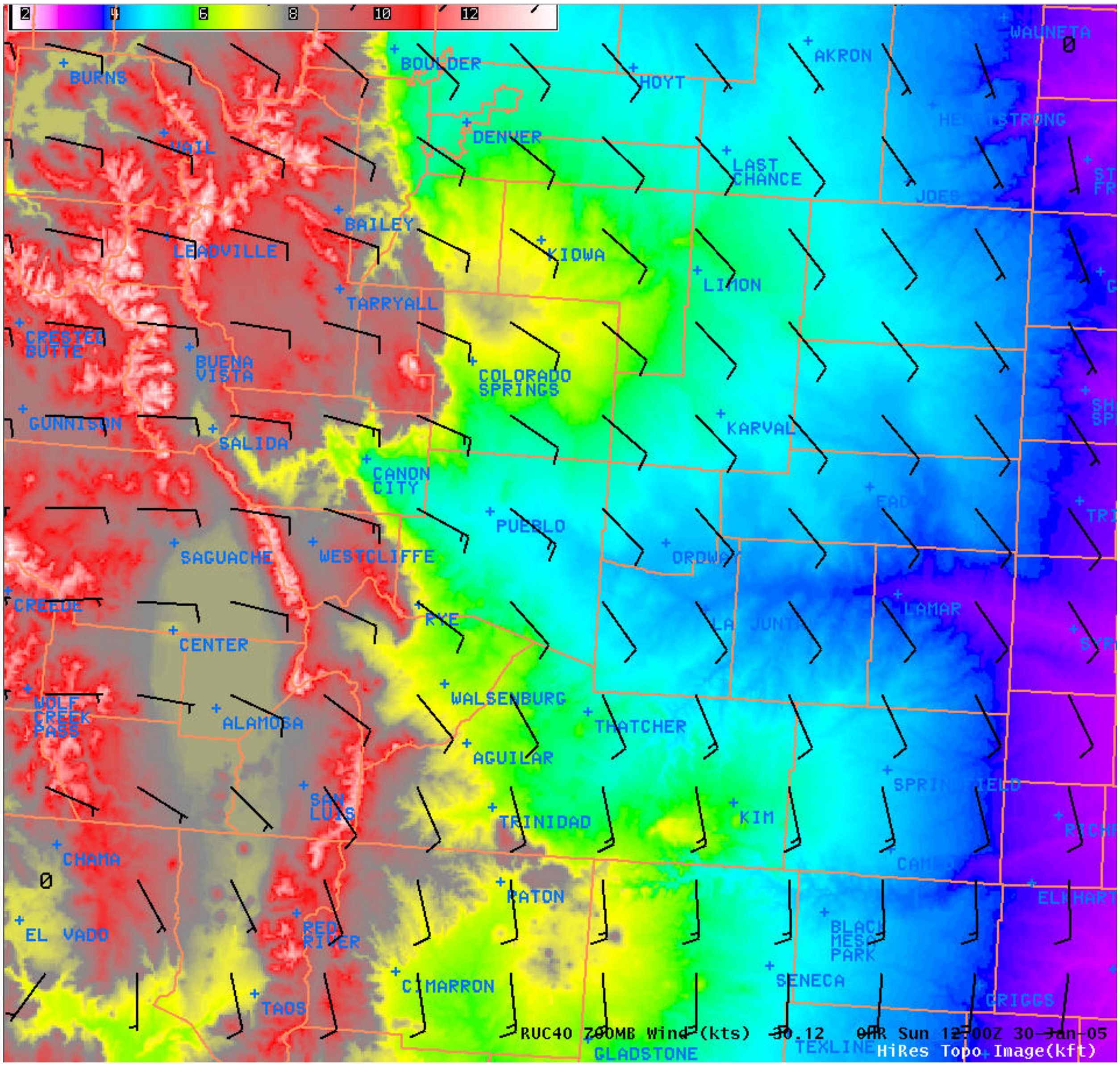

Figure 5. Same as figure 4 but for 1200 UTC 30 January 2005.

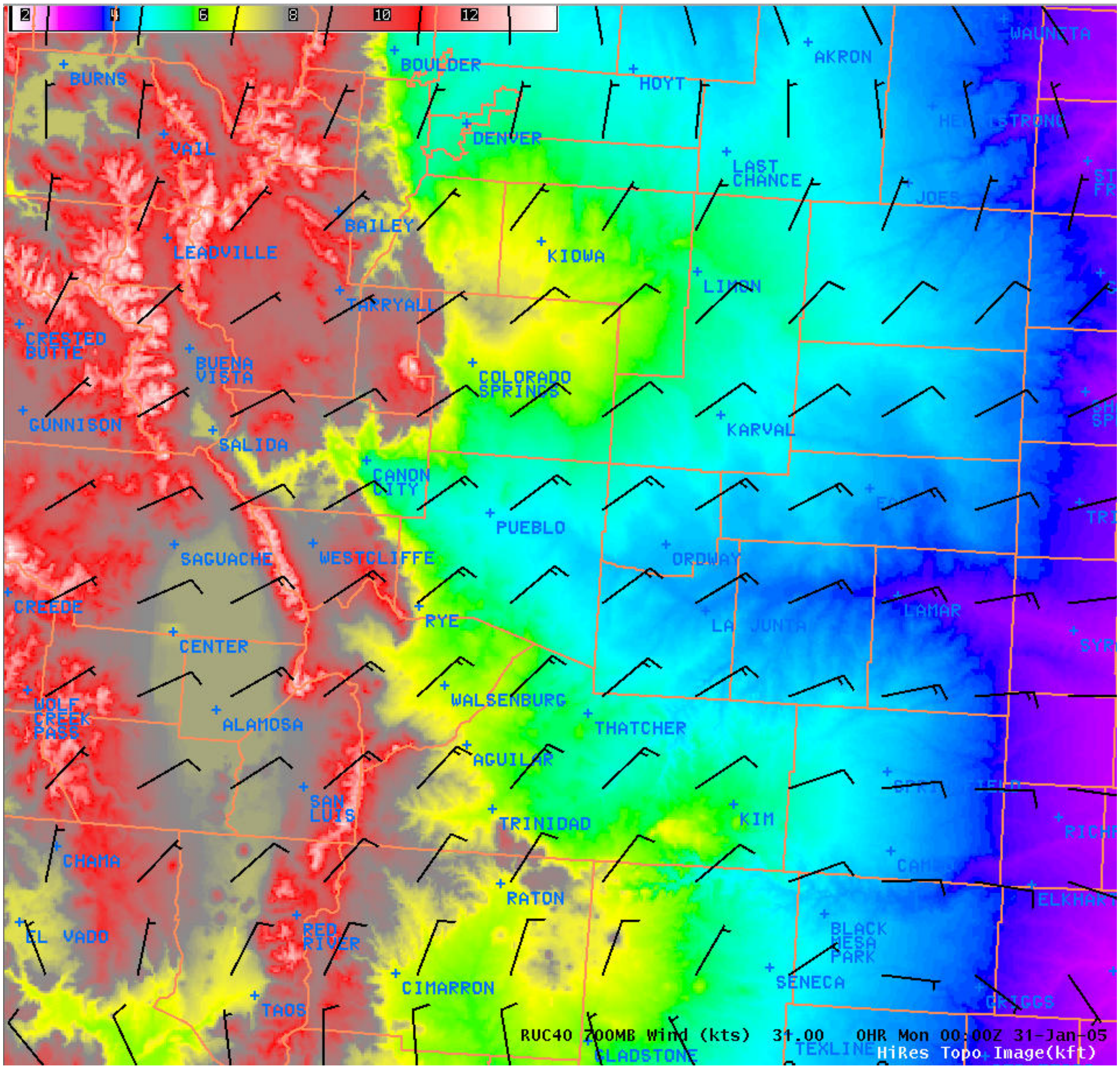

Figure 6. Same as figure 4 but for 0000 UTC 31 January 2005.

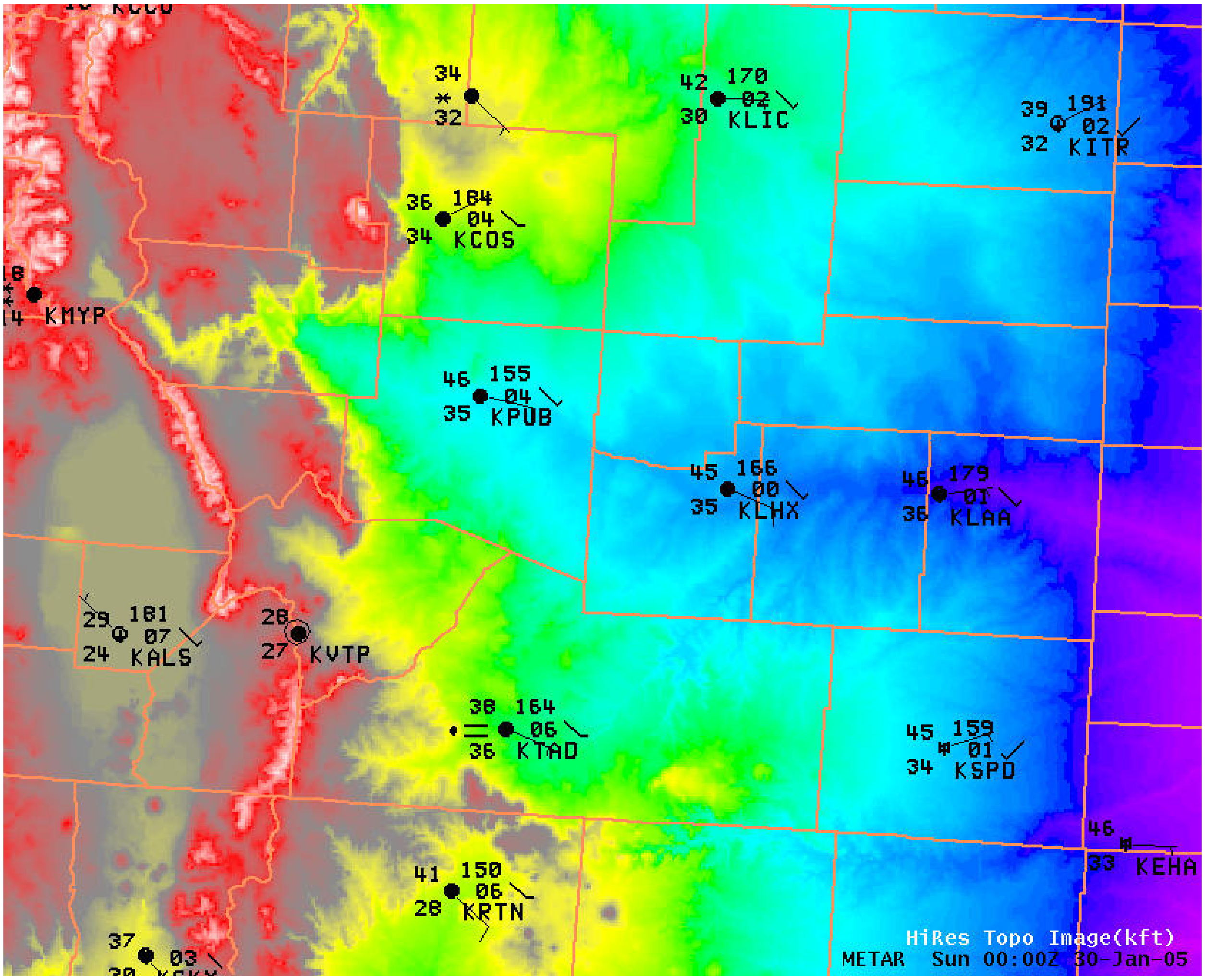

Figure 7. Surface observations at 0000 UTC 30 January 2005. Temperature and dew points are in °F. A full wind barb = 5ms^{-1} and a half wind barb = 2.5ms^{-1}. Background color is elevation and see figure 4 for the key.

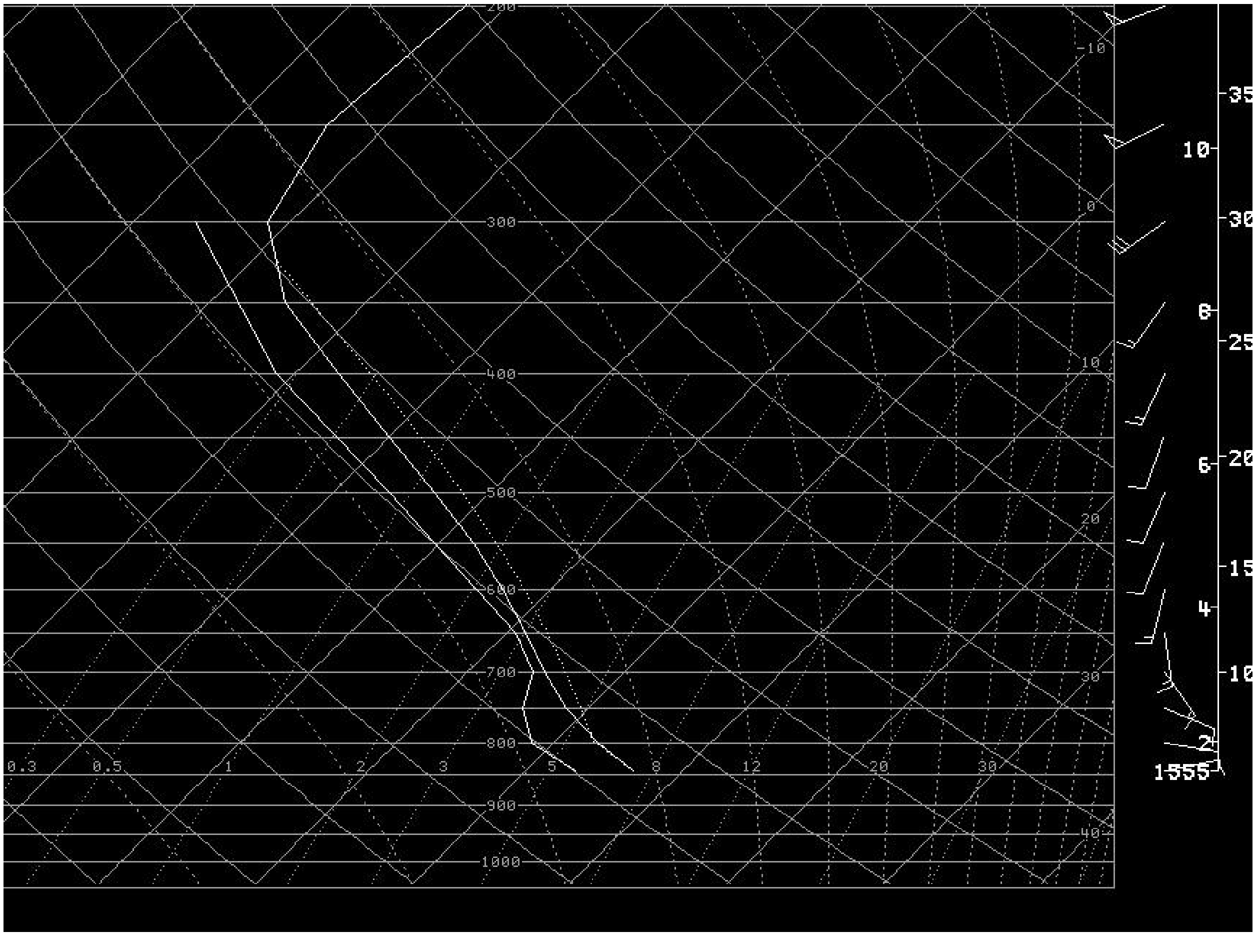

Figure 8. Skew-T diagram for Pueblo, CO at 0000 UTC 30 January 2005 from RUC initial field.

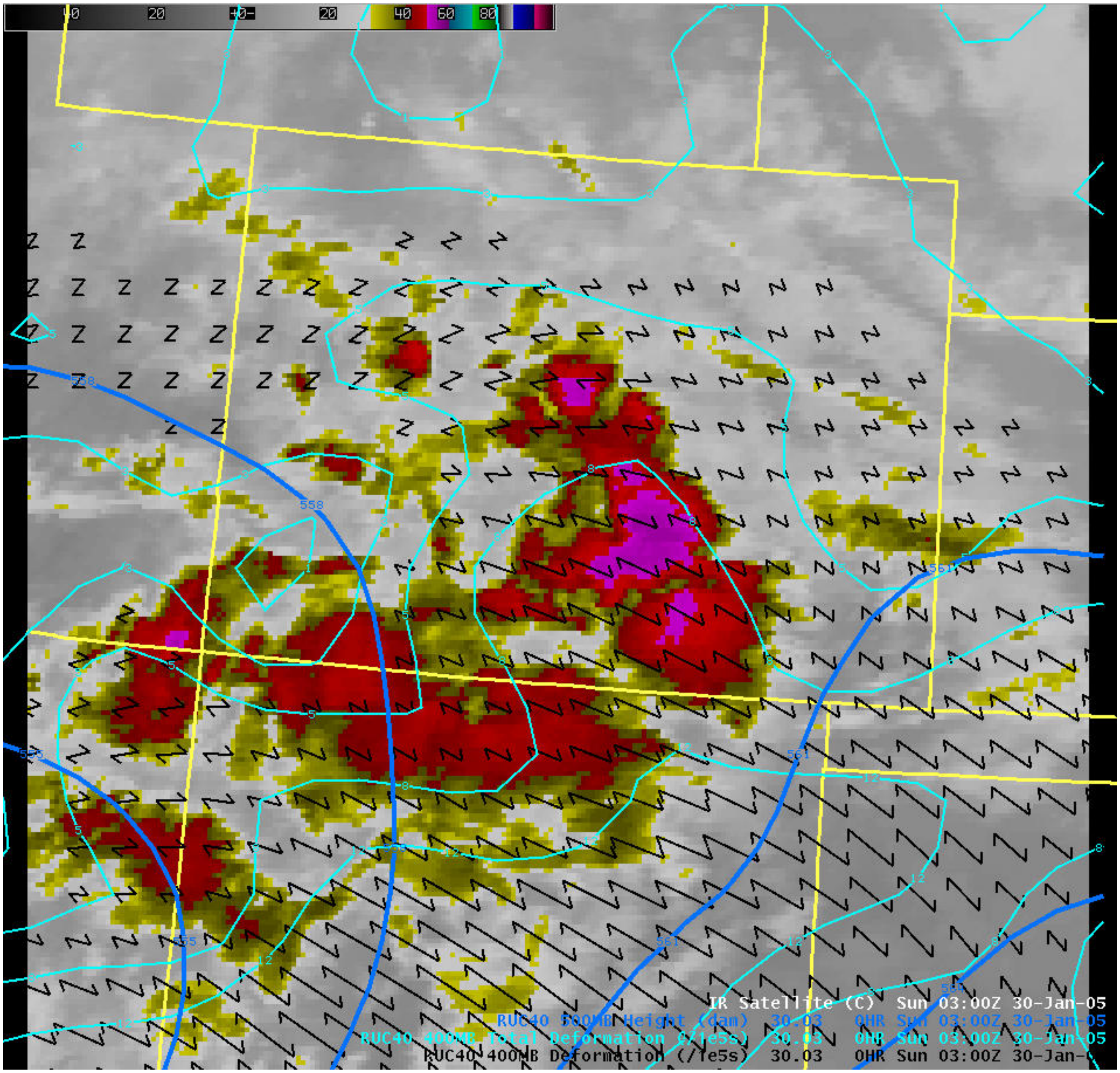

Figure 9. 50 hPa height (dm) (dark blue), 40 hPa deformation vectors (black), 40 hPa total deformation (10^{-5}s) (light blue) and IR image for 0300 UTC 30 January 2005.

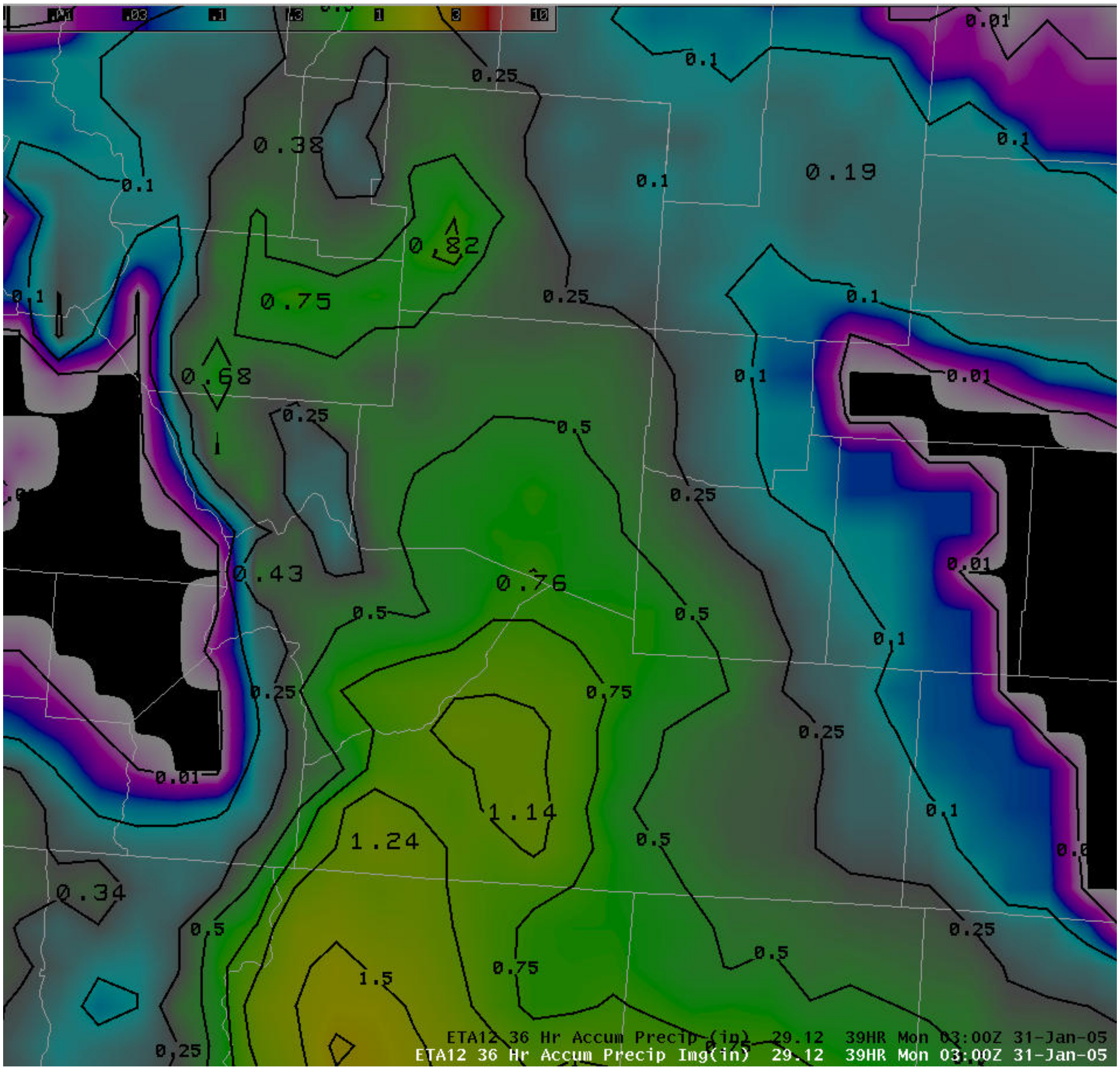

Figure 10. Storm total precipitation forecast from the 1200 UTC 29 January ETA (now called NAM). Totals are in inches. 1inch = 25.4mm.

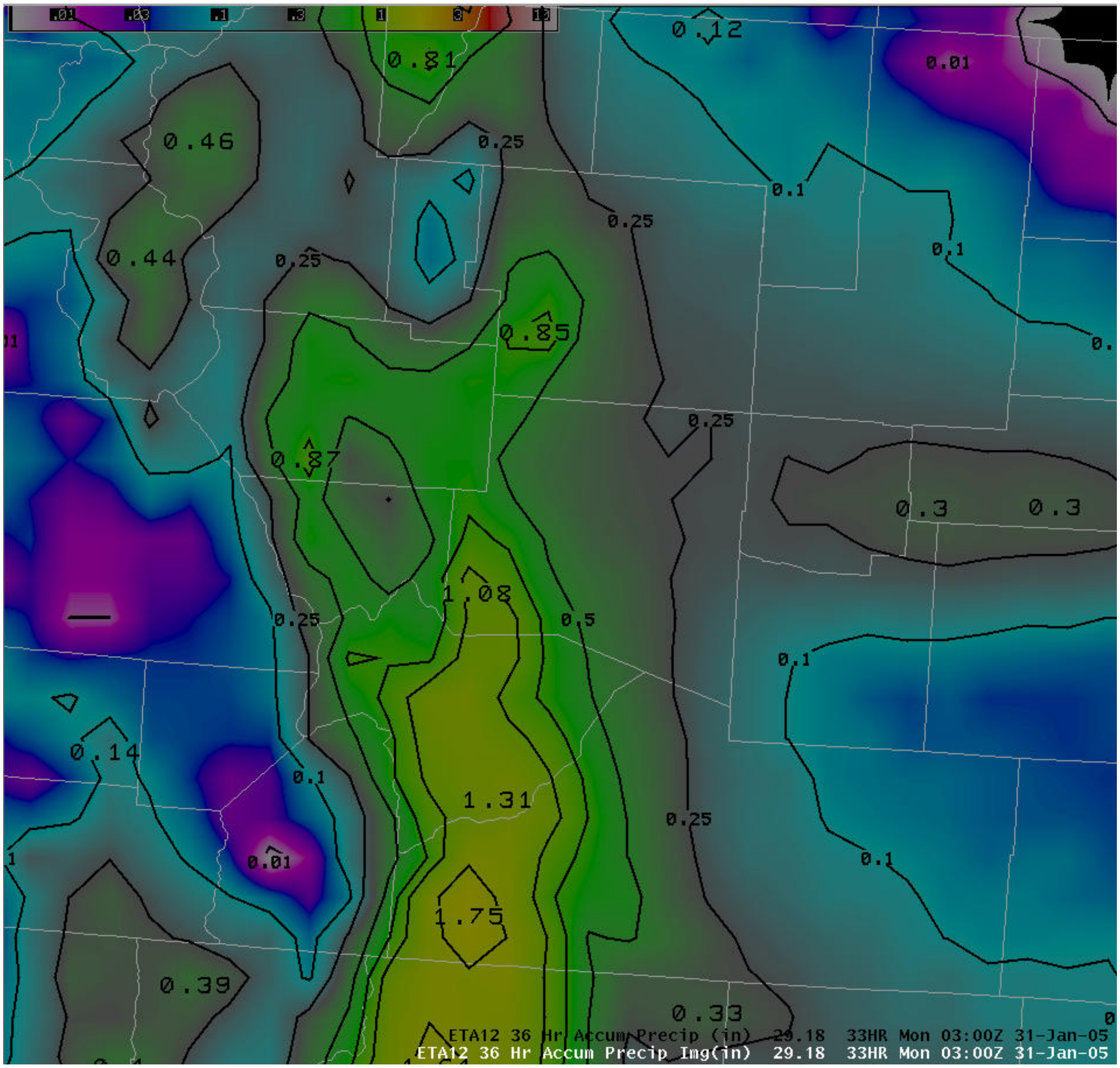

Figure 11. Storm total precipitation forecast from the 1800 UTC 29 January ETA (now called NAM). Totals are in inches. 1inch = 25.4mm.