

## Climate Science and Policy for Nonscientists

One picture is worth a thousand words.

### Tornadoes

There is no climate change with respect to tornadoes. The IPCC agrees that the mean annual number of US tornadoes remains “relatively constant.” [AR6 WGI p.1595 (2021)]. The frequency of powerful tornadoes has been declining.

But tornadoes kill more Americans than any other form of violent extreme event, an average of 71 per year. Most tornadoes have wind speeds of less than 110 miles per hour, are only about 250 feet across and, travel only a few miles along the ground before dissipating. But the Tri-State Tornado of 1925 had wind speeds over 260 miles per hour. It moved forward at over 70 miles per hour, and its path of destruction was 219 miles long. It killed over 700 people and injured over 2,300.



### Tornado Fujita Scale

F Number	Wind	Damage
<b>f 0</b>	45 - 78	little damage
<b>f 1</b>	79 - 117	minor damage
<b>f 2</b>	118 - 161	roof gone
<b>f 3</b>	162 - 209	walls collapse
<b>f 4</b>	210 - 261	blown down
<b>f 5</b>	262 - 317	blown away

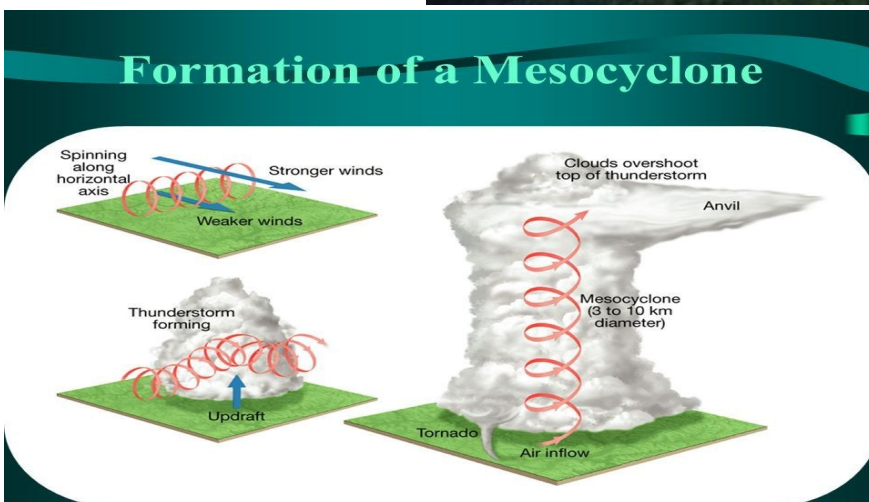
As with hurricanes, tornadoes are graded by strength. The Tri-State Tornado was EF5. Fortunately in the US roughly 80% of the tornadoes are EF0 or EF1.

The US has far more tornadoes than any other country in the world, more than 1,300 per year, whereas Canada, the country with the second most tornadoes, has only around 100 per year.



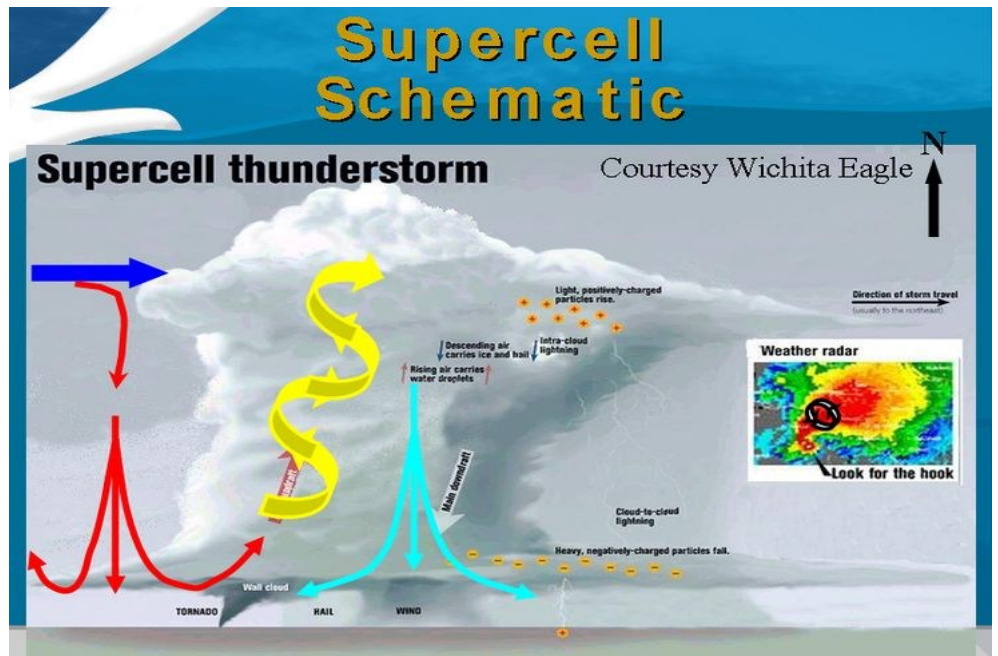
The central US provides ideal conditions for tornadoes to form. The tornado region is known as Tornado Alley. High altitude, cold, dry winds sweep down from the Rocky Mountains while low altitude, warm, moist winds move up from the Gulf of Mexico.

When these winds collide, they create spinning, horizontal cylinders of air.



Thunderstorms have very strong updrafts that can exceed 150 miles per hour. When a thunderstorm encounters a spinning horizontal air cylinder, it can lift the cylinder into a vertical position, which can then “touch down” forming a tornado.

Tornadoes are often accompanied in the area by torrential rains, hail, and lightning. Scientists have learned that, when the radar pattern of a thunderstorm displays a feature known as “the hook,” a tornado is likely to be formed.



### TORNADO WATCH

A Tornado Watch is issued when a tornado is *possible*.

Know your safe place (storm shelter, basement, interior hall away from windows). Be ready to act quickly if a Warning is issued.

Be Prepared.

### TORNADO WARNING

A Tornado Warning is issued when a tornado is *happening or about to happen*.

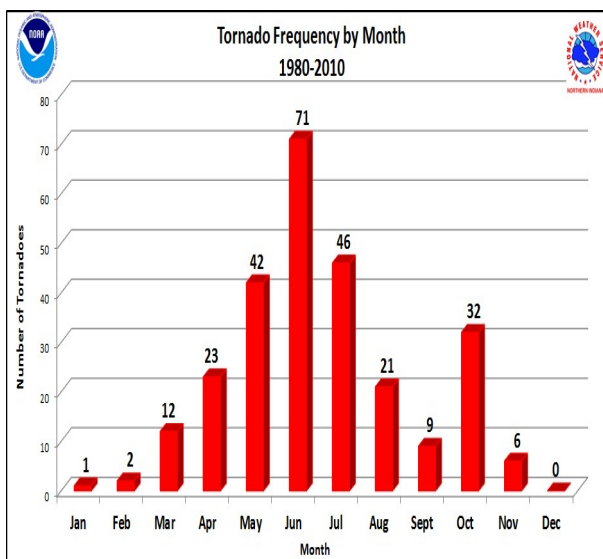
Immediately seek shelter in your safe place!

Take Action!

weather.gov

In Tornado Alley systems for spreading tornado warnings have been developed, but predicting tornadoes remains significantly problematical.

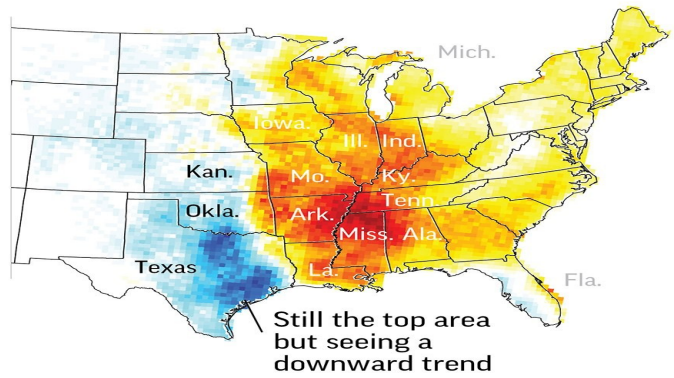
A common practice for homes in Tornado Alley is to have an underground, backyard tornado shelter.



June is the peak month for tornado activity. For example, on June 16, 2023, a tornado hit Perryton, Texas (population of about 8,000). It was EF3, strong enough to blow off roofs and collapse walls. It lasted 11 minutes. Its path on the ground was 6.39 miles long and half a mile wide. A tornado’s destruction depends on whether it strikes a populated area. Cities and towns occupy only about 0.5% of the earth’s surface, so tornadoes usually miss densely populated areas. Unfortunately this tornado went right through the center of Perryton. Three people were killed. Many homes and businesses were destroyed. Over 200,000 people in the area lost electric power.

Tornado frequency has increased in the Midwest and Southeast and decreased in the central and southern Great Plains.

Some analyses show that Tornado Alley is moving Eastward, and some scientists attribute this to climate change, but there is no consensus on these issues.



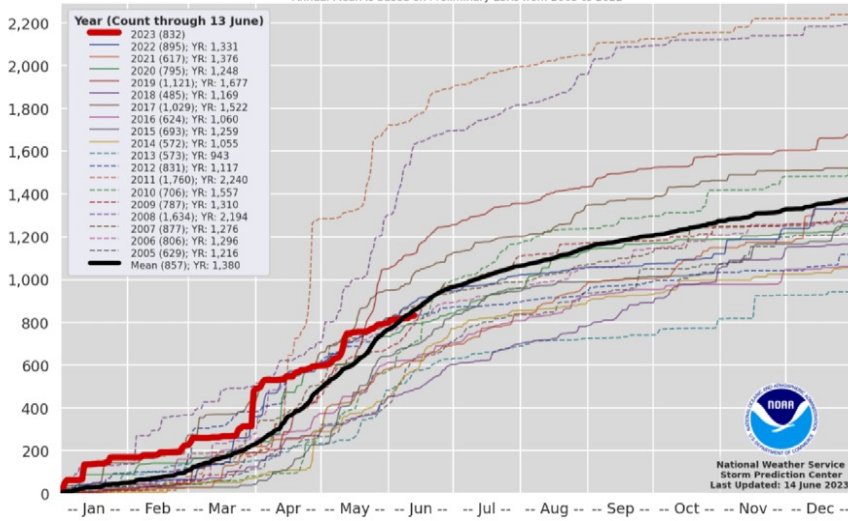
Still the top area but seeing a downward trend

SOURCE: Victor Gensini, Department of Geographic and Atmospheric Sciences, Northern Illinois University

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### United States Annual Counts of Tornado LSRs\*

\*Preliminary sightings/events from NWS Local Storm Reports (LSRs)  
Annual Mean is based on Preliminary LSRs from 2005 to 2022



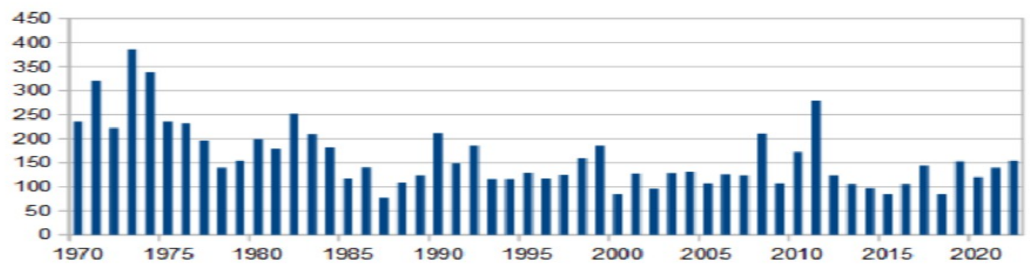
The frequency of US tornadoes varies significantly from year to year, but for 2023 through mid-June the frequency was at the mean for the period 2005-2022. Each of the years 2020, 2021, and 2022 had fewer tornadoes than the mean of 1,380.

<https://www.spc.noaa.gov/wcm/#data> (<https://www.spc.noaa.gov/wcm/#data>)

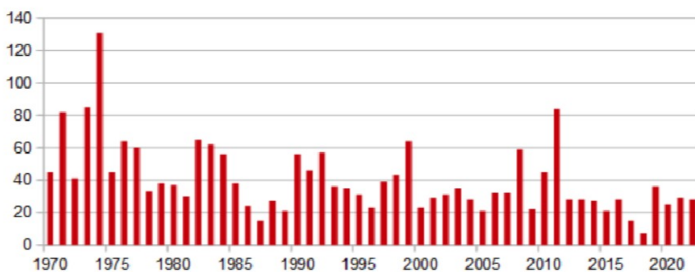
NOAA's Storm Prediction Center (SPC) has now published the full data for US tornadoes last year.

The frequency of EF2+ (EF2-5) tornadoes has been declining since 1970.

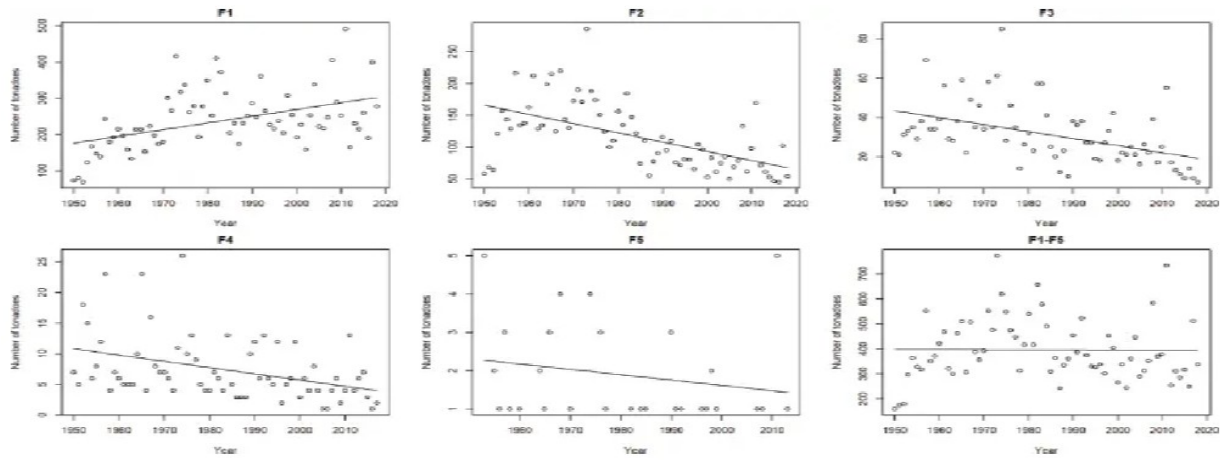
### Annual Count US Tornadoes EF-2 and Stronger 1970 to 2022



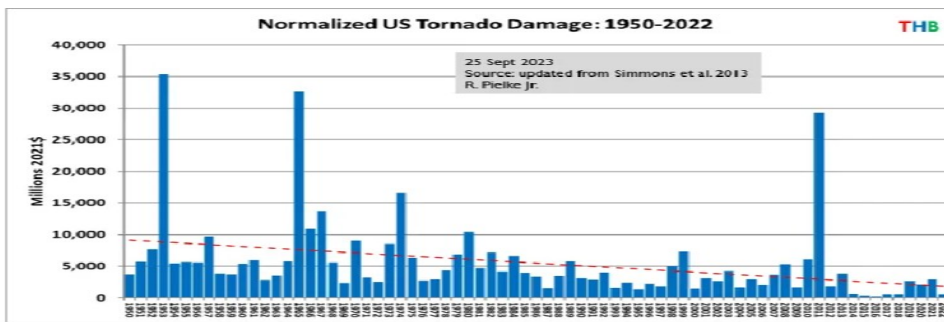
### Annual Count of US Tornadoes EF-3 and Stronger 1970 to 2022



The frequency of EF3+ (EF3-5) tornadoes has also been declining. Less than 1% of tornadoes are EF4+ (EF4 or EF5). There have been no EF5 tornadoes in the US since the Moore Tornado in 2013. The 10 years since 2013 is the longest period on record without an EF5 tornado.



In 2023 a new study has been published that counted US tornadoes per year from 1950 to 2022 by Fujita number. The first graph shows the numbers of F1 tornadoes increasing. The number of such tornadoes (F1) may be understated for the period prior to satellites being used to spot tornadoes (1950-1978). Each other F# (the second through the 5th graphs) declined. The 6th graph shows the total of all size tornadoes per year. It shows possibly a very slight decline.



Normalized U.S. annual tornado losses, 1950-2022. Source: Updated from Simmons et al. 2013.

Total normalized US tornado damage per year has been declining with significant annual variability. The two worst years by far were 1953 and 1965. About 90% of the total damage each year results from F2+ tornadoes.

## CONCLUSION AS TO TORNADES

Based on the actual measured data, the frequency and strength of US tornadoes is remaining the same or declining. Normalized damage per year is declining. As to the future, scientists have not yet been able to create models to predict the future number or strength of tornadoes, wind gusts, hail storms, or lightning [IPCC AR6 WGI p.1825 (2021)], so there are no models (and there is no data) suggesting that the number or intensity of any of these events will be increasing over the 21<sup>st</sup> century.



### Work Cited

Intergovernmental Panel on Climate Change Assessment Report 6, Working Group I Report, The Physical Science Basis (2021) (“AR6 WGI”)