Too Close for Comfort

Is St. Louis experiencing an increase in tornadoes?

David I Gustafson, Ph.D., St. Louis, MO
April 10, 2025

Though I've spent most of my adult life here in St. Louis I grew up in Washington State, far away from tornadoes. My only childhood exposure was the annual ritual of watching the *Wizard of Oz*. For me, as to which was the more terrifying, it was a tie between the twister that took Dorothy's house and the flying monkeys who carried her away.

Anyhow, I've lived here for most of the past 40 years, and absolutely can't remember a night more terrifying than the recent "Pi Day" storm (3-14) when I was sheltering in a ground floor bathroom along with my daughter's Doodle ("Misty") whom I was dog-sitting. For the first time, I witnessed the violent sloshing of water in the toilet bowl (a Bernoulli Principle effect) as one of the EF2's passed a couple of miles away. That's as close as I ever want to be! But the entire experience got the scientist in me to wonder whether the data supported my personal observation, which is that the number of tornadoes in the St. Louis area seems to have increased in recent years.

I began by doing a literature search, and found a recent published analysis (Coleman et al., 2024) which conclusively demonstrates that there indeed have been significant spatial and temporal shifts in US tornado activity over the past 70 years. Most of their analysis was based on dividing the period of reliable observations into two 35-year time periods: 1951-1985 and 1986-2020 (see their Figure 1 below). They used the Storm Prediction Center Tornado Database (freely available online) as their data source.

It is evident that total tornado counts (EF0 and above) have increased, but the authors explain (as have others) that this is likely due to vastly increased detection of smaller tornadoes, with the advent of Doppler Radar, the explosion in the number of smart phones, and the use of social media, etc.[1] However, the frequency of so-called "significant" tornadoes (EF2 and above) has trended downward over time, nationally.

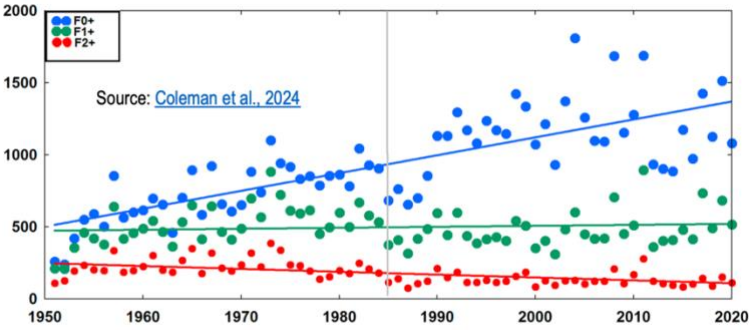
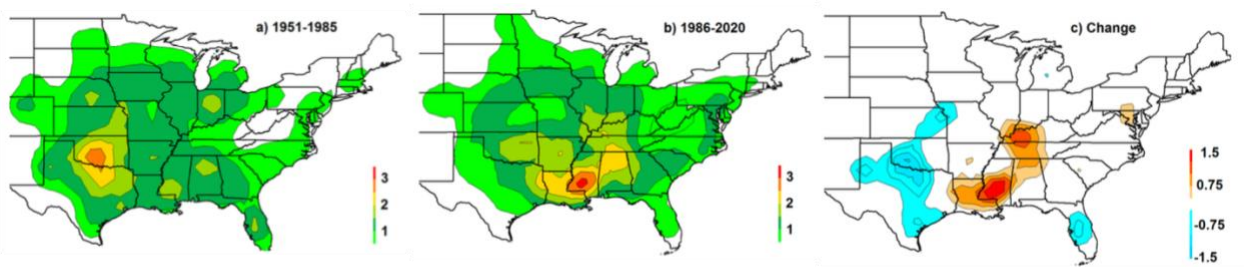


FIG. 1. Annual counts of F/EF0+ tornadoes (blue dots), F/EF1+ tornadoes (green dots), and F/EF2+ tornadoes (red dots) (1951–2020). Best-fit linear trend lines are shown. The gray vertical line denotes 1985, the dividing line between periods 1 and 2.

With regard to changes in spatial distribution, the authors report a very striking difference comparing the two time periods. During 1951-1985, tornadogenesis was centered on "Tornado Alley" (i.e., primarily Oklahoma and Texas and extending up into Kansas). However, the tornadogenesis hot-spot for 1986-2020 has shifted to the Mid-South and includes parts of the Ohio River Valley (as shown in the authors' Figure 3 on the next page).

[1] Given this likely artifact, Coleman et al. dropped EF0 tornadoes from their subsequent analyses.

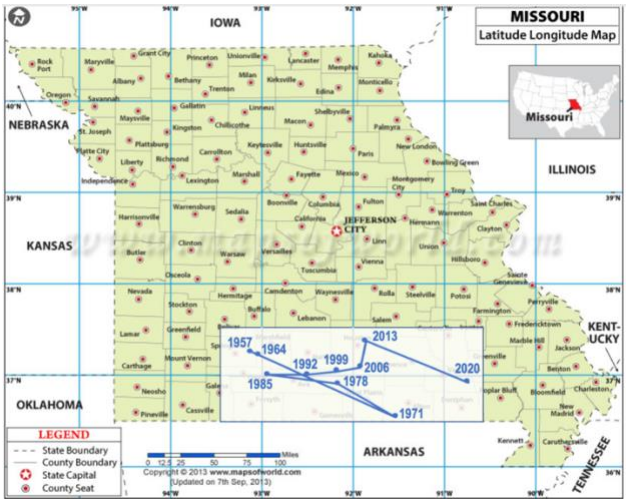


Source: Coleman et al., 2024

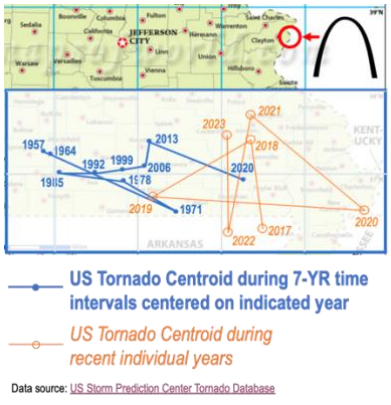
FIG. 3. Smoothed tornadogenesis events per 1° × 1° grid square during (a) period 1 (1951–85) and (b) period 2 (1986–2020). (c) Change in smoothed tornadogenesis events per grid square from period 1 to period 2.

But what does all of this mean for St. Louis? I downloaded the same data used by Coleman et al., but I chose a different methodology in which I divided a similar 70-year period into ten 7-year intervals, starting in 1954 and ending in 2023, the most recent year now in the database. I then used Excel to estimate the "geographic centroid" (using the average latitude and longitude, which ignores minor spherical corrections) for each of these time intervals for all tornadoes in the database (after removing all tornadoes in the following states/territories: AK, AZ, CA, HI, ID, MT, NV, OR, PR, UT, VI, WA – i.e., states/territories not included in Coleman's Figure 3 above).

Somewhat surprisingly, I found that all of the centroids were located in southern Missouri. However, they have moved eastward, starting near Springfield MO in 1957 and most recently being located near Poplar Bluff MO in 2020. If the centroid continues to follow this general trajectory it seems destined to cross the Mississippi River in the coming decades.

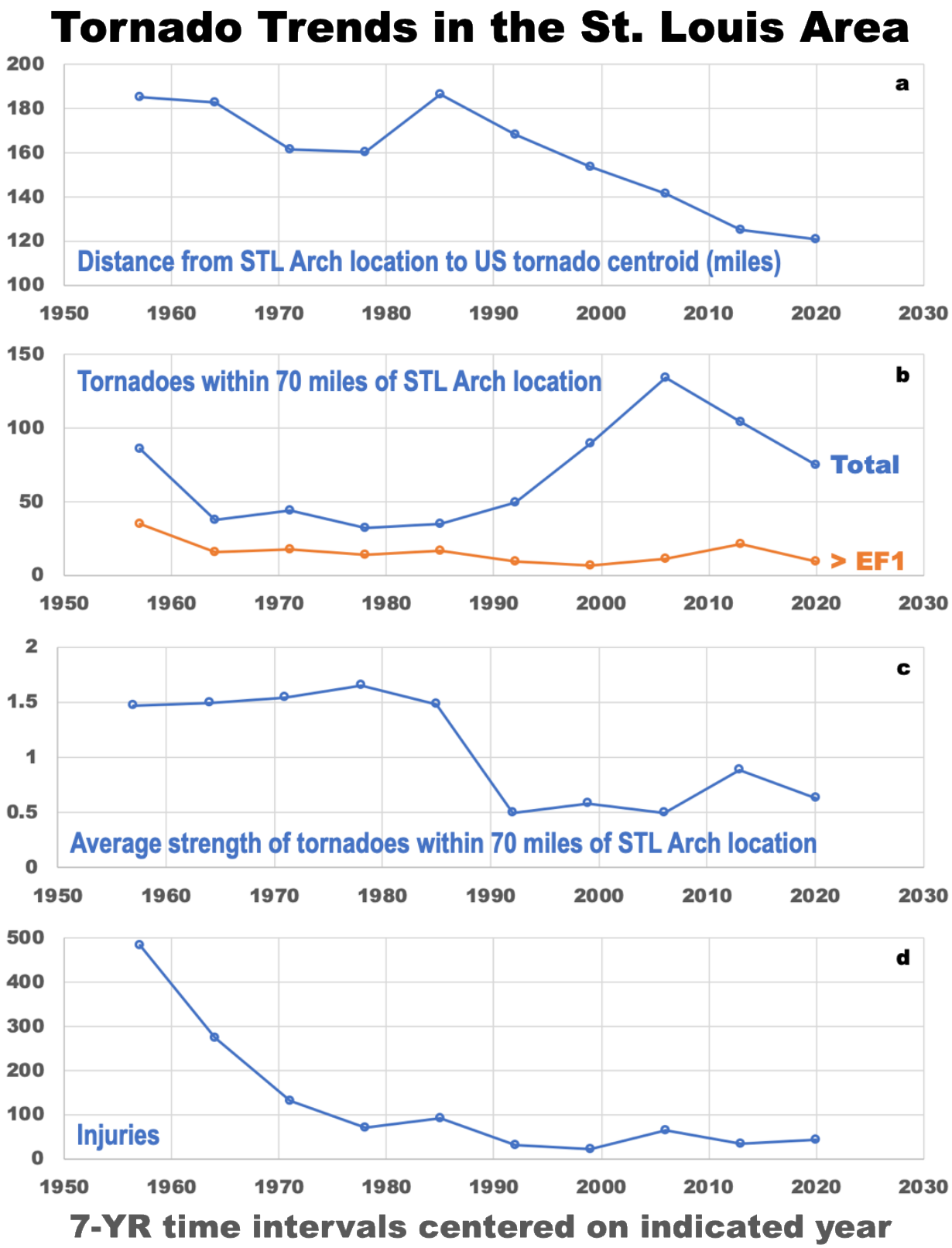


But given my specific interest in St. Louis and what has been happening since I moved here in 1985, I drilled in even closer. As shown below at right, I mapped the location of the centroid for recent individual years, and zoomed in to show how close the centroid has gotten to St. Louis. It turns out that the centroid has gotten uncomfortably close, reaching only 68 miles away from the Arch in 2021.[2]



However, the overall situation is not nearly as concerning. The charts on the following page tell the story. Yes, the centroid has gotten steadily closer to St. Louis (see panel **a**), but it seems likely to pass well to our south. At first, panel **b** seems a bit alarming, but it appears that most of the recent increase in tornadoes is due to the increased detection of weak tornadoes, the number of significant tornadoes (those stronger than EF1) having remained

[2] All distances calculated to the starting coordinates of the tornado using the Haversine Formula:
$d = 2*R*\arcsin(\sqrt{\sin^2((\phi_2-\phi_1)/2)+\cos(\phi_1)*\cos(\phi_2)*\sin2((\lambda_2-\lambda_1)/2)}))$, with latitude ($\phi$) and longitude ($\lambda$) in radians


Tornado Trends in the St. Louis Area
a
Distance from STL Arch location to US tornado centroid (miles)
200
180
160
140
120
100
1950
1960
1970
1980
1990
2000
2010
2020
2030
b
Tornadoes within 70 miles of STL Arch location
Total
> EF1
150
100
50
0
c
Average strength of tornadoes within 70 miles of STL Arch location
2
1.5
1
0.5
0
d
Injuries
500
400
300
200
100
0
7-YR time intervals centered on indicated year

relatively steady. This is supported by the large drop in average tornado strength (panel **c**), which is directly associated with modern methods of tornado detection (adding in all of those EF0 tornadoes brings down the average). Finally, the number of injuries (panel **d**) associated with tornadoes is now vastly lower than it was before the 1970's, when almost none of the modern methods for warning the public were available.

Having said all of the above, there are mildly alarming upward trends at the recent ends of charts **c** (strength) and **d** (injuries), particularly after having just experienced the past few weeks of repeated tornado watches and warnings here in the St. Louis area. But let's hope this is just a blip.

What about the cause of all these shifts and trends? Can it all be attributed to yet another consequence of man-made global warming? At first, this conclusion might seem tempting, but current climate models have insufficient spatial and temporal precision to provide a definitive answer.

One hint is that the first major shift to the east took place at the very time that the current global warming signal began to emerge from the noise (around 1970). However, this could just as easily be a simple coincidence related to some periodic oscillation in the global climate system. Tornadoes typically form at the "dry line" formed along the collision zone between the dry, cold air mass flowing down from the Rockies and the moist, warm air headed north from the Gulf. It's not immediately clear why that zone should be pushed east as a direct result of global warming.

So, it appears that we'll all simply need to stay tuned to see how this plays out for St. Louis. But my personal hunch is that more tornadic spring weather is here to stay. And if it is indeed a result of GHG emissions, then we'll be living out the biblical warning prophesied in Hosea 8:7, where God promises that our careless sins will eventually cause us to "reap the whirlwind." For real.