Severe microburst event in Utah

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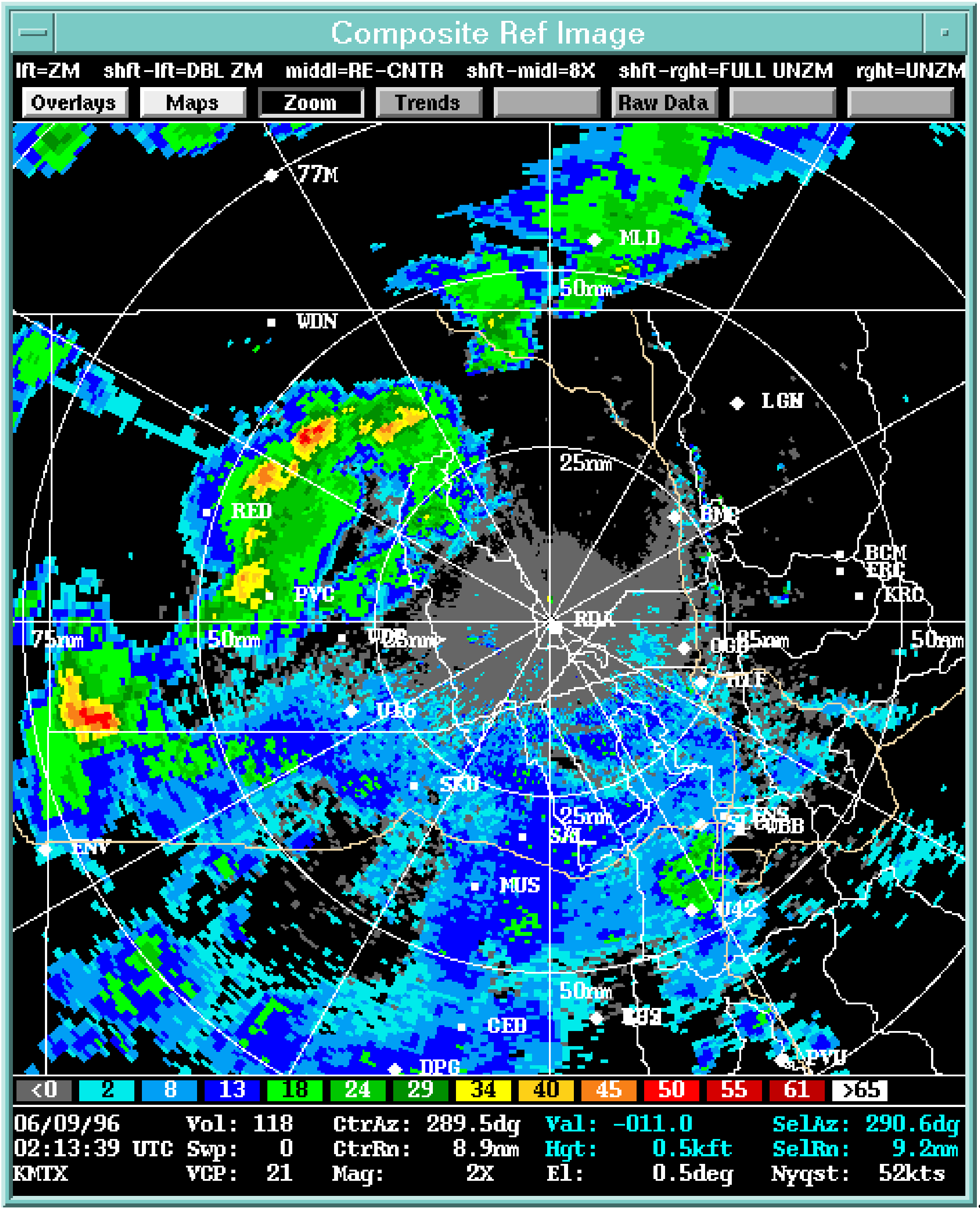
1. Introduction

On 8 June 1996 (LT), microbursts produced several areas of surface winds greater than 50 kts in the Salt Lake City (SLC) area. These storms were much weaker-appearing on radar compared to a line of intense storms to the west. This paper documents the structure of those storms, as seen by the KMTX radar north of SLC. Implications for developmental algorithms (such as the new Damaging Downburst Prediction and Detection Algorithm (DDPDA) recently developed by the National Severe Storms Laboratory) are discussed.

2. Data

Composite reflectivity shows a band of strong storms to the west through north of the radar at 0213 UTC (Fig. 1). Damaging winds were associated with the weak echo southeast of the Great Salt Lake (~40 nm; range rings are every 25 nm) with reports beginning around 0230 UTC.

FIGURE 1. Composite reflectivity image at 0213 UTC on 9 June 1996.



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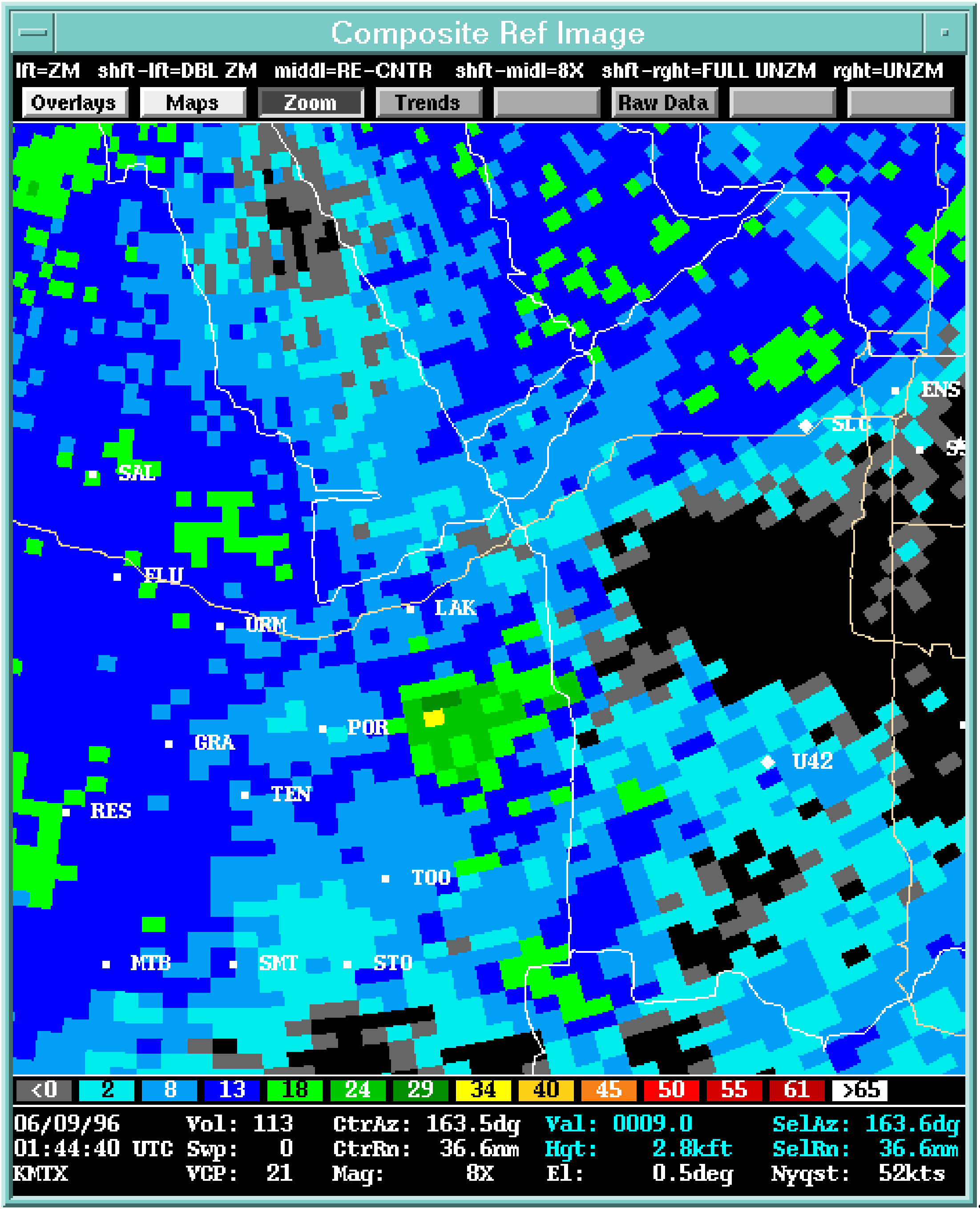
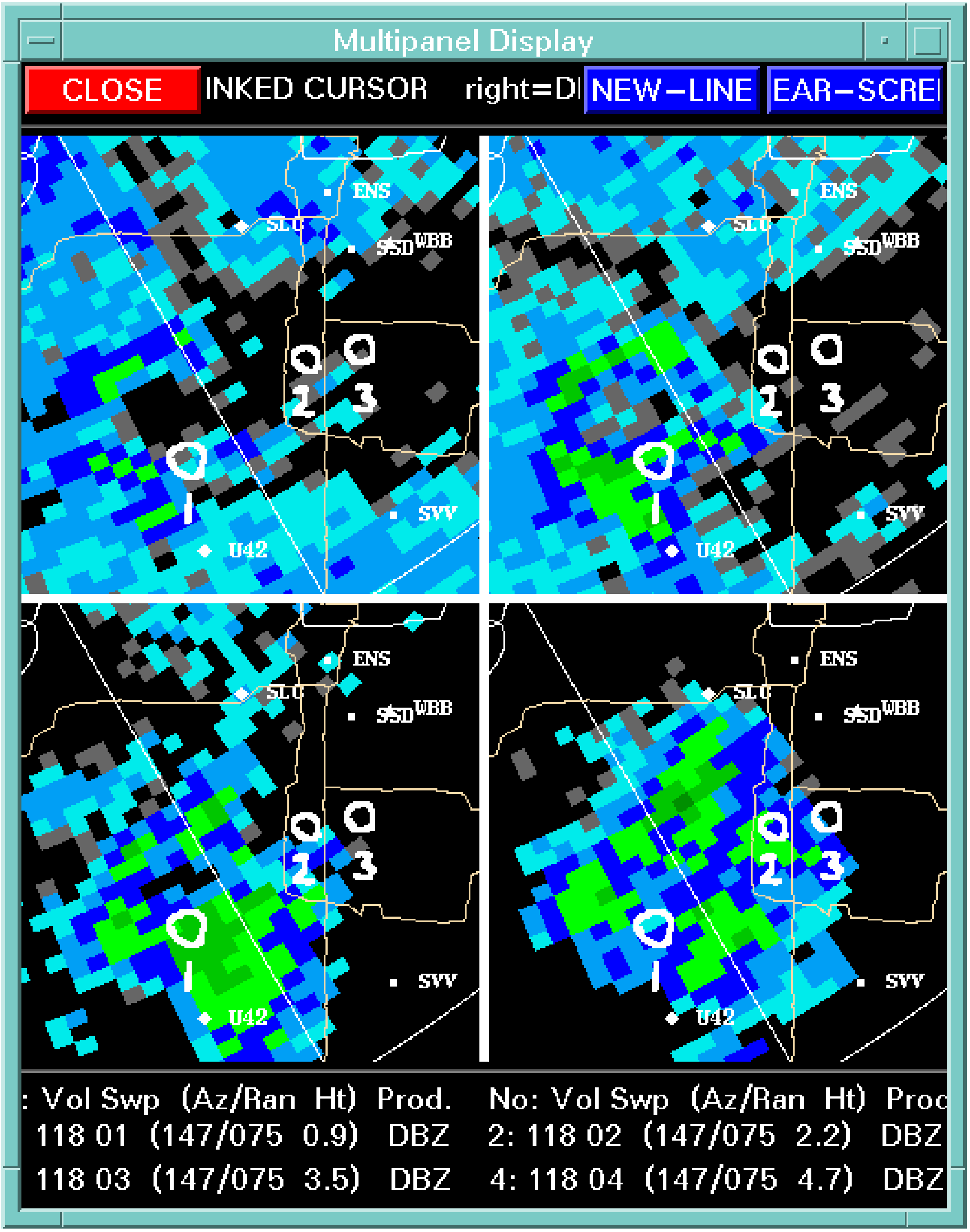
The peak reflectivity in the microburst storm occurred at 0144 (Fig. 2). The maximum reflectivity in the composite is 32 dBZ. However, there area greater than 30 dBZ (minimum threshold for cell ID algorithms) is not large enough to constitute a storm cell.

FIGURE 2. Composite reflectivity image at 0144 UTC on 9 June 1996.



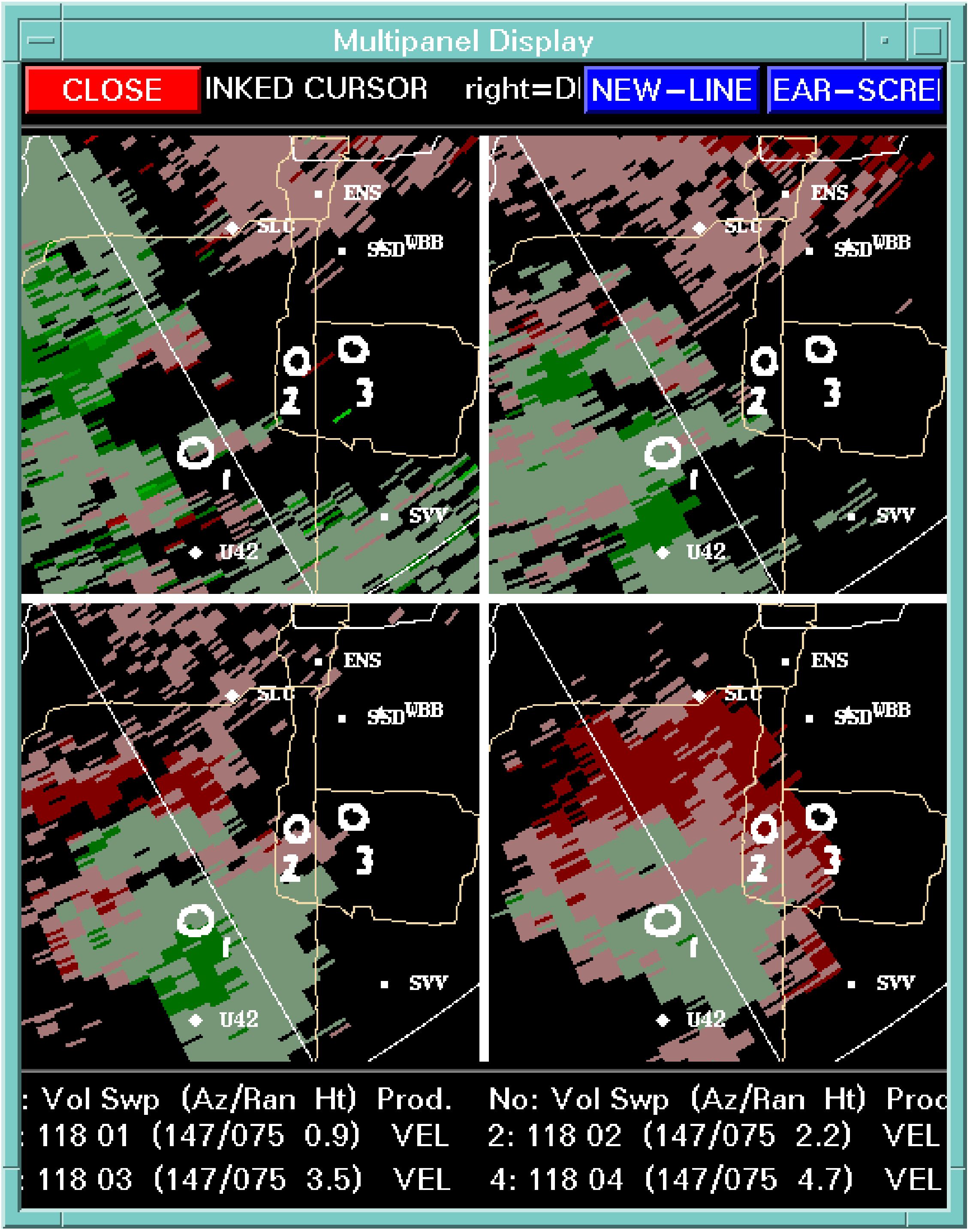
The vertical reflectivity structure of the microburst storm at 0213 UTC is shown in Figure 3. The numbered circles denote areas of wind reports greater than 50 kts. The maximum reflectivity at 0.5 deg is 17 dBZ and has a curious circular shape. From time lapse it appears that the circle represents a ring gust front precipitated by the microburst outflow with the center just northwest of area 1. Thus, the microburst has been in progress for several minutes, most likely beginning sometime very close to 0144 since, after that time, the "core" began to collapse resulting in a circular echo shape even before 0213. Also visible in the velocity image (Fig. 4), the ring expands with time while the storm moves east-northeast. It is not clear if the damage areas indicate pulse activity or sporadic reporting. Reflectivities are stronger at the higher tilts with a maximum of 27 dBZ at the 3.4 deg tilt.

FIGURE 3. Four-panel at 0213 UTC of reflectivity at 0.5, 1.5, 2.4 and 3.4 degrees. Cicles indicate areas of severe wind reports.



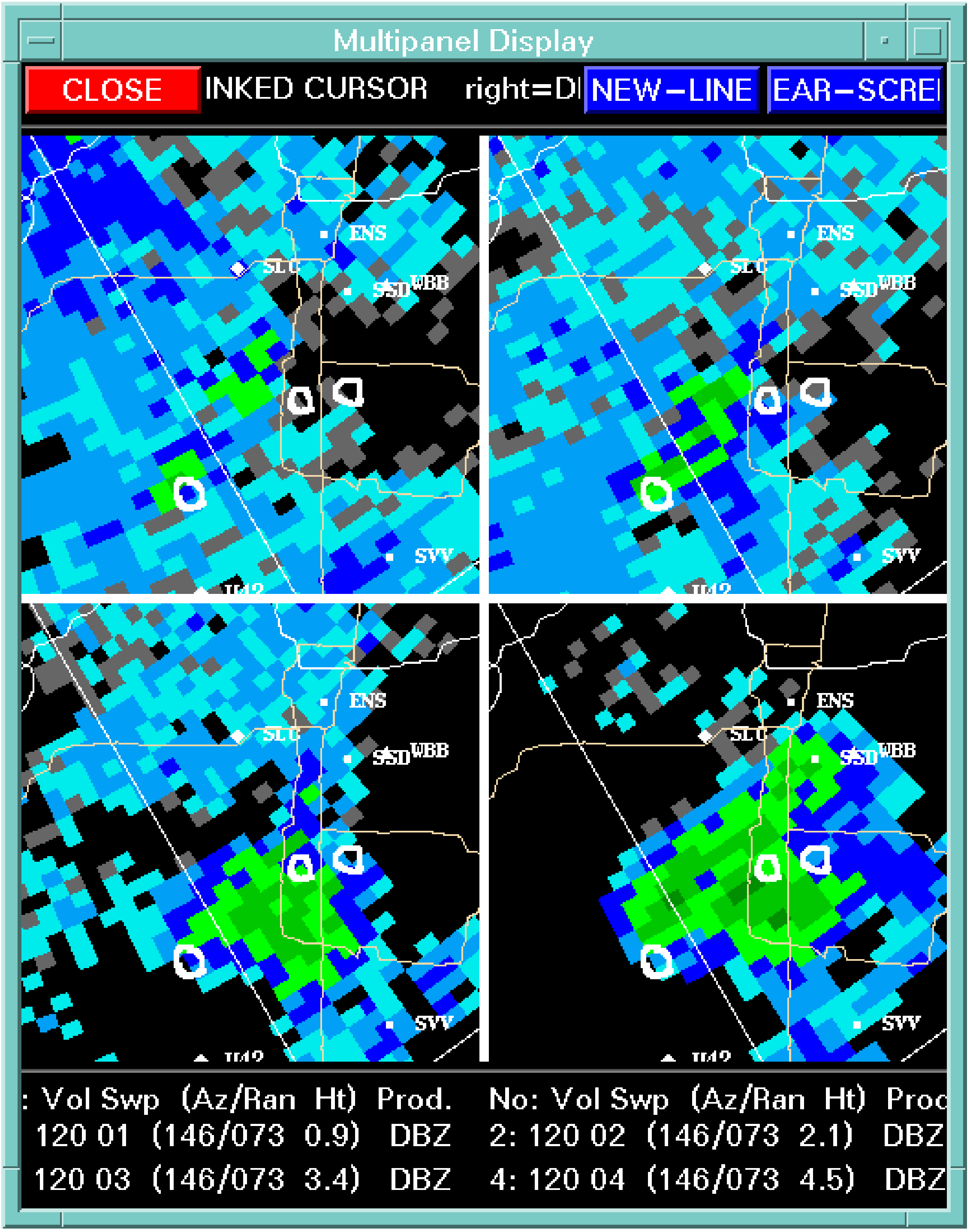
The velocity data (Fig. 4) show little divergence at the lowest tilt. There is ~17 kts convergence above the outflow center at the highest tilt. Inspection of previous scans some coherent convergence structure although values were very low. The convergence aloft in the storm actually strengthen with time.

FIGURE 4. Four-panel at 0213 of radial velocity at 0.5, 1.5, 2.4 and 3.4 degrees.



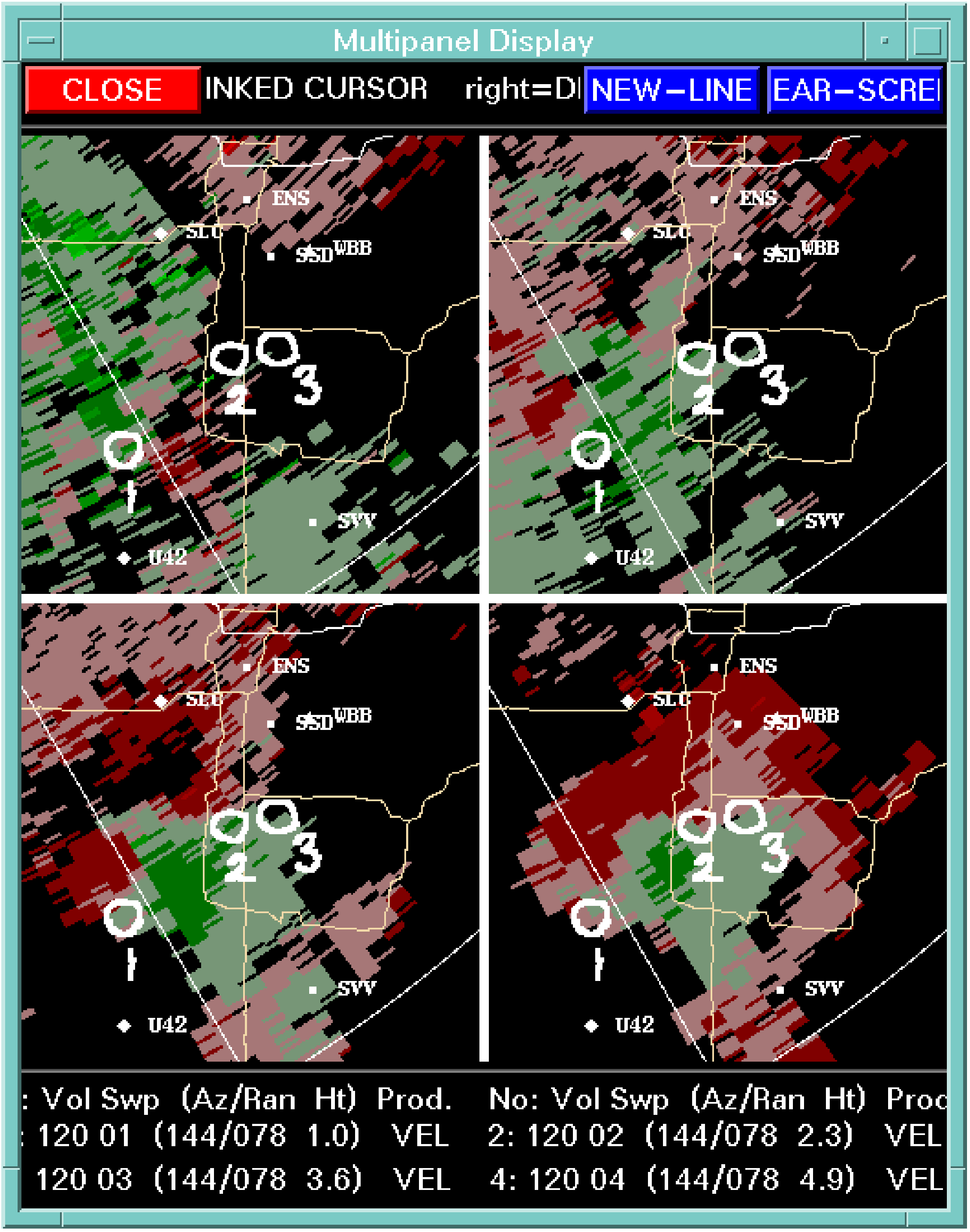
Reflectivity data at 0225 UTC (Fig. 5) reveal increasing reflectivity at the 0.5 deg tilt possibly indicative of a descending virga shaft. Maximum reflectivity values are 17 dBZ at 0.5 deg and 27 dBZ at the 3.4 deg tilt. The small core at 3.4 deg appears to be a new cell forming along the outflow boundary.

FIGURE 5. Four-panel at 0225 UTC of reflectivity at 0.5, 1.5, 2.4 and 3.4 degrees.



The velocity field at the 0.5 deg tilt (Fig. 6) shows a hint of divergence between SLC and U42 with 20 kts the maximum radial velocity, but nothing close to the 50+ kt winds reported at any of the three locations shown. Weak divergence at 0.5 deg gives way to 23 kts convergence at the 3.4 deg tilt.

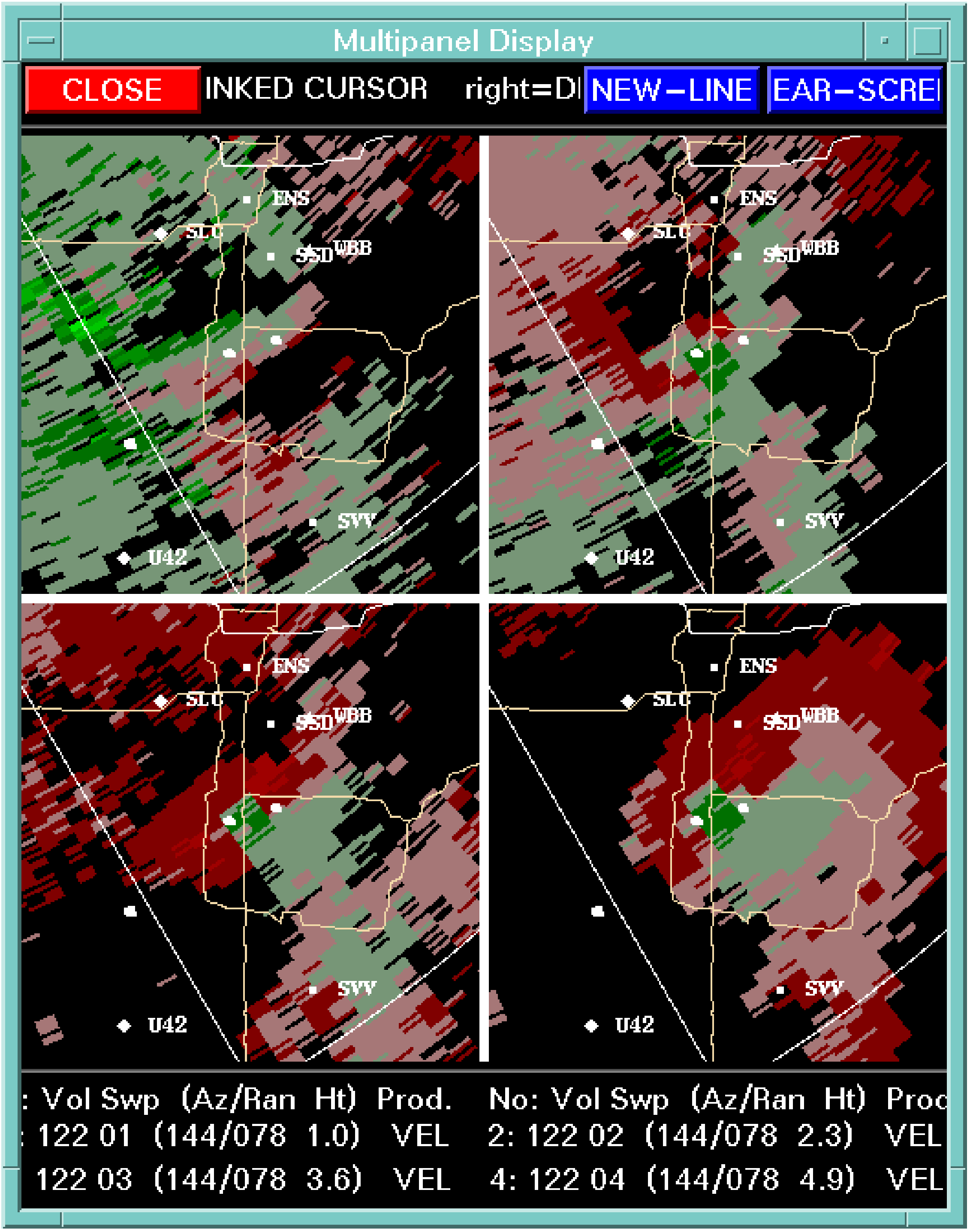
FIGURE 6. Four-panel at 0225 UTC of radial velocity at 0.5, 1.5, 2.4 and 3.4 degrees.



The vertical reflectivity structure at 0236 UTC (not shown) again shows that the highest reflectivity is aloft with a small local maximum at the 0.5 deg tilt. However, the 0.5 deg maximum value has increased to 28 dBZ.

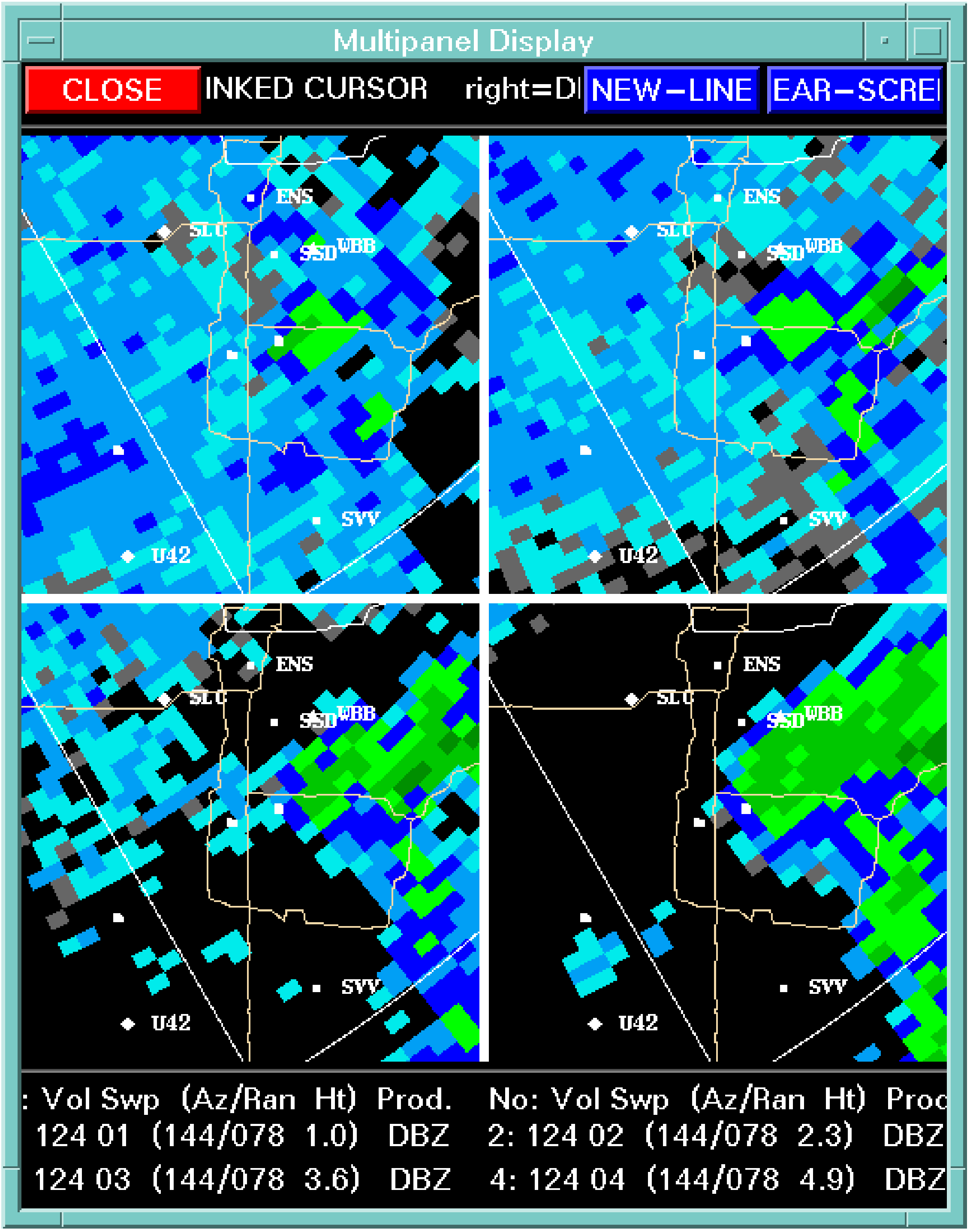
Weak divergence persists at the lowest tilt at 0236 UTC with moderate convergence aloft (Fig. 7). It is interesting that the velocity patter has evolved into more of a convergent vorticity couplet rather than convergence only.

FIGURE 7. Four-panel at 0236 UTC of radial velocity at 0.5, 1.5, 2.4 and 3.4 degrees.



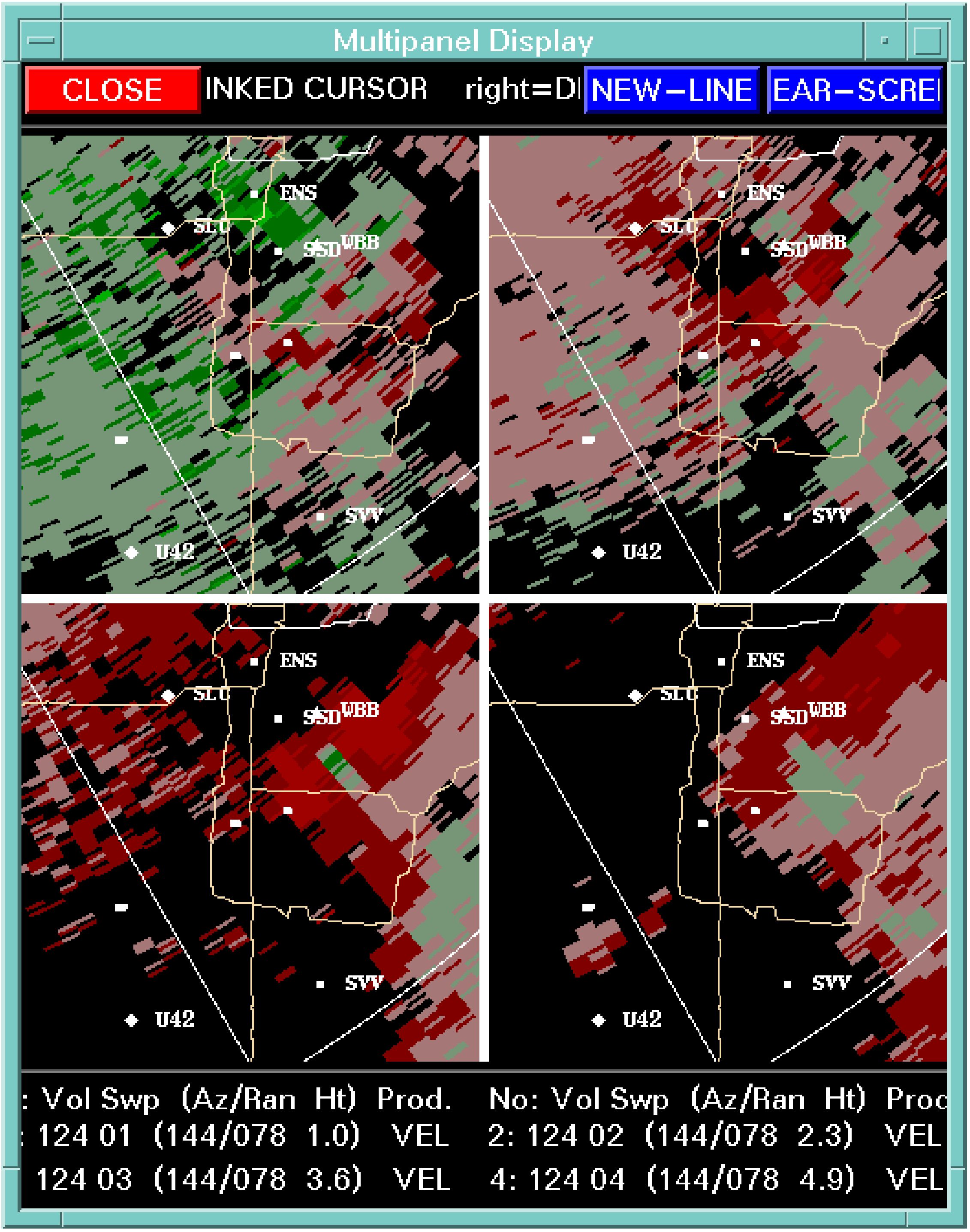
Eleven minutes later, the reflectivity has decreased to 23 dBZ at the lowest tilt and the maximum aloft has shifted to the east over the Wasatch mountains (Fig. 8).

FIGURE 8. Four-panel at 0248 UTC of reflectivity at 0.5, 1.5, 2.4 and 3.4 degrees.



The velocity data at 0248 UTC (Fig. 9) indicate weakening of the upper-altitude convergence- rotation signature. There is still an indication of divergence at the 0.5 deg tilt but maximum values are 25 kts or less. Please note the noisy data quality at the lowest two tilts where there are many range gates with no data. This has negative implications for algorithms that can fail when encountering missing and/or noisy data.

FIGURE 9. Four-panel at 0248 UTC of radial velocity at 0.5, 1.5, 2.4 and 3.4 degrees.



3. Conclusions

The weak reflectivity in the storms that produced severe microbursts on this day were in sharp contrast to the high reflectivity storms occurring simultaneously to the northwest. Maximum reflectivities in the microburst storms exceeded 30 dBZ at only one volume scan where there were 2-3 range gates of 32 dBZ. The minimum criterion for current and future WSR-88D storm cell identification algorithms is 30 dBZ. Lowering the threshold to detect these cells would cause a plethora of cell detections that may overwhelm the radar operator. Yet, cell detections are the foundation for tracking other important attributes of storms (e.g., rotation, convergence, reflectivity cores, etc.). Also, storms with such low reflectivities are easy to overlook in contrast to strong storms elsewhere.

Low-to-middle altitude convergence in the cells was not useful as a precursor to microburst activity. The maximum convergence (23 kts) occurred after microburst began, and quickly evolved into a convergent rotation signature.

Perhaps the most significant observation is the evolution of the reflectivity core. The storm produced an apparent ring gust front that expanded with time. The low-altitude core appeared 10-15 min after the reflectivity aloft peaked and at nearly the same time as the outflow ring appeared.

There are likely many other signatures in the data. However, one not seen here at a relatively short range (~45 nm) is the outflow divergence signature in the velocity fields. With the radar at least 2,300 ft above the Salt Lake, the beam height over SLC is more than .5 mi. Still, very weak divergence was noticable although the data had lots of gaps.

There is more data to be looked at. The morning sounding showed a classic inverted "v" structure: very dry below 500 mb with a steep temperature lapse rate. However, the evening sounding showed significant drying at mid-altitudes. Also interesting is the apparently-different storm environments as indicated by the proximity of very-high reflectivity cells to the west.

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