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Do You Track? A Look at the Difference Between Great Plains and Southeast Tornado Tracks

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Abstract

Tornadoes in the southeastern United States and in the Great Plains have both similarities and differences. For instance, Great Plains tornadoes are typically spawned out of individual supercells, while many more southeastern tornadoes are a part of synoptically-driven disturbances such as quasi-linear convective systems. Wintertime tornadoes also occur more frequently in the Southeast than in the Great Plains. Another difference can be seen in the tracks of Southeast and Great Plains tornadoes. Therefore, this paper compares tornado tracks from the southeastern United States and the Great Plains after the implementation of the enhanced Fujita (EF) scale. The comparison includes average tornado length and width for each EF rating, as well as track length and width in the spring and winter seasons. Results indicate that weaker tornadoes (EF-0 and EF-1) are relatively similar across both regions. However, as the tornado strength increases, the distances traveled and base widths across both regions are no longer as similar.

Introduction

Tornadoes in the southeastern United States (US) and Great Plains (GP) have general differences, particularly in timing, track length, and width. “This area is so clearly different than the tornado alley discussed by the media,” Coleman and Dixon (2014) wrote, referring to the Southeast. For instance, tornadoes in the southeastern US tend to develop in low convective available potential energy (CAPE) and high vertical wind sheared environments (Anderson-Frey et al. 2019). These tornadoes also have a peak in activity two times a year, occurring in late November and April (Long et al. 2018). Bunker et al. (2019) noticed nocturnal tornadoes tended to dominate the tornado activity in the Southeast during the November-January activity peak, notable because nocturnal tornadoes make up 20% of the tornadoes in the Southeast. Anderson-Frey et al. (2019) noted that strong tornadoes (tornadoes rated EF2 and up) form more frequently during the wintertime peak. The enhanced Fujita (EF) scale is the method by which tornadoes’ strengths are measured (WSEC 2006).

Could tornadoes in the southeastern US have longer tracks than those in the Great Plains? Strong (EF 2+) continental United States (CONUS) tornadoes have an average track length slightly more than five times the length of a weak tornado (Coleman and Dixon 2014). This may reveal a fundamental difference between tornadoes in the GP versus the Southeast.

In the GP, 73.8% of all tornadoes occur in the spring season (April–May) with a steep drop-off in activity happening during the late fall and winter (November–March; Elsner and Widen 2014). A large portion of the Great Plains tornadoes also occurred during the day or the early evening transition time with significantly fewer occurring during the nighttime hours (Anderson-Frey et al. 2018). Wade and Parker (2021) point out that GP tornadoes tend to happen in higher CAPE and high vertical shear environments; they also note tornadoes are spawned more out of supercells in the GP as opposed to the southeastern US. However, that is not meant to say that supercells are not the predominant storm type to spawn tornadoes in the southeastern US as well. A quasi-linear convective system (QLCS), a well-organized line of thunderstorms, is more likely to spawn tornadoes in the Southeast than in the GP (Smith et al. 2012). Over the years of 1998–2000, 25% of tornadoes east of a curve drawn from Louisiana to Pennsylvania were produced from QLCSs (Trapp et al. 2004).

The majority (roughly 77%) of tornadoes are classified as weak, less than EF-2 rating (Coleman and Dixon 2014). Brown et al. (2021) found that strong tornadoes make up over 25% of the total tornadoes reported in the Southeast, a higher percentage than the CONUS average of 19%. Also, about 65% of the longest-lived tornadoes occurred between November and April (Garner et al. 2021). Only 26% of GP tornadoes occur during the fall and winter (Elsner and Widen 2014) and, although the exact percentage is absent from previous literature, Moore (2017) alludes to the percentage of fall and winter tornadoes in the Southeast being higher than the GP. Having a higher percentage of tornadoes occurring during the fall and winter in the Southeast in addition to a high percentage of long-lived tornadoes implies a significant difference between Southeast and GP tornadoes. This paper will seek to analyze such differences in tornado tracks.

Data & Methods

Tornado track data were gathered from the Storm Prediction Center's tornado database. In order to account for differences in how F-rated and EF-rated tornadoes are determined, any tornado occurring before 1 February 2007 (the date of the implementation of the EF scale) was not analyzed. Tornadoes between the dates of 1 February 2007 and 31 December 2022 were used in this analysis.

The National Oceanic and Atmospheric Administration's (NOAA's) Damage Assessment Toolkit website shows the highest density of tornado reports and their tracks and helps to determine two regional hot spots. The longitude bounds for the chosen Southeast region are defined between 94°W and 83°W, with latitude bounds of 31°N and 36°N. A total number of 3327 tornadoes occurred in the Southeast. The longitude bounds for the GP region are defined between 104°W and 97°W and the latitude bounds are 32°N and 42°N. A total of 3017 tornadoes occurred in the GP (Figure 1).

A categorization of tornadoes in each region according to EF-scale rating allows a comparison of average damage widths and track lengths. These data are displayed in Figures 2 and 3, as well as in Tables 1 and 2.

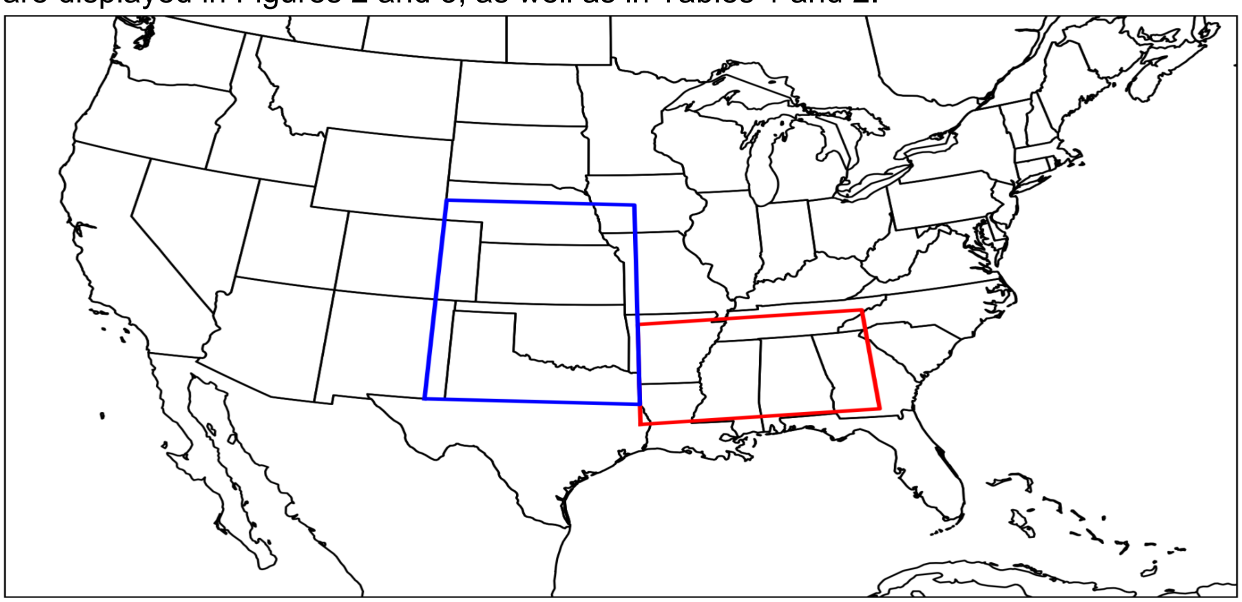

Figure 1. The Great Plains (blue) and Southeast (red) regions.

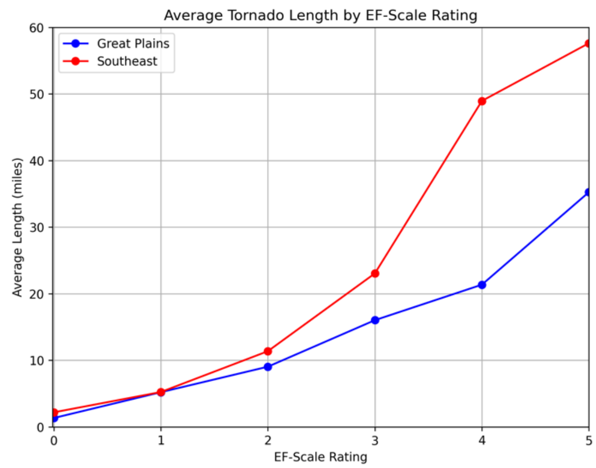

Figure 2. Average tornado track length by EF-scale rating in each region.

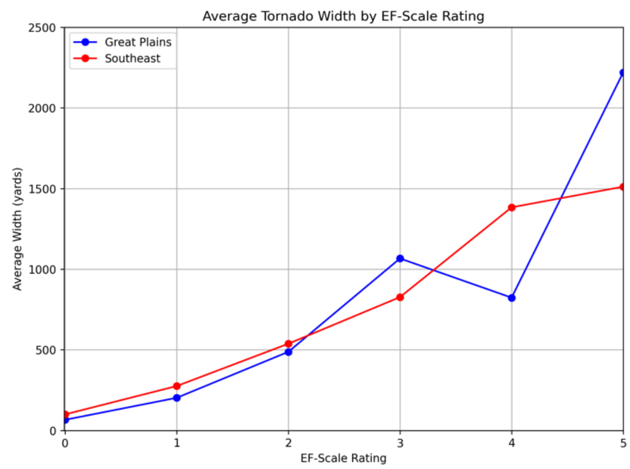

Figure 3. Average tornado track width by EF-scale rating in each region.

Table 1. Average tornado track data for the Southeast.

EF Rating	Percent of Total	Count	Length (km)	Width (meters)
EF-0	34.75%	1156	3.51	91
EF-1	47.28%	1573	8.42	252
EF-2	12.89%	429	18.28	492
EF-3	3.55%	118	37.08	756
EF-4	1.32%	44	78.78	1265
EF-5	0.21%	7	92.73	1382

Table 2. Average tornado track data for the Great Plains.

EF Rating	Percent of Total	Count	Length (km)	Width (meters)
EF-0	70.10%	2115	2.14	60
EF-1	20.32%	613	8.37	186
EF-2	6.17%	186	14.53	446
EF-3	2.72%	82	25.78	975
EF-4	0.60%	18	34.36	753
EF-5	0.10%	3	56.73	2012

Discussion

This study analyzed all tornadoes within the Southeast and Great Plains regions since the implementation of the EF scale in 2007. A total of 6344 tornadoes were analyzed, including 3017 in the Great Plains and 3327 in the Southeast. Figures 2 and 3 display the differences between length traveled and base width across all tornadoes. They display how different tornadoes are across each region and how different their impacts on people are. If you have a longer track and wider base width, the chances of a tornado hitting property increases. Tornadoes hitting a place of residence or vocation has a direct impact on people and if there are further traveling tornadoes in one region, there is a different impact on the residents.

Overall, weaker (EF0 and EF1) tornadoes are relatively similar in length and width stronger tornadoes (EF2+), however, tend to show differences. The Southeast tornadoes tend to travel farther distances than their Great Plains counterparts (Figure 2). The longer length may indicate stronger, undisrupted parent mesocyclones in the Southeast than in the GP.

The base widths of GP tornadoes show more variability than their Southeast counterparts (Figure 3). The average smaller width of EF4 than EF3 tornadoes in the GP may be due to the small sample size. Southeast tornadoes show a consistently higher width with increasing intensity. However, the rate of increase in length drastically changes between EF3 and EF4 rated tornadoes. A less drastic rate of change in widths, but a rather large change in lengths occurs in the same rating range. This may be due to a stronger parent mesocyclone in EF4 and EF5 tornadoes. The difference between EF4 and EF5 in both respects is also noteworthy, as the change in lengths and widths do not grow as much from the other strong tornadoes' ratings. The Southeast has also seen many more strong tornadoes since 2007 than the GP (Tables 1 and 2). This is a fascinating result because the GP region is usually associated with more numerous strong tornadoes. These tornadoes may be rated stronger due to the population density in the Southeast because there is a much higher chance the tornado will damage houses, other structures, and trees. Tornadoes are given their ratings primarily based upon damage indicators, so it is possible that some strong tornadoes in the GP are under-rated if they do not cause significant measurable damage.

The percentage of total tornadoes in each region yields fascinating results. In the Southeast, strong tornadoes make up a larger percentage of all tornadoes that occur in that region than those in the GP (Tables 1 and 2). EF2+ tornadoes make up 17.97% of all tornadoes in the Southeast, compare that to the GP where EF2+ tornadoes make up 9.59% of all tornadoes. That is a substantial difference in the percentage of total values. This means that the likelihood of a tornado being strong in the Southeast is much higher than that of the Great Plains.

The analysis of the tornadoes in the GP also show an interesting result. While an increasing EF-rating shows an increase in length traveled, the widths are a little less straight forward. EF-4 rated tornadoes show a dip in track width (Figure 3). They are on average 753 meters wide, while EF-3 and EF-5 tornadoes are both wider than 900 meters on average. These differences may be a result of how tornadoes are rated and how their widths are measured, though it is likely a sample size issue. It is very difficult to determine a width without much damage, say, if it only occurs over grasslands. The number of tornadoes and their corresponding rating in the GP also is noteworthy. There are over 2000 EF-0 tornadoes (Table 2) and that also may be linked to the damage survey process. A large number of storm spotters in the GP may inflate the number of weak tornadoes reported to the NWS, but a lack of damage indicators or reported damage may lead these to be classified as very weak (EF0). Due to a lack of visibility and fewer spotters, the weakest tornadoes in the Southeast may be underreported.

Conclusion

Comparing these two regions poses some challenges due to a lack of damage to assess in the GP, fewer spotters in the Southeast, or synoptic scale differences and thermodynamic influences, which are beyond the scope of this study. Regardless, there is a clear difference between strong tornadoes that occur in the GP and the Southeast.

Strong tornadoes (EF-2+) in the Southeast tend to be stronger and longer than their GP counterparts, and thus more likely to cause harm to life and property. A greater percentage of Southeast tornadoes are EF-2+ compared with those in the GP, and those that do form tend to have longer tracks. This is problematic due to the increased population density in the Southeast.

Future work may include further studies into why Southeast tornadoes travel farther than their GP counterparts. Investigations could consider synoptic differences among specific events and how that played into the production of tornadoes. Work may also explore differing thermodynamic processes and whether low CAPE and high shear provided a large number of weak or short-lived tornadoes. Research could also delve into whether there were areas in which strong tornadoes occurred in that environment and how their tracks differ. Another great path to take would be to look at social vulnerability and who stands to be in more danger from tornadoes. Also, an investigation and comparison of tornadoes in the Midwest region could pose thought-provoking results.

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