THE 4 MAY 2003 TRI-STATE SUPERCELLS

Daniel Spaeth
National Weather Service, Paducah Kentucky

1. INTRODUCTION

On the evening of 4 May 2003, three different environments produced storms of varying structure and severity across southeast Missouri, western Kentucky and the southern tip of Illinois. This extended abstract will document the three near-storm environments and the storms they supported.

2. ENVIRONMENT

The synoptic setting on the evening of 4 May 2003 was dominated by a closed low in the mid and upper levels of the atmosphere over eastern Montana. An examination of the upper air data from 0000 UTC 5 May 2003 indicated that a strong short wave trough at 250 hPa extended from the low southeast into South Dakota and then south through the Central Plains. In the base of this trough, a 51-62 m/s (100-120kt) sub-tropical jet extended from New Mexico through Arkansas.

In the low levels, a deep low at 850 hPa was centered over western Iowa. A warm front extended southeast from the low through central Illinois and into central Kentucky, while a cold front trailed southwest from the low into the Texas panhandle. At the surface, a low was centered over northeast Kansas. The surface warm front extended southeast from the low through southern Missouri and into western Tennessee. Meanwhile, the surface dry line extended to the south of the low through eastern Kansas and into central Texas.

The Paducah County Warning Area (CWA) was located in an area of strong warm, moist advection in the low levels and divergence aloft. Through 0200 UTC, in response to the subtropical jet nosing into the area, the southwesterly low level jet quickly increased from 23 m/s (45 kts) to 33 m/s (65 kts) and the surface warm front surged northeast into southeast Missouri and extreme southwest Kentucky. The strengthening low level jet and rain-cooled air from ongoing convection helped to focus a fairly narrow surface warm sector along the Mississippi River.

Beyond 0200 UTC, the warm front was stationary, while the core of the low level jet and the surface warm sector shifted gradually eastward across western Kentucky. This highly sheared, baroclinic low-level environment translated eastward with the storms, providing them a nearly constant environment along their paths.

3. NON TORNADIC SUPERCELL

The first storm of the evening had already developed mid-level rotation, as it moved into southwest New Madrid County, Missouri around 0000 UTC. By 0035 UTC, it had developed a strong low-level mesocyclone with a rotational velocity of 20.6 m/s (40 kts) at 0.5 degrees. However, it only lasted for about 15 minutes and no severe weather was reported in association with it. By 0050 UTC, the low-level circulation was gone, and by

Corresponding Author: Daniel R. Spaeth, National Weather Service, 8250 KY HWY 3520, West Paducah, KY 42086:
E-mail: daniel.spaeth@noaa.gov

0110 UTC, the storm had lost all rotation.

At the time this storm moved into the Paducah CWA, it was located near the warm side of the baroclinic zone associated with the warm front. However, the northeastward motion of the storm did not take it deeper into the cool air because the baroclinic zone was shifting northeast at the same time. Therefore, with meager low-level baroclinity and modest low-level shear, it was not surprising that the storm was not able to produce a tornado. However, it was surprising that this storm with a persistent mid-level mesocyclone produced no severe weather at all.

4. ISOLATED SUPERCELL

An isolated supercell produced at least 11 tornadoes, all of F1 or F2 intensity, along a path from extreme southeast Missouri through the southern tip of Illinois and across a portion of western Kentucky. This storm formed out of a cluster of storms near the advancing warm front along the western edge of the WFO Paducah CWA in southeast Missouri around 0030 UTC.

4.1 Radar Evolution

Mid-level rotation developed very quickly and persisted for the entire life of the storm. A tight low-level rotation first developed by 0100 UTC, but the rear-flank downdraft was too strong and quickly undercut the low-level circulation. Marginally severe wind gusts occurred with the RFD, but no tornados were reported.

As the storm marched eastward over the next hour, the mid-level rotation remained strong and broad, while the low-level rotation re-organized. By 0150 UTC, a low-level TVS had developed, (see figures 1 & 2) and a tornado touched down in Scott county, Missouri shortly thereafter. The tornado was on the ground for over 17.7 km (11 miles) and produced F2 damage at its strongest point.

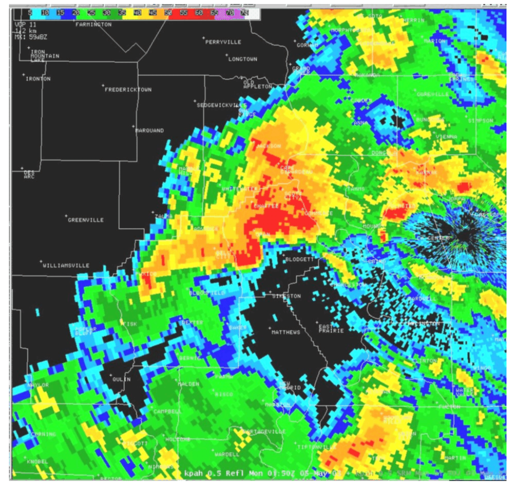

Figure 1 - 0150 UTC - 0.5 degree reflectivity

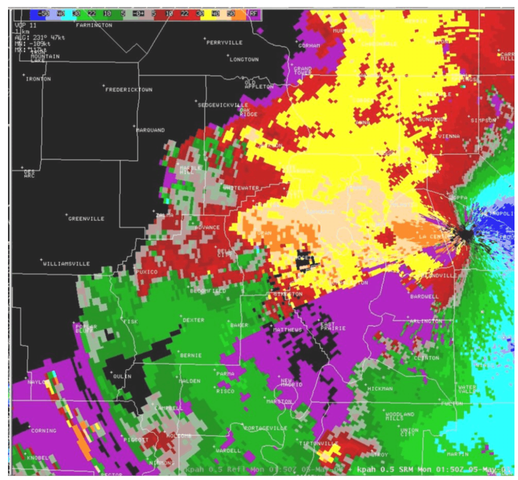

Figure 2 - Same as figure 1 except velocity

Over the next 3 hours, the storm moved just north of east, taking it deeper and deeper into the cool side of the baroclinic zone. Toward the end of its trek through the Paducah CWA, the storm s reflectivity structure became ill-defined, but the low-level circulation persisted (rotational velocity of 13.4 m/s (26 kts) at 0.5 degrees), and the storm continued to produce tornadoes.

4.2 Environment Evolution

Early in the storm s life cycle, its environment was characterized by 0-3 km helicity of 600+ m^2/s^2, 10 km shear of 46-51 m/s (90-100kts), and 6 km shear of 31-33 m/s (60-65kts). These parameters all supported supercell development, but the low level shear of 21-26 m/s (40-50kts) through 1.5 km was not overly strong. Thus the storm had a difficult time, initially, trying to maintain a low-level circulation.

However, by the time of the first tornado, the low-level jet increased to 33 m/s (65 kts) from the southwest, resulting in extreme shear, over 31 m/s (60 kts), in the lowest 1.5 km. In addition, the surface baroclinic zone strengthened and became stationary. The combination of these factors in conjunction with a storm motion taking the storm deeper into the baroclinic zone likely played a significant role in tornadogenesis.

5. SOUTHERN SUPERCELL

In response to strong low-level warm, moist advection and divergence aloft, numerous showers and thunderstorms developed and moved northeast across western Kentucky and western Tennessee during the early evening of 4 May 2003. By 0300 UTC, a supercell embedded in a larger area of light to moderate rainfall lifted northeast into southern portions of Graves and Calloway counties in western Kentucky.

At the time the storm entered western Kentucky, it had a supercell reflectivity structure with a thick hook echo, which was still located in northern Tennessee. The velocity data revealed that the storm had two separate circulations. The primary circulation was located in the hook echo, and a rain-wrapped circulation was located further northwest into the precipitation core of the storm.

As the storm continued northeast through 0330 UTC, the storm grew significantly in area, and the hook echo evolved into a thick appendage on the southwest side of the storm. An inflow notch was located on its south side. The primary circulation continued to reside near the inflow notch, but became more of a convergent signature rather than a cyclonic circulation. However, the rain-wrapped circulation, continued to move northeast, remaining well within the precipitation core of the storm.

By 0340 UTC, the rain-wrapped circulation tightened with rotational velocity of at least 17 m/s (33 kts). A brief F2 tornado formed with this feature 4.8 km (3 miles) northeast of Murray Kentucky. The circulation broadened shortly thereafter and ultimately dissipated completely by 0400 UTC. The southern portions of the storm later re-organized and moved east northeast just south of the Tennessee border.

This storm appeared to be rooted in the narrow surface warm sector, which would explain why it had difficulties trying to lift northeast and continually redeveloped on its southern flank. The environment of this storm was characterized by somewhat weaker low-level shear (21-23 m/s or 40-45 kts through 1.5 km) than the isolated supercell discussed in Section 4 and was obviously not impacted as much by the baroclinic zone which it seemingly avoided.

However, the tornado near Murray Kentucky came out of the low-level circulation that was further north into the baroclinic zone than any other of the circulations associated with this southern supercell. Therefore, the combination of the low-level shear and the baroclinic zone may have been just enough to allow for tornadogenesis.

6. CONCLUSIONS

The three separate storm systems that moved through the WFO Paducah CWA on 4 May 2003 all had distinctly different environments. The long track tornadic supercell and the southern supercell both had strong to extreme low-level shear and were able to produce at least one tornado. However, the persistent tornado producer had persistent exposure to a strong baroclinic boundary, in addition to the extreme low-level shear, to help tornadogenesis. Meanwhile the non-tornadic supercell had neither of these elements available to it.