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The 1925 Tri-State Tornado Damage Path and Associated Storm System

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ABSTRACT

The "Tri-State tornado" event of 18 March 1925, with an official death toll of 695 people, generally is accepted as the deadliest single tornado in United States recorded history. The officially accepted damage path is 352 km (219 mi) long. The entire damage path was not surveyed by the Weather Bureau in 1925 to determine if it truly was continuous, and the nature of the tornado event and the storm that produced it are not well known. Therefore, as much new data as possible have been gathered about this event in all three states along and near the purported damage path. Detailed information about the locations where damage was reported and the type of damage (recorded as "damage points") was obtained from: interviews and driving surveys with first- and secondhand eyewitnesses, many local 1925 and later newspapers, local books, and photographs and other materials found in local libraries and genealogy centers.

After plotting all damage points, a potential damage path of 378 km (235 mi) was indicated. However, 32 gaps ≥1.6 km (1 mi) appeared between consecutive damage points. This paper presents all the damage points, and indicates which of the gaps might be "real" (i.e., where one tornado ended and another tornado developed), as well as those gaps more likely to have been a continuous tornado. We speculate that path segments at the beginning of the potential damage path in eastern Shannon County, MO, and at the end of the potential path in central Pike County, IN, were both likely from separate tornadoes. In the very rural and hilly terrain of southeast Missouri, there were areas with a minimum of human development and no known witnesses to the tornado (parts of Reynolds, Iron and Madison Counties). This led to several relatively long damage path gaps >3.2 km (2 mi). The existence of the relatively long gaps prevents confidence in the continuity of the first section of the path. Beginning in central Madison County, MO, and continuing to Pike County, IN, a distance of 280 km (174 mi), there are no gaps >3.2 km (2 mi), more strongly suggesting that the tornado was likely continuous for that path segment. Because of having the highest density of damage reports and the most eyewitness reports, the part of the main damage path that is 243 km (151 mi) long from central Bollinger County, MO to the west edge of Pike County, IN can be considered likely a continuous path.

The tornado event was associated with what began as a classic supercell in Missouri, transitioning to high-precipitation mode in Illinois and Indiana. Witnesses saw a wedge tornado along most of the damage path and a large multivortex tornado in some areas. At two places in Illinois, a satellite tornado may have appeared at about the same time as the primary tornado was passing nearby. Another previously unreported tornado with a 32-km (20-mi) damage path occurred in Washington and Jackson Counties, IN, whose path and trajectory suggests that it may also have been produced by the same supercell. This new tornado started about 75 min later and about 105 km (65 mi) east-northeast of the apparent end of the Tri-State tornado damage path in Pike County, IN.

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1. Introduction

Henry (1925) concluded that the Tri-State tornado was singular and continuous, with a path length of 352 km (219 mi), acknowledged to be the longest on record (Grazulis 1993). In recent years, meteorologists have questioned whether this was really one continuous long-track tornado or a series of tornadoes associated with the same convective storm (Doswell and Burgess 1988).

Doswell and Burgess (1988) mentioned that, in the early 1900s, many tornadoes that were considered single, very long-track (VLT) tornado events were actually multiple tornadoes associated with the same convective storm. During that time period, a multi-mile gap with no damage was considered to be "skipping", rather than an ending followed by a new tornado. The term "skipping" meant that the tornado "lifted" for several or many miles and then the same tornado caused damage again. While a few non-damage gaps within a long-track path might be the result of "skipping", it is now known that many of these gaps could be the result of one tornado ending and another tornado starting with the same convective storm (Fig. 1). Cyclic supercells can produce multiple tornadoes with relatively short gaps between them. This issue is complicated by the fact that the absence of damage in a track segment simply might be the absence of any damage indicator, rather than a real gap between cyclic supercell tornadoes.

The Weather Bureau Climatological Data records summarizing the 1925 Tri-State tornado damage track were gathered for the three affected states. The Missouri record summary (Reeder 1925) was not based on a driving survey, and little was known about what happened across large segments of the track—one of which was 64 km (40 mi) long. The Illinois record summary (Root and Barron 1925) was based upon a detailed, seven-day automobile driving survey across Illinois and Indiana, and no "skipping" was found for 209 km (130 mi) of the path there (Root 1926). In the Indiana record summary (Armington 1925), many details were provided. However, the location of the tornado's ending in Indiana is different from what was mentioned in the Illinois record summary.

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Figure 1: Two tornadoes from the same supercell near Zurich, KS on 9 June 2005. The tornado on the left is shrinking on its way to dissipation. The tornado on the right is near the beginning of its track, with a gap <1.6 km (1 mi) between them. Photograph © 2005 C. Doswell. *Click image to enlarge*.

Published Weather Bureau records suggest that most of the path in Illinois and Indiana may have been associated with one tornado. However, the detailed damage survey records that were said to have been kept at the Illinois State Water Survey (S. Changnon 2004, personal communication) could be found neither there or at the National Climatic Data Center. Thus, it was impossible for us to give an independent evaluation of those records in light of modern-day surveying methods. To investigate possible gaps along the path, we gathered as much information as we could along and near the tornado track.

Another question about the Tri-State tornado concerns the nature of the associated storm system. Changnon and Semonin (1966) suggested that the tornado occurred on the front side of the associated storm, based on hail and rain occurring after the tornado. However, just prior to the time of the Changnon and Semonin paper, it became evident that many tornadoes occur on the trailing end of supercell storms, somewhat to the right of the track of the precipitation core (Browning 1964). Therefore, we gathered any information we could obtain about the storm's nature, precipitation character, and the relative location and evolution of the associated tornado (or tornadoes).

Also of interest is the meteorological setting that would have produced such a long-track and violent tornado. That subject is not discussed in this paper, but is described in a companion study by some of the same authors (Maddox et al. 2013).

Field research took 6 y because of the unfunded nature of the project and the need to find detailed information in three states and many counties. Our methods of gathering this information were inspired by the experience of one of the authors (DWB), who developed ways to gather information about the nature of the 1947 Woodward, OK long tornado damage path (Doswell and Burgess 1988). These methods and post-processing of the data are mentioned in section 2, however, more details about these methods will be given in a forthcoming publication. The storm-damage path is described in section 3, and the type of storm and tornado event are described in section 4. Section 5 is our concluding discussion.

2. Methods

a. Tornado damage-path analysis

Our basic approach has been to use as many sources as possible to determine locations where damage occurred (henceforth "damage points"). Where damage indicators existed close to the tornado path and we were aware of locations of undamaged indicators, we used them as non-damage points. Gaps between known damage points along the path are described as "data gaps". Non-damage points close to the edge of the path helped us to determine the maximum path width, while non-damage points within the path may represent a real gap where one tornado dissipated and another formed. Where damage reports were known to be very close together (e.g., homes in a city or a farm with home, barn and outbuildings), a damage point typically would represent more than one damage item. For this reason, damage points are typically >30 m (100 ft) apart in areas of dense damage.

Ultimately, damage and non-damage points were mapped using latitude and longitude values to assess path continuity and width. We never can be absolutely certain about the existence of the tornado within many of the longer gaps, whereas if we had information about a real gap where it was known definitely that no damage occurred, that would be a very different matter. In any case, it is not possible to be absolutely sure whether a damage-free gap of even a few km or less represents the dissipation of one tornado followed by the development of another.

In a case cited by Doswell and Burgess (1988), the storm track from a 1984 cyclic tornadic supercell included gaps of tens of kilometers between individual tornadoes. With modern information about tornado events in a reasonably well-populated area, a gap that large is most likely strong evidence for the tornado damage path being discontinuous. For an event >80 y ago, the existence of large data gaps in the damage at least would make the issue of tornado damage-path continuity more questionable. When this study began, it was not evident what detailed damage information we would be able to find.

Damage and non-damage points were obtained from several sources, including: 1) local eyewitnesses who were old enough in 1925 to remember many details, and 2) detailed damage listings from local newspapers of 1925. Other pertinent sources included: local people with secondhand knowledge from eyewitnesses (including family oral history), newspaper and magazine stories, city address lists, county plat maps, other types of maps, Red Cross records, census records, books, and photographs and movies of damage.

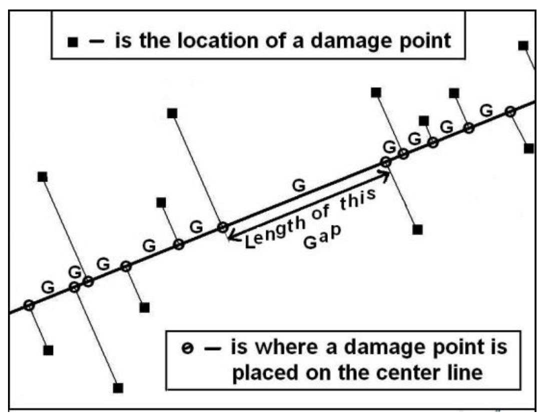


Figure 2: A schematic illustration of the method used to determine the length of gaps (G) along the damage path, as described in the text.

When data gathering was completed, the damage and non-damage points were plotted on a map. To determine the length of substantial data gaps, a line was drawn along the center of the path. Through each damage point, a line was drawn perpendicular to the center line (Fig. 2). Once all the damage points were projected onto the center line, we were able to determine the location and length of gaps along the center of path. We defined data gaps along the damage path that are ≥1.6 km (1 mi) long as "significant data (SD) gaps".

We used several types of additional information to see whether SD gaps likely represent a tornado-dissipation gap or a continuous tornado path. The types of information we have used, and their associated letter codes are listed in Table 1.

Table 1: Letter codes and descriptions for tornado path characteristics in the Tri-State event.

(**L**) **The length of the SD gaps that are ≥1. 6 km (1 mi) long**. The likelihood of tornado dissipation increases with greater SD gap length

(D) The directions of the SD gap and the damage paths on both sides. If there are different directions between the center line length of the SD gap and the damage on both sides of the gap, or if there are different directions between the damage paths on each side of an SD gap, it is likely that the SD gap represents tornado dissipation. However, a continuous tornado track is indicated where the damage paths on both sides of the gap lay in the same direction.

(**W**) **The apparent width of the damage path where an SD gap starts and/or ends**. In areas of dense damage points, a large width of the damage points at the edge of a short SD gap suggests that the gap represents a continuous tornado path. Also in dense damage areas, if the width of the damage path gets very small near an SD gap, the gap likely represents tornado dissipation. Where a local 1925 newspaper mentions wide tornado damage near or within an SD gap, that gap likely represents a continuous tornado path.

(E) Eyewitness observations in an SD gap. Interviews from firsthand or secondhand eyewitness, or local newspaper stories about eyewitnesses that were near an SD gap, were used to evaluate the likelihood of tornado continuity in the gap. An eyewitness seeing or hearing the tornado as it passed through an SD gap suggests a continuous tornado through the area. An eyewitness seeing either no tornado, a tornado dissipating, or a tornado developing in the SD gap suggests likely tornado absence in the gap.

(**N**) **SD gap information suggested by local 1925 newspapers.** Tornado dissipation was likely where one or more local newspapers mention that the tornado ended within an SD gap. Path continuity was more likely within an SD gap if one or more local newspapers mention that certain types of damage occurred in the gap area, but did not specify damage places within the gap.

(**P**) **Non-damage points within an SD gap**. Tornado dissipation may have occurred where only one non-damage point has been found in the SD gap, or where several non-damage points appear to be within the path but near its edge. Tornado dissipation is more likely where several verified non-damage points have been found in the center of the gap.

(G) SD gaps near the start or the end of the path. In VLT tornado damage paths (e.g., the 1947 Woodward, OK event), gaps where a tornado dissipates and another develops are most common near the beginning and ending of the long damage path rather than near its middle. SD gaps near the start or end of the damage path therefore may represent tornado dissipation.

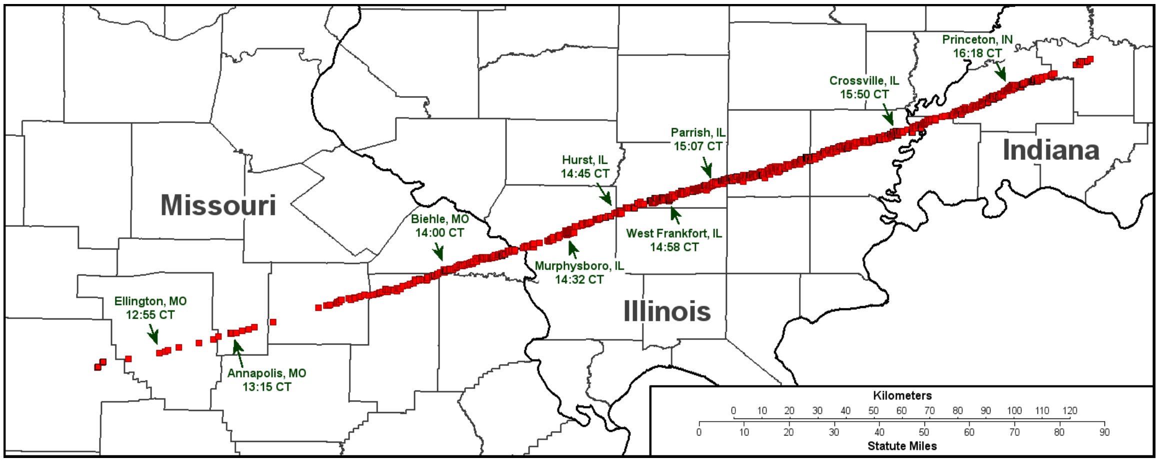


Figure 3: The length and locations of damage points found along and near Weather Bureau records of the Tri-State tornado, from Missouri to Indiana. Illustrative times of damage (green labels) in Central Time (CT = UTC – 6 h) are further discussed in the text. *Click image to enlarge.* An interactive version of Fig. 3 is available. (All path maps in this paper by J. A. Hart.)

b. Tornado and supercell structure

To learn about the nature of both the Tri-State tornado and its parent storm, information was gathered from eyewitnesses and local newspapers about the following characteristics:

- What the storm looked like and how it was associated with the Tri-State tornado;
- Where the Tri-State tornado was located within the storm and how it evolved;
- Characteristics of other associated tornadoes and severe weather events;
- When and where rain and/or hail occurred relative to the storm and tornado;
- The perceptions of weather (temperature, wind and other storms) that day and how it changed;
- The wind direction and speed close to the storm;
- The location and size of fallen tornado debris.

Where possible, we also categorized damage points (e.g., homes, schools, churches, and business buildings) in one of three intensities: 1) slightly damaged (e.g., windows blown out, porch blown down, shingles blown off roof, or bell tower blown off of church), 2) severely damaged (e.g., home uninhabitable, or school, church, or business building unusable), and 3) destroyed (home or other type of building completely flattened or blown away). By mapping the damage-point intensities, we could learn more about the nature of the parent storm and the Tri-State tornado [e.g., occurrence of a satellite tornado or a multivortex structure of the primary tornado, areas of rear-flank downdraft (RFD) winds, and in some cases the width of the Tri-State tornado].

3. Damage-path findings

As of this report, 2395 damage points and 142 non-damage points have been found along and close to the Tri-State tornado (Fig. 3) from southeastern Missouri to southwestern Indiana. [An interactive version of Fig. 3 is available at http://ejssm.org/ojs/public/vol8-2/map/map.php.] Using all known damage points, the path length is estimated to be 378 km (235 mi). Weather Bureau records from Missouri mention that the Tri-State tornado began in the center of Reynolds County, about 6.4 km (4 mi) northwest of Ellington. However, damage points in Missouri were found in western Reynolds County and in eastern Shannon County, west of where the Weather Bureau recorded the first damage. In Indiana, Weather Bureau records mention that the Tri-State tornado ended near Oatsville, next to the Gibson–Pike County line. However, the Weather Bureau records from Illinois mention that the tornado ended 4.8 km (3 mi) southwest of Petersburg, IN, which is farther into Pike County. The last damage point we found in that county was 4 km (2.5 mi) south-southeast of Petersburg, IN, farther east than the Illinois records mention. These changes account for the 378-km (235-mi) path length.

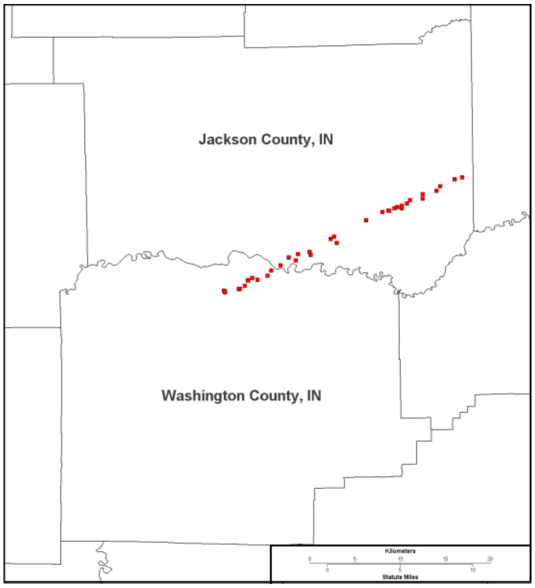


Figure 4: Damage points (red dots) associated with a tornado in Washington and Jackson Counties, IN. *Click image to enlarge.*

The most common type of damage points in the path involved homes in rural areas and towns. Of our 2395 total damage points, 1961 (82%) involved homes. Most of the remainder involved other types of buildings. On farms, 67 additional damage points involved barns and outbuildings that were far enough from farm homes to count as separate damage points. Another 118 damage points involved business buildings and some public buildings. Also, 48 damage points involved schools, and 29 more were churches. Many of the schools were in rural farm areas, since at that time, one-room schools were placed about 3.2 km (2 mi) apart because students generally had to walk to school.

We were able to determine and record the damage intensities for 2223 homes and buildings, comprising 92.5% of our total damage points. The remainder of the damage points included 84 other objects (e.g., bridges, water towers, cars, buses, horse wagons, etc.), people who were injured or killed outside, and 88 areas of trees. These 172 other damage points are only 7.5% of the total. Although we were able to assign damage intensities for some of these “non-building” points, most were unsuitable for that purpose.

Relatively few estimated damage times were found along the path, and some of those were conflicting. Illustrative times have been annotated on the path in Fig. 3. These are thought to be the most reliable because they come from publications of some kind, such as written records (e.g., those from railroads), eyewitnesses, or where a number of sources agreed on the time. However, even with those criteria, conflicting times were still found. For example, several sources agreed that the tornado struck Biehle, MO, at 1400 Central Time (CT[1]). However, one eyewitness, who otherwise gave reliable information corroborated by other sources, believed that the tornado struck Biehle at 1410 CT. Because of the relatively few points and the conflicting times, we discourage use of the times in Fig. 3 to estimate timing for shorter path segments. Instead, we suggest using the average translation speed derived from the existing times, which was 26 m s^{-1} (59 mph, 51 kt). First damage in Shannon County, MO likely began at ≈1240 CT, and last damage in central Pike County likely ended at ≈1640 CT. Times for the possibly continuous path segment from the Shannon–Reynolds County, MO, border to far western Pike County, IN, would have been ≈1245 CT to ≈1630 CT.

Weather Bureau records and local 1925 newspapers from Indiana mentioned convective winds in Jackson County on the same day as the Tri-State tornado. Given the location and time of occurrence, they may have been associated with the same storm. Surprisingly, the newspapers also mentioned that a 32.2 km (20 mi) long tornado moved from north-central Washington County, IN to the Jackson–Jennings County line (Figs. 4 and 5). Those newspapers revealed many details about injuries, eyewitness experiences of the tornado, and the homes and buildings that were damaged or destroyed.

Using the newspapers, county plat maps and topographic maps, we determined the location of this tornado. Since this damage path began 104.6 km (65 mi) from the last Tri-State tornado damage points in Pike County, IN, and there were many undamaged items in that gap, we are confident that if it was associated with the same storm this would be a real dissipation gap between two tornadoes. In other words, this almost certainly was a separate tornado.

Within the 378-km (235-mi) path from Shannon County, MO to Pike County, IN, there are 32 SD gaps. A listing of the identification number, the length, and the location for each of

[1] Throughout this article, UTC = CT + 6 h.

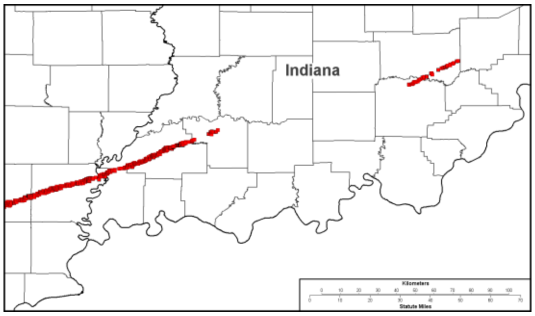


Figure 5: Tornado damage path (red, at right) in Washington and Jackson Counties, IN (per Fig. 4), relative to the location of the Tri-State tornado damage path in eastern Illinois and southwestern Indiana (at left). *Click image to enlarge.*

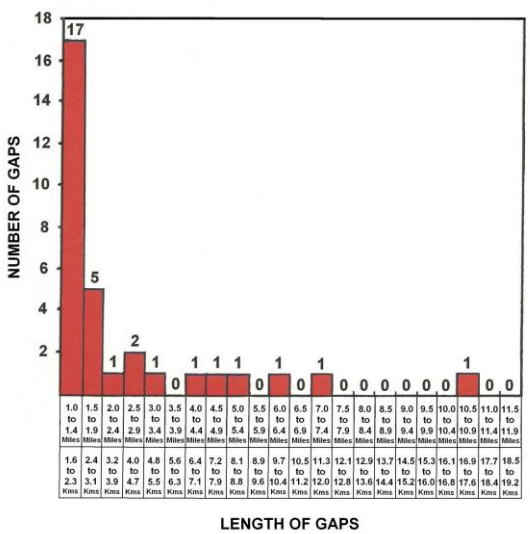
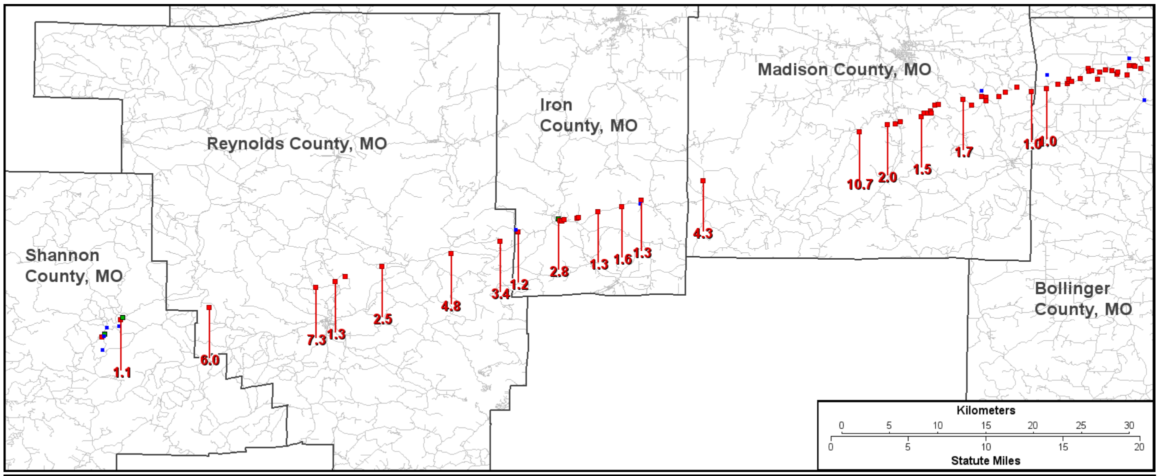


Figure 6: Histogram by gap-size range, as labeled, showing the number of ≥1 mi gaps without damage points from Shannon County, MO to Pike County, IN. *Click image to enlarge.*

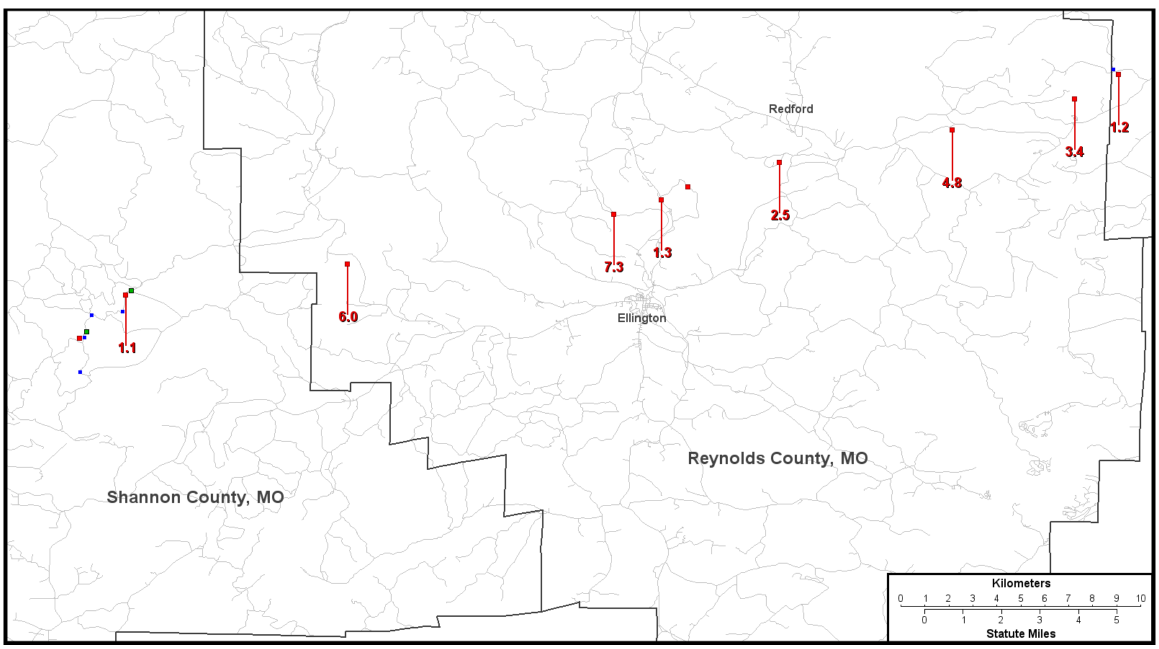
those gaps is in Appendix A. Appendix B describes each gap area, what types of the Table 1 information were used for the gap, and if the information resulted in plausible conclusion about what likely happened within the gap. Most of the SD gaps are <3.2 km (2 mi) long (Fig. 6).

More than half (59%) of all SD gaps, and a large majority (89%) >3.2 km (2 mi) long, are within the first 109.4 km (68 mi) of the path from eastern Shannon County to western Bollinger County, MO (Fig. 7). This part of the damage path is located within the Mark Twain National Forest of the Ozark Mountains. Owing to the rugged topography of this area, there were few farms, towns, roads, and people in this part of the damage path when the Tri-State event occurred, much like it is today. We assumed that many trees in the area likely would have been damaged. However, because few people lived in the area in 1925, there were not very many sources to learn about what happened to the trees. We found only 20 damage points involving trees in this region and learned that extensive regions west of Bollinger County had been clear-cut logged at the beginning of the 20th century. Therefore, in the data-sparse regions near the beginning of the path in Missouri, the region looked very different than it does today (i.e., no extensive forests in 1925). In some of these cases where eyewitnesses or secondhand accounts mentioned trees downed by the Tri-State tornado, we found detailed locations for the damage points based on uprooted tree mounds and depressions that still were detectable. Some independent corroboration was available that these mounds and depressions could be associated with the Tri-State tornado, but all of the mounds and depressions are within the limits of the known tornado path.

The first SD gap along the damage path, Gap 1 in Shannon County (Fig. 8), is only 1.8 km (1.1 mi) long, but there was not enough information to draw conclusions about the nature of this gap. However, we have been able to estimate the nature of the second one in this area, the 9.7 km (6.0 mi) long Gap 2 that goes across the Shannon–Reynolds County line (Fig. 8). It is near the beginning of the tornado path, and the direction of the damage-point path in Shannon County is different than that in Reynolds County. It appears that this SD gap is likely a "real" gap where one tornado dissipated and another developed. Even though there are quite a few additional SD gaps (Gaps 3–19) along the path from Reynolds County to Bollinger County (Fig. 7), there is not enough information to draw conclusions about their nature. Unlike Gap 2, the SD gaps and the damage points near the subsequent gaps appear to be lined up in the same direction. However, many of the gaps are >3.2 km (2 mi). The longest is the 17.2 km (10.7 mi) long Gap 14 in the western half of Madison County, where it crossed the Saint Francois Mountains (Fig. 9). This part of the Ozark region is characterized by relatively high, rugged terrain. Even though this is the longest SD gap within the entire path, it is much shorter than the 64.4-km (40-mi) gap through the Ozarks noted in official 1925 Weather Bureau records.



<u>Figure 7</u>: Damage points (red is severe damage and complete destruction, green is slight damage), non-damage points (blue), and gap lengths in the damage path through the Ozark Mountain area from eastern Shannon County, MO to the western part of Bollinger County, MO. *Click image to enlarge.*



<u>Figure 8</u>: As in Fig. 7, but zoomed into Shannon and Reynolds County, MO. *Click image to enlarge.*

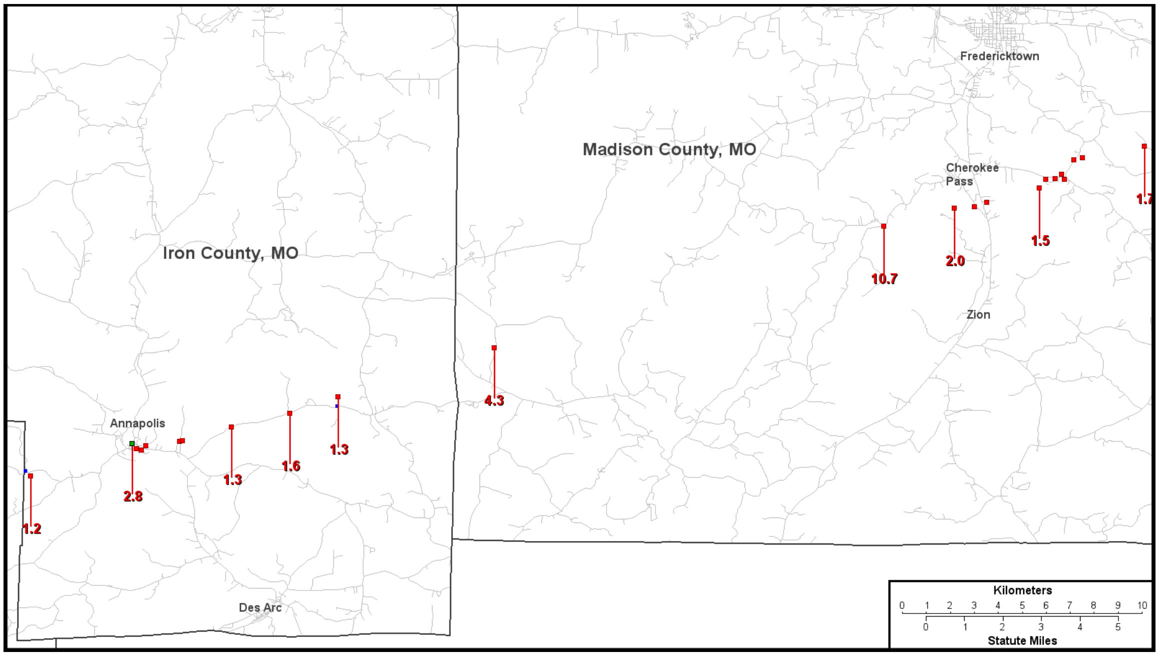


Figure 9: As in Fig. 7, but zoomed into Iron and Madison County, MO. *Click image to enlarge.*

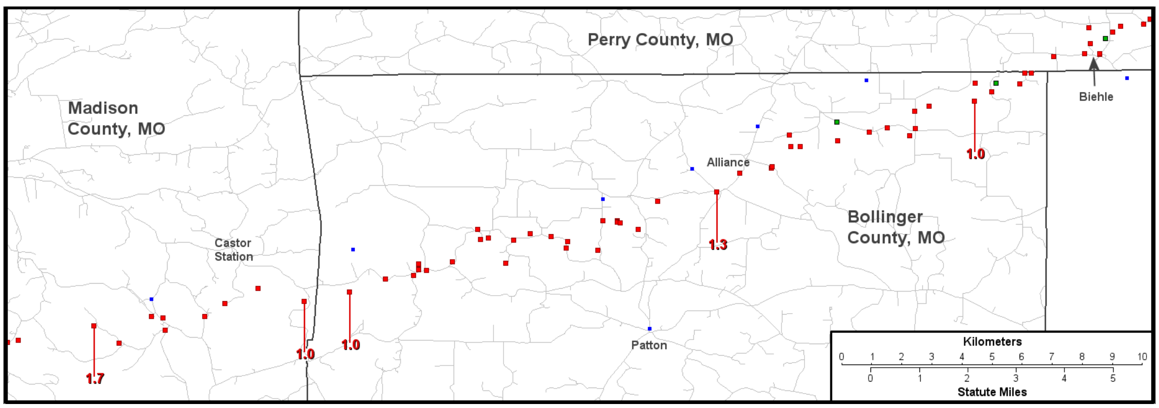


Figure 10: As in Fig. 7, but for eastern Madison and Bollinger Counties, MO. *Click image to enlarge.*

In central and eastern Bollinger County, two SD gaps (Gaps 20 and 21) are <3.2 km (2.0 mi) long (Fig. 10). These are in hills with fewer farms and buildings than in nearby agricultural areas. The tornado track likely is continuous through both of these Bollinger County gaps, since the width of the damage points on both sides of each gap is 0.8–1.2 km (0.5–0.75 mi) wide. Furthermore, the directions of the SD gap and the damage-path points on both sides are the same.

Across most of Perry County, there are no SD gaps between damage points (Fig. 11). However, near the eastern border of Perry County, the 3.1-km (1.9-mi) long Gap 22 crossed the Mississippi River into Jackson County, IL. In this area, the river is oriented more east–west than north–south, so most of the SD gap is over the river. The lack of damage points there is mostly because of a lack of structures on or close to the river. This gap also is likely a continuous tornado track since the width of the damage points on both sides of the SD gap is >0.8 km (0.5 mi) wide, and since the directions of the gap and the adjacent damage path points are the same. Furthermore, an eyewitness on the Illinois side of the river saw the tornado crossing the river, appearing as a large dark mass that was throwing river water.

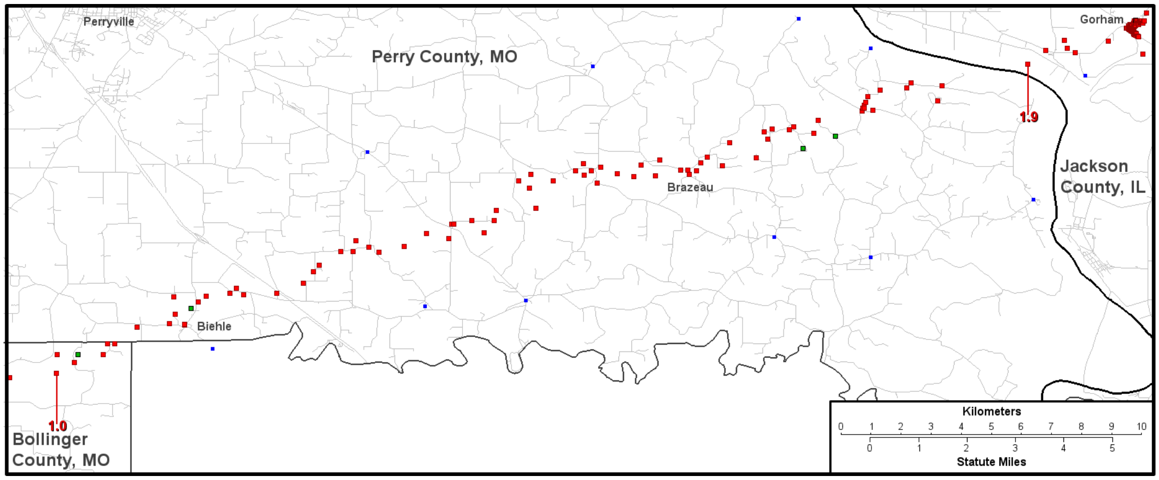


Figure 11: As in Fig. 7, but for Perry County, MO and the western edge of Jackson County, IL. *Click image to enlarge.*

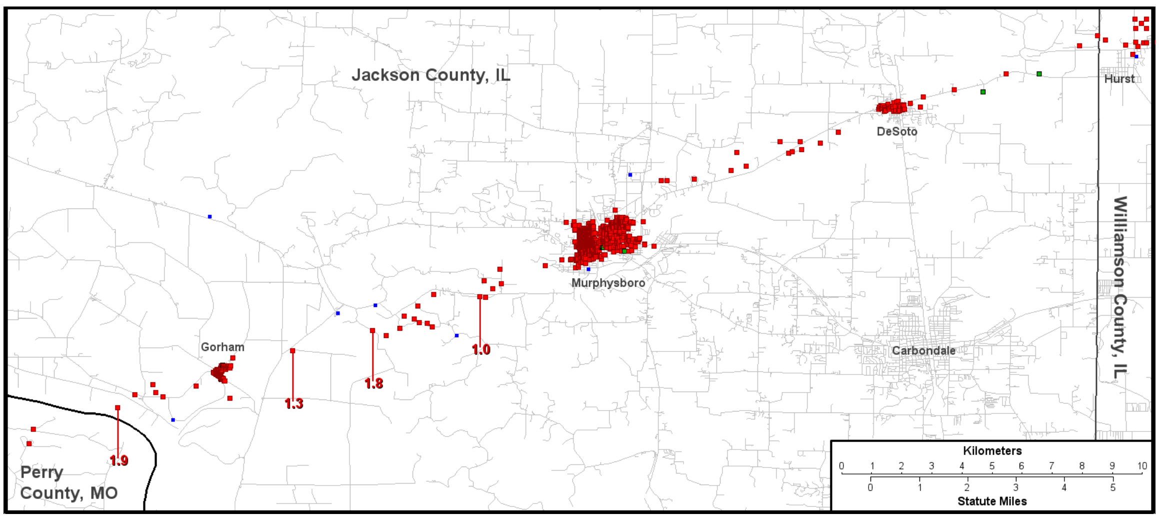


Figure 12: As in Fig. 7, but for Jackson and western Williamson Counties, IL. *Click image to enlarge.*

In the western half of Jackson County, IL, three SD gaps are <3.2 km (2.0 mi) long (Fig. 12). The first two [2.1 km (1.3 mi) long Gap 23 and 2.9 km (1.8 mi) long Gap 24] are along the Mississippi River floodplain, characterized then and now mostly by open agricultural land with few buildings. The third SD gap [1.6 km (1.0 mi) long Gap 25] is in the hilly area east of the floodplain where there also may have been few farm homes and other buildings.

Through all three of these SD gaps, the tornado damage path was likely continuous for several reasons. The gaps and nearby damage points appear to be lined up in the same direction. Gaps 23 and 24 are close together in the floodplain area. On the west edge of Gap 23 is Gorham, IL, where many people were killed and the damage points indicate a path about 1.2 km (0.75 mi) wide. Just one damage point was found in the floodplain on the east edge of Gap 23 and the west edge of Gap 24. However, this damage point represents a farm home and farm buildings that were flattened, killing some of the family members. On the east edge of Gap 24 where the floodplain ends and the damage points of homes, buildings and trees are at least 0.8 km (0.5 mi) wide, one person was killed. A person who lived in the area mentioned that the tornado was seen by his parents in Gaps 23 and 24. Farther east into the hilly area, the damage points on both sides of Gap 25, which is only 1.6 km (1.0 mi) long, are about 1.2–1.6 km (0.75–1 mi) wide. The local newspaper mentions that as the tornado moved from Gorham to

Murphysboro where these three gaps are located, the damage path appeared to be from 0.2–1.6 km (200 yd to 1 mi) wide through the entire area.

In Williamson County, IL, there is no SD gap, but in the southwestern portion of Franklin County, IL, there is one (Fig. 13). This 2.3 km (1.4 mi) Gap 26 is along the Big Muddy River area with few homes, buildings or roads. The tornado was likely continuous here for the following reasons: 1) the SD gap and adjoining damage points are in the same direction, and 2) on the east edge of the gap, where the river turns away (and there were many more homes and buildings), the damage points are 1.2–1.6 km (0.75–1 mi) wide, with similar damage width well past the end of the gap. Three people's family members who lived just east of the gap were able to see the tornado coming toward them, while it remained within the gap area and appeared to be very large. Two of the family members realized that it was a tornado, but another did not recognize it as a tornado because it was so large. To her it looked like a bad storm with rapidly rotating clouds. A person in Zeigler, IL, northwest of the gap, reported that his mother was able to watch from the second floor of the high school in Zeigler as the large tornado moved through the gap.

The longest part of the damage path without any SD gaps is 98.2 km (61 mi) long, between southwestern Franklin County, IL, and eastern White County, IL (Figs. 13–15). The width of our damage points suggest that the path was 1.2–1.6 km (0.75–1 mi) wide through most of this area and may have been even wider in parts of Hamilton County, IL. The density of damage points in the rural area from eastern Franklin County to eastern White County is because of more farm homes and buildings than in the hilly areas or rivers. Further, detailed Red Cross Permanent Relief Committee records were found in McLeansboro of Hamilton County listing needed relief. Those revealed damage to every home, building, and other personal items affected by the tornado within that county.

At the east edge of White County, one SD gap was in the floodplain area on the west side of the Wabash River, with fewer farm homes and buildings because of occasional river flooding (Fig. 15). Gap 27, is fairly short, 1.8 km (1.1 mi). The SD gap and adjacent damage points are in the same direction. The width of the damage points on the bank above the floodplain, about 2.4 km (1.5 mi) west of where the gap starts, is 1.2–1.6 km (0.75–1 mi). The gap ends right next to the west edge of the Wabash River.

A local newspaper mentioned that southwest of Griffin, IN, a 1.2 km (0.75 mi) wide row of broken and damaged trees along the edge of the Wabash River had been hit by the tornado. As the tornado approached the gap, an eyewitness and his brother were riding horses from a school in Calvin, north of the SD gap, toward their home on the south side of the gap. When they got to the edge of the bank over the floodplain, they stopped because they could see the tornado approaching. The gap was about 3.2 km (2 mi) southeast of them. They saw a large tornado move all the way across the gap in the floodplain. After the tornado passed, one of them started back home along a floodplain road and noticed a long area of damage. Therefore, in this SD gap, the tornado was very likely continuous.

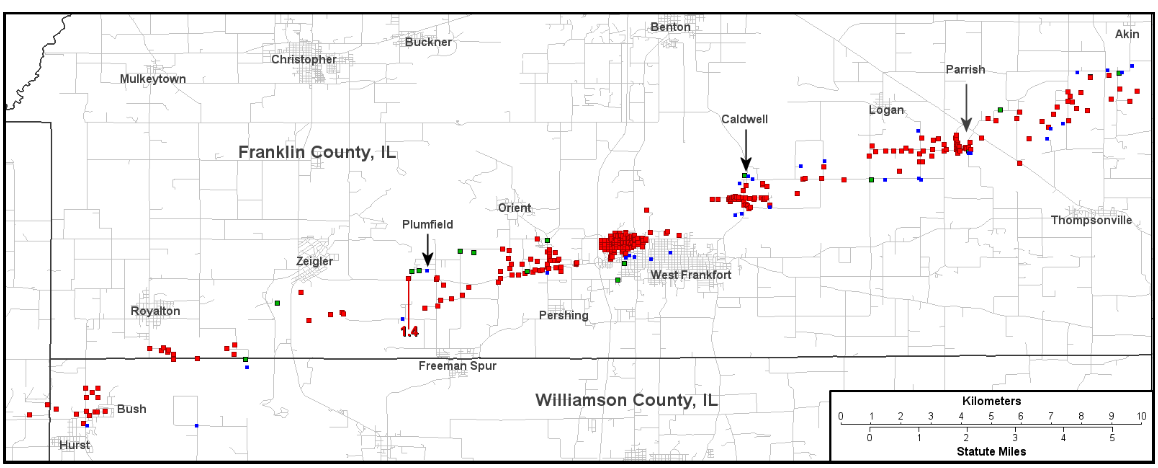


Figure 13: As in Fig. 7, but for Williamson and Franklin Counties, IL. *Click image to enlarge.*

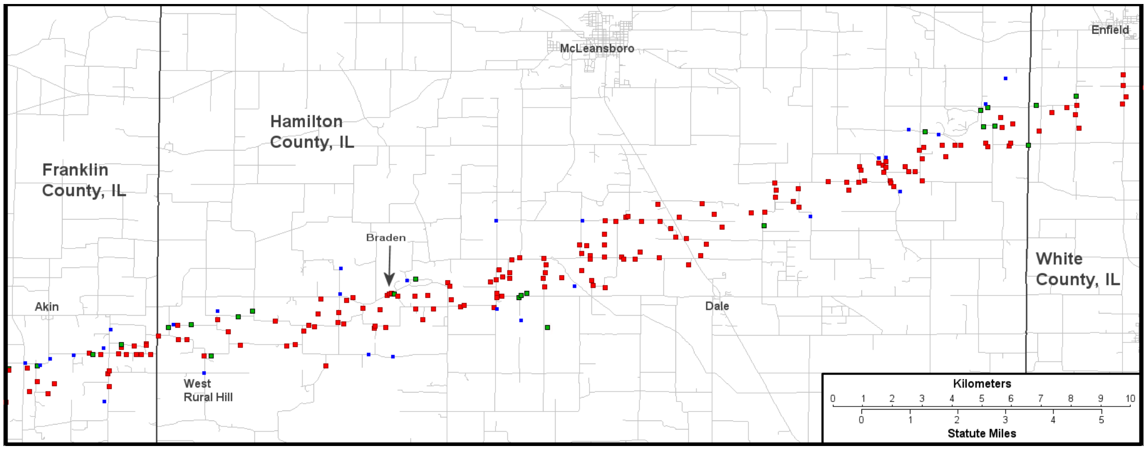


Figure 14: As in Fig. 7, but for Hamilton County, IL. *Click image to enlarge.*

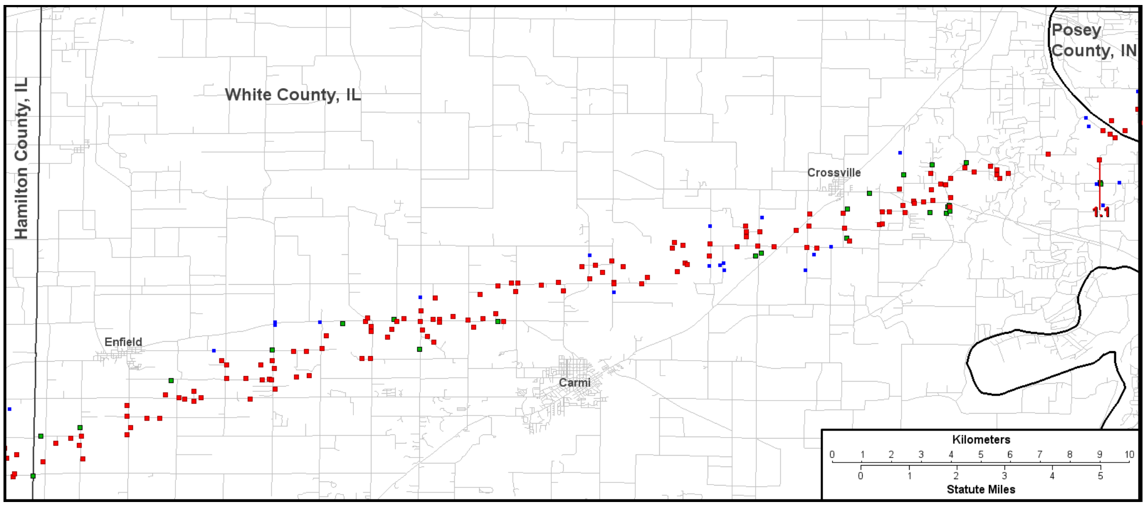


Figure 15: As in Fig. 7, but for White County, IL and western Posey County, IN. *Click image to enlarge.*

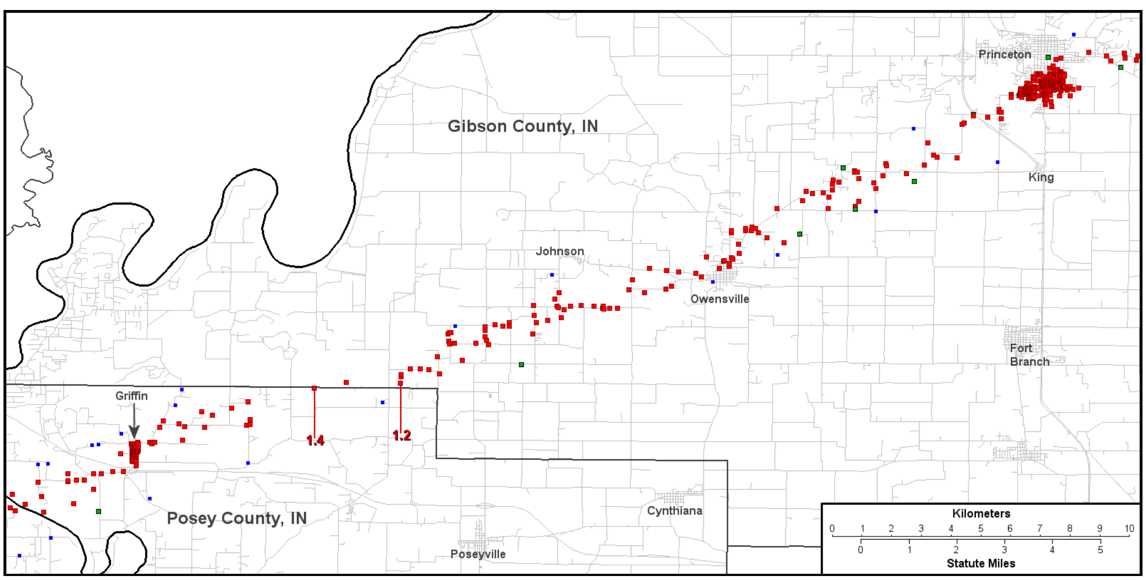


Figure 16: As in Fig. 7, but for Posey County, IN and western and central Gibson County, IN. *Click image to enlarge.*

Beyond the Wabash River in Indiana, the next two SD gaps were located in the Black River floodplain area, a few kilometers northeast of Griffin, IN (Fig. 16). The 2.3-km (1.4-mi) Gap 28 is in northwest Posey County near the Posey/Gibson County line. Gap 29 in Gibson County is only 1.9 km (1.2 mi). Some interviewees mentioned that almost no one lived in this part of the floodplain area in 1925, and the same still was true during our survey. The two SD gaps and the damage points we found near them appear to be lined up in the same direction.

Local people apparently were observing a multivortex tornado as it destroyed most of the homes and buildings in the town of Griffin, <4.8 km (3 mi) from the start of Gap 28. An eyewitness who lived on a ridge about 0.4 km (0.25 mi) northwest of Griffin saw one part of the tornado coming back through town as it was moving out of Griffin. Also, a local newspaper mentioned that clouds in several directions moved around and came together (a common description of a multivortex tornado by eyewitnesses, even today) causing destruction in Griffin. The newspaper also reported that two men who were close to Foote Pond, about 1.6–2.4 km (1–1.5 mi) north of Gap 28, saw the tornado moving away from Griffin and going across Gap 28 south of their location. The two men saw two tornadoes meet and form one giant tornado within the gap. This could mean either that the Tri-State tornado was continuing to be a multivortex system, or that one tornado dissipated as it moved around a new tornado that had already developed and was growing in size, similar to what happened northeast of Hesston, KS on 13 March 1990 (Davies et al. 1994). However, since the two men could have watched a multivortex tornado instead of seeing one tornado dissipate and another tornado develop, we do not have enough information to make a firm determination about the nature of Gap 28. A tornado likely moved continuously across Gap 29. Because the two men who were close to Foote Pond saw a tornado become large as it was leaving Gap 28 (close to entering Gap 29), and the width of the damage located <1 mi from the end of the short Gap 29 was about 1.2–1.6 km (0.75–1 mi) wide, it seems likely that the tornado was continuous across Gap 29.

The next two SD gaps were in eastern Gibson County, IN (Fig. 17) along a frequently flooded area of the Patoka River. There were no homes or buildings in the area during our survey, and likely none in 1925 either. Gap 30 was 1.6 km (1.0 mi) across the Patoka River while Gap 31 was 1.8 km (1.1 mi) on the east side of Patoka River. These two gaps are near the end of the damage path where it was more likely for a tornado to dissipate and another to form. However, for several other reasons, we propose that the tornado was likely continuous as it crossed these gaps. From the locations of our damage points, the direction of the damage path appears to shift to the right across central and eastern Gibson County. However, in the area where the two gaps are located, there are no noticeable direction shifts.

A local newspaper reported a narrowing damage path after the tornado crossed Princeton, IN. Our damage points suggest that in Princeton, the damage path was about 1.2 km (0.75 mi) wide (Fig. 18) while the local newspaper mentioned that the tornado was 0.8 km (0.5 mi) wide as it crossed the road that goes north from Francisco. This road and the 0.8-km (0.5-mi) wide damage path are on the west edge of Gap 30. The damage points near the east end of Gap 31 suggest that the damage path was between 0.4–0.8 km (0.25–0.5 mi) wide, certainly not very small. Given that the path on both sides of the floodplains appears to be fairly wide, it seems unlikely that a tornado had dissipated and another developed within either gap. An interviewee said that at his family's farm, the fences were blown away, and cattle appeared to have been lost initially. However, several days later, they found their livestock in the damage area south of Oatsville, about 7.2–8.0 km (4.5–5 mi) from their farm and just past the east edge of Gap 31. The eyewitness said the cows were located there since the tornado had torn down all the farm fences and other barriers along that 7.2–8.0-km (4.5–5-mi) path. Therefore, it appears that the tornado passed continuously through the gaps.

The last SD gap was in western Pike County, IN, an agricultural and mining area where many roads, homes, and buildings exist, as in 1925. Gap 32 is 8.1 km (5.0 mi), much longer than any of the other gaps in Illinois and Indiana. The gap starts fairly close to Oatsville, IN, where several local newspapers said that the Tri-State tornado ended. Also, Weather Bureau records from Indiana mentioned that the Tri-State tornado ended at Oatsville, close to where this gap starts. In 1925, an interviewee lived in a home located on an east–west road about 1.6 km (1 mi) east of Oatsville, inside the gap and near where the gap started. Her family's home was not hit by the tornado. She also pointed out other undamaged homes along the east–west road, most of which were within the gap area. A different eyewitness was in his home with his ill father, about 11.3 km (7 mi) east of where Gap 32 starts and about 5.6–6.4 km (3.5–4 mi) southeast of where Gap 32 ends. During that afternoon, he looked out of the kitchen door on the west side of his home, noticing dark clouds moving up from the southwest. As the dark clouds moved west-northwest of him, he noticed what he thought was an "arm coming down out of the clouds". When he told his father what had seen, his father went to the kitchen door, and they both looked out at the dark clouds. He noticed that the "arm" had reached the ground; his father told him it was a tornado. Since the feature did not seem to be coming toward them, they watched as it

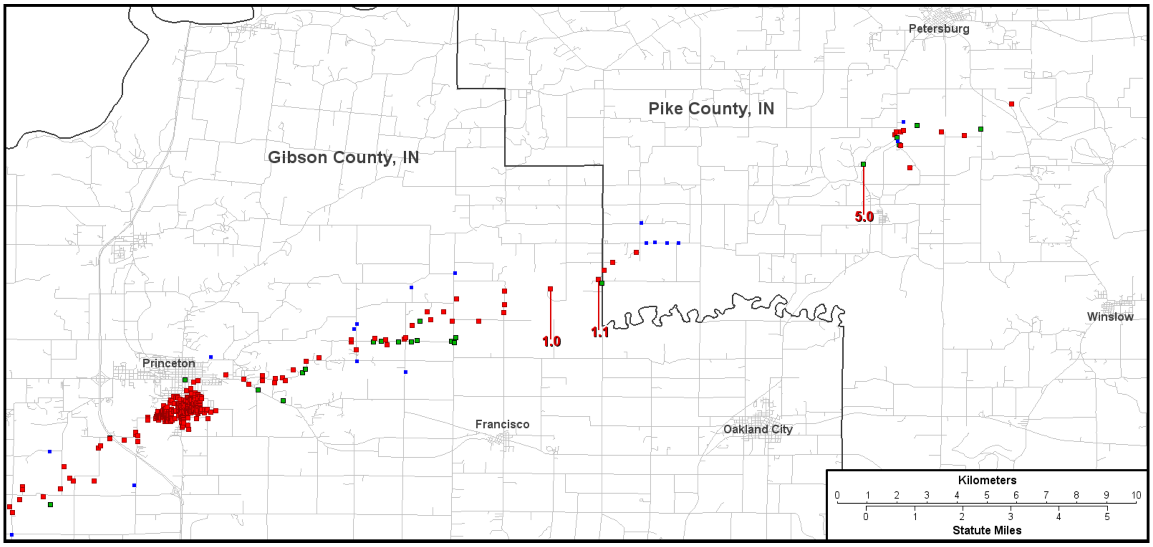


Figure 17: As in Fig. 7, but for eastern Gibson and Pike Counties, IN. *Click image to enlarge.*

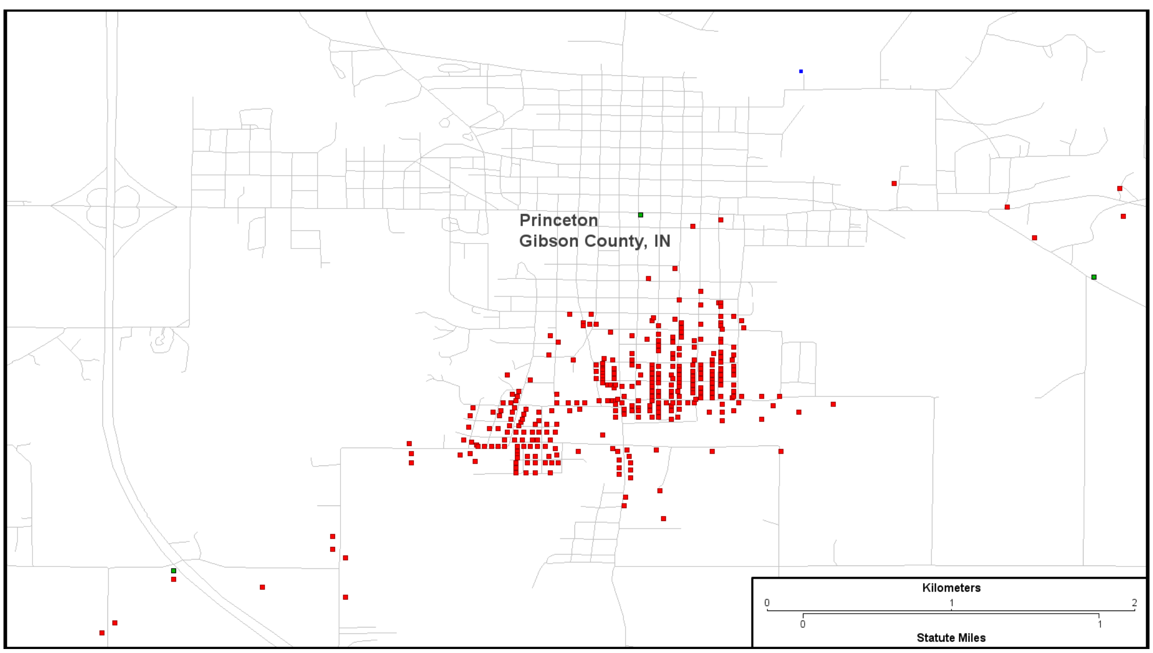


Figure 18: As in Fig. 7, but zoomed in on Princeton, IN. *Click image to enlarge.*

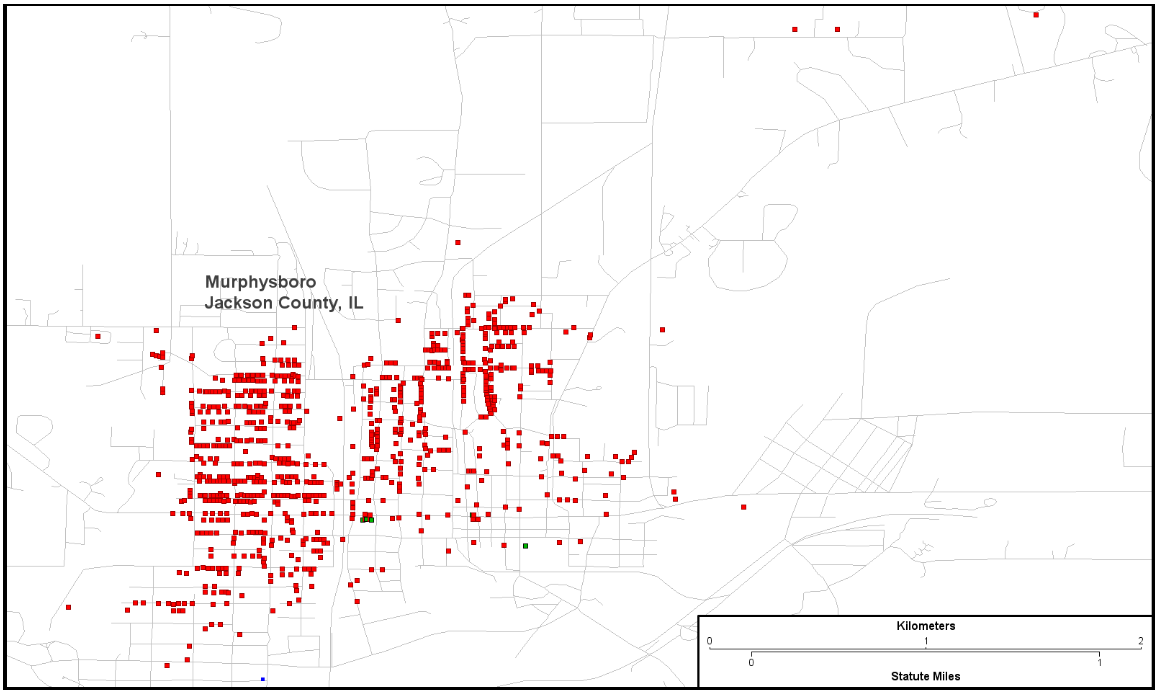


Figure 19: As in Fig. 7, but zoomed in on Murphysboro, IL. *Click image to enlarge.*

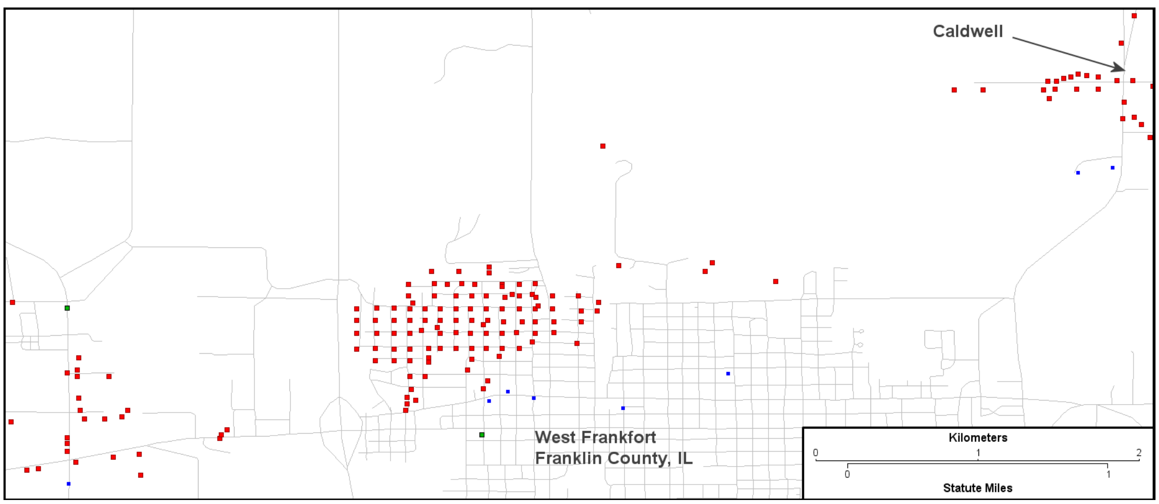


Figure 20: As in Fig. 7, but zoomed in on West Frankfort, IL. *Click image to enlarge.*

moved to their north until it disappeared. This suggests a new tornado before the end of Gap 32. They also noticed when this new tornado ended south-southeast of Petersburg. Based on this information, local newspapers, and one of the Weather Bureau records, we determined that this was likely a "real" gap where one tornado dissipated and another formed. However, since the new tornado was observed before the end of Gap 32, this "real" gap appears to have been <8.0 km (5 mi).

4. Storm-scale results

From our sources mentioned in section 2, we obtained information about the nature of both the Tri-State storm and associated tornadoes. (In supplemental Appendix C, the details about these findings are described for each of the 14 counties along the damage path from Missouri to Indiana.) Our findings show that a supercell produced the Tri-State tornado, which occurred on the right side and near the back end of the storm, rather than the front end.

Eyewitnesses in or near the tornado damage path in Shannon County, MO, Bollinger County, MO, Perry County, MO, Jackson County, IL, White County, IL, and Posey County, IN, noticed that the main part of the storm with all or part of the precipitation core had passed to the north of them, followed by the tornado approaching them from the west-southwest. Such descriptions are consistent with modern conceptual models of tornadic supercells (e.g., Browning 1964; Lemon and Doswell 1979).

In several counties, heavy rain and very large hail occurred with what was likely a part of the precipitation core a few miles north of the tornado path. In Jackson County, IL, the storm produced baseball size (7 cm; 2.75 in) hail about 5.6 km (3.5 mi) north of the damage path in Murphysboro, with much smaller hail in Murphysboro. In Hamilton County, IL, the storm produced 3.5-inch-diameter hail a few miles north of the damage path (at McLeansboro) that was larger than any hail along the damage path. This is common with supercells (Browning 1965; Lemon et al. 1977).

In many of the counties along the damage path, pieces of moderately large debris (e.g., clothes, rugs, tin roofing, boards, etc.) generated by the tornado landed in areas from 1–36 km (0.5–22 mi) north-northwest of the path. Also, some of the small debris with people's names listed on them (e.g., letters, checks, photographs, etc.) typically were blown to the northeast. The farthest traveled 653 km (406 mi) east-northeastward from Murphysboro, IL to near Newark, OH. Final resting locations of "intermediate" and "small" debris relative to the location of the storm and the damage path in the Tri-State tornado are similar to relative locations found in other strong and violent supercell tornadoes (Snow et al. 1995).

In the cities of Murphysboro and West Frankfort, IL, we were able to find more detailed information about the nature of the damage on and near the damage path. In Murphysboro, there were many points of lesser damage south of the severe damage associated with the tornado (Fig. 19 and Fig. C4). Much of the weaker southern damage area may have been associated with RFD winds that can be associated with both tornadic and nontornadic supercells (Lemon and Doswell 1979). A tornado is possible with no RFD, or vice versa, but the two commonly occur together. Eyewitnesses from West Frankfort also indicated an area south of the primary damage path that experienced strong southerly winds producing some slight damage (Fig. 20). The only tornado they knew about was north of this damage, which therefore may have been associated with the supercell's inflow winds. Strong inflow winds also occurred as far as 8 km (5 mi) southeast of the tornado in eastern Perry County, MO (in Fronha, Altenburg, and Wittenberg; Appendix C). One report of damage from inflow winds was in northwestern Bollinger County (see Appendix C).

The nature of the Tri-State supercell appeared to change along the damage path. During its Missouri stage, rain or rain with hail started before the tornado arrived and ended either before the tornado arrived or as it was moving by. A few eyewitnesses also noted that right after the tornado moved away, the sky became bright and sunny. These findings suggest that along this part of the damage path, the storm was likely a classic supercell (Moller et al. 1994).

As the supercell entered Illinois and moved into West Frankfort, precipitation along and near the damage path occasionally had occurred after the tornado had gone by, while sometimes the precipitation was not occurring before the tornado had gone by. Thus, the storm may have been changing its character at that time. After the supercell passed West Frankfort, most sources in the rest of Franklin County said that rain and hail did not begin along the damage path area before the tornado, but rather as the tornado was going by or just afterward.

As the supercell moved through the rest of Illinois and southwestern Indiana, no rain or hail occurred before the tornado arrived. Instead, most of the time, the rain and hail started as or just after the tornado passed by. Across Hamilton County, IL, and all the way over to southwestern Gibson County, IN, the supercell apparently transitioned to "high precipitation (HP) character (Moller et al. 1994). Within this part of the damage path, some sources noticed that the first part of the storm passed north of them before the tornado. Some other sources, including local newspapers, reported heavy rain and large hail north of the tornado path before it arrived, which is normal with supercells. Many sources in this part of the path noticed heavy rain and hail lasting a few minutes after the tornado went by, along with local flooding in a few places.

Several sources reported rain and hail for a few miles south of some part of damage path as the storm was going by. However, several sources also stated that after the rain and hail finally ended along the damage path, it cleared up and became sunny, which is common with supercells. During the remainder of the damage path from southwestern Gibson County to Pike County, IN, most of the rain and hail followed the tornado, did not last as long, and occurred without flooding. So, in this part of the damage path, the storm may have changed back to being a classic supercell.

In summary, it appears that the Tri-State storm started as a classic supercell in Missouri, may have changed to an HP supercell in the central part of southern Illinois, and stayed that way until entering Indiana. Moller et al. (1994) suggested that HP supercells do not produce strong and violent tornadoes as often as classic supercells; however, a major tornado associated with an HP supercell may be more likely east of the Great Plains. The Tri-State supercell may have been in an HP mode over some part of its very long damage path.

When the first tornado started with the Tri-State supercell in Shannon County, MO, it was observed to be funnel-shaped and was not large. However, when the primary tornado crossed Reynolds County, it was already large. As it was crossing Iron County, the tornado had become large enough to not appear funnel-shaped. By the time the Tri-State supercell was entering Bollinger County, the primary tornado was already wedge-shaped; to many people it appeared as a big black cloud rolling along the ground. From west of Bollinger County, MO, to Gibson County, IN, the primary tornado was very large, sometimes with multivortex appearance. Since it was so large, many people observed a big black storm "cloud", "smoke", "fog", or "big black mass" that was "rolling" or "swirling" around on the ground as it approached. As a result, some people did not recognize it as a tornado. Occasionally, it was observed as a multivortex tornado. In several places from Franklin County, IL, to where the tornado damage ended in Pike County, IN, some eyewitnesses saw a funnel-shaped tornado that was a part of the multivortex circulation.

The Tri-State supercell could have developed satellite tornadoes at two places where homes were destroyed: eastern Franklin and southwestern Hamilton Counties, IL. They were about 0.8–1.2 km (0.5–0.75 mi) south of the primary damage path. Also, between the damage point in eastern Franklin County and the primary path to the north, some buildings were not damaged.

Along most of the damage path, the Tri-State supercell developed a primary tornado that was very large and wedge-shaped, occasionally displaying multiple vortices in Illinois and Indiana. Also, the Tri-State supercell apparently developed two brief satellite tornadoes just south of the primary tornado in central Illinois. The nature of the report of alleged twin tornadoes on parallel tracks near Biehle, MO (in the original Weather Bureau report of the event and mentioned by Changnon and Semonin 1966), is unknown. We found no evidence to corroborate that report; however, it might have been another instance of a satellite tornado, evidence of a multivortex mode at that time, or perhaps apocryphal.

5. Summary and discussion

As we expected, our findings have shown that the 1925 Tri-State tornado event was associated with a supercell storm. We found that the storm was in the form of a classic supercell as it moved from where the tornado damage started in southern Missouri and reached the Mississippi River. However, as the supercell traversed southern Illinois, it may have become an HP supercell near West Frankfort and stayed that way until it got to southwestern Indiana.

We were able to find many places where tornado damage occurred along the supercell's path from Shannon County, MO, to Pike County, IN, which is 378 km (235 mi) long. We also found more than one tornado likely associated with the supercell along this path. We found two places in Illinois where brief satellite tornadoes apparently occurred. A primary tornado was associated with the supercell in every county from Missouri to Indiana. There were two separate tornadoes near both ends of the damage path. In the intervening part of the damage path, we cannot determine conclusively if there were any real gaps where one tornado ended and another started. In the 280-km (174-mi) part of this path from central Madison County, MO, to the west edge of Pike County, IN, no gaps exceeded 3.2 km (2 mi), suggesting a continuous tornado for that path segment. More damage reports and eyewitness interviews suggest a likely continuous path segment from north-central Bollinger County, MO, to the west edge of Pike County, IN—a distance of 243 km (151 mi). In the Griffin area, and also in many other places in Illinois and Indiana, the primary tornado was a multivortex (Agee et al. 1976).

Unfortunately, since the Tri-State tornado event occurred >80 y ago, and it was sometimes in a multivortex form, our findings cannot determine whether there was just one continuous primary tornado or how many separate tornadoes occurred in association with the long-lived supercell. With no radar information available, we cannot know for sure if the supercell changed from classic to HP structure along the damage path. However, we can compare what we have found about the Tri-State event with more recent major tornado events where a supercell produced a long damage path from its tornadoes.

On 28 March 1984, a long-lived supercell produced a series of devastating tornadoes along a 708-km (440-mi) path from Georgia to South Carolina and North Carolina. This storm developed near a major mesoscale cyclone that had formed near the original synoptic-scale cyclone (Doswell and Burgess 1988). The supercell moved along with the intensifying mesoscale cyclone while tornadic. Since this event formed similarly to the 1925 Tri-State supercell event, we can compare their tornado paths.

The part of the 28 March 1984 supercell path from northeastern South Carolina to east-central North Carolina was about 217 km (135 mi) long and had gaps between its serial tornadoes of <16 km (10 mi). The longest continuous tornado damage path within this area appeared to be only about 68 km (42 mi) long. In several of the gaps, a new tornado formed several miles to the right (rather than directly ahead) of where the previous tornado ended. This is very different from the Tri-State gaps. In the latter, the only area where there was an SD gap in a different direction than the damage path was close to the beginning in Missouri. In a cyclic supercell, tornado tracks on either side of gaps are typically in different directions than the track of the supercell itself (Fujita 1974). The 28 March 1984 supercell had such path characteristics, with a series of distinctly separate tornadoes. Since the 1925 Tri-State supercell only had one gap in a different direction than the damage path, long-track tornado continuity is more likely than in the 28 March 1984 event.

On 9 April 1947, a major tornado event occurred from the Texas Panhandle through northwestern Oklahoma and southern Kansas striking Woodward, OK. This initially was listed as one continuous VLT tornado 356 km (221 mi) long. However, Doswell and Burgess (1988) concluded that it involved a series of four tornadoes toward the end of the damage path. The gaps between these four tornadoes were 6.5–9.7 km (4–6 mi), In three of these gaps, one tornado ended and a new one formed several miles to the right of the previous tornado's track. Therefore, it is likely that the Woodward supercell was cyclic, and the tornado track was not continuous over the entire length. However, unlike the 28 March 1984 event, no gaps in the center segment of the damage path could be found, and a continuous VLT tornado caused very severe damage for at least 161 km (100 mi). Over a substantial part of the Woodward tornado's path, especially in the Texas Panhandle, there were few structures and little evidence of damage.

The Tri-State event may be more similar to the 09 April 1947 event than to the 28 March 1984 event. For the Tri-State event, we found substantial gaps near both ends of damage path likely representing tornado dissipation and new development. However, away from the path's beginning and end, we did not find any significant gaps that were in a different direction than the damage path. As such, the Tri-State supercell was very close to steady-state along most of the path, apart from the early and dissipating stages of the tornadic phase.

On 3 April 1974, a major tornado outbreak occurred in many states east of the Great Plains. One of the supercells created a series of tornadoes along a 420-km (261-mi) path from central Illinois to southeastern lower Michigan. Near the middle was a continuous, 194-km (121-mi) tornado damage path from west of Lafayette, IN, to east of Goshen, IN, within which 24 people were killed and 432 were injured. Radar imagery suggested an HP supercell in the form of a line-echo wave pattern along this continuous damage path (Agee et al. 1976). After the 1925 Tri-State supercell moved past West Frankfort, IL, it may have resembled this 1974 supercell.

Even though we are unable to say conclusively if there were real gaps along the center part of the 1925 Tri-State damage path, two were apparent near both ends. Omitting the beginning and ending path segments, the Tri-State tornado started either in far western Reynolds County or in extreme southeastern Shannon County, MO, and ended in western Pike County, IN, having a possible path length of at least 352 km (219 mi). Despite this length estimate being the same as originally reported, the revised path differs from that original version, notably at the beginning and the end.

The part of the Tri-State damage path that is 280 km (174 mi) long from central Madison County, MO to the west edge of Pike County, IN was found not to have any gaps along the damage path ≥3.2 km (2 mi) long, and there are no significant damage-point tracks in a different direction than the main path. Because of the relative density of damage and eyewitness reports, the 243-km (151-mi) part of the main damage path from central Bollinger County, MO to the west edge of Pike County, IN can be considered the most likely to be continuous.

Still, it is not possible to rule out completely the possibility of "handoffs" within our data gaps. In many cases, for the SD gaps <3.2 km (2 mi) long, we know that if the gap was real, the distance between the two tornadoes would be shorter than the gap we found. This is because eyewitnesses saw the tornado within the gap and/or on one or both sides of the gap. The damage path was 0.8–1.6 km (0.5–1 mi) wide at the edge of the gap. Also, Weather Bureau meteorologist Clarence Root drove on a path survey from western Jackson County, IL to Pike County, IN, finding absolutely no "skipping" for 209 km (130 mi). Therefore, although we can't say definitively if it contained just one tornado, we do know that this part of the damage path was nearly continuous.

ACKNOWLEDGMENTS

We really appreciate being able to find so many people who were in or had been in or near the counties where the tornado occurred and were willing to give us information about what happened.

Some of those people we met with in the damaged counties or nearby were very helpful by providing us old newspapers, photographs, maps, and/or other information, and/or showing us where we should go to find out what happened, and/or also giving us the names and addresses of eyewitnesses we should contact to learn what they experienced and where damage occurred. They and the counties we gathered information about from them are:

Missouri: Shannon County: *Helen (Ferguson) Thompson*. Bollinger County: *Bob Fulton, Connie (Murray) Caster and Anna (Shrum) Mungle*. Perry County: *Lonnie Schott*, *Mary Jane Buchheit and Carla Jordan*.

Illinois: Jackson County: *C. J. Calandro, Mary Riseling, Cliff Swafford, Ken Cochran, and Mike Jones.* Franklin County: *Lynda Savka, Dawn Taitt, Goebel and Allen Patton, Pat Hindman, Ryan Presley, Dave Sanders, Shirley Payne, Barbara Cairel, Lois Short, Mary Taylor, Mary Eubanks, Kyran Hanagan, David Garavalia, and Dayle Williams.* Hamilton County: *Eileen Drake, Micki Lazzuri, Nadine (Braden) Broyles, and Kenneth and Joyce Kirkpatrick.* White County: *Barry Cleveland, Charlene Shields, Janet Armstrong, Larry Gwaltney, Jan Prince, Linda Kuykendall.*

Indiana: Posey County: *Beverly Stone, Pat Hancock, and Sue Travis.* Gibson County: *Rev. William Ping, Peggy Callis, Bonnie Johnson, Dean Higginbotham, and Jean Watkins.* Pike County: *Robert Jack Kinman and Shirley Behme.*

Those who went on driving surveys with us, and showed us where damage occurred or places that were not damaged, are:

Missouri: Bollinger County: *Bob Fulton*. Bollinger and Perry Counties: *Lonnie Bangert*. Perry County: *Lonnie Schott, Bob Fielher, and Dale and Arlene (Petzoldt) Koenig*.

Illinois: Jackson County: *Denver Brewer, Brian Brewer, C. L. Calandro, Laura Varner, and Ella Cook.* Williamson County: *James Holland*. Franklin County: *Charles Brandon, Don Vancil, Charles Mathis, Bob Proctor, Reba (Sanders) Bennett, Pete Jackanicz, Marge (Murphy) Presley, Edward Vene, Burl Worsham, Stanley Diadus, Gary and Mary Ann (Thomas) Wade, James Carrier, Cordell Cairel, Eula (Kerley) Spain, Lovill (Woodrum) Carlile, Jerry Duckworth, Ronald Huffine, Dempsey Summers, and William Neal*. Hamilton County: *Nadine (Braden) Broyles, Howard Taylor, Mark White,*

Cecil Shasteen, Micki Faruzzi, Roy Schuster, Eddie Thompson, and Eli Hook. Hamilton and White Counties: *Lee Wilson*. White County: *Dorothy Jordan, Roy Robley, Frank Nix, Bob Armstrong, Hal Davenport, Ella Mae (Walker) Brown, and Cyril Barton*.

Indiana: Posey County: *Bob Nesler, Ed and Beverly Stone, and Ed Martin*. Posey and Gibson Counties: *Wayne Couch and Wayne Sharp*. Gibson County: *David and Kathryn Armstrong, Alice (Bush) Strickland, Cody White, Jack Woods, Jim Kolb, Virginia (Durring) Ott, and Phil Perry*. In Pike County: *Delmas Wyatt.*

Those who had written an account, a story or a book about how they or others experienced this event, and about where damage occurred, are:

Missouri: Reynolds, Iron, Madison, Bollinger, and Perry Counties: *Matt Chaney (Chaney, 1997). Matt was kind enough to let us use all his interview notes and other background material.* Bollinger County: *Dorothy (Bangert) Phillips and Daisy Shrum.*

Illinois: Franklin County: *Ryan Presley, Sheila Cadwalader and James Carrier*. Hamilton County: *Geneva (Sloan) Nipper and Juanita (Mezo) Harris*. White County: *Cyril Barton.*

Indiana: Gibson County: *Dean Higginbotham*. Pike County: *Imel Willis.*

The eyewitnesses, and family members or neighbors of eyewitnesses we met with or heard from regarding damage locations, are:

Missouri: Shannon County: *Helen (Ferguson) Thompson.* Iron County: *Buford and Alice "Peachy" Jones, Bud Jackson, and Lester Ruble*. Bollinger County: *David McCutcheon, Edith (Shrum) and Clint McCormack, Bill Smith, Lulu (Fulton) Snyder and Bob Fulton, Elliot Murray and Connie (Murray) Caster, Ruby (Bangert) Stearns and Dorothy (Bangert) Phillips, and Kelly Clements.* Perry County: *Lonnie Schott, Rudy Buchheit, and Arlene (Petzoldt) and Dale Koenig*

Illinois: Jackson County: *Harold Maerker, Benjamin Dunn and Wibur Jaquot*. Franklin County: *Venita McPhail, Ken Curry, David Dobill, Linda (Vancil) McVey, Maxine (Johnson) Uhls, Nellie (Wallace) Brocker, Bertha (Karnes) Barwick, Robert Sanders, Rev. Paul Ramsey, Pete Golid, Blodwen (Coleman) Wittcamp, Zella Spani, Mary (Crawford) Cockrum, Paul Wilburn, Nancy Tanner, Easter (Summers) Hardin, Gussie (Launius) Heiple, and Evan Smith.* Hamilton County: *Elsie (Hurt) Reed, Geneva (Sloan) Nipper, Max Warren, Dean Johnson, Norma Brehm, and Lawrence Unfield*. White County: *Bill Williams, Beulah (Rhein) Phillips, Bob Lamp, Ruby (Mitchell) Akers, Violet Veatch, Lorene (Myers) Fields, John Puckett, Berniece (Winter) Dartt, Herman Winter, Deanna Winter, Marjorie Seitz, Mary (Carter) Stokes, Clarlotte (Fieber) Porter, Linda Kuykendall, and Charles Kuykendall.*

Indiana: Posey County: *Ellen (Vanway) Nottingham, Charles Campbell, Tom Straw, and Mildred (Sanders) Hancock.* Posey and Gibson Counties: *Steve Nottingham*. Gibson County: *Evelyn (Almon) Nottingham, James Armstrong, Bill Johnson, Mary (Kendall) Kirby, Peggy (Keneipp) Callis, Evelyn (Myers) Miley, James Moore, Roger Skelton, Marjorie (Wilson) Woods, Rev. William Kell, Isabel (Crecelius) Kolb, Jack Laswell, Ada McClurkin, James Robert Moore, Dorothy Robinson, Dean Townsend, Joseph Carithers, Ellen (Amy) Dawson, Evelyn (Russ) Cotterill, Mrs. Clarence Jenkins, Bill Hart, Joy (Miller) Woods, Roger Skelton, Edward Moore Jr., and Elsie (Dunning) McDowell.* Gibson and Pike Counties: *Ray Falls, and Clarence Jenkins.* Pike County: *Linda Fears, Delmas Wyatt, Walter Evensoll, Vernie Cumming, and Imel Willis.*

We also appreciate other people and organizations who provided information about what happened:

Missouri : Iron, Bollinger and Perry Counties: *Harold Brooks (NSSL)*. Shannon, Iron, Madison, and Bollinger Counties: *The National Archives in Washington, DC, and the Missouri Department of Conservation, Ellington, MO.*

………………………………………………

[Editor's note: Because of their size and tabular, page-width format, the appendices are found after the references in this article.]

………………………………………………

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APPENDIX A

The 32 significant data (SD) gaps listed in order of greatest length are:

17.2 km (10.7 mi)	Gap 14	Madison County, MO, Liberty and Center Townships (Twps.)
11.8 km (7.3 mi)	Gap 3	Reynolds County, MO, Jackson and Logan Twps.
9.7 km (6.0 mi)	Gap 2	Shannon and Reynolds County, MO, Moore and Jackson Twps.
8.1 km (5.0 mi)	Gap 32	Pike County, IN, Logan and Washington Twps.
7.7 km (4.8 mi)	Gap 6	Reynolds County, MO, Logan and Webb Twps.
6.9 km (4.3 mi)	Gap 13	Iron and Madison County, MO, Union and Liberty Twps.
5.5 km (3.4 mi)	Gap 7	Reynolds County, MO, Webb Twp.
4.5 km (2.8 mi)	Gap 9	Iron County, MO, Western Union Twp.
4.0 km (2.5 mi)	Gap 5	Reynolds County, MO, Central and Eastern Logan Twp.
3.2 km (2.0 mi)	Gap 15	Madison County, MO, Center and St. Michael Twps.
3.1 km (1.9 mi	Gap 22	Perry County, Mo and Jackson County, IL, Brazeau and Fountain Bluff Twps.
2.9 km (1.8 mi)	Gap 24	Jackson County, IL, Middle Sand Ridge Twp.
2.7 km (1.7 mi)	Gap 17	Madison County, MO, Western Castor Twp.
2.6 km (1.6 mi)	Gap 11	Iron County, MO, Central and Eastern Union Twp.
2.4 km (1.5 mi)	Gap 16	Madison County, MO, Eastern St. Michael Twp.
2.3 km (1.4 mi)	Gap 26	. Franklin County, IL, Six Mile and Denning Twps.
2.3 km (1.4 mi)	Gap 28	Posey County, IN, Bethel Twp.
2.1 km (1.3 mi)	Gap 4	Reynolds County, MO, Western and Central Logan Twp.
2.1 km (1.3 mi)	Gap 10	Iron County, MO, Center Union Twp.
2.1 km (1.3 mi)	Gap 12	Iron County, MO, Eastern Union Twp.
2.1 km (1.3 mi)	Gap 20	Bollinger County, MO, Union and Whitewater Twps.
2.1 km (1.3 mi)	Gap 23	Jackson County, IL, Western Sand Ridge Twp.
1.9 km (1.2 mi)	Gap 8	Reynolds and Iron County, MO, Webb and Union Twps.
1.9 km (1.2 mi)	Gap 29	Gibson County, IN, Wabash Twp.
1.8 km (1.1 mi)	Gap 1	Shannon County, MO, Moore Twp.
1.8 km (1.1 mi)	Gap 27	White County, IL, Phillips Twp.
1.8 km (1.1 mi)	Gap 31	Gibson County, IN, Center and Washington Twps.
1.6 km (1.0 mi)	Gap 18	Madison County, MO, Eastern Castor Twp.
1.6 km (1.0 mi)	Gap 19	Madison and Bollinger County, MO, Castor and Union Twps.
1.6 km (1.0 mi)	Gap 21	Bollinger County, MO, Whitewater Twp.
1.6 km (1.0 mi)	Gap 25	.Jackson County, IL, Eastern Sand Ridge Twp.
1.6 km (1.0 mi)	Gap 30	Gibson County, IN, Center Twp.

APPENDIX B

The listing of SD gaps below is chronological. For each one, the first sentence describes its land-surface characteristics and structures (if any). Next, it is shown if there was estimation about whether the SD gap was likely real (one tornado dissipated and another developed) or contained a continuous tornado. The types of information (as listed in Table 1) that influenced any estimation are shown.

……….………………………………………………………………………..……………………………

Gap 1: 1.8 km (1.1 mi), Shannon County, MO, Moore Twp.

This SD gap is in a mountainous area with no known homes or buildings and no source found who knew whether any trees were damaged or destroyed in the area.

NO ESTIMATION: Not enough agreeing information to make an estimation.

INFORMATION suggesting a continuous tornado path was possible:

L The gap is not very long.

D The directions of the damage path appear to be the same on both sides of the gap.

INFORMATION suggesting a tornado dissipation and new development was possible:

G The gap is very close to the beginning of the damage path.

……….………………………………………………………………………..……………………………

Gap 2: 9.7 km (6.0 mi), Shannon and Reynolds County, MO, Moore and Jackson Twps.

This SD gap is in a mountainous area with no known homes or buildings and no source found who knew whether any trees were damaged or destroyed in the area.

ESTIMATION: Seems more likely to be a tornado-dissipation gap.

INFORMATION suggesting a tornado dissipation and new development was possible:

L This gap is the third longest gap along the entire damage path.

D The directions of the damage path are quite different on both sides of the gap.

G The gap is close to the beginning of the damage path.

……….………………………………………………………………………..……………………………

Gap 3: 11.8 km (7.3 mi), Reynolds County, MO, Jackson and Logan Twps.

This SD gap was in a mountainous area with no known homes or buildings and no source found who knew whether any trees were damaged or destroyed in the area.

NO ESTIMATION: Not enough agreeing information to make an estimation.

INFORMATION suggesting a continuous tornado path was possible:

D The directions of the damage path appear to be the same on both sides of the gap.

INFORMATION suggesting a tornado dissipation and new development was possible:

L The gap is the second longest gap along the damage path.

G The gap is very close to the beginning of the damage path.

……….………………………………………………………………………..……………………………

Gap 4 2.1 km (1.3 mi) Reynolds County, MO, Western and Central Logan Twp.

Gap 5 4.0 km (2.5 mi) Reynolds County, MO, Central and Eastern Logan Twp.

Gap 6	**7.7 km (4.8 mi)**	**Reynolds County, MO, Logan and Webb Twps.**
Gap 7	**5.5 km (3.4 mi)**	**Reynolds County, MO, Webb Twp.**
Gap 8	**1.9 km (1.2 mi)**	**Reynolds and Iron County, MO, Webb and Union Twps.**
Gap 9	**4.5 km (2.8 mi)**	**Iron County, MO, Western Union Twp.**
Gap 10	**2.1 km (1.3 mi)**	**Iron County, MO, Center Union Twp.**
Gap 11	**2.6 km (1.6 mi)**	**Iron County, MO, Central and Eastern Union Twp.**
Gap 12	**2.1 km (1.3 mi)**	**Iron County, MO, Eastern Union Twp.**
Gap 13	**6.9 km (4.3 mi)**	**Iron and Madison County, MO, Union and Liberty Twps.**
Gap 14	**17.2 km (10.7 mi)**	**Madison County, MO, Liberty and Center Twps.**
Gap 15	**3.2 km (2.0 mi)**	**Madison County, MO, Center and St. Michael Twps.**
Gap 16	**2.4 km (1.5 mi)**	**Madison County, MO, Eastern St. Michael Twp.**
Gap 17	**2.7 km (1.7 mi)**	**Madison County, MO, Western Castor Twp.**
Gap 18	**1.6 km (1.0 mi)**	**Madison County, MO, Eastern Castor Twp.**
Gap 19	**1.6 km (1.0 mi)**	**Madison and Bollinger County, MO, Castor and Union Twps.**

These 16 SD gaps were in portions of the Ozark Mountain area with no known homes or buildings in the gaps. No sources knew whether any trees were damaged or destroyed in the gap areas.

NO ESTIMATION: Not enough agreeing information to make an estimation.

INFORMATION suggesting a continuous tornado path was possible:

D The directions of the damage path appear to be the same on both sides of each of the 16 gaps, and the line of damage between the start of Gap 4 and the end of Gap 19 is straight.

G All of the gaps appear to be away from the ends of the damage path.

INFORMATION suggesting tornado dissipations and new developments were possible:

L The length of Gap 5, Gap 6, Gap 7, Gap 9, Gap 13, and Gap 14 are >3.2 km (2.0 mi), making tornado dissipation and new development more probable.

……

Gap 20: 2.1 km (1.3 mi), Bollinger County, MO, Union and Whitewater Twps.

Although this SD gap is near the edge of the Ozark Mountain area, it still is hilly, with fewer farms and buildings than on some nearby flatter ground.

ESTIMATION: Seems more likely to be a tornado-continuous gap.

INFORMATION suggesting a continuous tornado path was possible:

L The gap is not very long.

D The directions of the damage path appear to be the same on both sides of the gap.

G The gap is not near the end of the damage path.

………………………………………………………………………………………………………..

Gap 21: 1.6 km (1.0 mi), Bollinger County, MO, Whitewater Twp.

Although this SD gap is outside of the Ozark Mountain area, it is hilly, with fewer farms and buildings than on nearby flatter ground.

ESTIMATION: Seems more likely to be a tornado-continuous gap.

INFORMATION suggesting a continuous tornado path was possible:

L The gap is not very long.

D The directions of the damage path appear to be the same on both sides of the gaps.

G The gap is not near the ends of the damage path.

W On both sides of the gap, the damage points were about 0.8–1.2 km (0.5–0.75 mi) wide.

……..

Gap 22: 3.1 km (1.9 mi) Perry County, MO, Jackson County, IL, Brazeau and Fountain Bluff Twps.

This SD gap is where the damage path crosses the Mississippi River in such a way that much of the gap is over the river.

ESTIMATION: Seems more likely to be a tornado-continuous gap.

INFORMATION suggesting a continuous tornado path was possible:

L The gap is not very long.

D The directions of the damage path appear to be the same on both sides of the gaps.

W The width of the damage path appears to be >0.8 km (0.5 mi) on both sides of the gap.

G The gap is not near the ends of the damage path.

E An eyewitness on the Illinois side of the river saw the tornado crossing the river as a large, dark mass that was throwing river water.

………

Gap 23: 2.1 km (1.3 mi) Jackson County, IL, Western Sand Ridge Twp.

This SD gap is within the Mississippi River floodplain, an open agricultural area with very few homes or buildings, as in 1925.

ESTIMATION: Seems more likely to be a tornado-continuous gap.

INFORMATION suggesting a continuous tornado path was possible:

L The gap is not very long.

D The directions of the damage path appear to be the same on both sides of the gap.

W The width of the damage path on the west edge of the gap is 0.8–1.2 km (0.5–0.75 mi) wide. A local newspaper mentions that the damage path in this part of the county was 0.2–1.6 km (200 yd to 1 mi) wide.

E An eyewitness saw the tornado moving through the gap.

……...

Gap 24: 2.9 km (1.8 mi) Jackson County, IL, Middle Sand Ridge Twp.

This SD gap is within the Mississippi River floodplain, an open agricultural area with very few homes or buildings, as in 1925.

ESTIMATION: Seems more likely to be a tornado-continuous gap.

INFORMATION suggesting a continuous tornado path was possible:

L The gap is not very long.

D The directions of the damage path appear to be the same on both sides of the gap.

W The width of the damage path near the east edge of the gap is 0.8 km (0.5 mi). A local newspaper mentions that the damage path in this part of the county was 0.2–1.6 km (200 yd to 1 mi) wide.

E An eyewitness saw the tornado moving through the gap.

………

Gap 25: 1.6 km (1.0 mi) Jackson County, IL, Eastern Sand Ridge Twp.

This SD gap is in a hilly area where there are not as many farm homes or other buildings.

ESTIMATION: Seems more likely a tornado-continuous gap.

INFORMATION suggesting a continuous tornado path is possible:

L The gap is not very long.

D The directions of the damage path appear to be the same on both sides of the gap.

W On both sides of the short gap, the width of the damage path appears to be 1.2 km (0.75 mi) wide.

………

Gap 26: 2.3 km (1.4 mi) Franklin County, IL, Six Mile and Denning Twps.

This SD gap was along a river with not many homes, buildings, or roads.

ESTIMATION: Seems more likely to be a tornado-continuous gap.

INFORMATION suggesting a continuous tornado path is possible:

L The gap is not very long.

D The directions of the damage path appear to be the same on both sides of the gap.

W On the east edge of the gap, the damage points are 1.2–1.6 km (0.75–1) mi wide.

E Four secondhand eyewitnesses knew the tornado was seen while it was within the gap.

…………………………………………………………………………………………………..…………..

GAP 27: 1.8 km (1.1 mi) White County, IL, Phillips Twp.

This SD gap was on the floodplain area on the west side of the Wabash River channel, with fewer homes and buildings because of occasional river flooding.

ESTIMATION: Seems more likely to be a tornado-continuous gap.

INFORMATION suggesting a continuous tornado path was possible:

L The gap is not very long.

D The directions of the damage path appear to be the same on both sides of the gap.

W Just outside of the floodplain, and about 1.5 mi from the start of the gap, the damage points are between 1.2–1.6 km (0.75–1 mi) wide. Also, a local newspaper mentions that a 1.2 km (0.75 mi) long row of trees next to Wabash River and near the end of the SD gap were broken by the tornado.

E An eyewitness saw the large tornado move all the way across the SD gap in the floodplain.

…………………………………………………………………………………………………..……

Gap 28: 2.3 km (1.4 mi) Posey County, IN, Bethel Twp.

This SD gap was in a floodplain area near Black River. Some interviewees mentioned that almost no one lived in that area in 1925, as is true now.

NO ESTIMATION: Not enough agreeing information to make an estimation.

INFORMATION suggesting a tornado dissipation and new development was possible:

E A local newspaper mentions that two men saw two tornadoes meet and form a giant tornado within the gap.

INFORMATION suggesting a continuous tornado path was possible:

L The gap is not very long.

D The directions of the damage path appear to be the same on both sides of the gap.

E A local newspaper's description and an eyewitness each suggest it was a multivortex instead of multiple tornadoes.

……

Gap 29: 1.9 km (1.2 mi) Gibson County, IN, Wabash Twp.

This SD gap was in a floodplain area near Black River. Some interviewees mentioned that almost no one lived in that area in 1925, as is true now.

ESTIMATION: Seems more likely to be a tornado-continuous gap.

INFORMATION suggesting a continuous tornado path was possible:

L The gap is not very long.

D The directions of the damage path appear to be the same on both sides of the gap.

W Within 1 mi of the end of the gap, the width of the damage points are about 1.2–1.6 km (0.75–1 mi) wide.

E A local newspaper contained eyewitness reports of a very large tornado moving toward the start of the gap.

……

Gap 30: 1.6 km (1.0 mi) Gibson County, IN, Center Twp.

This SD gap was in a floodplain area across the Patoka River with no homes or buildings, as probably true in 1925.

ESTIMATION: Seems more likely to be a tornado-continuous gap

INFORMATION suggesting a tornado dissipation and new development was possible:

G It is more common for the tornado-dissipation gaps to be near the beginning or ending of a long damage path.

INFORMATION suggesting a continuous tornado path was possible:

L The gap is not very long.

D There is no noticeable direction change associated with the damage points near this gap.

W A local newspaper reported that the tornado path was 0.5 mi wide as it crossed the north–south road on the west edge of the gap.

E An eyewitness mentioned that cows were able to walk through the area since the tornado had torn down all of the fences and other obstacles.

N Local newspapers said the Tri-State tornado ended near Oatsville, >1 mi northeast of the gap.

……

Gap 31: 1.8 km (1.1 mi) Gibson County, IN, Center and Washington Twps.

This SD gap was in a floodplain area across the Patoka River with no homes or buildings, as probably true in 1925.

ESTMATION: Seems more likely to be a tornado-continuous gap

INFORMATION suggesting a tornado dissipation and new development was possible:

G Tornado-dissipation gaps are more common near the beginning or end of a long damage path.

INFORMATION suggesting a continuous tornado path was possible:

L The gap is not very long.

D There is no noticeable direction change associated with the damage points near this gap.

W At the east end of the gap the damage points suggest that the path was between 0.4–0.8 km (0.25–0.5) mi wide.

E An eyewitness mentioned that cows were able to walk through the area since the tornado had torn down all of the fences and other obstacles.

N Local newspapers said the Tri-State tornado ended near Oatsville, >1 mi northeast of the gap.

………

Gap 32: 8.1 km (5.0 mi) Pike County, IN, Logan and Washington Twps.

This SD gap was in a farm and mine area with many roads, homes and buildings now, and probably in 1925 also.

ESTIMATION: Seems more likely to be a tornado-dissipation gap.

INFORMATION suggesting a tornado dissipation and new development was possible:

L This gap is longer than any other gap in Illinois and Indiana.

E An eyewitness who lived east southeast of the gap saw a tornado developing (probably a new one) when he was looking toward the gap.

P In one area where a road crossed the gap, a local person stated that none of the homes were damaged (non-damage points).

N Some local 1925 newspapers mentioned that the Tri-State tornado ended at Oatsville, close to where this gap starts. This was corroborated by 1925 Weather Bureau records.

W The damage path continued to narrow across the eastern half of Gibson County and to the start of the gap in Pike County.

INFORMATION suggesting a continuous tornado path was possible:

D The directions of the damage path appear to be the same on both sides of the gap.

APPENDIX C

Appendix C is available as supplemental material to this paper, hosted by EJSSM at the following web site:

http://ejssm.org/ojs/public/vol8-2/johns_burgess_doswell_gilmore_hart_piltz-2012-layout1-supplement.pdf

REVIEWER COMMENTS

[Authors' responses in *blue italics.*]

REVIEWER A (Ernest J. Ostuno):

Initial Review:

Recommendation: Accept with minor revisions.

Substantive Comments: Here are some of the specific points I would like to see addressed: In the abstract it is stated that there have been no formal science papers written about the tornado and its damage path since the event occurred. The reference section does contain a paper published in the April, 1925 *Mon. Wea. Rev.* by A. J. Henry, which did include information on the damage path. This paper is not cited in the text, so I am not sure if the authors have read it. I found the paper in the NOAA library at: http://docs.lib.noaa.gov/rescue/mwr/053/mwr-053-04-0141.pdf

I think it would be useful to cite the findings of this paper in the Introduction.

We had every intention of citing this paper. Apparently, the citation disappeared at some point in the revision process during the many drafts of the manuscript, which would explain why it is in the references but not cited in the paper. This has been corrected, thanks.

I felt the finding that there were separate tornadoes at the beginning of the damage path was not well-substantiated since it was only based on differing directions between damage points in a gap that occurred in a sparsely populated area, with very few damage indicators. There are examples of long track tornadoes that have shown a turn to the right near the beginning of the damage path, such as tornado 13 plotted by Fujita in the Super Outbreak. The damage path was said to be wide where it picked up again, which would indicate the tornado had at least reformed somewhere to the west of the eastern edge of the gap.

Although examples of abrupt direction changes in a tornado path certainly can be found, we see no compelling reason, based on that possibility, to change our interpretation. Our paper provides the evidence as well as our interpretation of that evidence and we have been careful throughout to make clear our reasoning for our interpretation. Any reader is free to come to an alternative interpretation of the data at any point, as we could not justify any absolutely definitive conclusions about any of our findings. We have modified the text somewhat to clarify this point.

I believe the finding of separate tornadoes for the longer gap at the end of the track in Indiana was well-corroborated.

I would like to see the issue of the forward speed of the tornado addressed. Many of the references such as Grazulis mention the remarkable speed of the tornado and cite it as a factor in the huge death toll. Was the speed steady over its long path or did it change? It would be interesting to see times plotted along the damage path along with estimated forward speeds at various locations along the path.

We have only a few isolated instances along the track where we have observed times and some those are in conflict. We appreciate that this might be a significant issue, but given questions of the accuracy of any such times, we don't believe our limited data about the timing justify attempting to describe the variations in the translational speed of the tornado. Rather, we provide what amounts to an estimate of the average forward speed along the entire path…toward the front of Section 3.

It would also be interesting to see debris fall locations plotted on the maps along with locations where eyewitnesses saw the tornado moving through the SD gaps such as river/flood plain crossings.

It might indeed be interesting, but we haven't the time or the resources to construction such a map. The data in Appendix C could be used for this purpose, but it simply isn't feasible for us to provide it in this paper.

This may go under the heading of "major revision", but I would like to suggest taking all the eyewitness accounts in [supplemental] Appendix C and linking them to an interactive map of the damage path. This could possibly be made into a Google Earth map or something similar, where it would be possible to zoom into various places along the damage path and click on "eyewitness icons" that would pop up text boxes with the eyewitness accounts. I feel this would be fully utilizing the capabilities of on online journal. I found it fascinating, but at the same time exhausting to read Appendix C in one sitting. It would be much more enjoyable to follow along an interactive map and read the eyewitness accounts while being able to readily link them to a geographic place.

We have added reference to an interactive map that summarizes all Tri-State tornado damage points. The reference to the map is located toward the front of Section 3. The map is located at: http://ejssm.org/ojs/public/vol8-2/map/map.php. *Note, however, that the interactive map does not have all the elements you requested. The map does not contain many of the eyewitness details found in Appendix C (now, Supplemental Material)…only a summary of information is included on the interactive map.*

In Section 4, there is a discussion of the possibility of satellite tornadoes south of the primary damage path. I have seen several cases of small, isolated areas of damage along the south/southeast side of tornado damage paths when surveying. Some of these damage areas are worthy of an EF1 rating. They do not appear to be tornadic and one of the possible causes that has been suggested when I described them in the past are "occlusion downdrafts". Perhaps this can be mentioned in the text as a possibility?

We have referred to the possibility of such isolated, off-path damage points as possibly being attributable to satellite tornadoes or "rear flank downdraft" winds (RFD is more general than "occlusion downdraft") or inflow winds, but given our limited information, we have chosen not to make such an interpretation of single, isolated damage points.

Also in Section 4, the case is made for RFD or inflow winds causing lighter damage on the south side of the damage path, with more intense damage on the north side. Figure 19 is cited as evidence of this. I found this assertion confusing, since I believe the most intense damage would be not at the north edge of the damage path, but along the center and just south of the damage path given that the translational speed would be subtracted from the rotational speed of the vortex or vortices on the north edge.

The text has been modified to clarify this point … the most intense damage would be associated with the tornado, not RFD winds. Also please see the new Figs. C4 and C5 and the discussion surrounding them.

There are several other questions/comments that are included as annotations in the reviewed document, but they are relatively minor.

[Minor comments omitted...]

Second review:

Recommendation: Accept with minor revisions.

General Comments: I have gone over the latest version of "The 1925 Tri-State Tornado Damage Path and Associated Storm System," for *E-Journal of Severe Storms Meteorology*, including the supplement. All the main points from the first review were addressed to my satisfaction in the revisions and I recommend publication as soon as the typos and very minor points are addressed/corrected. See the attached files.

This and the paper by Maddox et al., along with the interactive map of the damage points, will serve as an outstanding resource for this historic event. It also will be a great reference for future archivists researching this and other tornado events of the distant past!

Thanks for the opportunity to review these papers.

[Minor comments omitted...]

REVIEWER B (Thomas P. Grazulis):

Initial Review:

Reviewer recommendation: Accept with minor revisions.

Substantive comments: I have a few suggestions that may be rejected by the authors. That rejection would not be enough to prohibit publication; for it is just personal opinion as a casual reader.

My main suggestion is the inclusion of photographs. If space were an issue, the authors could have done without much of the appendix material. If size is not an issue in electronic publishing, then why are there no photographs?…especially of the mounds and depressions so key to the research. Except for a few gaps such as #3, some other manner of summary would be enough. The details of each gap are fine for the authors notes, but of little interest to anyone else. They could be made available to someone in the unlikely event that anyone else would continue this level of research. I understand that the idea of a gap is key to the concept of a continuous path. But the exclusion of photographs in order the focus on gap details and lengthy appendix descriptions was not a good idea.

We have added a few representative damage photographs from the event to [supplemental] Appendix C, but we don't believe we have enough photographs of journal quality to be comprehensive in providing photographic damage documentation

Old photographs are not needed. They are available elsewhere. A "before-after" pair of photographs (1925-current) would be very interesting, [but] that might not be possible unless planned for ahead of time. Current photographs showing remaining "evidence" of the tornado passage was the very first thing I looked for when the paper was downloaded. Instead, there were 38 pages of marginally useful appendices that could have been summarized, organized by type of description. Instead of descriptions of hail (useful to the authors, I am sure), a map showing the positions of the hail with some conclusions would be far more useful to the reader. The same goes for the debris descriptions. An author's comment on the reliability of 406-mile all-time-record piece of debris would be interesting. Was this ever checked in an Ohio newspaper?

In short: –more maps—fewer words---

Before/after images likely would be interesting, but we have only a few cases where we could do so and it's not clear that it adds to the scientific content of this paper. As noted, we have neither the time nor the resources to convert the data into another map, unfortunately. Two current photos associated with supposed 1925 tree damage have been added to Appendix C. We do not have comments on the reliability of the long-distance debris travel. We did not check Ohio newspapers. We hope the large amount of information in the paper, particularly Appendix C, might be used by others in the future to accomplish additional research.

I am curious as to why there was no reference to the separate works of Wallace Akin and Peter Felknor…both spent some time interviewing, although the Akin book has some real problems.

The reason we have not cited these non-scientific publications is that we found nothing within them that would add scientific value to the manuscript.

Photographs might enhance the future "credibility" of this unique work for some people who are unfamiliar with the authors. For me personally, their credentials and reliability are the highest of anyone alive. But not everyone knows them, and some may believe that this kind of work is not even possible at a truly scientific level.

If this is a request for photographs of the authors, it would be an unprecedented addition to a scientific paper. Moreover, it's not evident how a photograph could enhance our credibility in the minds of future readers.

I am delighted to see that this work was done by the level of people who did it. The main text, with clearly done maps, was excellent. It was those easy to understand maps and text that made me want more from the appendices. Sorry, when it comes to this historical stuff, I just want more.

No need to apologize … we understand, but a journal paper necessarily has limited scope.

[Minor comments omitted…]

Second Review:

Reviewer recommendation: Accept.

General comments: I have nothing more to say about the paper. I love it and it reads well enough to publish. I never suggested that credibility involved photos of the authors. My idea was that photos would add credibility to the idea that this sort of effort could realistically be done at all, and have validity.

I still hope to eventually add something more to knowledge of the day's events.

[Minor comments omitted...]

REVIEWER C (Gregory S. Forbes):

Initial Review:

Reviewer recommendation: Accept with minor revisions.

Substantive comments: The authors are to be commended for their exhaustive research on this historical tornado. I have just two comments. One is that the authors may be unaware that there is actually (and amazingly) aerial damage film of some of the Tri-State tornado path. I believe it is in the National Archives. I'm not sure, though, that it would make much if any difference to their results. My recollection is that much of the aerial flight was near Murphysboro, IL.

We have incorporated this suggestion. We had seen the film (in video form) and one of us (Piltz) painstakingly had used the film to contribute to the data in the vicinity of Murphysboro. A new figure of a still image made from the film has been added to the paper (supplemental Appendix, Fig. C5), and new analysis associated with data from the film has been added (Fig. C4). We have not found film from any other areas than Murphysboro.

The second comment is a suggestion that this group of distinguished authors make a statement, after their exhaustive study, regarding how long they feel the path of the tornado was. The reader is left to sense that it might have been 173 mi (or maybe 151, or maybe 130).

We understand the interest in such a statement. We have done so, but in a qualified way (see new text concerning path length in the Abstract and Sections 3–5). Anything definitive is simply not possible, for reasons which we have explained.

Second Review:

Reviewer recommendation: Accept.

General comments: The authors are to be commended for the amount of effort they have undertaken in order to gather as much information as possible about this benchmark event in United States weather history. They have presented the data and their analysis of it very clearly. While it is impossible to determine the exact length of the continuous tornado path, the reader is guided to conclude that it was most likely 174 miles, certainly 151 miles or longer. Additional damage, likely from a series of at least 3 tornadoes in a family, covered a path of 235 miles.