P9.11 AN ANALYSIS OF THE 22 MAY 2008 WINDSOR, COLORADO, TORNADO

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1. INTRODUCTION

On 22 May 2008, a rare (EF3) tornado struck the town of Windsor, Colorado. Windsor is situated in north central Colorado, about 10 miles southeast of Fort Collins, which is along the populated "Urban Corridor" (Fig. 1). According to the Boulder National Weather Service Forecast Office, there have been 20 tornadoes rated F3 or higher in Colorado since 1950; however, this was only the second F3 tornado reported in Weld County since 1950 (May 15, 1952 – with 5 people injured). Weld County has recorded more tornadoes than any other county in Colorado and the track and speed of this tornado was also somewhat longer (about 35 miles) and faster than most. However, the most unusual aspect was the storm's directional track, moving from the south-southeast to the north-northwest (Fig. 1). It formed near Denver International Airport in a climatologically favored region for initiation, then moved to the north-northwest passing west of Greeley and striking the east side of Windsor, before crossing into eastern Larimer County and weakening. Fig. 2 shows an example of the EF3 damage. The storm later produced more tornadic activity which caused damage in southeastern Wyoming (Finch and Bikos 2008).

2. SYNOPTIC AND MESOSCALE ENVIRONMENTS, AND STORM OBSERVATIONS

A deep upper-level trough encompassed much of the Western U. S. (Fig. 3), allowing for south-southeasterly mean winds to steer storms forming east of the Front Range into more populated regions. The 500 mb low was centered near Las Vegas, and a few notable jet streaks rotated around it. One such jet streak was located in Eastern Colorado, placing the northern Front Range in the favored left-exit region (enhanced vertical motion arising from divergent ageostrophic winds aloft; Holton 1992). At the surface, an extremely deep low (MSLP of 982 mb) was centered near Denver with relatively dry air south and east of it, and a tongue of moist air was being advected westward north of a roughly east/west-oriented boundary. (Fig. 4)

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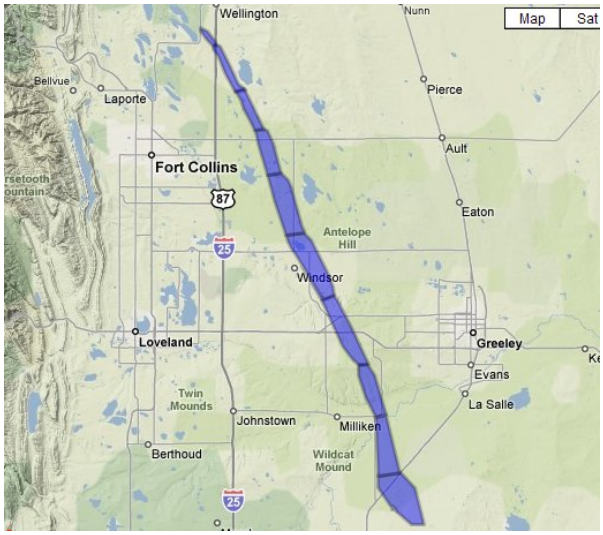

Figure 1. Damage track of the tornado affecting portions of Weld and Larimer Counties, Colorado, in 22 May 2008. The storm moved from the southeast to the northwest. Image courtesy of the BOU NWS.

Figure 2. Power line support sheared off at base. Estimated winds 140 mph -155 mph. Evaluated as EF3. Location is near the Missile Silo Park Campground west of Greeley. (Courtesy NWS BOU)

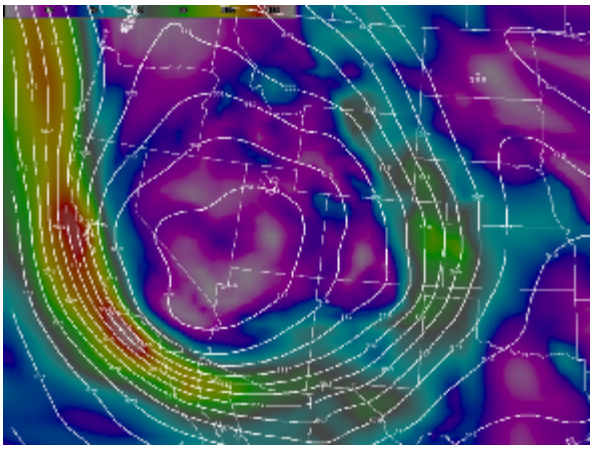

Figure 3. 500 mb Heights (contours) and Wind Speed (colors) from the 1800 UTC NAM Analysis on 22 May 2008.

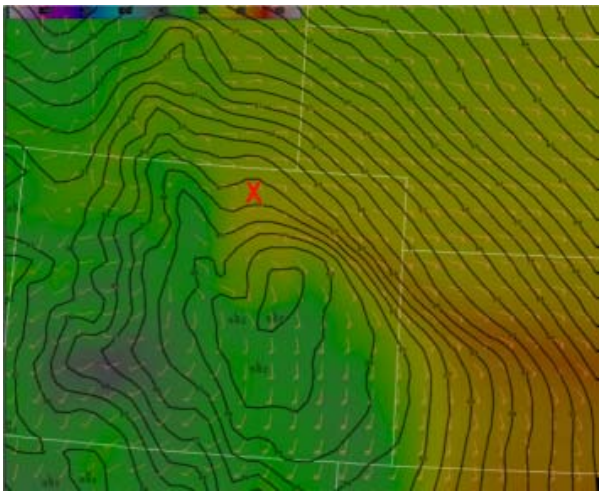

Figure 4. MSLP (contours, 1 mb interval), Surface Wind (wind barbs), and Surface Dewpoint (colors) from the 1800 UTC NAM Analysis on 22 May 2008. The green to yellow transition represents a dewpoint of approximately 50 ˚F. The red 'X' denotes the location of Windsor.

A loop of the GOES-12 Visible band (available here: http://rammb.cira.colostate.edu/case_studies/20080522/goes_visloop.asp) clearly shows (by way of a demarcation in the low cloud cover) the boundary between dry air to the south and moist air to the north. As the moist air noses to the southwest toward the north side of Denver between 1400 - 1600 UTC, the low stratus clouds just behind the boundary dissipate, allowing for surface warming from direct sunlight and further destabilization in a narrow region. Fig. 5 shows an annotated visible image from 1615 UTC with the location of this boundary denoted with a black line. The storm of interest initiates just south of this boundary around 1645 UTC, and really blows up around 1700 UTC as it reaches the warm, moist air.

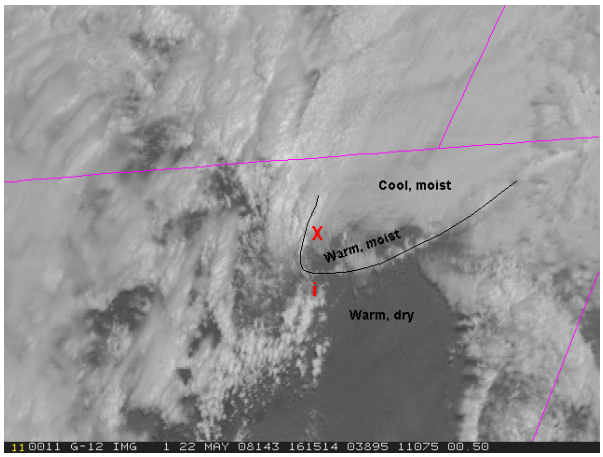

Figure 5. GOES-12 Visible image from 1615 UTC, with a frontal boundary and three air masses denoted. The image covers northeast Colorado, southeastern Wyoming, and the southwestern Nebraska panhandle. The red 'i' denotes the approximate location of storm initiation shortly after this time, and the red 'X' denotes the location of Windsor.

The visible image from 1745 UTC with surface observations (Fig. 6) shows the tornadic storm shortly before it has reached Windsor. Note the ob from Greeley: temperature of 70 F, dewpoint of 55 F, with 30 kt easterly winds gusting to 41. This provides the best estimate of the low-level air which the storm was ingesting. Taking the 18 UTC sounding from Denver and altering it with the Greeley surface data (i.e. changing the low level temperature, moisture, and wind profiles to make them match realistically with the surface obs), we get the sounding shown in Fig. 7. Note the 2094 J/kg 100-mb MLCAPE, and 219 m^2/s^2 0-1 km storm-relative helicity (indicative of significant potential energy and spin in the atmosphere). Additionally, an LCL of only 1.3 km AGL is unusually low for Colorado.

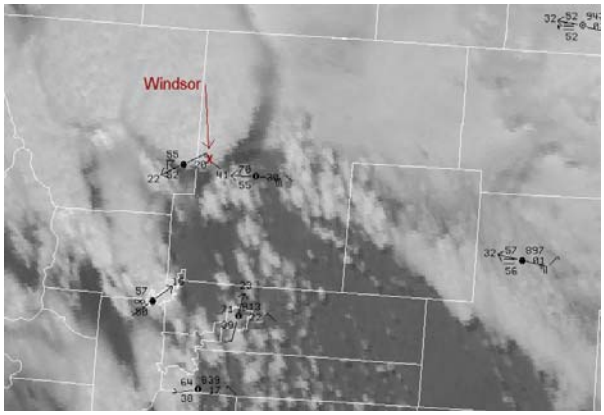

Figure 6. GOES-12 Visible image from 1745 UTC and surface observations. The location of Windsor, Colorado, is shown with a red 'x'.

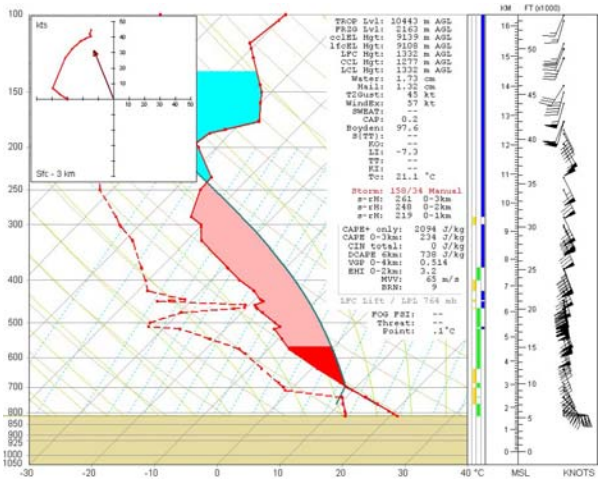

Figure 7. 18 UTC sounding from Denver modified with Greeley surface ob.

Radar reflectivity and radial velocity loops from KFTG can be found at these links: http://rammb.cira.colostate.edu/case_studies/20080522/kftg_reflloop.asp and http://rammb.cira.colostate.edu/case_studies/20080522/kftg_velloop.asp . Figs. 8 and 9 show the reflectivity and radial velocity, respectively, from 1757 UTC, shortly before the storm passed through Windsor. An inflow notch can be seen on the storm's southeastern flank (Fig. 8), and a well-defined velocity couplet is evident (Fig. 9). Fig. 10 shows the storm-relative radial velocity having a maximum inbound velocity of 30-40 kts and the maximum outbound velocity of 50-60 kts.

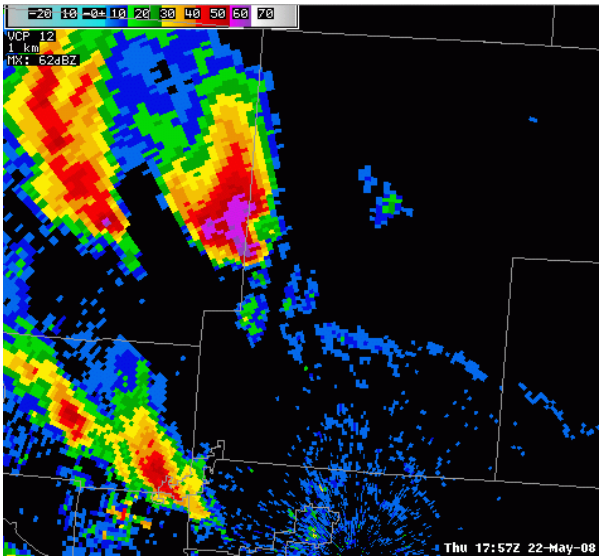

Figure 8. KFTG 0.5 degree reflectivity from 1757 UTC.

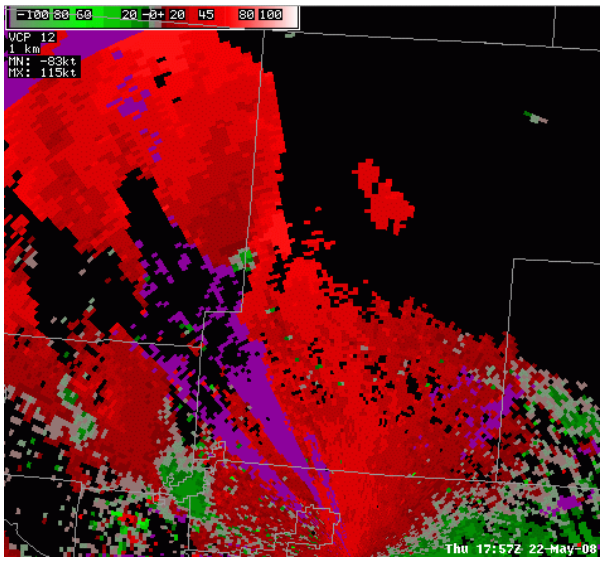

Figure 9. KFTG 0.5 degree radial velocity from 1757 UTC.

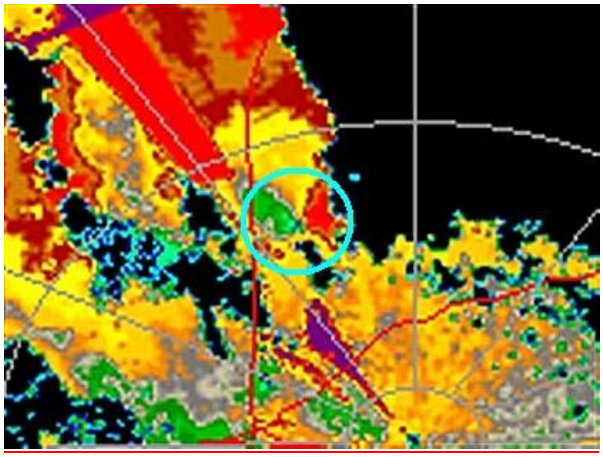

Figure 10. 1.3 deg SRM Velocity at 1740Z, prior to arrival in Windsor, showing a maximum inbound velocity of 30 to 40 knots and maximum outbound velocity of 50 to 60 knots (circled area).

3. CONCLUDING REMARKS

Although not one of the most deadly storms of 2008 (1 fatality, 15-20 injuries), the 22 May Windsor tornado is noteworthy due to its proximity to Colorado's Urban Corridor and its unusual storm motion. The Boulder NWS estimates that 850 homes were damaged, with 300 sustaining significant damage or being destroyed. Insurance damage estimates indicate the current total at just under 150 million dollars. Post-event case studies of significant storms is an excellent way to better understand the meteorology, which allows for better prediction of future events.

4. ACKNOWLEDGEMENTS

The authors would like to thank the Boulder National Weather Service, John Finch, and Brian McNoldy for useful input to this work. The views, opinions, and findings in this report are those of the authors, and should not be construed as an official NOAA and or U.S. Government position, policy, or decision.

5. REFERENCES

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