P 11.3 AN OVERVIEW OF THE 28-29 MAY 2001 SEVERE WEATHER OUTBREAK OVER SOUTHEAST COLORADO

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1. Introduction

This paper documents a severe weather episode which occurred across southeast Colorado over a two day period from the evening of 28 May to the late afternoon of 29 May 2001. During this time frame, numerous supercell and non supercell storms produced a total of 16 tornadoes across the WFO Pueblo county warning area (Fig 1). A few of the tornadoes were documented as significant (1 F3, 2 F2s), while the remainder were F0s. Fortunately, no fatalities occurred with any of the tornadoes, although 20 injuries did occur when the two F2 tornadoes, along with 120 mph winds rolled numerous mobile homes in the town of Ellicott, Colorado. A total of 14 million dollars worth of damage occurred due to the severe weather.

Figure 1. *Map showing locations of tornadoes across southeast Colorado. Numerical value overlayed on tornado symbol indicates the number of tornadoes that occurred in that immediate vicinity.*

This outbreak was noteworthy due to the number and strength of tornadoes. Typically, WFO Pueblo (in the modernized era; i.e., since 1995) documents 10 tornadoes across its' county warning area in a year; 16 occurred in a 24 hour time period! In addition, one of the tornadoes was an F3. This was the first documented F3 in southeast Colorado since 1979 (Grazulis 1993).

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2. Tornadogenesis

2.1 Supercell tornadoes

Many of the tornadoes that occurred on the 28th and 29th of May 2001 were well documented by the storm chase community. All of the storms which produced tornadoes on 28 May were supercells, as observed by video and still photograph documentation. Recent research has found supercell tornadoes are associated with sustained updrafts which are 1.) In a low level moist environment, and 2.) The shear from the surface to 1 kilometer is enhanced. More specifically, Rasmussen and Blanchard, 1998, found the height of the Lifted Condensation Level (LCL) can add additional useful information for discerning supercells which produce tornadoes versus those which do not. It was found LCL heights above about 1200 meters led to a decreasing likelihood of significant tornadoes. Operationally, LCL values can be judged by nearby surface observations in which the temperature/dewpoint depression is low.

Operationally, identifying enhanced low level shear (0-1 km), is more problematic than inferring a low level moist environment. It is infrequent that tornadic supercell storms develop in the immediate vicinity of a vertical wind measuring system (wind profiler, VAD, balloon sounding, etc). However, Markowski et. al., 1998 observed that supercells that develop along, or interact with boundaries are more prone to be tornadic. The reason for this is the boundaries act to augment the low level environmental horizontal shear. Operationally, boundaries can be observed with numerous data sources, including satellite, radar and surface data. It is also believed that along and behind the boundary the low level environment is more moist due to moisture convergence in the vicinity of the boundary.

2.2 Non Supercell Tornadoes

Video documentation of a storm which produced 6 of 7 tornadoes near Lamar, Colorado on 29th May were non supercell tornadoes. Past research has shown the non supercell process occurs along a boundary,

in which vertical vorticity is stretched by a rapidly growing updraft (Wakimoto and Wilson, 1989, Brady and Szoke, 1989). What makes this storm quite interesting is the 7th tornado produced considerable (F3) damage, Video and still photography indicated this storms' updraft was more supercell in nature, although the deep shear environment was not favorable for significant tornado activity.

3. Meteorological Discussion

3.1 28 May 2001

A 500 mb trough was located over the inter mountain west at 00Z 29 May (6 pm MDT 28 May). During the afternoon of the 28th, low level moist southeast flow developed in response to this trough over the plains of southeast Colorado. As the shortwave trough moved towards the region, thunderstorms developed over the higher terrain of the Palmer Divide and Raton Mesa and moved slowly east. A modified sounding from Denver, Colorado indicated CAPE values of 1500 J Kg^{-1} (Fig. 2). Although northerly winds were noted in the sounding in the low levels, 0-3 km storm relative helicity of 150 m^2 s^{-2} was observed. The low level northerly flow was associated with the Denver Cyclone Vorticity Zone (Wilczak 1988), which was located east of Denver at the time. This low level northerly flow was not representative of the environment over southeast Colorado, as surface observations along with KPUX VAD wind data indicated southeasterly flow was occurring over the region.

WATADS analysis of KPUX data at 0039 UTC 29 May indicated a line of broken convection developed NE-SW across El Paso county (Fig. 3). The development of convection in this fashion implied a boundary was located over this region. A storm in the vicinity of Ellicott, Colorado slowly gained in intensity and began to develop a mesocyclone aloft at 0045 UTC. This mesocyclone continued to intensify and worked down to the surface, reaching maximum intensity in the lowest gate at 0115 UTC. Shortly thereafter, 3 tornadoes touched down in the immediate Ellicott area, causing considerable damage to the community. This storm continued to move to the east-southeast and produced two additional tornadoes. Nearby surface observations from the Colorado Springs municipal airport (KCOS), 29 km west of Ellicott, at 0100 UTC indicated a temperature/dewpoint of 19/12 C^o. When these values were inserted into the 0000 UTC Denver sounding, an LCL value of 1100 meters AGL was observed.

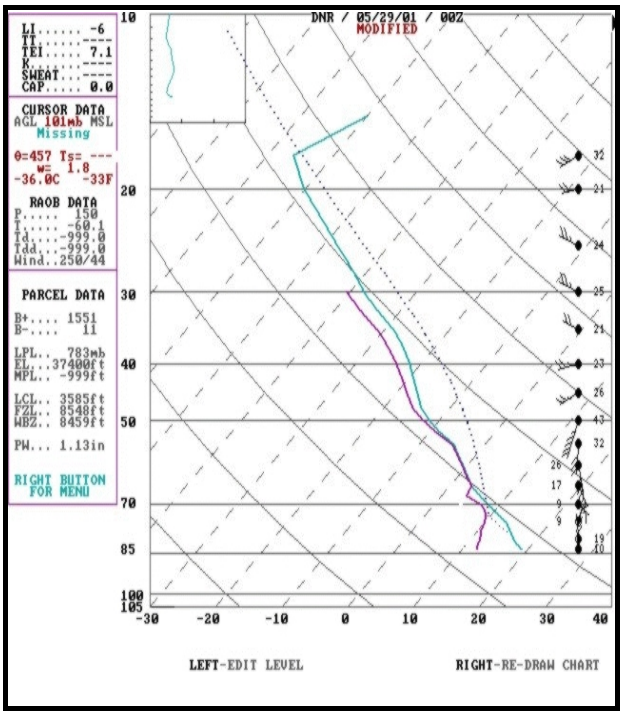

Figure 2. *00 UTC 29 May 2001 modified sounding from Denver, Colorado.*

Farther south during the same evening, chasers observed 4 supercell storms over the Raton Mesa in Las Animas county. These supercell developed consecutively and moved along the same path across the county. This motion inferred a boundary was in place, and was the focusing mechanism for the storms. Supercell #1 in Figure 4 produced a tornado at 0231 UTC 29 May (8:31 pm MDT 28 May) 5 km northwest of the Trinidad airport (KTAD), producing F0 damage to a residence. Surface observations from KTAD at 0200 UTC indicated 19/13 C^o. These values once again inferred a low level moist environment in which this tornado developed.

3.2 29 May 2001

The 500 mb trough which was located over the intermountain west the evening before was located across western Colorado by 1200 UTC on the 29th of May. Stronger wind flow associated with the trough was located well south of Colorado (southern New Mexico into central West Texas). However, low level moisture over southeast Colorado was quite high, as dewpoints in the lower 60s were over the region. The combination of the rich low level moisture, cold air aloft and weak wind flow aloft made for a high CAPE/low shear environment over far southeast Colorado.

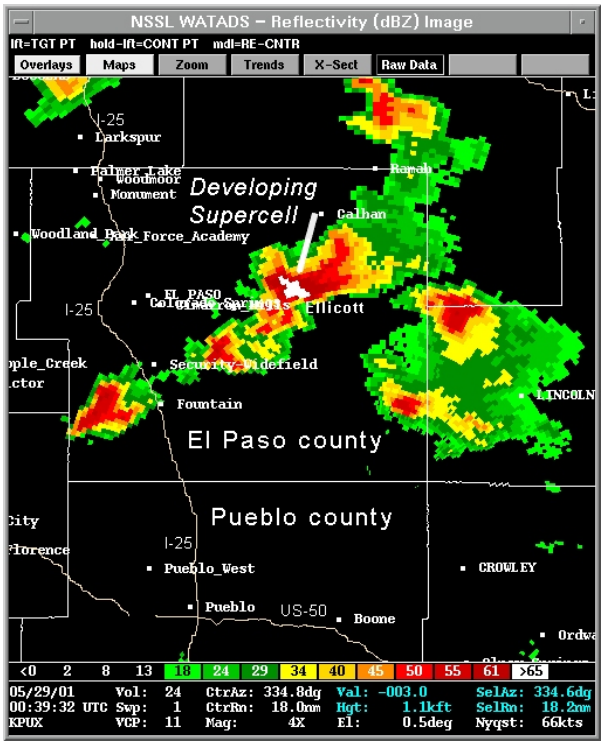

Figure 3. *KPUX 0.5 reflectivity at 0039 UTC 29 May indicating broken line of convection extending northeast-southwest across El Paso county.*

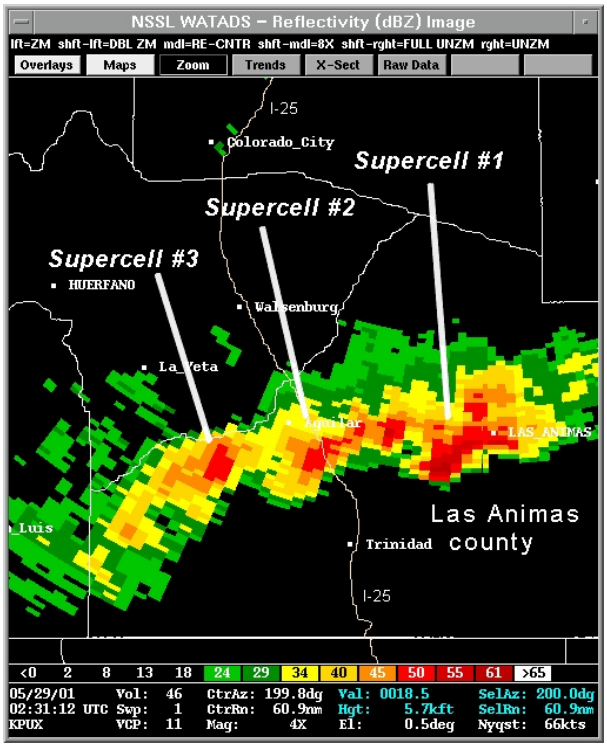

Figure 4. *KPUX 0.5 reflectivity at 0231 UTC 29 May indicating 3 supercells lined up over Las Animas county. The storm northeast of Trinidad at this time was producing an F0 tornado. The western-most storm is being partially blocked by the 12,000 foot Spanish Peaks.*

Late morning satellite data indicated well defined boundaries over southeast Colorado. Initiation of convection developed along one of the boundaries in the vicinity of Lamar, Colorado, prior to noon local time, and quickly became tornadic (Fig. 5). Video documentation by a chase team indicated a total of 7 tornadoes occurred with this storm. The first 6 tornadoes were non supercell tornadoes, while the 7th tornado (updraft) showed well defined supercell characteristics. This small cluster of convection remained in the Lamar vicinity for over 2 hours. All 7 tornadoes formed and remained within a 3 mile radius of the Lamar municipal airport (KLAA).

A sounding constructed for the immediate Lamar area using thermodynamic data from the 1800 UTC ETA model, the 1900 UTC Granada profiler (located 27 km from the tornadic activity) and the 19 UTC surface observations from KLAA indicated CAPE in the order of 3000 J Kg^{-1}. Given the weak wind flow aloft over the area, 0-6 km shear was weak (15 m s^{-1}), while the 0-3 km SRH was modest at 127 m^2 s^{-2}. It is believed the combination of the boundary and a significant amount of CAPE below the LCL played an important role in the development of the F3 tornado. See Hodanish and Davies (this volume) for more information regarding this multiple tornadic storm.

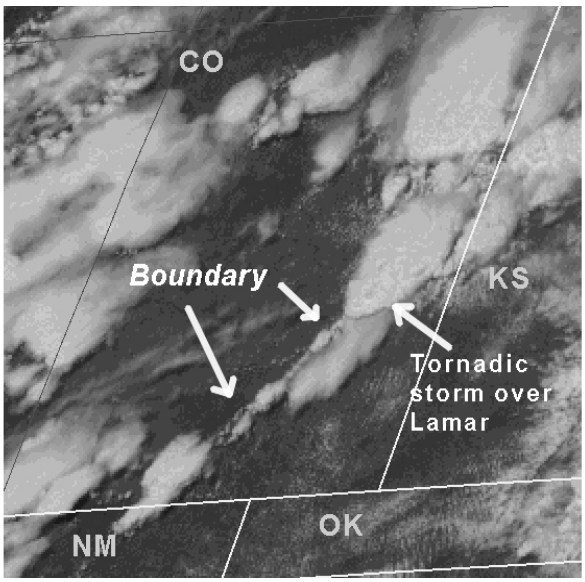

Figure 5. *Visible satellite image at 18:15 UTC showing tornadic storm along boundary over southeast Colorado.*

Two other storms moving along boundaries became tornadic on this date; one across Kiowa county and the other near Ellicott, Colorado (Figs. 5 and 6). The

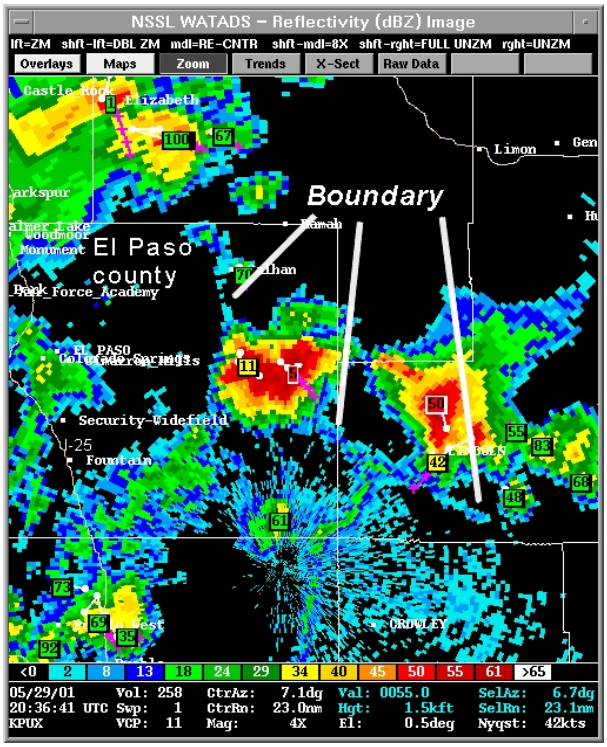

Figure 6. *KPUX 0.5 reflectivity at 2036 UTC 29 May indicating boundary extending across El Paso and into Lincoln counties. Non supercell tornado was occurring at this time with storm #11.*

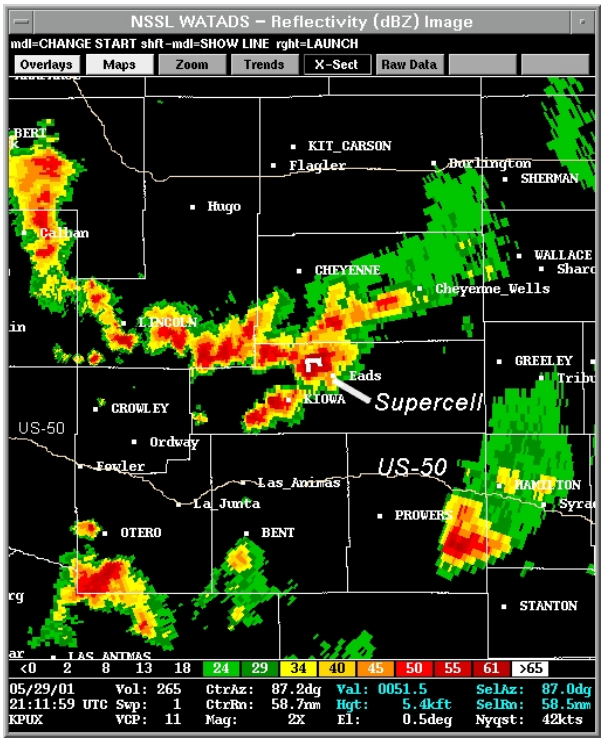

Figure 7. *KPUX 0.5 reflectivity at 2111 UTC 29 May indicating convection along boundary extending across eastern Colorado. Tornadic supercell storm was moving south-southwest at this time across central Kiowa county.*

tornado near Ellicott was observed by NWS personnel who were conducting a damage survey of the Ellicott area from the tornadoes the night before.

4. Conclusion

This paper documents 16 tornadoes which occurred over a 2 day period over southeast Colorado. Tornadoes which developed on these dates were both supercellular and non supercellular in nature. One of the storms produced both non supercell and supercell tornadoes. What all of these tornadoes had in common was 1.) Boundaries appeared to play an important role in their development, and 2.) The low level environment was relatively moist, especially by Colorado standards.

5. Acknowledgements:

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6. References

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