Western Region Technical Attachment
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OREGON SUPERCELL OF JULY 9, 1995 AS SEEN BY THE KRTX WSR-88D

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Introduction

On Sunday morning, July 9, 1995, a supercell thunderstorm developed in north-central Oregon southwest of Redmond. The storm moved northeast past Pendleton to the Tri-Cities area in Washington, leaving behind a multi-county path of destruction caused by golf ball to baseball size hail and flash flooding. This Technical Attachment details the storm as seen from the KRTX WSR-88D radar on Dixie Mountain northwest of Portland, documenting characteristics of the supercell and highlighting the role of UCP operators when viewing severe weather.

Synoptic Pattern

The synoptic pattern in which the supercell developed consisted of an unusually strong low-pressure system that moved into western Oregon on Saturday, July 8. The radar estimated that 1 to 2 inches of rain fell over a large area of southwest Washington and northwest Oregon in a 12 hour period ending Sunday morning, resulting in areas of urban flooding. Radar echoes from this system continued to cover much of the radar's viewing area during the lifetime of the supercell, proving the advantages of the WSR-88D's 10 cm wavelength and its narrower, more powerful radar beam in overcoming attenuation from intervening precipitation.

The thunderstorm developed around 1730 UTC southwest of Redmond at the leading edge of the precipitation echoes as they moved into north central Oregon. In this region, the storm tapped a supply of moist, unstable air to the southeast, and this inflow to the storm was unhindered by any intervening convection. When the storm was near Redmond, a spotter reported one-half inch diameter hail and very heavy rain. The decision was made at this point to issue a severe thunderstorm and flash flood warning. Reflectivity (56 dBZ), echo tops (32,000 feet), and vertically integrated liquid water content (30 kg/m^2) were increasing.

Radar Analysis

VAD wind profiles from the KRTX and KCBX (Boise) WSR-88Ds (Figs. 1 and 2) displayed diffluence aloft over central Oregon. The winds on the KRTX WSR-88D above 15,000 feet showed a southerly or even southeasterly direction when compared to the southwesterly winds on the KCBX radar. The KCBX radar indicated inflow to the storm was from the cloud free southeast. The KCBX wind profile also exhibited significant veering with height supportive of supercell development.

The storm tracked from just northeast of Redmond to its ultimate demise near the Tri-Cities area (Fig. 3). The storm track, estimated at 220 degrees, was to the right of the mid-level winds on either VAD wind profile. The nearly four hour lifetime of the storm testified to its highly organized structure. Composite (peak) reflectivities remained above 60 dBZ through most of the period, with a maximum of 70 dBZ at 1922 UTC measured at a distance well beyond the conventional 124 nm range of the radar. All three of these characteristics support the storm's supercell structure.

KRTX WSR-88D estimates of echo tops, vertically integrated liquid content, and storm total precipitation comprise three of the four panels in Fig. 4. Maximum echo tops were 44,000 feet, fairly substantial by Pacific Northwest standards. VILs reached 67 kg/m^2. This is the highest value to date recorded by the KRTX WSR-88D. Even though this value is likely biased upward by the method the WSR-88D uses to calculate VILs when the beam is so far above the ground at this range, it is still very impressive.

The storm total precipitation product shows impressive rainfall estimates along the path of the storm, with localized amounts exceeding 1.5 inches. Roads were damaged by the rainfall in several areas, especially near Condon.

Figure 5 presents reflectivities at 1916 UTC from the lowest four elevation angles while the storm was just within 124 nm of the RDA, a distance within which velocity, precipitation, echo top, and other derived products are available from the WSR-88D. This display shows the higher reflectivities aloft overhanging or shifted to the southeast toward the inflow side of the storm. Note the 69 dBZ peak reflectivity at 1.5 degrees.

Figure 4 (lower right panel) shows the 2.4 degree slice of base velocity at 1916 UTC using an alternate color scale to highlight peak values. Note the fairly large area of outbound values exceeding +60 kt, with nearby inbound values of -40 kt, resulting in a storm top divergence estimate of at least 100 kt. Golf ball to baseball size hail was reported just after this time at Condon, and continued through much of the storm's remaining lifetime. This value approaches the NSSL guidelines (obtained from the WSR-88D Operations Course notes) of golf ball size hail when storm top divergences range from 110 to 135 kt.

At 1933 UTC, the storm produced an impressive signature on the lower elevation angles of the storm relative velocity products (Fig. 6). The nearby inbound and outbound velocities of approximately 45 kt each on the 0.5 degree slice, together with -26 kt inbound and +35 kt outbound values at 1.5 degrees, provided strong evidence of a mesocyclone. The OSF Mesocyclone Recognition Criteria near the limiting 124 nm range indicate that a 45 kt rotational velocity maximum would place this mesocyclone at the lowest end of the "Strong Mesocyclone" category. Shortly after the time shown on Fig. 6, the storm was beyond the range for the radar to compute radial velocities.

The UCP operator took important actions that day in order to obtain the above velocity data. There was a considerable amount of reflectivity echos displayed on the radar between the RDA and the supercell. The Auto-PRF function of the WSR-88D allowed these nearby echoes to obscure the velocities of the supercell (i.e., to be range-folded and colored purple on the PUP display). It was important for the UCP operator in this case to turn off the Auto-PRF function, then try different PRFs to change the unambiguous range of the radar for calculating radial velocities. Ultimately, using the PRF accompanying the shortest Doppler velocity unambiguous range enabled the radar to detect the supercell's velocity signals.

Detecting this storm at such a large distance from the RDA, much of the time beyond the customary 124 nm range, was impressive. At 124 nm, the centerline of the radar beam under standard atmospheric conditions is already about 17,000 feet above the elevation of the RDA (or about 19,000 feet MSL in this case). The beam at this distance is about 2 nm wide. Nonetheless, the WSR-88D clearly detected important attributes of this supercell thunderstorm.

As the storm moved beyond 124 nm from the radar, data were requested from the Boise and Missoula WSR-88Ds at frequent intervals to monitor the storm's progress. Still, the KRTX WSR-88D gave the best view of the storm throughout its lifetime. NWSFO Portland continued to issue warnings until the storm was handed over to WSO Pendleton, after which NWSFO Portland staff frequently briefed WSO Pendleton in support of their warnings until the storm dissipated in the Tri-Cities area.

The strong rotation produced concern about the possibility of any tornadoes, though the rotation was not along adjacent radials. There was only one tornado noted by eyewitnesses who gave accounts to the NWS and to the news media. It briefly touched down near the intersection of Interstate 84 and Highway 207, southwest of Hermiston.

The storm dissipated just south of Pasco, Washington, but new convection spawned along an outflow boundary to the northeast and east of the storm later produced a severe thunderstorm east of Pendleton, and several severe thunderstorms and a tornado through eastern Washington into the Idaho panhandle.

Conclusion

Despite the distance of the storm from the KRTX WSR-88D, the radar presented an excellent view of this supercell storm, confirming that Midwest type severe weather does occur at times in the Pacific Northwest. It also gave valuable experience to the NWSFO Portland office in using the radar to observe severe weather, and emphasized the importance of the UCP operator in manipulating the radar to maximize its usefulness in gathering velocity data.

Note: Color Figs. 1-6 appear on the WR SSD Homepage at http://ssd.wrh.noaa.gov.

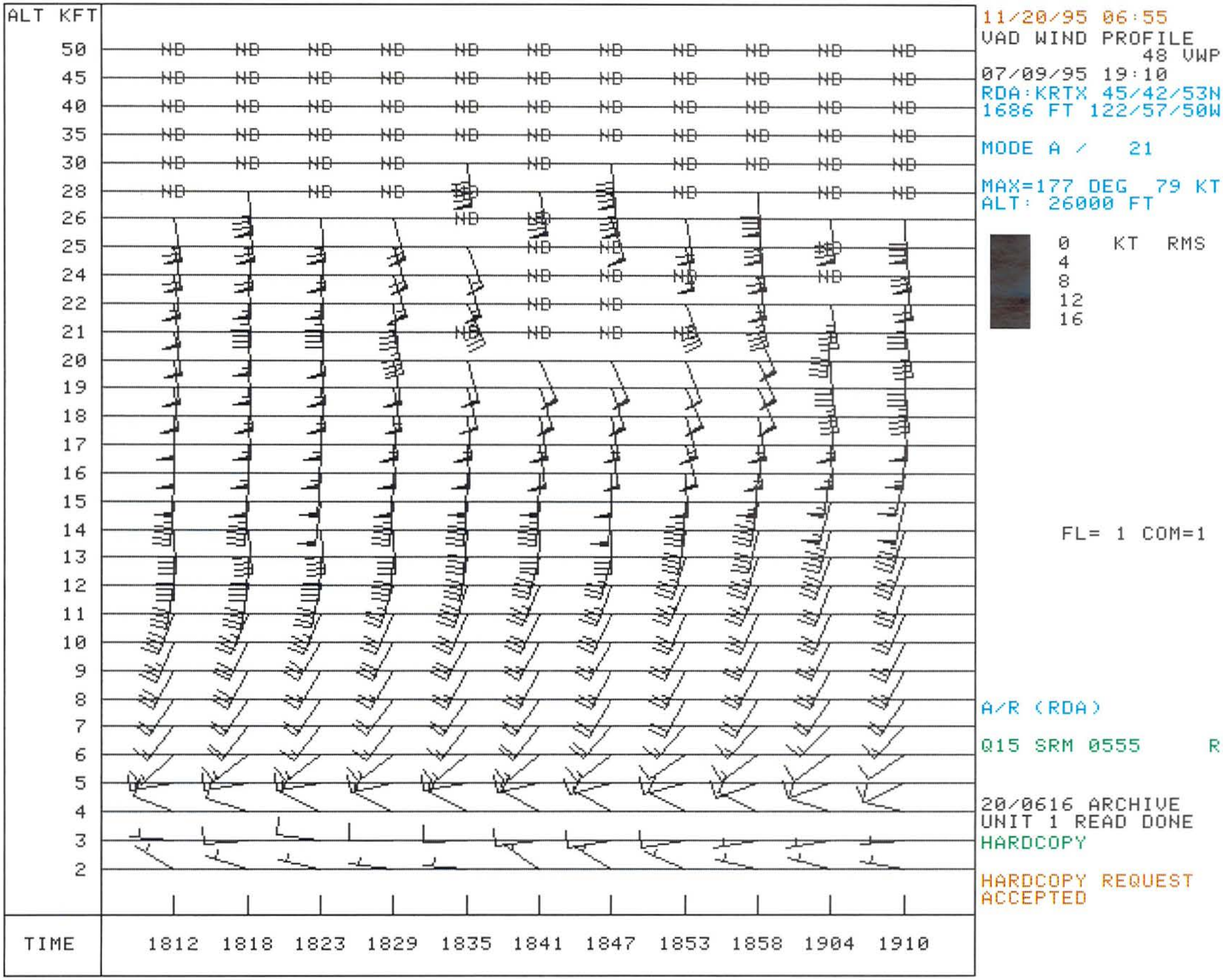

Figure 1. VAD Wind Profile from the KRTX WSR-88D on 7/9/95 at 1910 UTC.

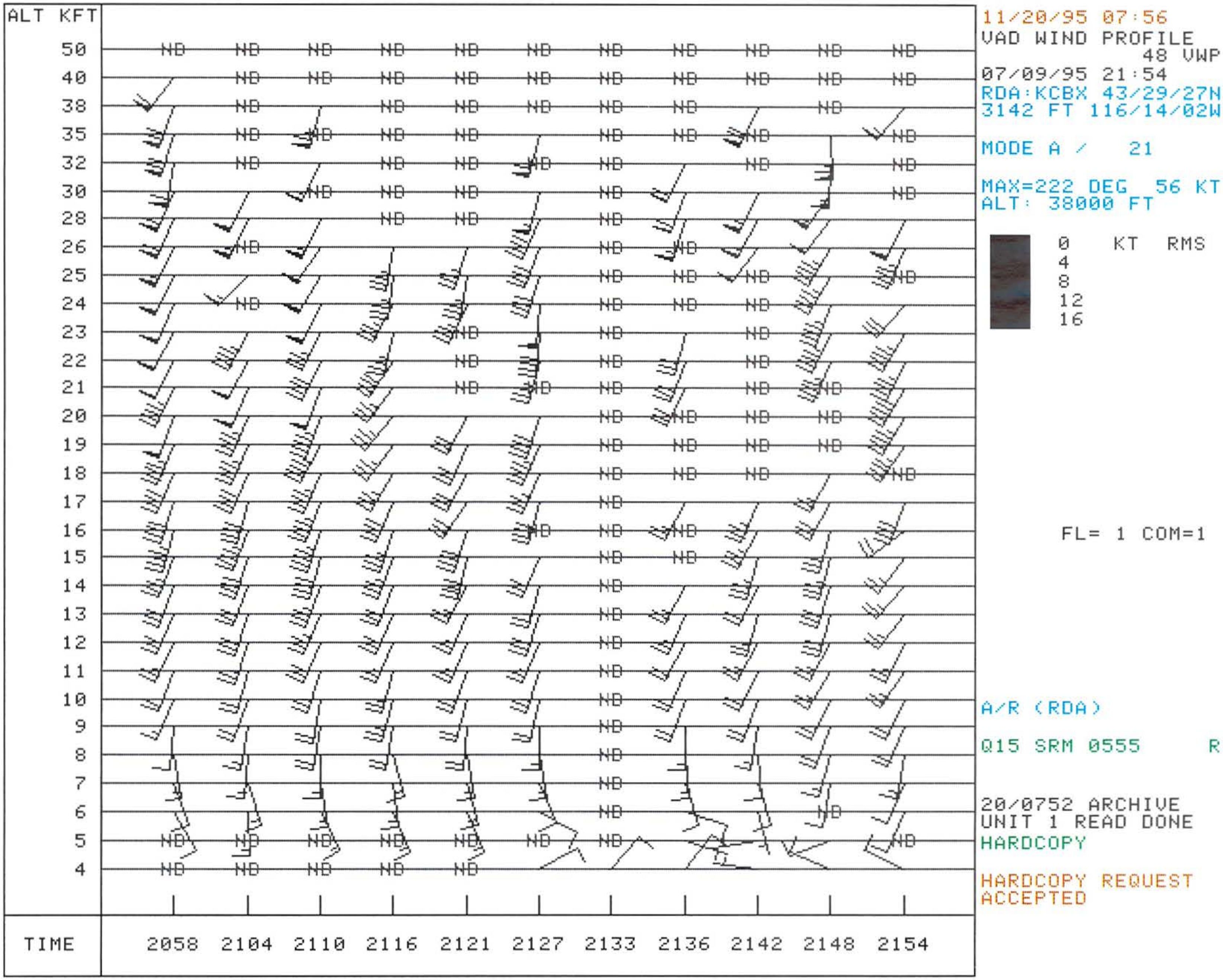

Figure 2. VAD Wind Profile from the KCBX WSR-88D on 7/9/95 at 2154 UTC.

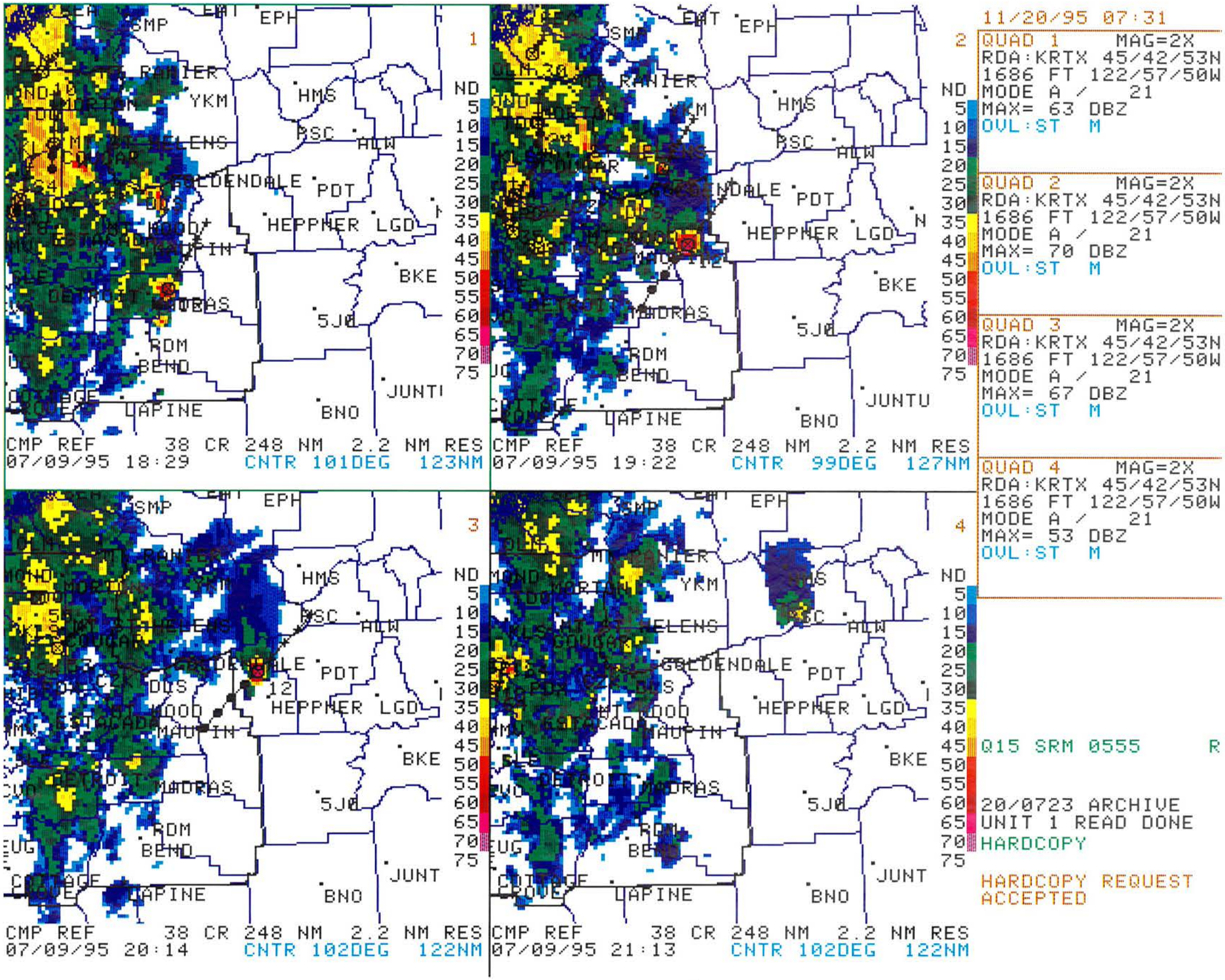

Figure 3. 4 panel display of composite reflectivities on 7/9/95 at 1829 UTC (upper left), 1922 UTC (upper right), 2014 UTC (lower left), and 2113 UTC (lower right).

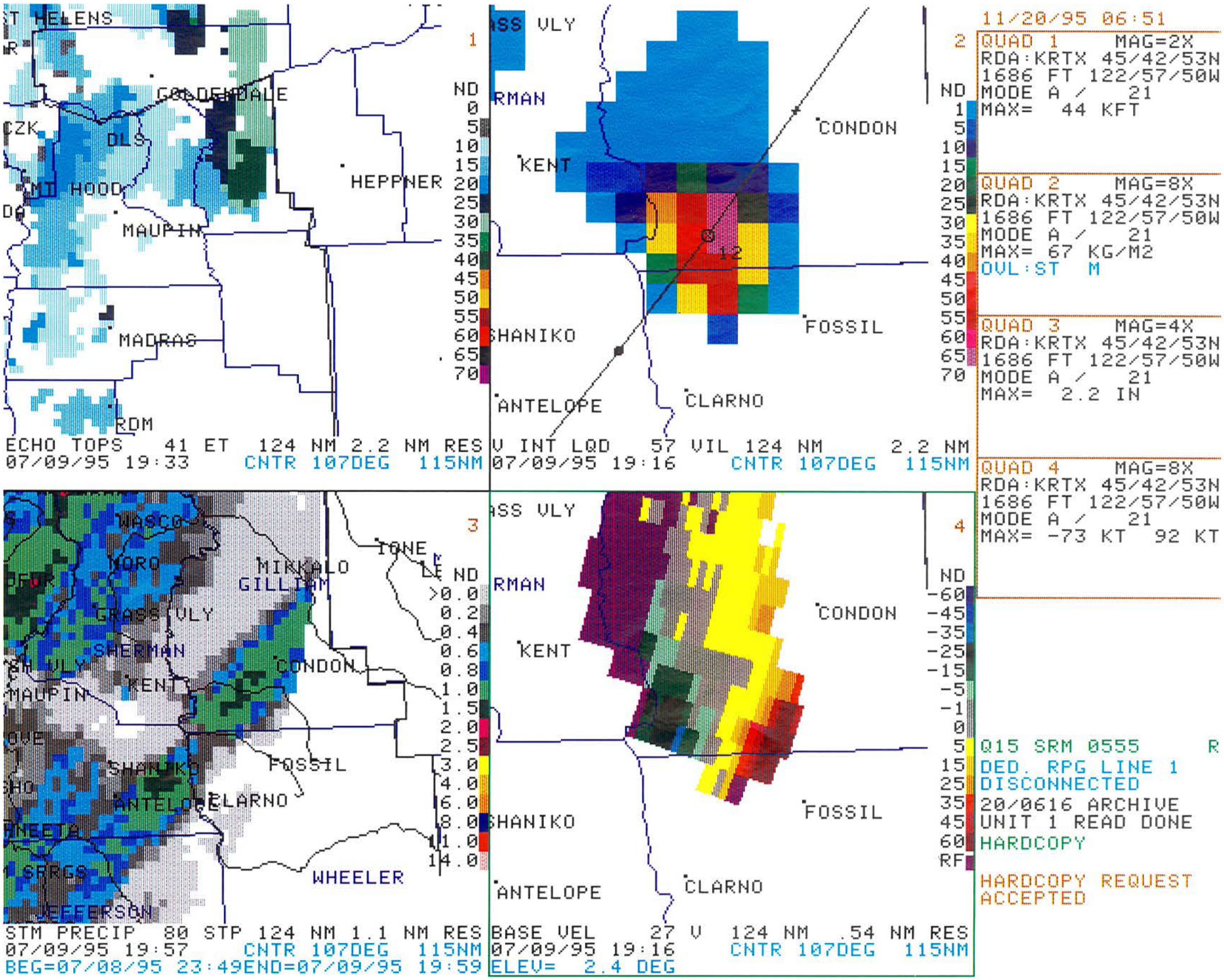

Figure 4. 4 panel display of echo tops at 1933 UTC on 7/9/95 (upper left), vertically integrated liquid water content at 1916 UTC (upper right), storm total precipitation from 2349 UTC on 7/8/95 to 1959 UTC on 7/9/95 (lower left), and base velocity at 2.4 degrees elevation at 1916 UTC on 7/9/95 (lower right).

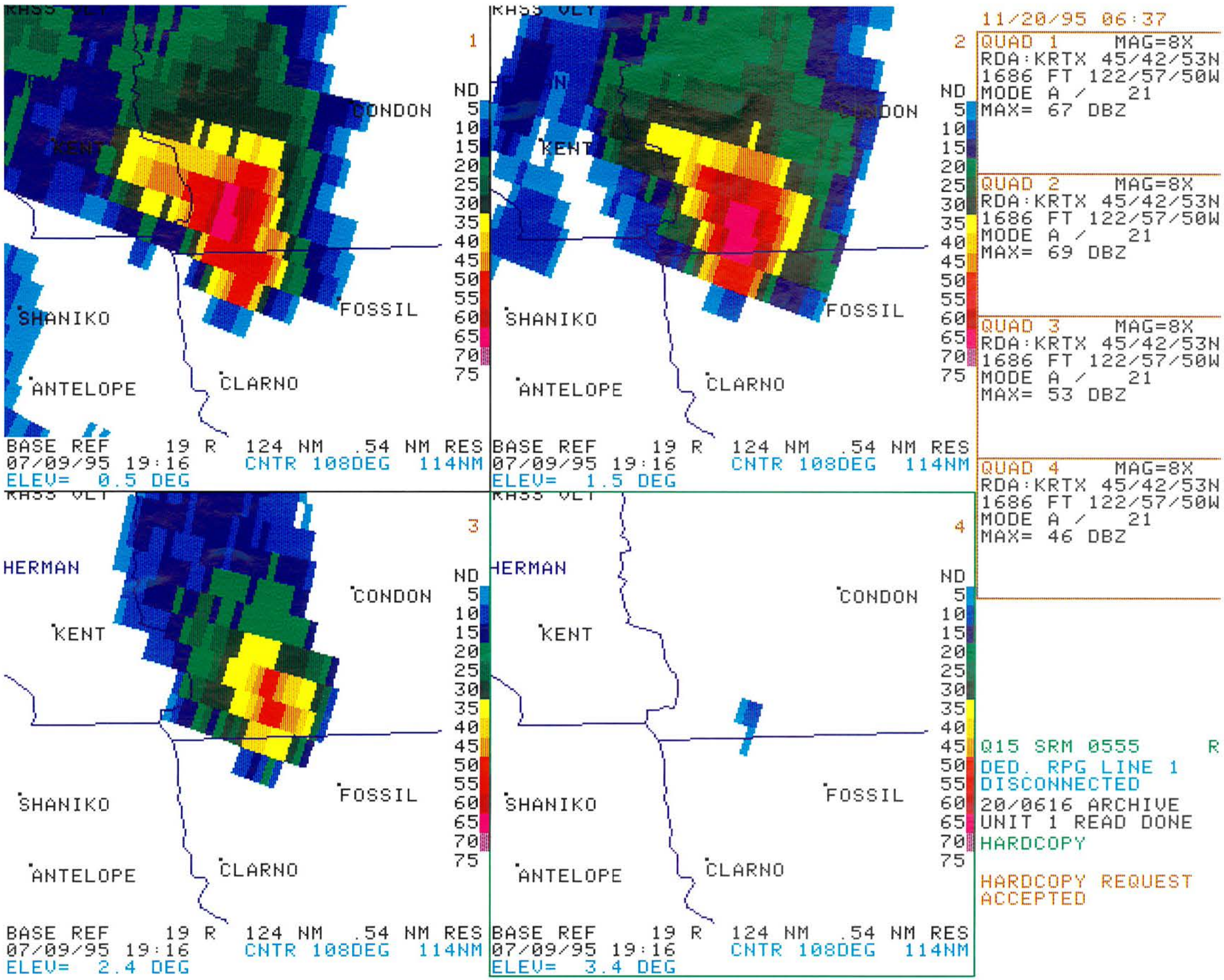

Figure 5. Lowest 4 elevations (0.5, 1.5, 2.4, and 3.4 degrees) of base reflectivity at 1916 UTC on 7/9/95.

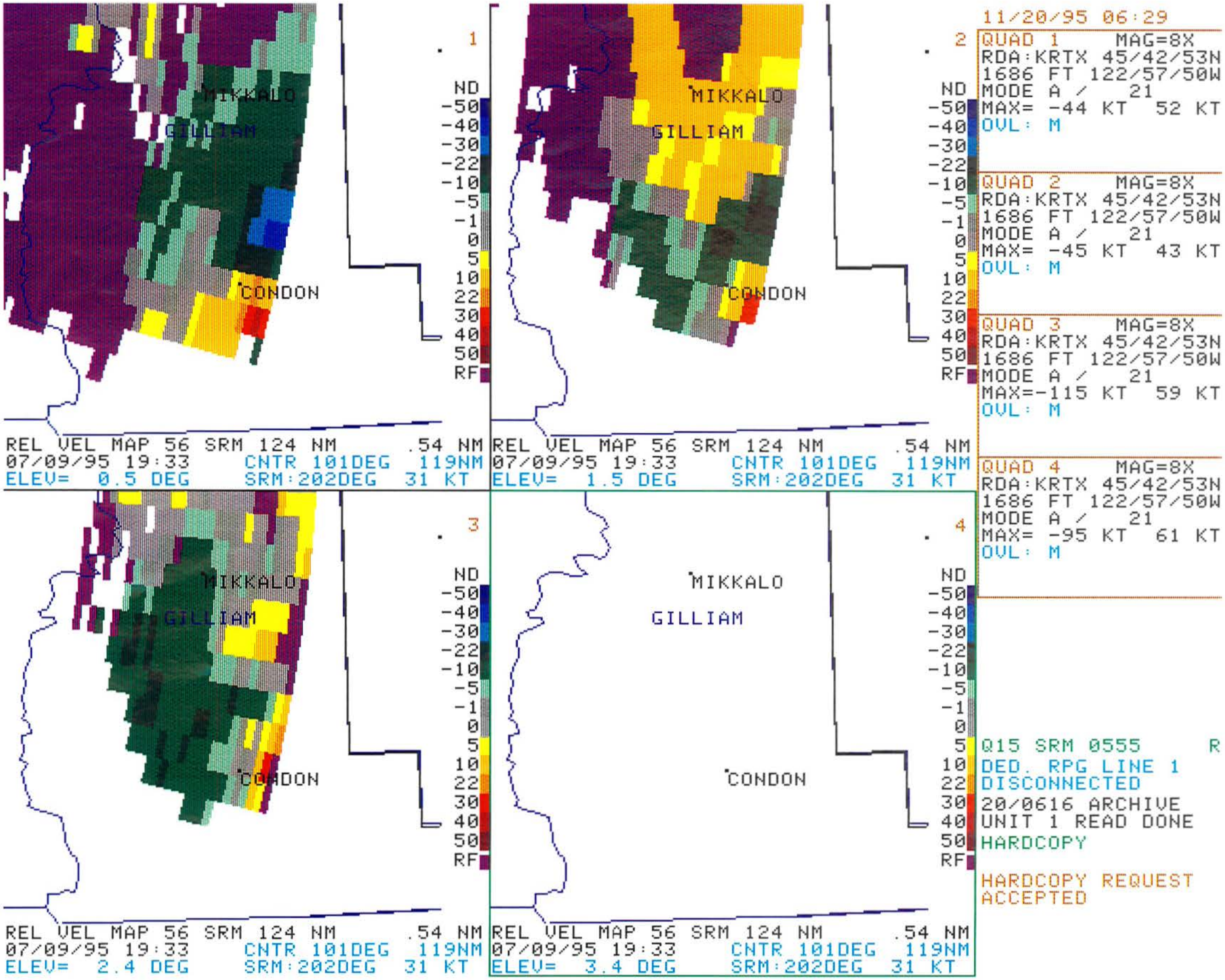

Figure 6. Lowest 4 elevations (0.5, 1.5, 2.4, and 3.4 degrees) of storm relative velocity at 1933 UTC on 7/9/95.