A PRELIMINARY REVIEW OF WSR-88D RADAR SIGNATURES SEEN IN THE F0 AND F1 CENTRAL ILLINOIS TORNADOES DURING THE RECORD SETTING 2003 TORNADO SEASON

James L. Auten*
Ernest H. Goetsch
NWS Weather Forecast Office
Lincoln Illinois

1. INTRODUCTION

The severe weather season for 2003 in central Illinois was a record setting one. In the month of May alone, a record number of tornadoes (41) occurred. The total number of tornadoes for the year was 63, which approached the yearly record of 65 (set in 1974). Of those 63 tornadoes, 56 of them were rated either of F0 or F1 intensity on the Fujita Tornado Damage Scale (Fujita, 1971). Though weak in nature, such storms remain a concern to the public. Their observance continues to threaten public safety and gain extensive media coverage. These phenomena remain a significant forecast challenge to the local NOAA's National Weather Service (NWS) office.

Strong tornado events (F2 or higher on the Fujita Scale) have been well documented (Davies and Johns, 1993; Concannon et al, 2000; Thompson and Edwards, 2000) Extensive research has also been done on supercell tornado development, and more recently on bow echoes and squall lines (quasi-linear convective systems) (Przybylinski, 1988; Wakimoto and Wilson, 1989; Przybylinski, et al, 1996; Klimowski et al, 2000; Tessendorf and Trapp, 2000; Ketcham and Przybylinski, 2002). In contrast to the strong tornado events, the weak tornado cases in central Illinois are extremely challenging to operational field forecasters. Figure 1 shows a 0.5 degree elevation scan from the Lincoln, IL WSR-88D (KILX) on 13 July 2004. A classic supercell is seen in the reflectivity and storm relative velocity map (SRM) data with a rotational velocity (Vr) of 30 ms^{-1} (58 knots) and a circulation diameter of 1.5 km (0.8 nm). An F4 tornado was on the ground at the time of this figure. In contrast, Figure 2 shows the reflectivity and SRM display from a more typical type of central Illinois tornado event. A small F0 tornado occurred from the cell at the "home location" at the time of the figure. Only a weak echo region (WER) is visible with no circulation found in the SRM data. This storm complex is also north of an outflow boundary, produced a few hours earlier. The boundary can be seen in the reflectivity data south of the storm. These events are much more frequent in occurrence than the strong tornadoes produced by the classic supercell.

This study is a preliminary investigation of the radar signatures associated with "weak tornado events" which occurred during the record year of 2003. It will test current conceptual models (Doswell and Burgess, 1993) and radar interpretation techniques used in monitoring such events.

2. DATA USED

The types of events that occurred in 2003 varied significantly. Some tornadoes were produced by strong dynamic systems, with the result being classic supercells. Such cases occurred on 10 and 30 May 2003, and were documented by Barker and Miller (2003) and Holicky and Przybylinski (2004). This study however, focuses on the more "difficult" operational forecast problem of the weaker events, the F0 and F1 tornadoes, where the radar features were not as "classic" in nature. Radar data was viewed on the office Weather Event Simulator (WES) (Magsig and Page, 2001). This system has been in use since 2001 and is a training and research tool. Event data archived at the NWS Lincoln office was solely used in playback mode on the WES for this study. Only 39 of the 56 weak tornado cases in 2003 were used in this study due to data archival limitations.

3. STUDY FOCUS AND METHOLOGY

This preliminary investigation focuses on a number of aspects of the events in 2003. The events were first classified by storm type and radar signatures accompanying tornado formation. Signatures in four types of WSR-88D radar data (Crum and Alberty, 1993) were evaluated: radar base reflectivity, SRM, base velocity, and spectrum width (SW). The use of typical operational warning forecaster techniques such as data loops, four panel displays, and the all-tilts display were investigated. Finally, pre-event signatures were searched for, with the goal of finding details that would give the forecaster possible clues to future tornadic development.

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* Corresponding Author's Address: National Weather Service, 1362 State Route 10, Lincoln, IL 62656: James.Auten@noaa.gov or Ernest.Goetsch@noaa.gov.

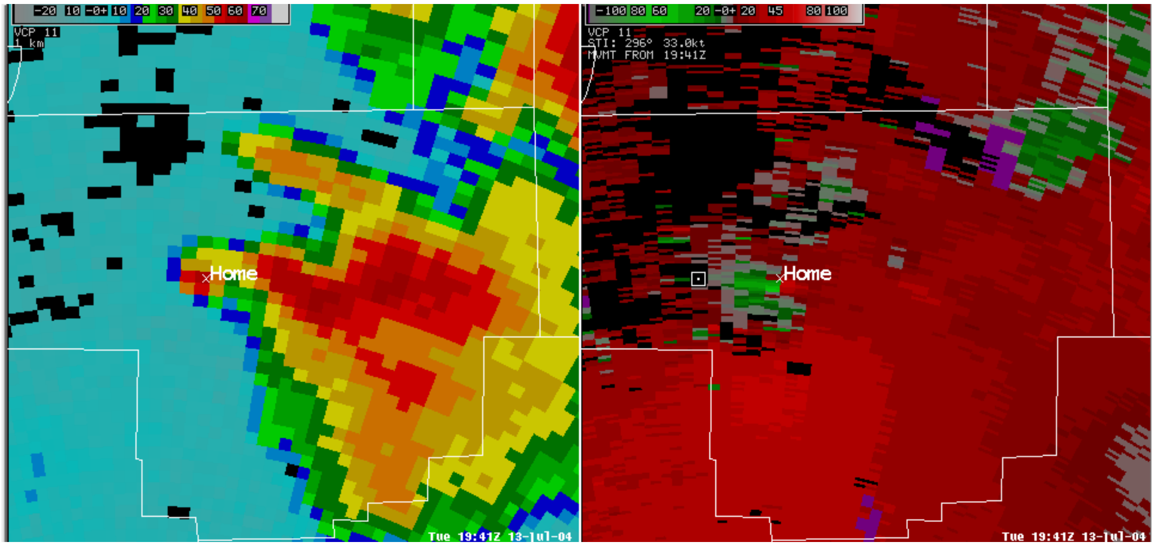

Figure 1. (a) KILX 13 July 2004 1941 UTC 0.5 degree reflectivity. (b) Same as (a), but for SRM. "Home location" represents the hook echo, the circulation center, and the F4 tornado that hit the Parsons Plant outside of the town of Roanoke, IL.

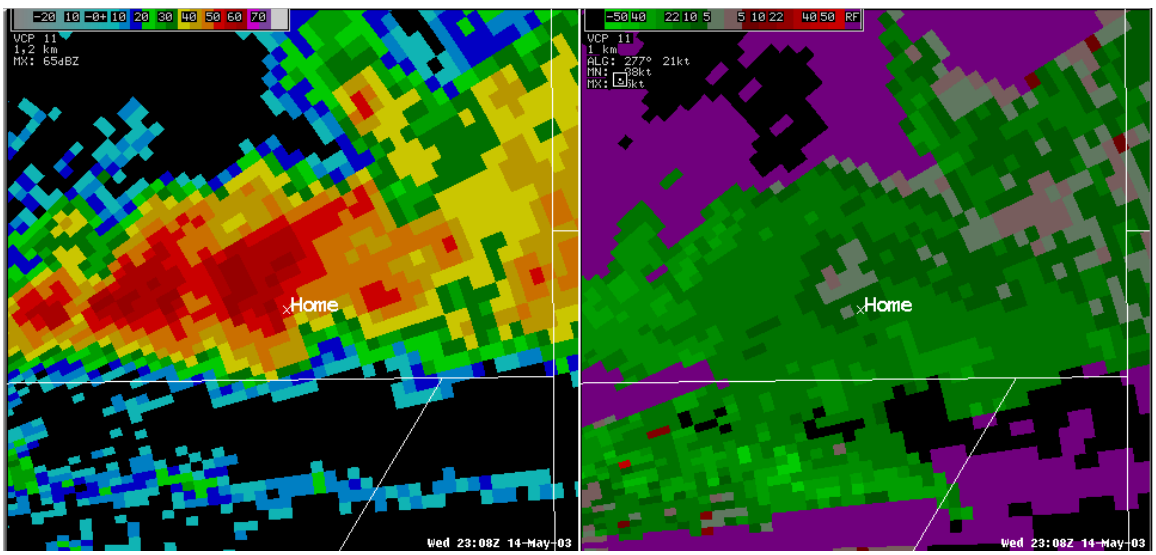

Figure 2. (a) KILX 14 May 2003 2308 UTC 0.5 degree reflectivity. (b) Same as (a), but for SRM. "Home location" represents the WER with no apparent circulation found. An F0 tornado occurred at 2308 UTC, 3.7 km (2 nm) east of LeRoy, IL.

4. PRELIMINARY FINDINGS

This presentation is just the first step in the investigation of the significant operational forecast problem of anticipating weak tornadoes in central Illinois. However, a number of obvious findings were a result of this effort.

Radar features were found to be generally more subtle and more transient than evident in the stronger tornado cases. In the majority of cases investigated, typical signatures that warning forecasters have been using for many years for strong tornadoes, also appear in the weak tornado cases. Such signatures include: hook echoes, WERs, bounded weak echo regions (BWERs), rear inflow notches (associated with a rear inflow jet), and forward inflow notches (WDTB, 1991). Conceptual models appeared to generally still apply, but in weaker magnitudes. Hook echoes, appendages, and notches continued to be an important reflectivity signature of a storm's stage of development. SRM data did show minor weak circulations with a number of the weak tornadic cases, but in general, the reflectivity signatures occurred more often than the weak circulation signatures. The transient nature of these signatures was also evident, as in the majority of cases the lead time on these weak features was extremely small, with the feature lifetime relatively short.

Tornadoes associated with heavy precipitation (HP) supercells and bow echoes are common in central Illinois. The occurrence of such events can be difficult to forecast. Such events fit well into the realm of this study. Even though features with these systems were weak in comparison to classical supercells, in most cases these events also fit current conceptual models. Tornado occurrence was normally to the left of the rear inflow jet (notch), to the left of the forward inflow notch, and sometimes in the head of the bow.

In order to attempt to pick up the more subtle features found in these weak events quicker, several different techniques were evaluated. The four panel display was found to be generally very useful in quickly determining the vertical depth of the small features in the operational environment. In approximately half of the cases, the all-tilts product was also very useful, especially when the target storms were relatively close to the radar. Different types of looping procedures for the radar data were also evaluated. Increasing the use of these data loops appears to be a key to quickly identifying the development of some of the weak signatures.

The importance of boundaries is well documented by a number of individuals (Markowski et al, 1998; Atkins et al, 1999). Identifying these mesoscale and sometimes even "storm-scale" boundaries appears to be critical in aiding the forecasting of many of the study's events. Surface convergent boundary induced cases have historically been a critical local forecast problem in central Illinois. Such cases where opposing surface wind flow converges on a nearly stationary boundary have produced some major events with large numbers of funnel clouds and several weak tornadoes. Researched recently by Caruso and Davies (2005), two such events occurred in 2003. The resultant multicell convection that was triggered did show the common radar signatures of hook echoes and weak circulations with the weak tornadoes that developed on the boundary.

Other types of boundary intersection cases involved weak tornadoes being formed when a storm complex intersected an area where a previous thunderstorm cell had moved through and laid down a rainfall generated "cold air dome", producing a mesoscale or "storm-scale" boundary. The focusing of low level vorticity at the intersection point triggered the development of a weak tornado in several cases. The use of reflectivity loops in such a way to annotate the track of these "antecedent storms" appears to be critical to defining where such intersections and possible development would occur.

Finally, the knowledge of the pre-existing storm environment has been stressed as essential for operational severe weather forecasters (WDTB, 2004). This study also illustrates this fact and strengthens this argument.

5. STUDY EXAMPLES

5.1 WER, BWER, AND HOOK ECHO EXAMPLES

Figure 3 illustrates an example of a typical WER pattern in the observed weak tornado cases that were studied. In this 2258 UTC 14 May 2003 image, a weak hook echo shape is found just west of the "home location", with high reflectivities seen aloft over the hook region. As was the case in many such events in the study, even the 0.5 degree SRM slice did not show any evidence of circulation. The appearance of the weak hook and WER signatures at 2258 UTC were the only precursors to the F0 tornado that occurred just 10 minutes later, 3.7 km (2 nm) east of the town of LeRoy in McLean county.

Figure 4 shows a four panel display of a weak hook echo pattern and BWER for 2024 UTC on 4 April 2003. The placement of the "home location" in the image is on the low level circulation seen in the SRM data. Note the echo overhang and the presence of the BWER signature. Figure 5 is the SRM four panel for 2024 UTC 4 April 2003. A broad circulation is seen above the "home location" at the 1.5, 2.5, and 3.5 degree elevation slices.

As distances between a target storm and the radar decrease, higher elevation slices must be used. This can either be done by use of the all-tilts product or by different types of four panel displays, such as is shown in Figure 6. In the 2108 UTC image on 4 April 2003, an example of a "mini-supercell" is shown using a four panel display of 0.5, 2.4, 4.3, and 5.3 degree elevation slices. A hook echo is found again at the "home location" with its vertical structure evident. Figure 7 is the corresponding SRM four panel display. The circulation is visible near the "home location" up to 5.3 degrees (1496 m AGL or 4908 feet AGL) at 16.5 m (9 nm) from the radar. In this case, the circulation formed 13 minutes before tornado touchdown (3 minutes after this image). The strength of the circulation in the lowest elevation angle changed from 15.5 m s^{-1} (30.5 kt) at formation to greater than 23 m s^{-1} (45 kt) at the time of the tornado formation. The circulation diameter changed from 3.7 km (2 nm) to 0.7 km (0.4 nm).

5.2 HEAVY PRECIPITATION (HP) SUPERCELLS, BOW ECHOES, SQUALL LINES, BOWING LINE SEGMENTS, AND MULTICELL STORM EXAMPLES

A number of HP supercell and bow echo examples were examined in the study. Figure 8 is an example of a storm on 4 April 2003 that began as an HP storm and then transitioned into a classic supercell. The "home location" identifies the circulation center at the 0.5 degree elevation near the forward center of the storm. There is also a rear inflow notch evident, to the left or west of the "home location". A forward inflow notch is also seen south of the "home location".

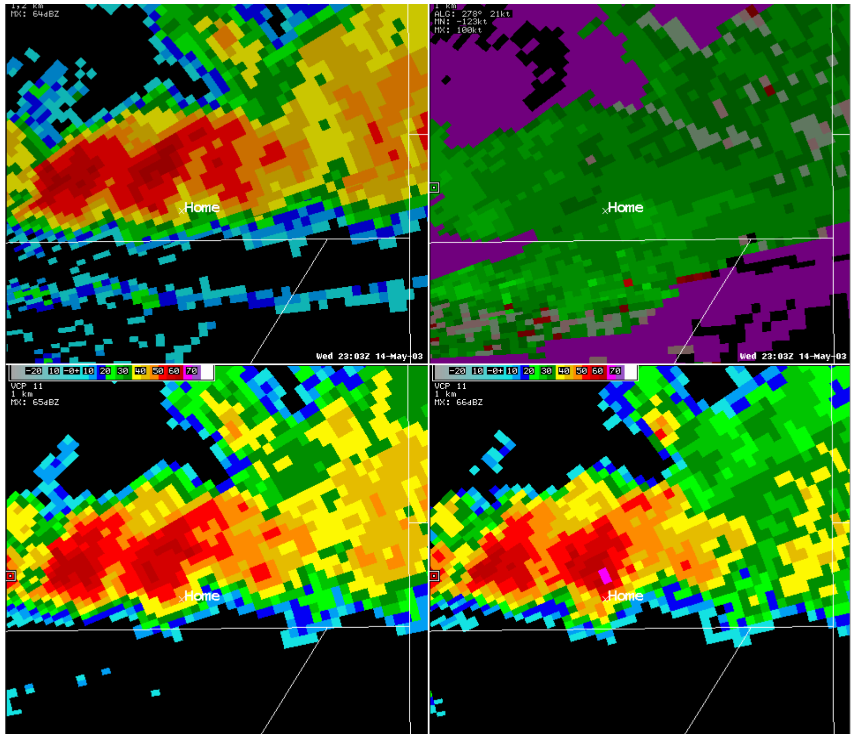

Figure 3. (a) KILX 14 May 2003 2258 UTC 0.5 degree reflectivity. (b) Same as (a), but for SRM. (c) Same as (a), but for 1.5 degrees. (d) Same as (a), but for 2.5 degrees. "Home location" represents the WER.

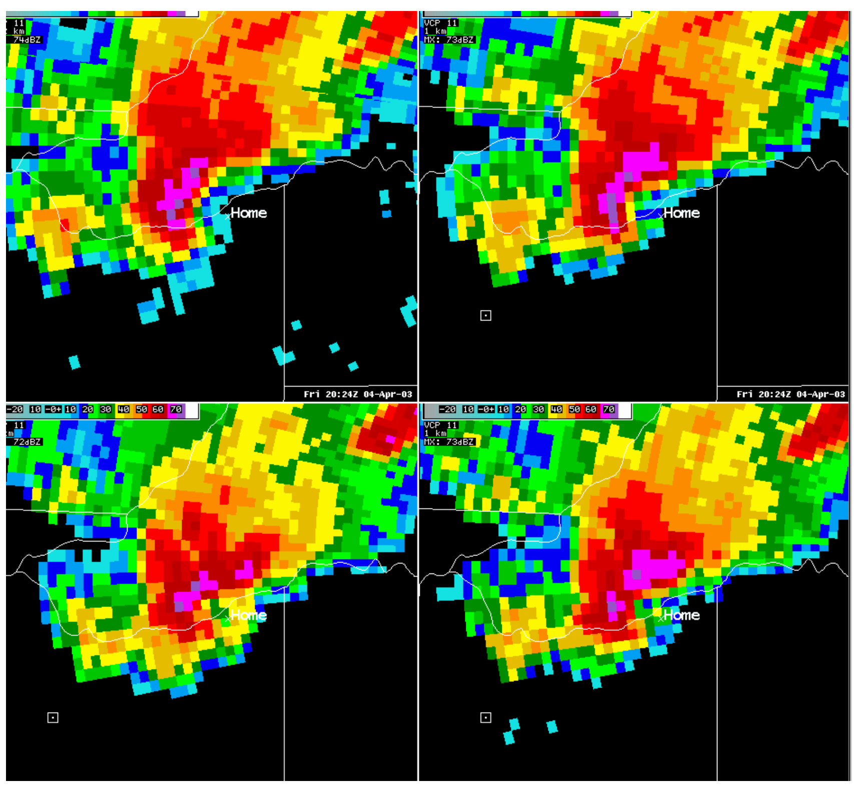

Figure 4. (a) KILX 4 April 2003 2024 UTC 0.5 degree reflectivity. (b) Same as (a), but for 1.5 degrees. (c) Same as (a), but for 3.4 degrees. (d) Same as (a), but for 2.5 degrees. "Home location" represents the circulation center. Note that the BWER is located just to the left (west) of this location in this reflectivity 4 panel.

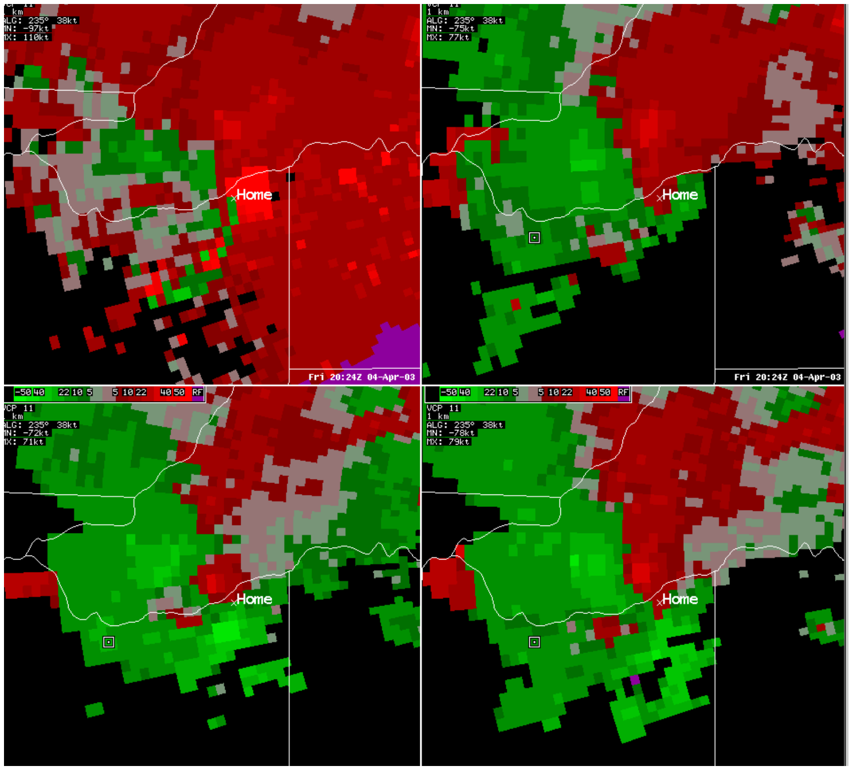

Figure 5. (a) KILX 4 April 2003 2024 UTC 0.5 degree SRM. (b) Same as (a), but for 1.5 degrees. (c) Same as (a), but for 3.4 degrees. (d) Same as (a), but for 2.5 degrees. “Home location” represents the circulation center.

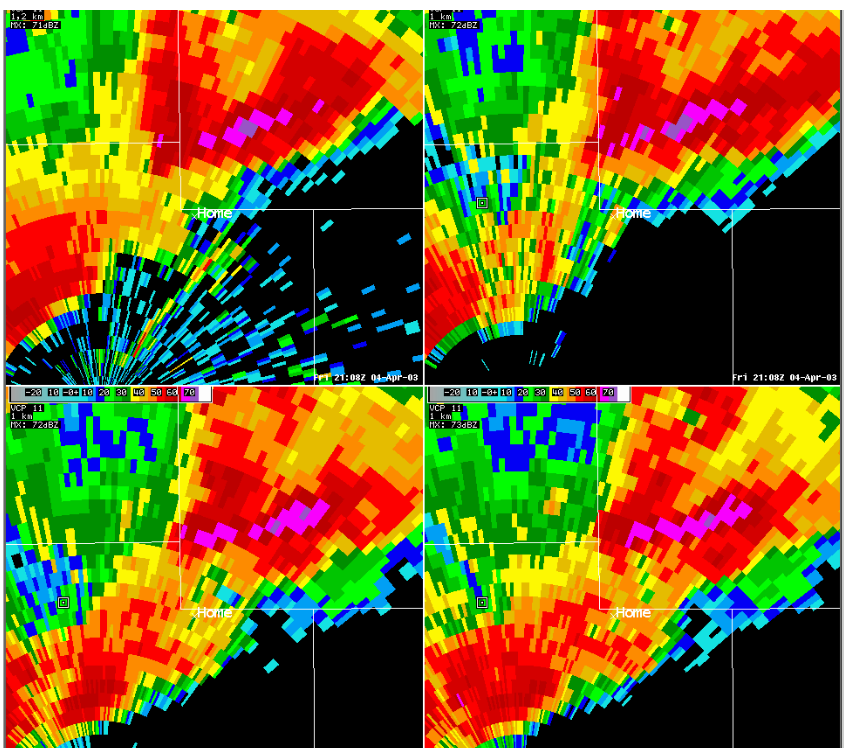

Figure 6. (a) KILX 4 April 2003 2108 UTC 0.5 degree reflectivity. (b) Same as (a), but for 2.4 degrees. (c) Same as (a), but for 5.3 degrees. (d) Same as (a), but for 4.3 degrees. “Home location” represents the hook echo and circulation center. Three minutes later, an F0 tornado occurred 0.9 km (0.5 nm) north of Atlanta, IL, at 2111 UTC.

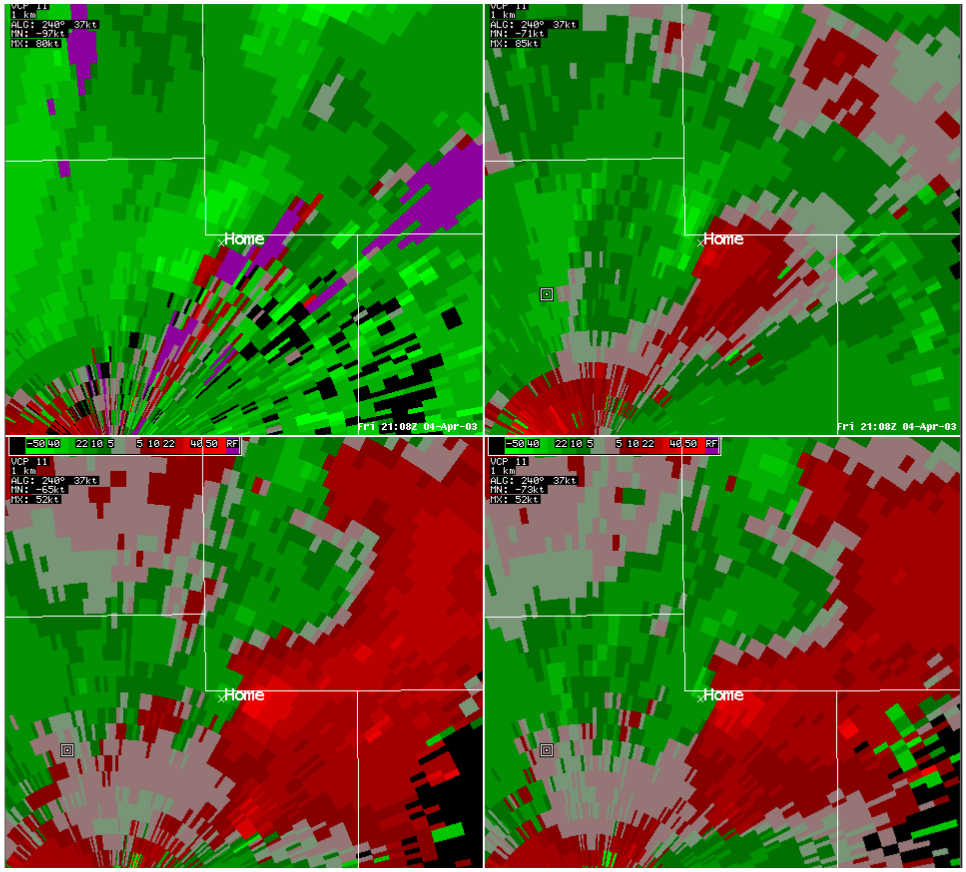

Figure 7. (a) KILX 4 April 2003 2108 UTC 0.5 degree SRM. (b) Same as (a), but for 2.4 degrees. (c) Same as (a), but for 5.3 degrees. (d) Same as (a), but for 4.3 degrees. “Home location” represents the circulation center.

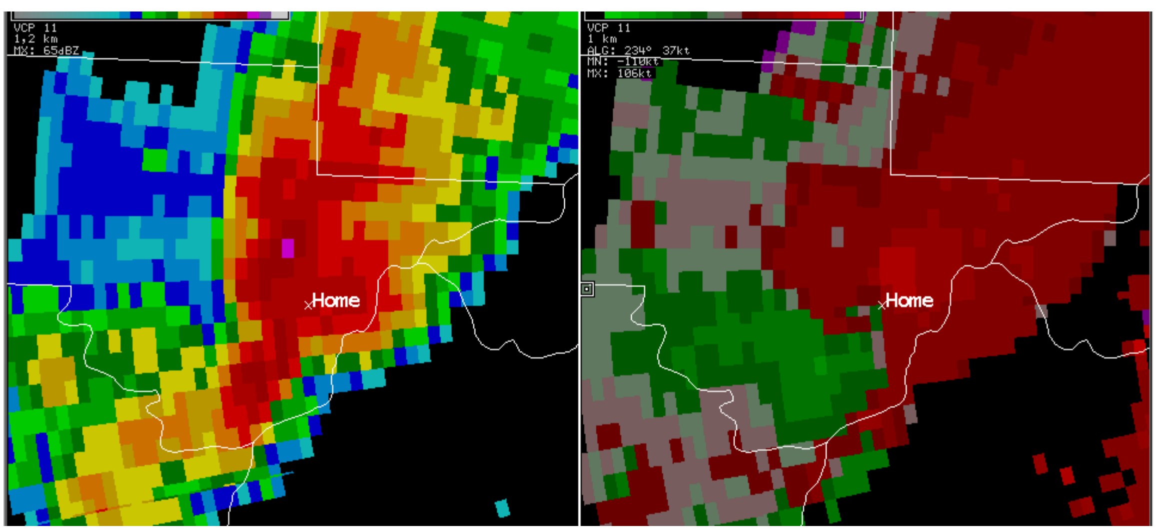

Figure 8. (a) KILX 4 April 2003 1954 UTC 0.5 degree reflectivity. (b) Same as (a), but for SRM. “Home location” represents the circulation center in a HP supercell.

Figure 9 depicts a four panel reflectivity sequence of another HP storm that occurred on the morning of 10 May 2003. No significant signatures were visible in the SRM data for this case. The reflectivity data though, did yield some important keys. Three F0 tornadoes occurred near the “home location” between 1253 UTC and 1258 UTC, with a fourth F0 tornado at 1303 UTC near the forward inflow notch (in Figure 9, section d).

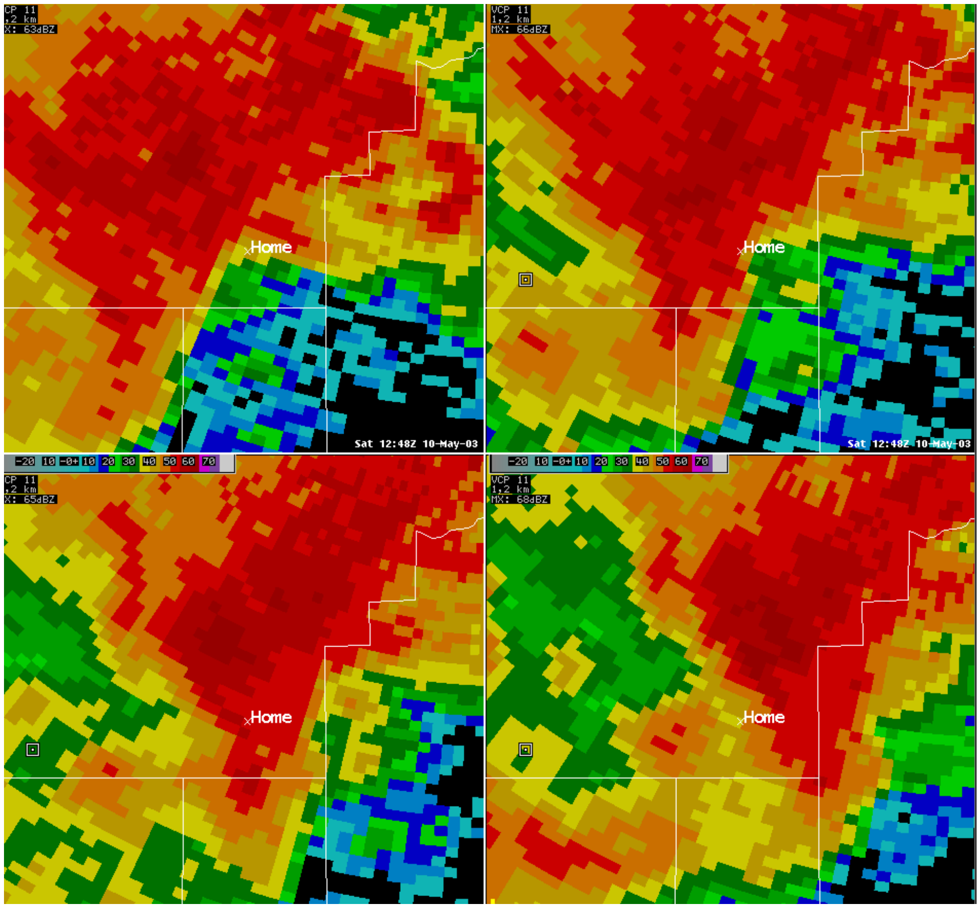

Figure 9. (a) KILX 10 May 2003 1248 UTC 0.5 degree reflectivity. (b) Same as (a), but for 1253 UTC. (c) Same as (a), but for 1258 UTC. (d) Same as (a), but for 1303 UTC. "Home location" represents the area where three F0 tornadoes occurred between 1253 UTC and 1258 UTC.

A rear inflow jet (notch) was visible at the back of the HP storm. A significant forward inflow notch was visible throughout the sequence. Each of the four F0 tornadoes occurred in the vicinity of this forward inflow notch.

The study also contained a number of small bow echo events. Figure 10 shows an example of one that occurred on 26 September 2003. The "home location" in the image shows the location of the F1 tornado that occurred at 2350 UTC. The reflectivity data shows a weak rear inflow notch west northwest of the tornado occurrence (evident 10 minutes before tornado development) with weak front inflow notches to the north and south. The corresponding SRM at 0.5 degrees elevation shows a weak circulation near the tornado location (formation also about 10 minutes before tornado development). Vr values for this circulation were 10.75 m s^{-1} (21 kt) with a width of 1.8 km (1 nm).

One of the most frequent types of cases to effect central Illinois is a combination of storm types during the same event. Squall lines with bowing line segments (Przybylinski, 1988) combined with multicell clusters are a common occurrence. Figure 11 represents a typical example which occurred on 26 September 2003. This sequence shows a line of storms in section (a) of Figure 11 at 2128 UTC. After 30 minutes, at 2158 UTC (section b), the line had developed into a series of bowing line segments, one in the central part of the line with a weak multicell storm complex in the north. After another 15 minutes, at 2113 UTC (section c), the central bow continues east with the multicellular cluster beginning to take on a more HP storm type appearance, just southwest of the radar. After another 10 minutes, at 2223 UTC (section d), the original bow has weakened. However, the cluster over and just south of the radar appears to have the appearance of an HP storm, possibly developing into a small bow echo. In zooming in on the storm cluster south of the radar, Figure 12 shows a small circulation at the "home location" on the forward flank of this HP type storm over Logan County (southwest of the radar). No circulation was visible in the SRM data previous to this radar scan. An F1 tornado briefly touched down and then lifted two minutes after this image. In Figure 13, it is evident that the multicellar storm cluster has developed into an HP storm (observe the S shape in the storm). There is a forward inflow notch and a circulation center still visible at the "home location". Downburst damaging winds were being produced from this storm at the "home

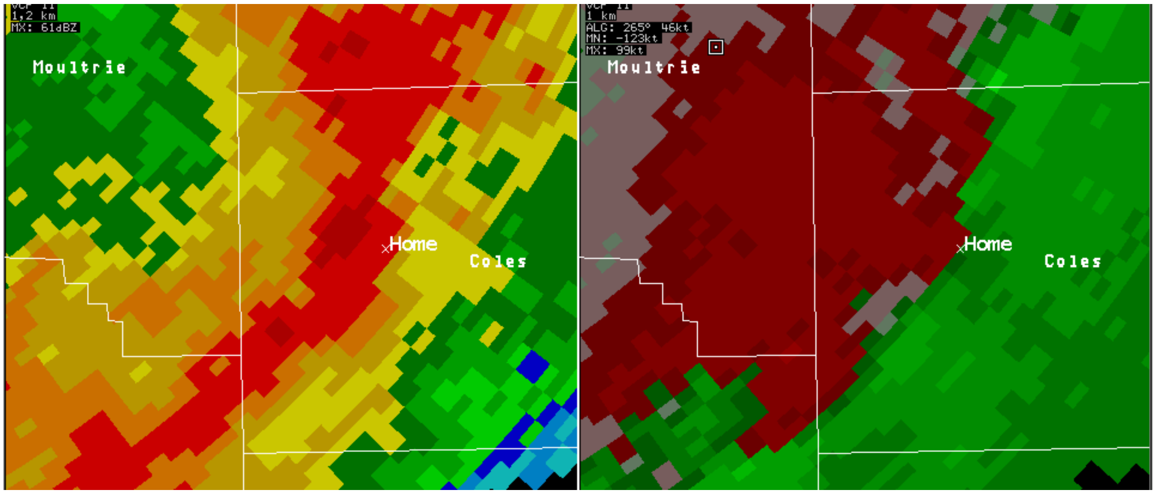

Figure 10. (a) KILX 26 September 2003 2352 UTC 0.5 degree reflectivity. (b) Same as (a), but for SRM. "Home location" represents where the F1 tornado occurred 4 miles north northeast of Mattoon, IL at 2350 UTC.

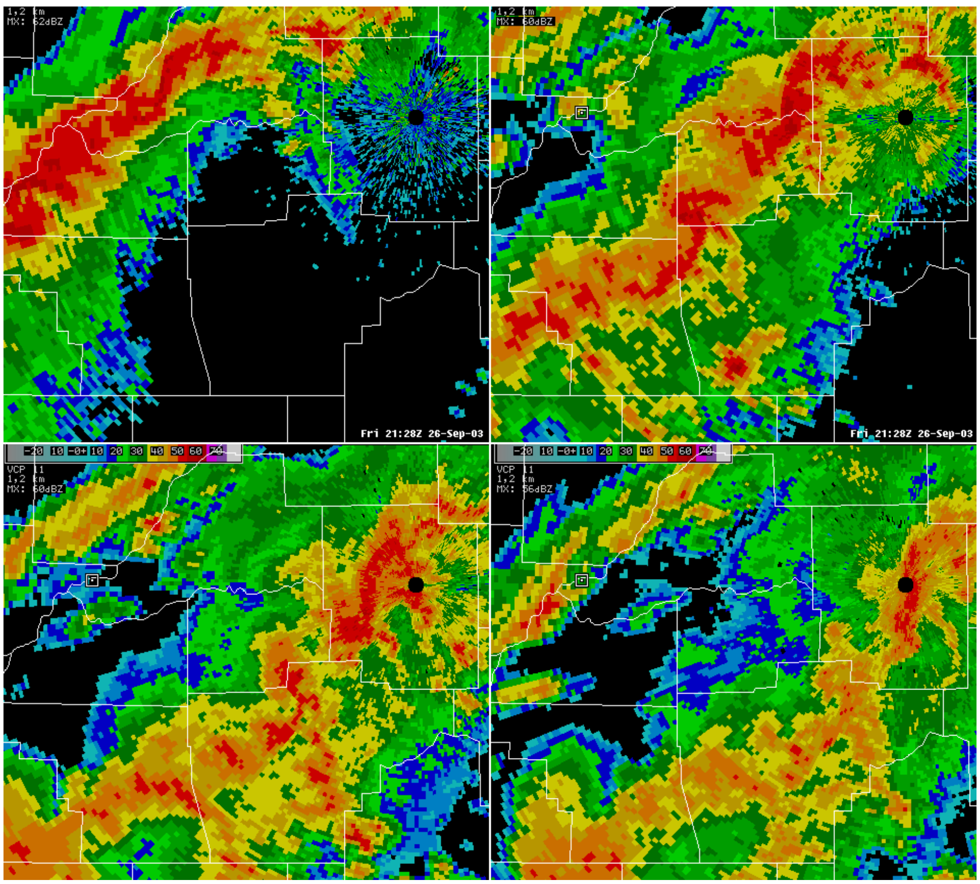

Figure 11. (a) KILX 26 September 2003 2128 UTC 0.5 degree reflectivity. (b) Same as (a), but for 2158 UTC. (c) Same as (a), but for 2113 UTC. (d) Same as (a), but for 2223 UTC.

location" in the town of Mt. Pulaski, IL at the time of this image, 2118 UTC on 26 September 2003. This event is an excellent example of how rapidly significant storms can develop and how short lived the tornado damage can be. The circulation dissipated 10 minutes later.

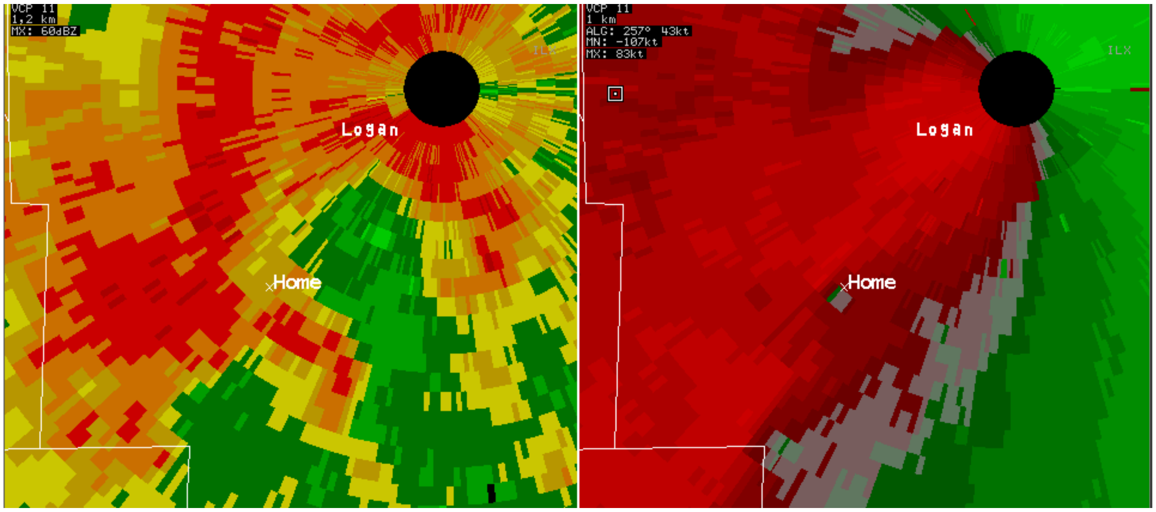

Figure 12. (a) KILX 26 September 2003 2113 UTC 0.5 degree reflectivity. (b) Same as (a), but for SRM. "Home location" represents the small low-level circulation, where a small F1 tornado occurred 3.2 km (2 miles) southeast of Broadwell, IL at 2215 UTC.

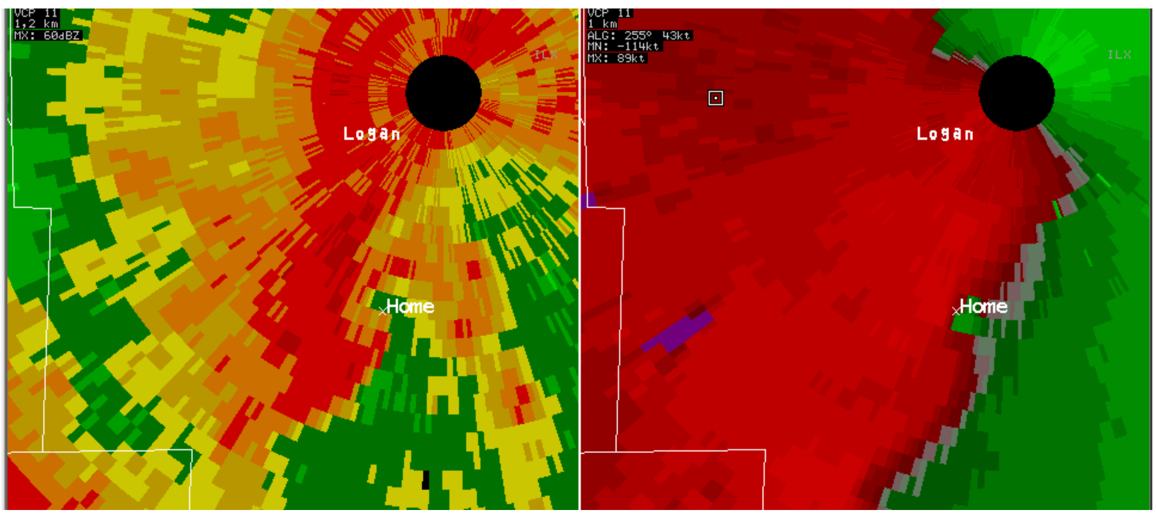

Figure 13. (a) KILX 26 September 2003 2118 UTC 0.5 degree reflectivity. (b) Same as (a), but for SRM. "Home location" represents the small low-level circulation. Downburst winds caused significant tree damage throughout the town of Mt. Pulaski, IL.

5.3. IMPORTANCE OF BOUNDARIES, AND BOUNDARY INTERSECTIONS

Numerous cases in the study further strengthened the importance of boundaries in the development of tornadoes. Some of the cases observed could only be explained by the presence of a previously laid down boundary of cooler air that was intersected by an ongoing storm complex.

Figure 14 shows a sequence of reflectivity images in which two separate outflow boundaries are moving together. They intersect at the "home location" and storm development is triggered in this area. The result of this merger is the development of eight separate F0 tornadoes and numerous funnel cloud reports during a 30 minute period between 2310 UTC and 2338 UTC on 11 June 2003. Figure 15 zooms in on one of the storms, with the "home location" illustrating a small circulation on the northern side of the multicell storm at 2320 UTC (a tornado occurred at this location 3 minutes later at 2323 UTC). The same storm has another weak circulation on it's southern edge. From this circulation, another F0 tornado occurred at the time of this image at 2320 UTC. Radar data for all of the other events on this date show similar, weak circulations in weak multicell storms producing weak brief tornadoes.

Understanding the history of the track of storms that develop and move ahead of a significant storm complex can be critical in recognizing boundary interactions and intersections. Figure 16 shows a reflectivity sequence

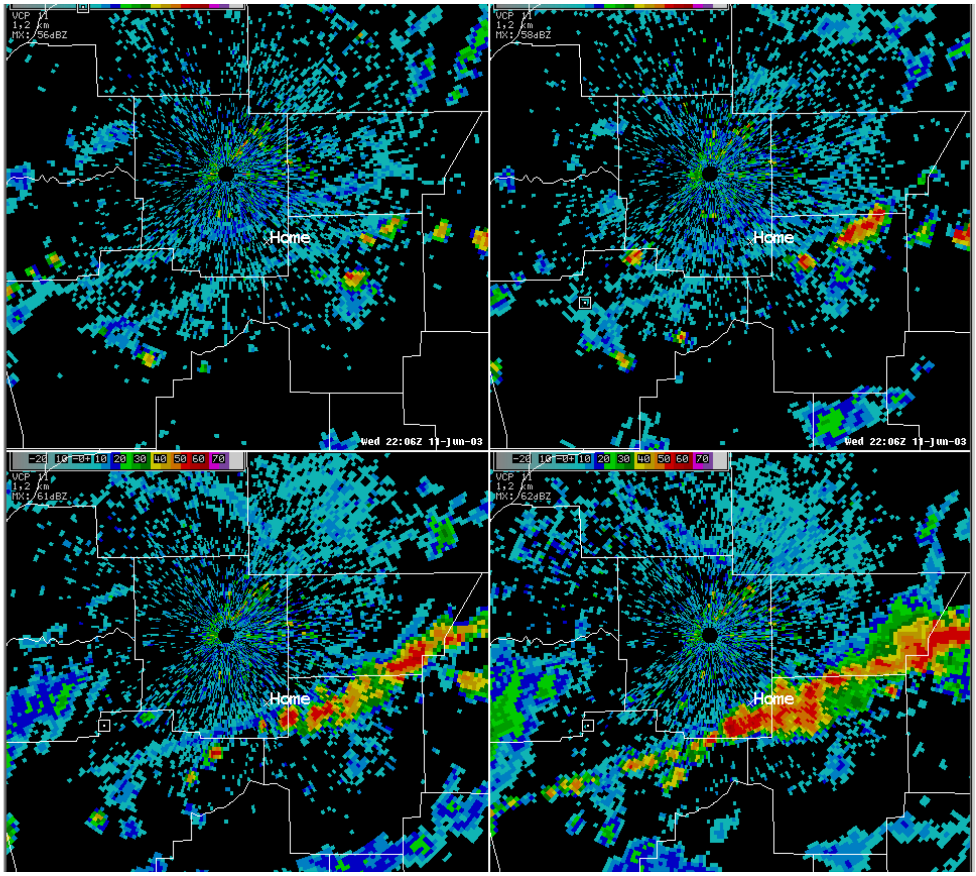

Figure 14. (a) KILX 11 June 2003 2206 UTC 0.5 degree reflectivity. (b) Same as (a), but for 2226 UTC. (c) Same as (a), but for 2256 UTC. (d) Same as (a), but for 2320 UTC. "Home location" represents where the two boundaries intersect and trigger storm development.

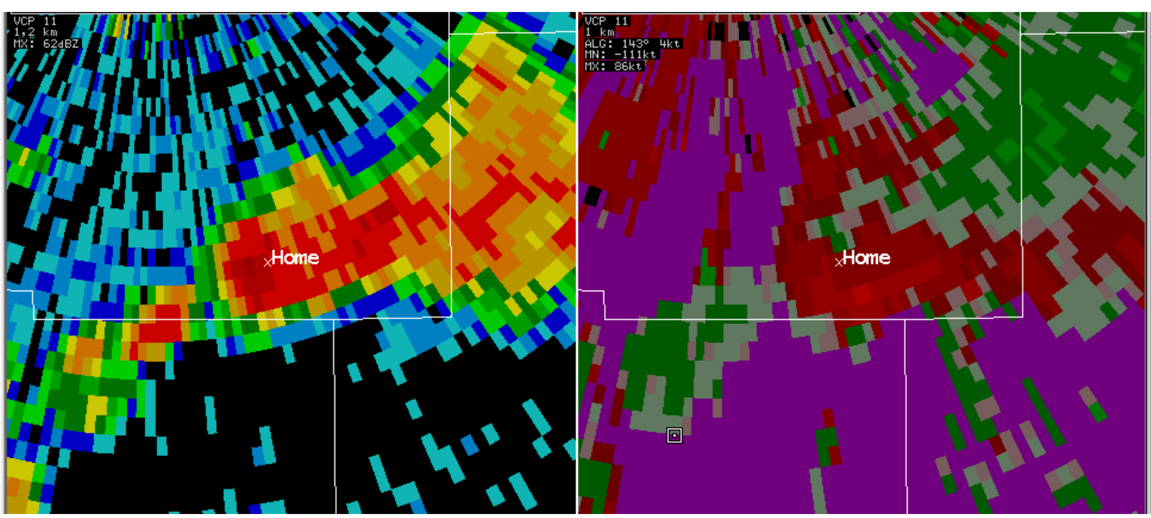

Figure 15. (a) KILX 11 June 2003 2320 UTC 0.5 degree reflectivity. (b) Same as (a), but for SRM. "Home location" represents the small low-level circulation on the north side of this multicell storm, where an F0 tornado occurred 6.4 km (4 nm) south of Mt. Pulaski, IL at 2323 UTC. Another F0 tornado associated with a second weak low-level circulation occurred south of the "home location" near the county line, 3 miles north of Illiopolis, IL at 2320 UTC.

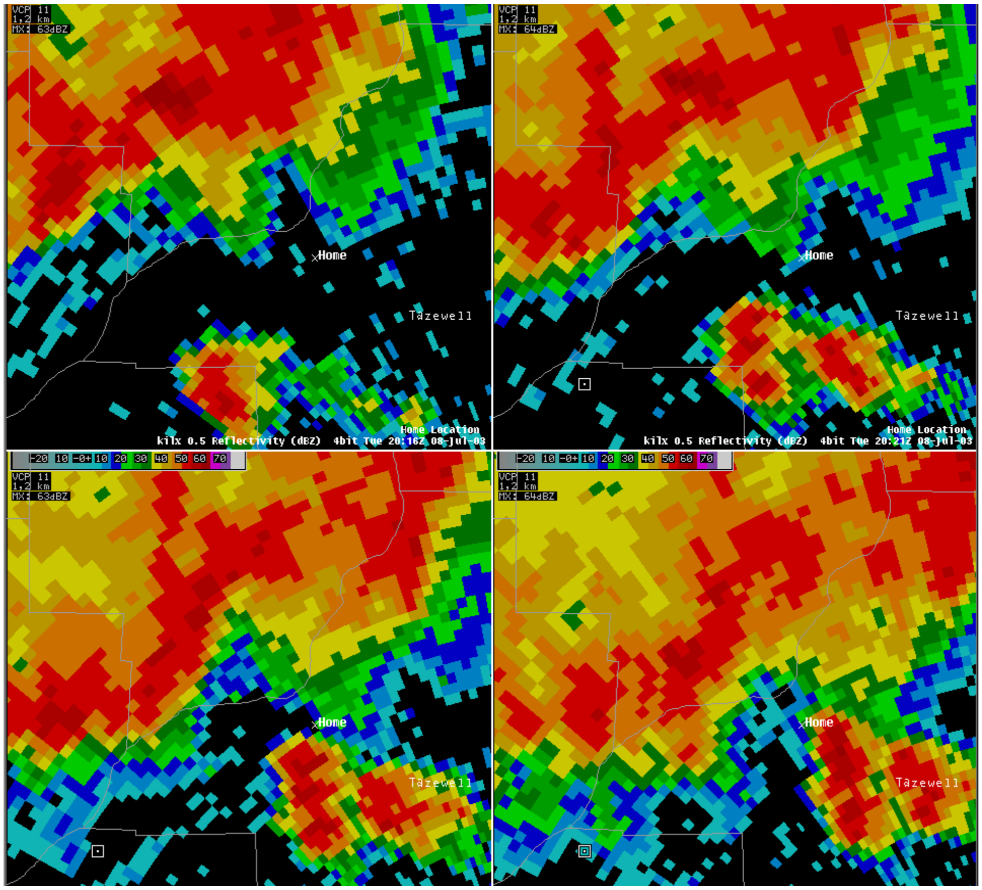

Figure 16. (a) KILX 8 July 2003 2016 UTC 0.5 degree reflectivity. (b) Same as (a), but for 2021 UTC. (c) Same as (a), but for 2026 UTC. (d) Same as (a), but for 2031 UTC. “Home location” represents where the outflow boundary from the storm complex to the west intersects a cell ahead of the complex. An F0 tornado occurred at 2031 UTC 5.5 km (3 nm) southwest of Pekin, IL.

of a bow echo type complex moving toward an antecedent storm out ahead of the approaching complex on 8 July 2003. At the “home location”, the outflow boundary from the complex reaches and intersects the western edge of the antecedent cell. An F0 tornado is produced at the “home location” at 2031 UTC (section d). In Figure 17, the outflow boundary at 2021 UTC is shown at the “home location” using the SRM velocity data. The boundary is nearly invisible in the reflectivity data. This is where a loop of both the reflectivity and SRM data is critical. Figure 18 shows the intersection of the boundary produced by the storm complex and the antecedent cell, 10 minutes later at 2231 UTC. The SRM data shows a small weak circulation at the “home location” concurrent with an F0 tornado occurrence.

The track of an antecedent storm ahead of an approaching storm complex also occurred on 4 April 2003. Figure 19 shows a northeast moving storm ahead of an HP supercell. The “home location” is where the western track of the cell later intersects the supercell. At the intersection point, the storm develops into a classic supercell, later producing tornadoes and wind damage.

Figure 20 is another sequence showing the importance of merging storms. On the morning of 10 May 2003, an antecedent storm just east of an approaching cluster, moves north and merges with the approaching cluster. The result is an HP storm that produces three F0 tornadoes around 1255 UTC, 10 minutes after section (d), near the “home location”.

5.4 USE OF THE WSR-88D SPECTRUM WIDTH DATA SET

One aspect of the study was to investigate the possible use of the WSR-88D SW data set for the weak tornado events. Some research had previously been done using this data (Lemon, 1999, Buller and Mentzer, 1998), but it was unknown as to its applicability to central Illinois events. Figure 21 shows an example of SW data for the 10 May 2003 event with the corresponding reflectivity. Note the SW values of 8 ms^{-1} to 10.5 ms^{-1} (16 to 20 kts) signaled the presence of severe to extreme turbulence in the forward inflow notch area as defined by WDTB, 1991. This appeared at the same time and near the

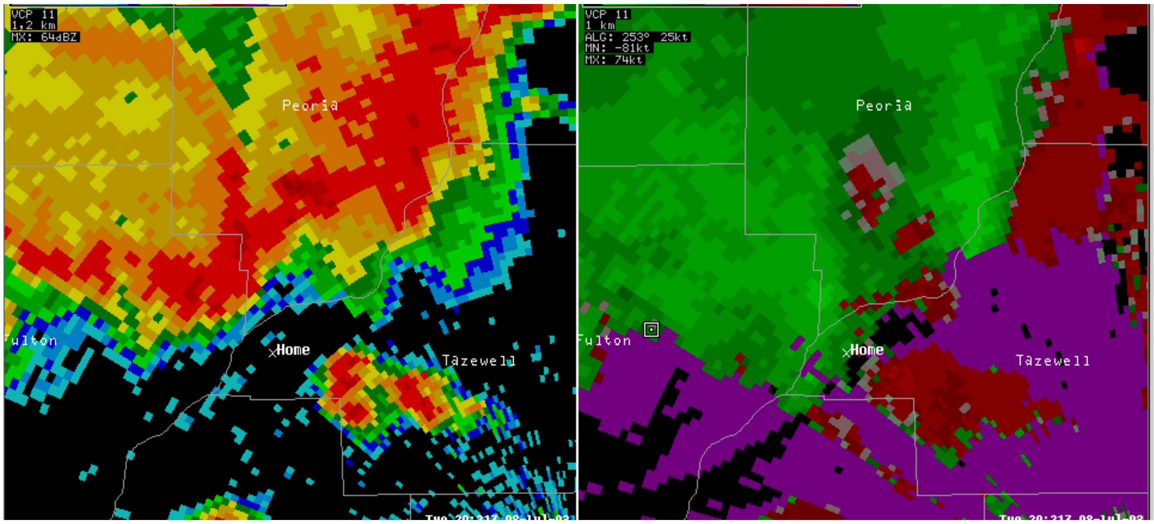

Figure 17. (a) KILX 8 July 2003 2021 UTC 0.5 degree reflectivity. (b) Same as (a), but for SRM. "Home location" represents the position of the outflow boundary produced by the storm complex to the west.

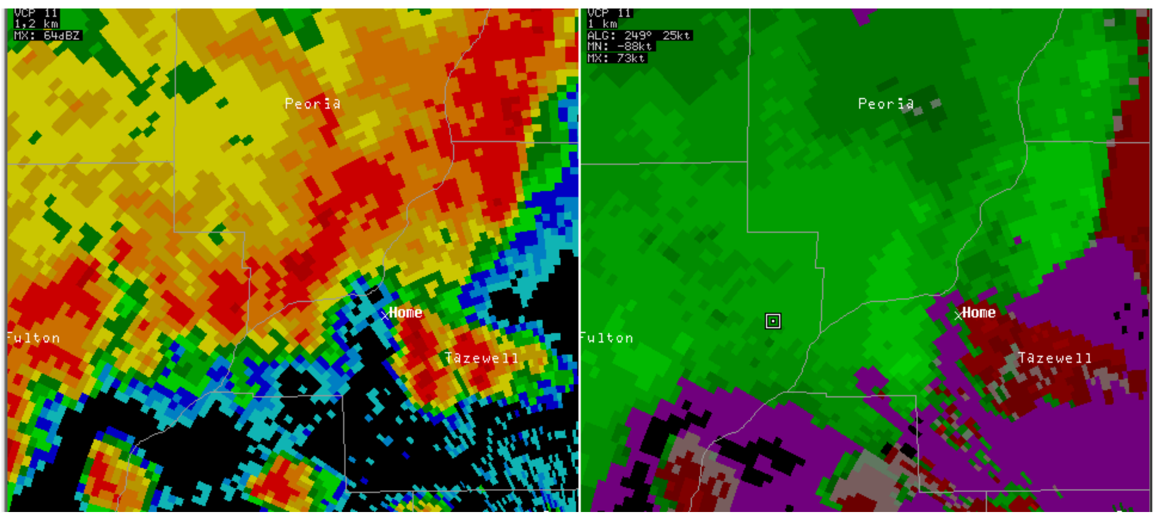

Figure 18. (a) KILX 8 July 2003 2031 UTC 0.5 degree reflectivity. (b) Same as (a), but for SRM. "Home location" represents where the outflow boundary from the storm complex to the west intersects a cell ahead of it. An F0 tornado occurred at 2031 UTC 5.5 km (3 nm) southwest of Pekin, IL.

location of the development of the three F0 tornadoes mentioned earlier. In a few other cases in the study, a similar pattern of turbulence near a hook echo or notch signature in an HP storm was found, sometimes as much as 10 minutes before tornado occurrence. Along convergent boundaries, SW showed little value. No defined pattern was evident to identify where tornado production would occur.

6. OPERATIONAL RECOMMENDATIONS

Even though the study is only an initial step in examining the weak tornado cases, a number of operational recommendations can be made. Due to the subtle and transient nature of the signatures found in these weak tornado cases, heightened attention to the small scale details needs to be maintained.

One recommendation to aid in the identification is to keep a loop of reflectivity and base velocity (or SRM) going at all times to keep track of and to discover the subtle processes involved. Storm outflow development, microburst formation and intersections of boundaries and storms can all be monitored more effectively using loops.

The second recommendation is to expand the operational use of the spectrum width data. The need to determine its viability as a weak tornado identification tool is evident.

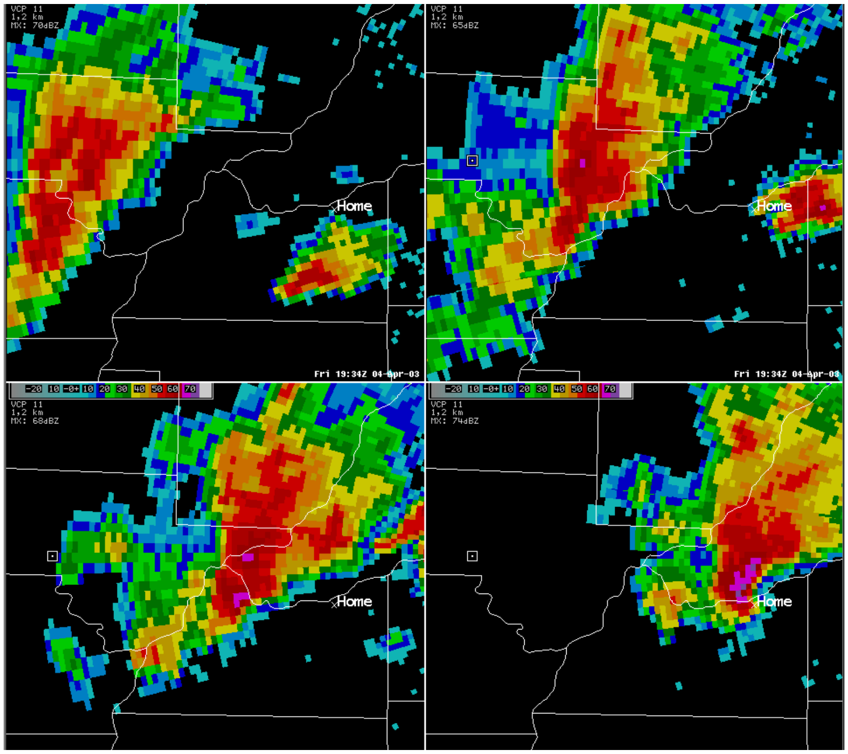

Figure 19. (a) KILX 4 April 2003 1934 UTC 0.5 degree reflectivity. (b) Same as (a), but for 1954 UTC. (c) Same as (a), but for 2009 UTC. (d) Same as (a), but for 2024 UTC. "Home location" is the western edge of the track of the antecedant cell ahead of the approaching HP storm in the west.

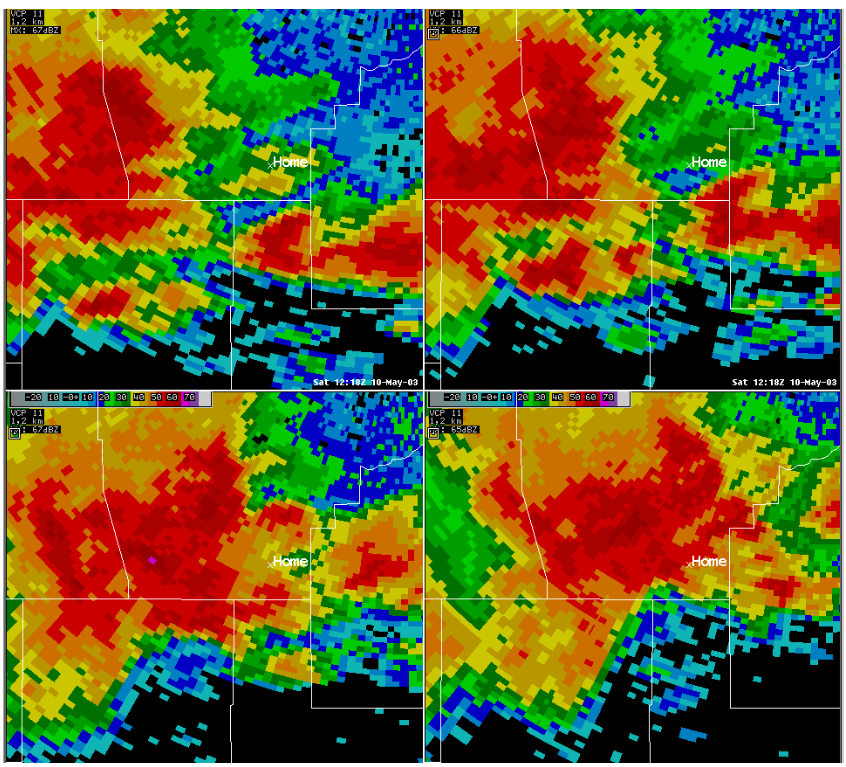

Figure 20. (a) KILX 10 May 2003 1218 UTC 0.5 degree reflectivity. (b) Same as (a), but for 1223 UTC. (c) Same as (a), but for 1233 UTC. (d) Same as (a), but for 1243 UTC. "Home location" represents tornado occurrence position.

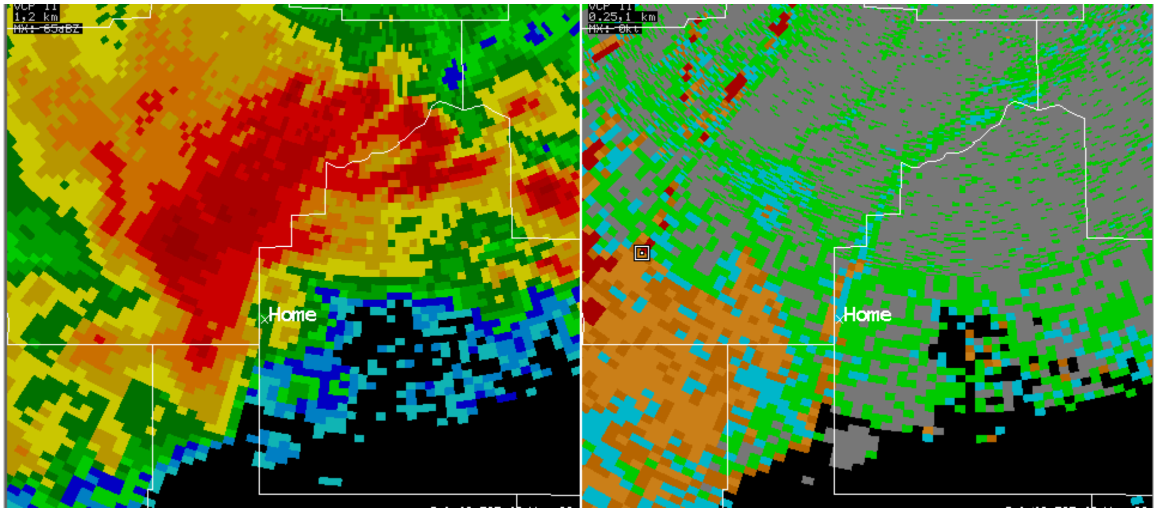

Figure 21. (a) KILX 10 May 2003 1258 UTC 0.5 degree reflectivity. (b) Same as (a), but for SW. "Home location" represents where the SW shows turbulence that corresponds to a forward flank reflectivity notch in a HP storm.

The third recommendation concerns the operational forecaster having a well defined knowledge of the environment for that day. It is critical to have a mesoscale analyst assigned to each event to monitor the type of storms expected and to perform continuous monitoring of the environment throughout the event. This appears to be especially critical in the boundary convergence events that produce numerous funnel clouds and weak non-mesocyclone tornadoes. Identifying such an environment ahead of time is critical since many boundaries are only visible in the 0.5 degree slice and only to a limited distance from the radar.

This study has shown that a "storm-scale" monitoring of the track of some antecedent storms ahead of storm complexes can prove extremely critical to the accurate forecasting of weak tornado formation. It is recommended that forecasters maintain an awareness of the track of such storms.

In order to better accomplish these recommendations, a new four panel radar data display is proposed for operational use. This display is called the "Storm-scale Surveillance Display" (SSD) with Figure 22 being an example. In Figure 22, panel (a) contains the 0.5 degree reflectivity overlaid with the Storm Track Algorithm. Panel (b) contains the 0.5 degree SRM. Panel (c) contains the 0.5 degree base velocity. Panel (d) contains the 0.5 degree SW. The design of the display is such that all three of the base data sets and the SRM are visible in the same display. Looping these data is easily done so that all data sets can be monitored simultaneously. Surveillance of an event can be easily maintained, so that storm evolutions can be discovered quicker. Use of the linked cursor will allow the forecaster to compare all four data types at the same time. This display is not used to replace others, but to aid in identifying threat areas. Once a suspect cell or area is found, four panel displays, the all-tilts or other methods can be used to further interrogate a storm and assess the need for an appropriate warning. Because most of the weak tornado cases are non-mesocyclone events with the circulations in the lower layers, this surveillance display only uses the 0.5 degree slice. Overlaying the storm track algorithm on the reflectivity display, combined with looping the display, will aid in following the track of antecedent storms. Increasing the storm scale analysis of the environment and watching for intersections of outflow boundaries caused by cool air domes generated from antecedent storms should aid in improving the ability to forecast some of these weak tornado events. Finally, so that the forecaster still has the ability to toggle between the reflectivity display and the velocity data, each of the panels (b), (c), and (d) can be set to toggle between the reflectivity image and other data sets. Figure 23 shows another example of the new proposed SSD. This example of a weak mini supercell at 2118 UTC on 4 April 2003 shows a circulation at a weak hook echo location (near the "home location"). There is no SW turbulence found in this case at the hook echo location. This new display will be evaluated during the 2006 severe weather season and in further research into the 2003 case data set.

7. SUMMARY

A preliminary investigation of the cases of F0 and F1 tornadoes in 2003 was done. Study results showed that signatures with these events did fit most current conceptual models. However, the signatures were generally much weaker than those associated with stronger events. In many cases, signature pre-cursors to tornado formation were only visible a short time before tornado development. The signatures and the tornadoes were also very short lived. A number of examples of the events typical of central Illinois cases were briefly presented. In addition, several operational recommendations were covered.

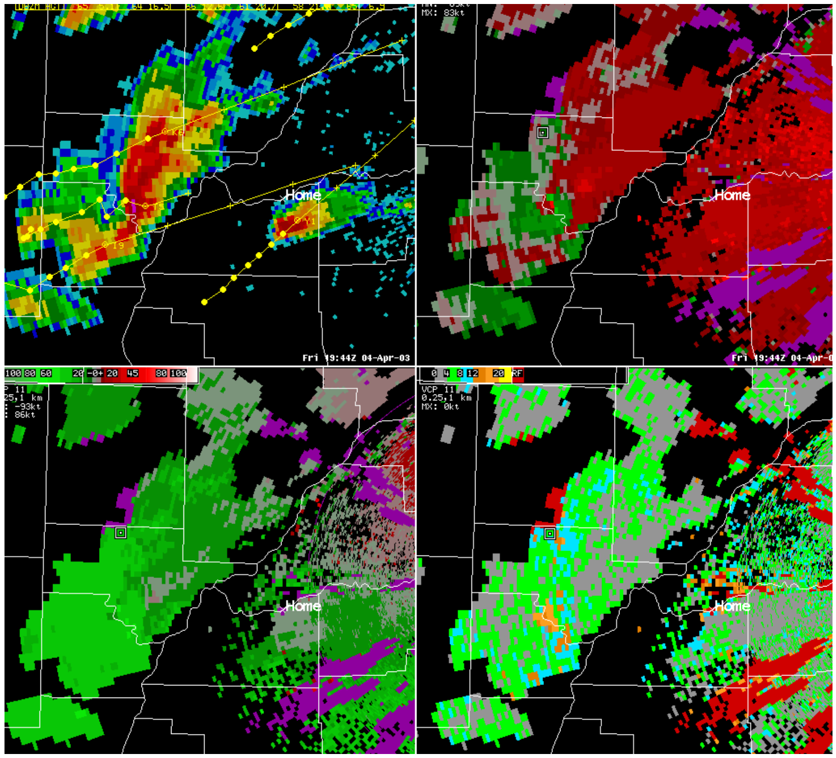

Figure 22. (a) KILX 4 April 2003 1944 UTC 0.5 degree reflectivity with the Storm Track algorithm overlay. (b) Same as (a), but for SRM. (c) Same as (a), but for Base Velocity. (d) Same as (a), but for SW. This display is an example of the Storm-scale Surveillance Display (SSD).

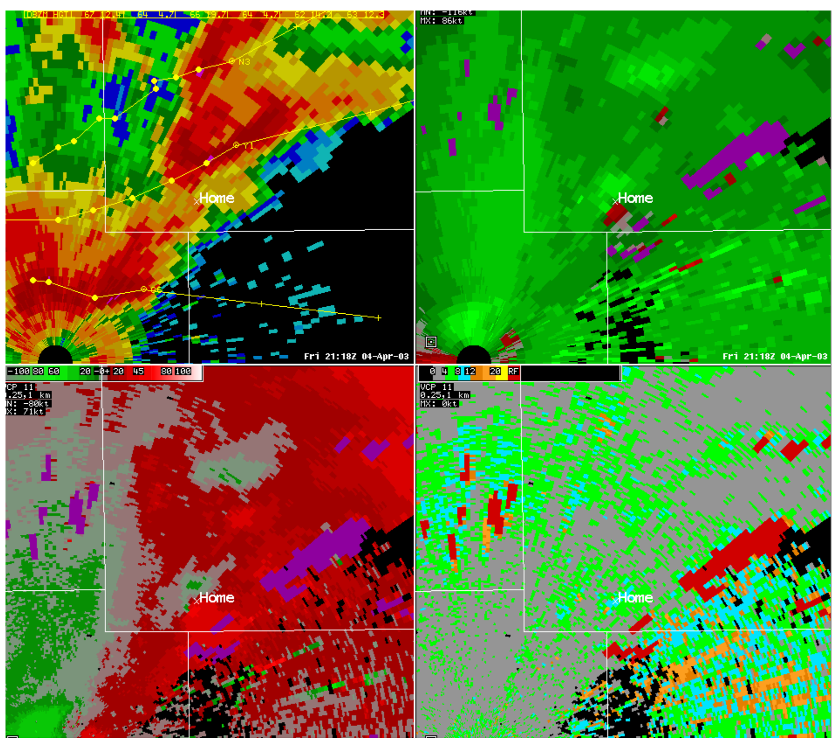

Figure 23. Same as figure 22, but for 4 April 2003 2118 UTC. “Home location” represents the low-level circulation and hook echo.

Additional study of these events typical for central Illinois is needed. A complete classification of all events, with an expanded analysis of radar signatures is planned. The WSR-88D 8 bit data archive was unavailable for cases in this study. Investigations of the 8 bit data is planned for cases in which the data is available. An expansion of the study to include events in 2004 and 2005 is also planned, using the 8 bit data set.

The use of the spectrum width (SW) data was analyzed with some minor utility found. It is recommended that a more expanded use of the SW data be done operationally in an attempt to determine its possible uses for central Illinois. To do this, a new prototype procedure display was presented for possible use by the operational forecast staff.

8. ACKNOWLEDGEMENTS

The authors wish to thank Llyle Barker (Science Operations Officer for the Central Illinois WFO) for his extensive assistance, advice, review, and recommendation for this manuscript and the study. Chris Miller (Warning Coordination Meteorologist at Central Illinois WFO) also deserves thanks for providing assistance and his expertise in making WSR-88D displays.

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