Claim: Global warming is causing more and stronger tornadoes

REBUTTAL

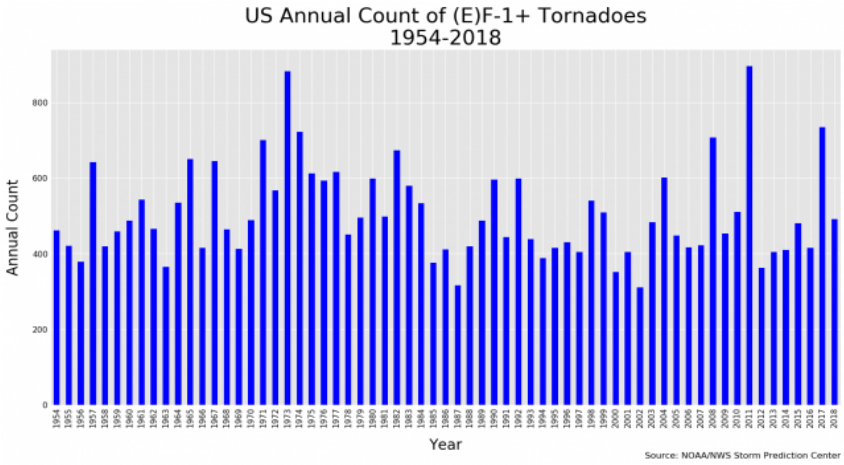
Tornadoes are failing to follow "global warming" based predictions. Strong tornadoes have seen a drop in frequency since the 1950s. The years 2012, 2013, 2014, 2015, and 2016 all saw below average to near record low tornado counts in the U.S. since records began in 1954. 2017 rebounded only to the long-term mean while 2018 activity has returned to well below the 25th percentile. This lull followed a very active and deadly strong La Nina of 2010/11, which like the strong La Nina of 1973/74 produced record setting and very deadly outbreaks of tornadoes. When an amplified La Nina like jet stream pattern developed in the spring of 2019, a very active period raised the seasonal total to above the 50th percentile for the first time in years. A similar transient pattern in April 2019 produced a major outbreak centered on Easter Sunday.

Population growth and expansion outside urban areas have exposed more people to the tornadoes that once roamed through open fields.

Tornado detection has improved with the addition of NEXRAD, the growth of the trained spotter networks, storm chasers armed with cellular data and imagery as well as the proliferation of cell phone cameras and social media. This shows up most in the weak EF0 tornado count but for storms from moderate EF1 to strong EF 3+ intensity, the trend has been down despite improved detection.

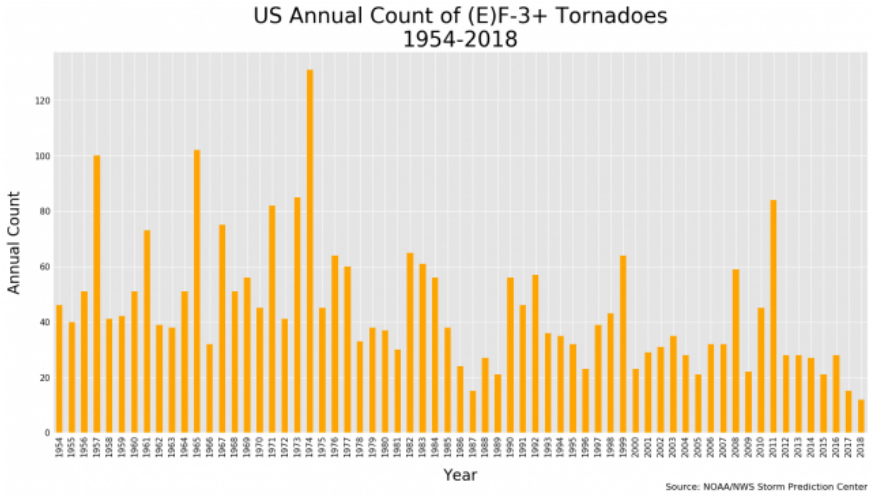
Tornadoes like most all weather extremes are driven by natural factors with active seasons strongly correlated with stronger La Nina events and the cold phase of the Pacific Decadal Oscillation, which favors more frequent and stronger La Ninas.

Indeed, in the US Annual count of EF1+ tornadoes shown below, more active years are clear but there is no discernible upward slope trend.

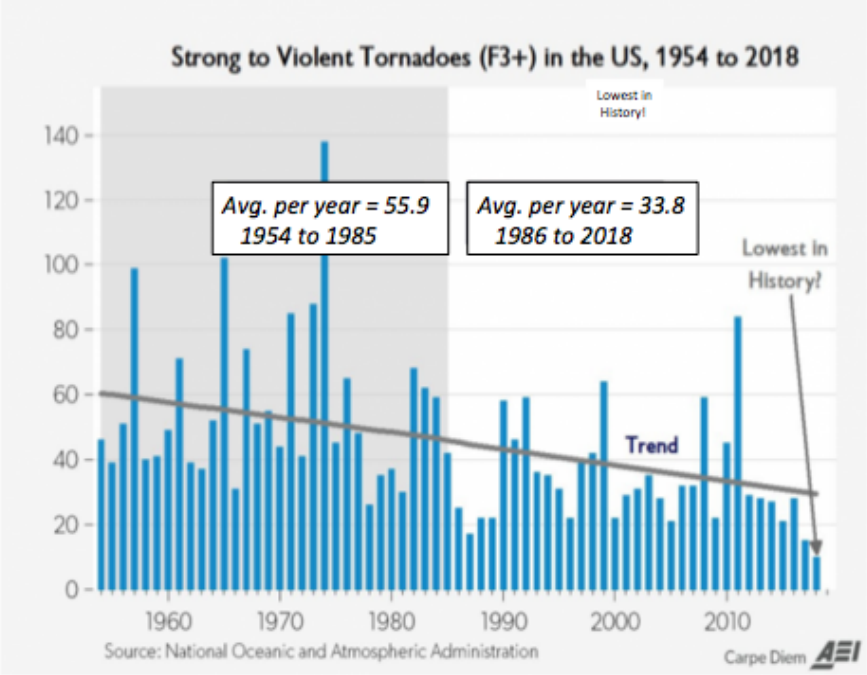


Source: Storm Prediction Center

For strong EF3+ tornadoes, there are again active years and periods. But the trend, despite better detection, has been clearly down, not up.



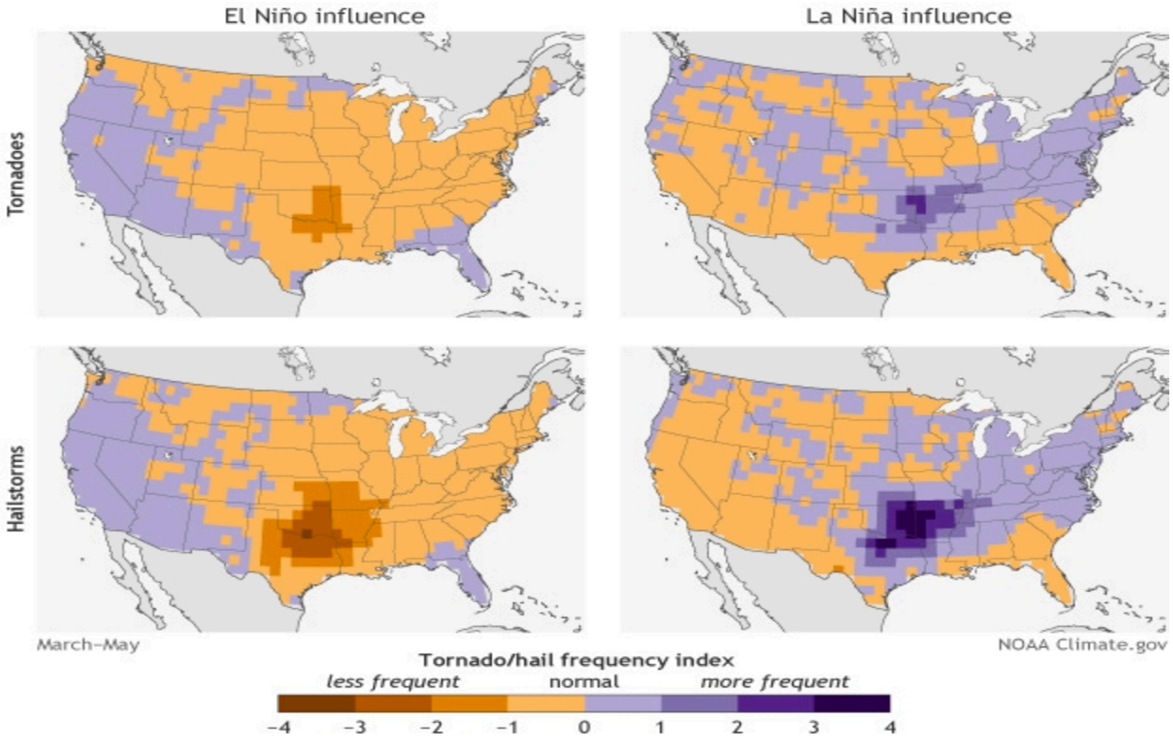
Source: Storm Prediction Center



Source: Storm Prediction Center NOAA

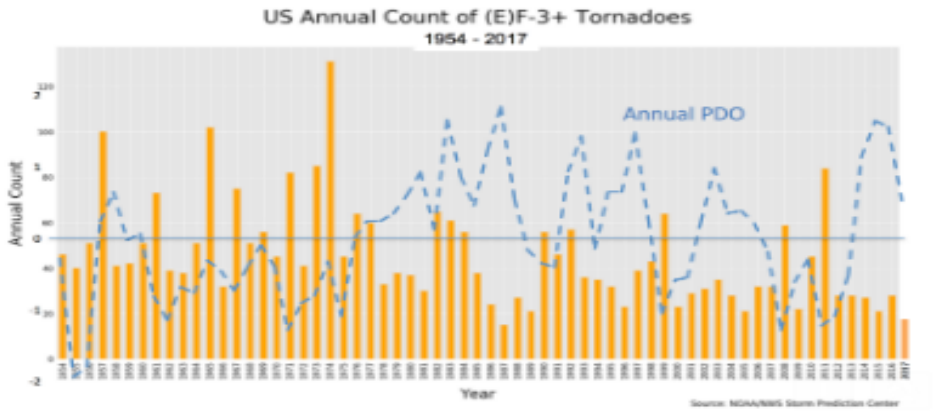
ENSO (AND PDO) ROLE IN TORNADO SEASONS

Tornado outbreaks of significance occur most frequently in La Nina years, which are favored when the Pacific is cold (the Pacific Decadal Oscillation is cold) as it was in the 1950s to the early 1970s and more recently 1999, 2008, 2010 and 2011. The downward trend results really from the 1977 Pacific Central Tendency Shift from La Nina to El Nino.



Source: Storm Prediction Center

Note below how the number of strong tornadoes corresponds to cycles in the Pacific Decadal Oscillation (NOAA CPC) in the Pacific, which determines the favored state and relative strength of ENSO (El Nino or La Nina). The negative PDO favors La Ninas, which produce a jet stream pattern that favors more significant tornado outbreaks and as a result, more active seasons.



Source: Storm Prediction Center

The death toll in the strong La Nina of 2011 was the highest since the "Superoutbreak" in the strong La Nina year of 1974. Population growth and expansion outside urban areas have exposed more people to the tornadoes that once roamed through open fields.

The Superoutbreak of 2011

The 2011 Superoutbreak was the largest, costliest, and one of the deadliest tornado outbreaks ever recorded, affecting the Southern, Midwestern, and Northeastern United States and leaving catastrophic destruction in its wake.

The event affected Alabama and Mississippi the most severely, but it also produced destructive tornadoes in Arkansas, Georgia, Tennessee and Virginia and affected many other areas throughout the Southern and Eastern United States. In total, 362 tornadoes were confirmed in 21 states from Texas to New York to southern Canada.

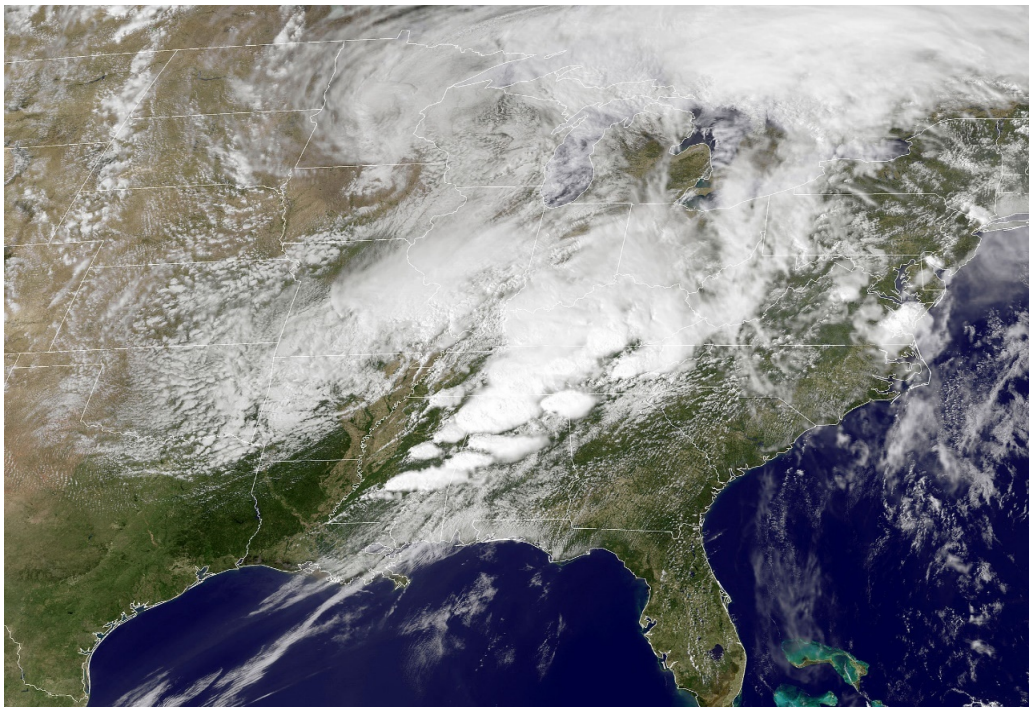
Widespread and destructive tornadoes occurred on each day of the outbreak, with April 27 being the most active day with a record of 218 tornadoes touching down that day. Four of the tornadoes were destructive enough to be rated EF5, which is the highest-ranking possible on the Enhanced Fujita scale; typically these tornadoes are recorded about once each year.

348 people were killed as a result of the outbreak, which includes 324 tornado-related deaths across six states and an additional 24 fatalities caused by other thunderstorm-related events such as straight-line

winds, hail, flash flooding or lightning. In Alabama alone, 238 tornado-related deaths were confirmed.

April 27, 2011's 317 fatalities were the most tornado-related fatalities in the United States in a single day since the "Tri-State" outbreak on March 18, 1925 (when at least 747 people were killed. This event was the costliest tornado outbreak and one of the costliest natural disasters in United States history (even after adjustments for inflation), with total damages of approximately $11 billion (2011 USD).

Shown below is a satellite image during 2011 outbreak (source NOAA):



The 2011 Joplin tornado was a catastrophic EF5-rated tornado that struck Joplin, Missouri, late in the afternoon of Sunday, May 22, 2011. It was the third tornado to strike Joplin since May 1971. Overall, the tornado killed 158 people (with an additional three indirect deaths), injured some 1,150 others, and caused damages amounting to a total of $2.8 billion. It was the deadliest tornado to strike the United States since the 1947 Glazier–Higgins–Woodward tornadoes, and the seventh-deadliest overall. It also ranks as the costliest single tornado in U.S. history.

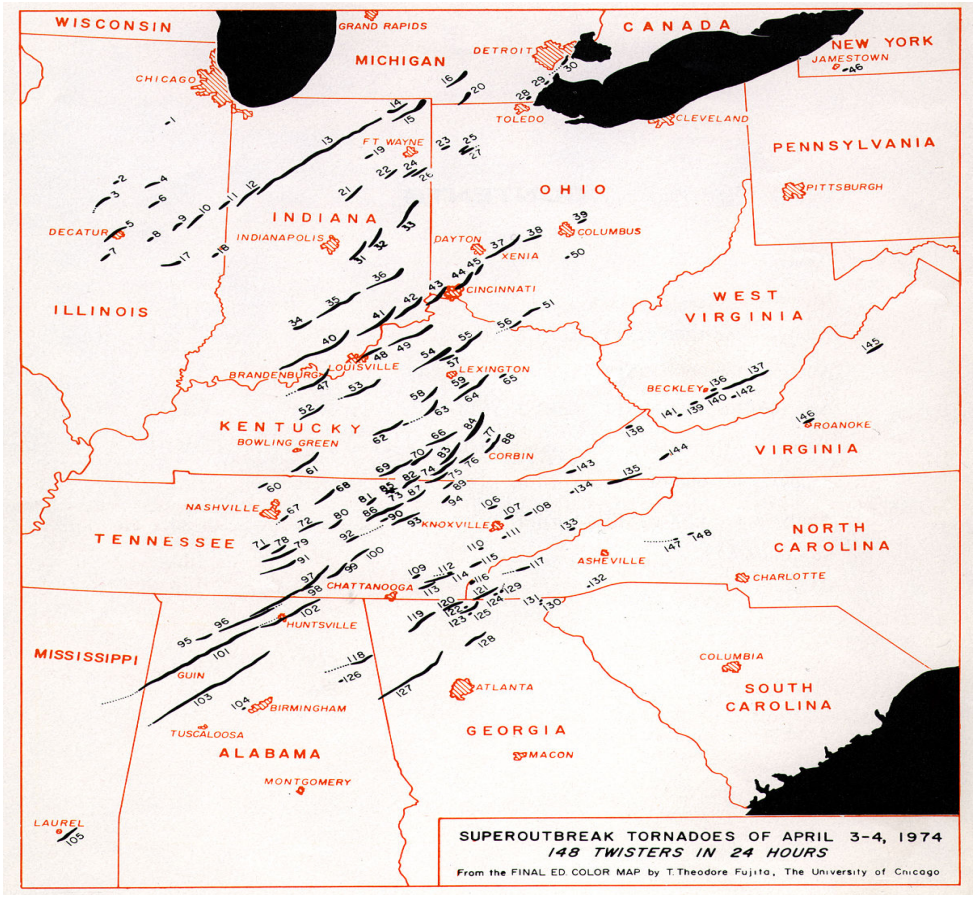
It was the first F5/EF5 tornado in Missouri since May 20, 1957, when an F5 destroyed several suburbs of Kansas City. It was only the second F5/EF5 tornado in Missouri history dating back to 1950. It was the

deadliest U.S. tornado since the April 9, 1947 tornado in Woodward, Oklahoma, the seventh-deadliest in U.S. history. It was also the first single tornado since the June 8, 1953 F5 tornado in Flint, Michigan, to have 100 or more associated fatalities.

The Superoutbreak of 1974

The 1974 Super Outbreak was the second-largest tornado outbreak on record for a single 24-hour period, just behind the 2011 Superoutbreak. It was also the most violent tornado outbreak ever recorded, with 30 F4/F5 tornadoes confirmed. From April 3 to April 4, 1974, there were 148 tornadoes confirmed in 13 U.S. states and the Canadian province of Ontario. The entire outbreak caused more than $600 million (1974 USD) in damage in the United States alone, and extensively damaged approximately 900 square miles along a total combined path length of 2,600 mi (4,184 km).

The 1974 Super Outbreak remains one of the most remarkable severe weather episodes of record in the continental United States. The outbreak far surpassed previous and succeeding events in terms of severity, longevity, extent, and death toll, with the notable exception of the 2011 Super Outbreak, which lasted from April 25 to 28 and killed a total of 324 people.

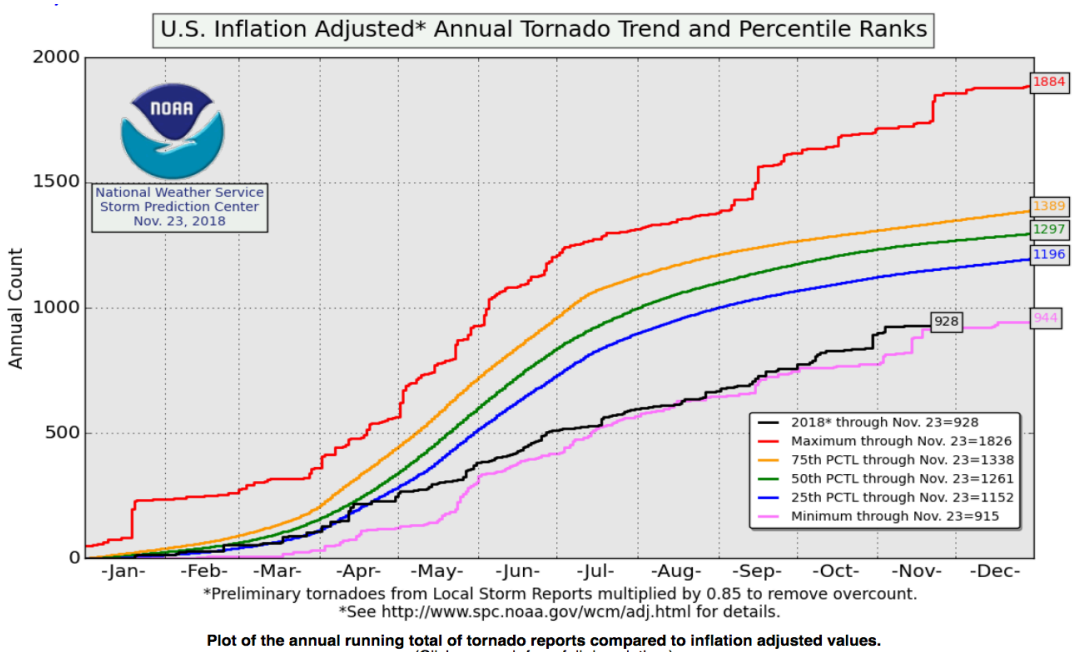


Source: Ted Fujita, University of Chicago

The bottom line is that tornado frequency and major outbreaks relate to natural cycles both short and long term in the oceans that produce jet stream patterns that favor or suppress tornado outbreaks of significance in the U.S. Hence, the claim that global warming is causing more and stronger tornadoes is invalidated by the relevant empirical data. However, when tornados do occur, expansion of populated areas puts more property and lives at risk. Fortunately, improved tornado detection and warnings, coupled with the addition of storm shelters and improved building codes do help mitigate the death tolls and property damage associated with tornadoes.

THE TRANQUIL 2018 SEASON

A near record-low 928 tornadoes (inflation adjusted) formed in the U.S. in 2018, according to the National Oceanic and Atmospheric Administration's Storm Prediction Center (SPC).

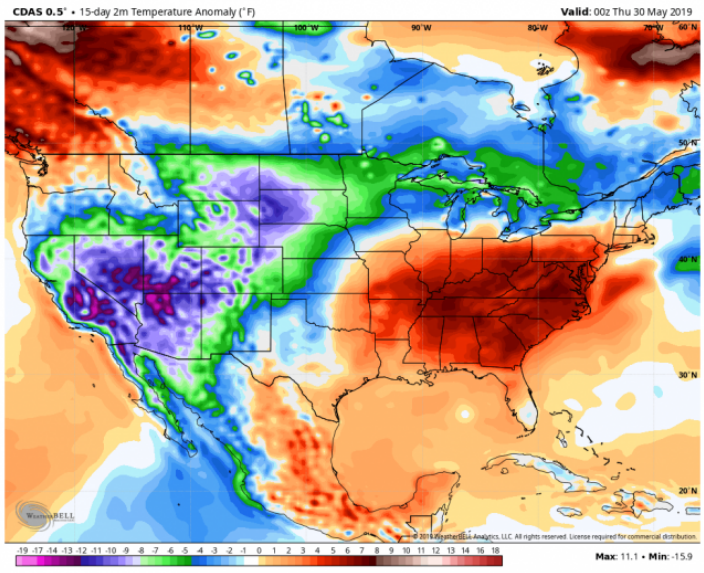


Plot of the annual running total of tornado reports compared to inflation adjusted values.

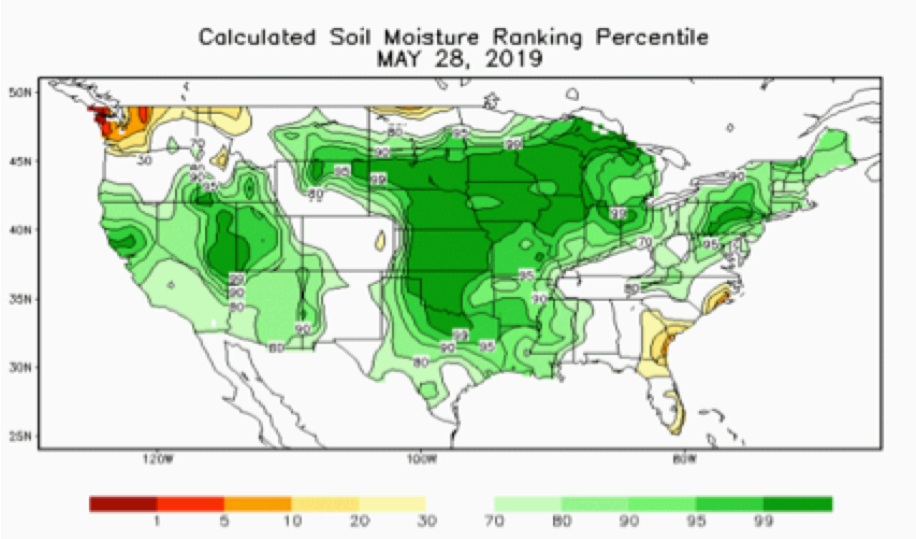
THE ACTIVE SPRING OF 2019

Just like the hurricane impact spike in 2017 and 2018 after a record almost 12-year period without a landfalling major hurricane, tornadoes bounced back big-time after 7 quiet years ending in 2018. 2019 was a cold winter and spring in much of the nation (except the southeast). In the cold air, heavy snowpack persisted in the west through May and into June in places.

By Mid-May, the deep and very cold western trough helped pump up a warm southeast ridge and produced a zone of strong thermal contrast in the central states in a region called 'tornado alley'. This generated many strong storm systems with heavy precipitation.



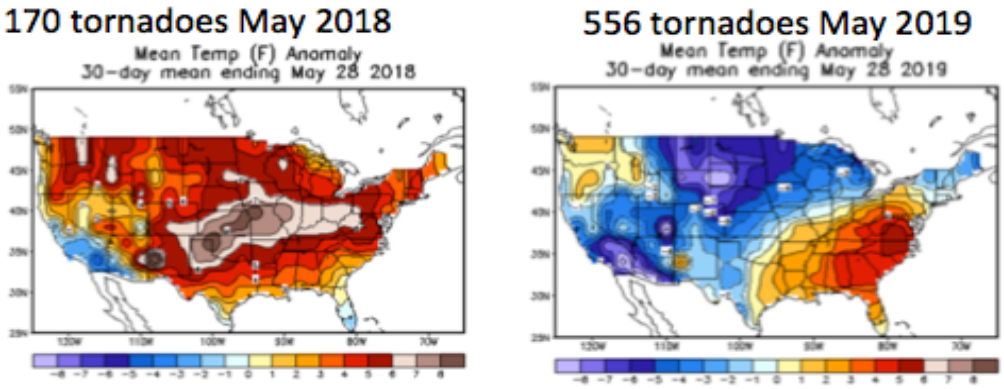
With frequent heavy rains and melting snows, soil moisture reached historic levels - above the 99% percentile in parts of the central U.S.



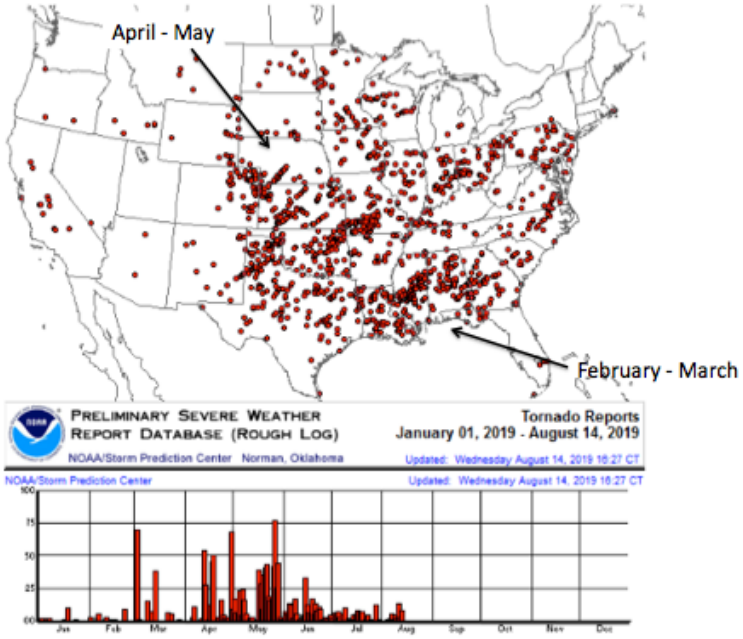
In the presence of abundant moisture, when heat energy built in the southeast ridge, the thunderstorms became increasingly severe, a phenomenon meteorologists call the 'ring-of-fire'. 13 straight days of tornado outbreaks brought the monthly tornado totals to 556 in May.

Claims in the media that these storms were the result of climate change/global warming are not supported by the facts. As noted above, 2018 was among the quietest tornado seasons – (with just 170 tornados in May) compared to 556 in May 2019. The quiet 2018 had a very warm

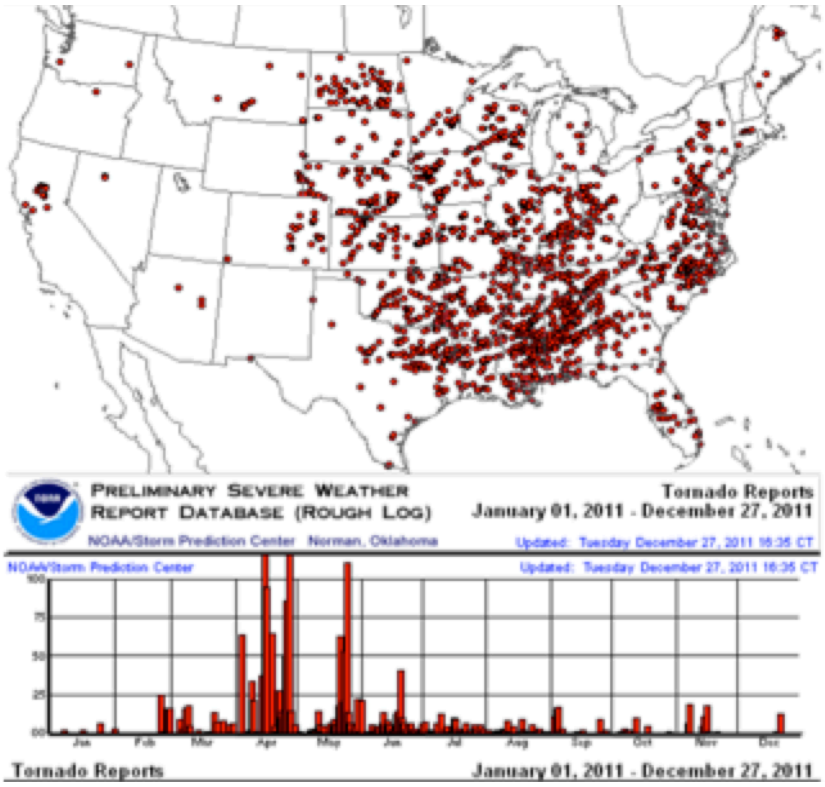
May compared to the extremely active May in 2019, which had strong contrast.



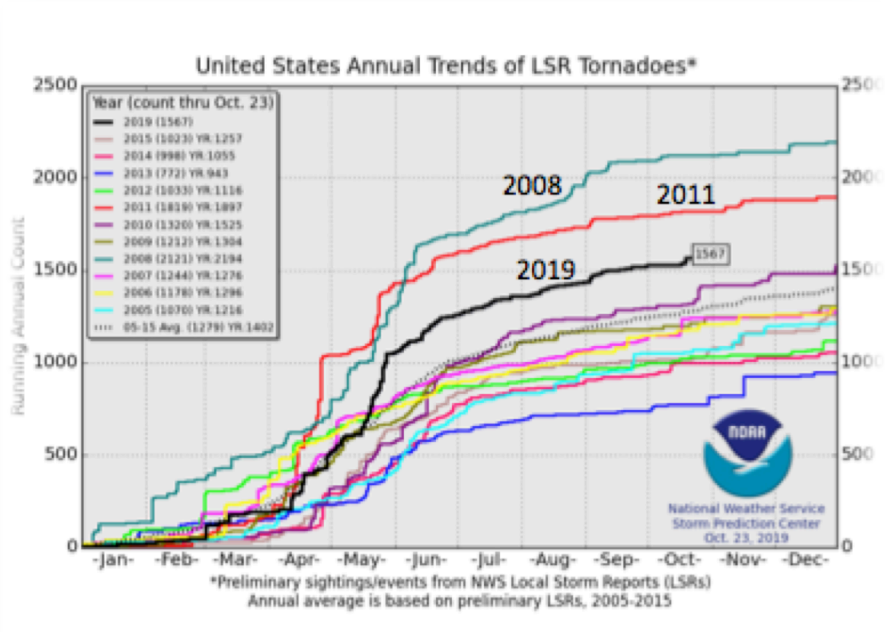
2019 became very active, a throwback to 2011. The early season in 2019 was active in the Gulf, fitting climatology. After April, action shifted to the central states and points east then subsided in June.



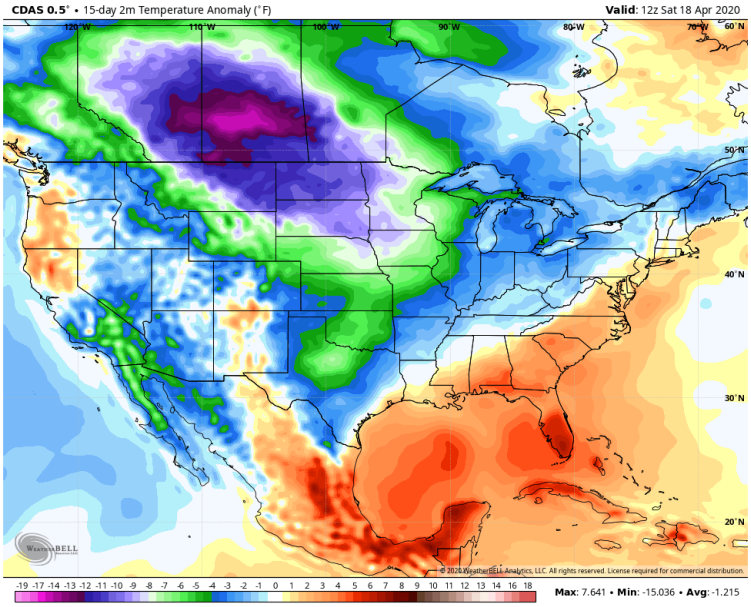
In 2011, the last La Nina, the U.S. had very extreme severe weather in the spring. It too quieted in June.

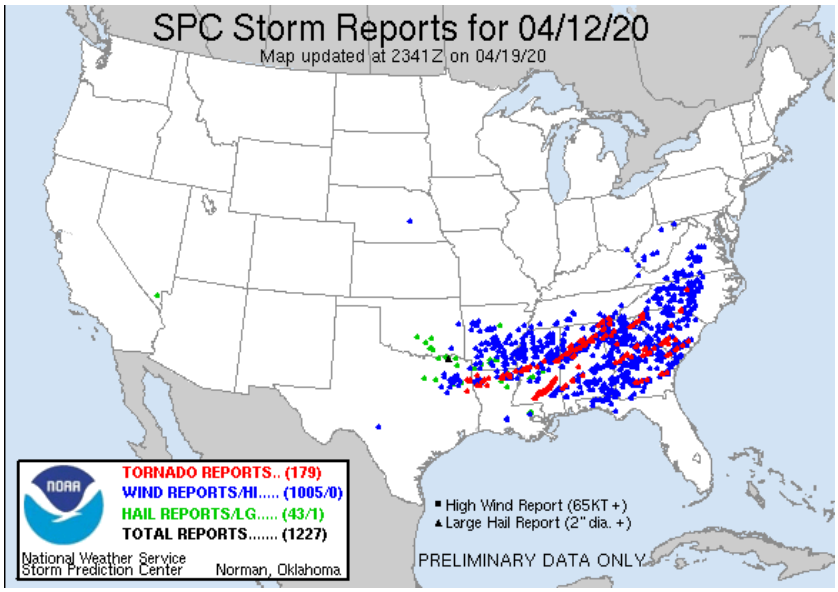


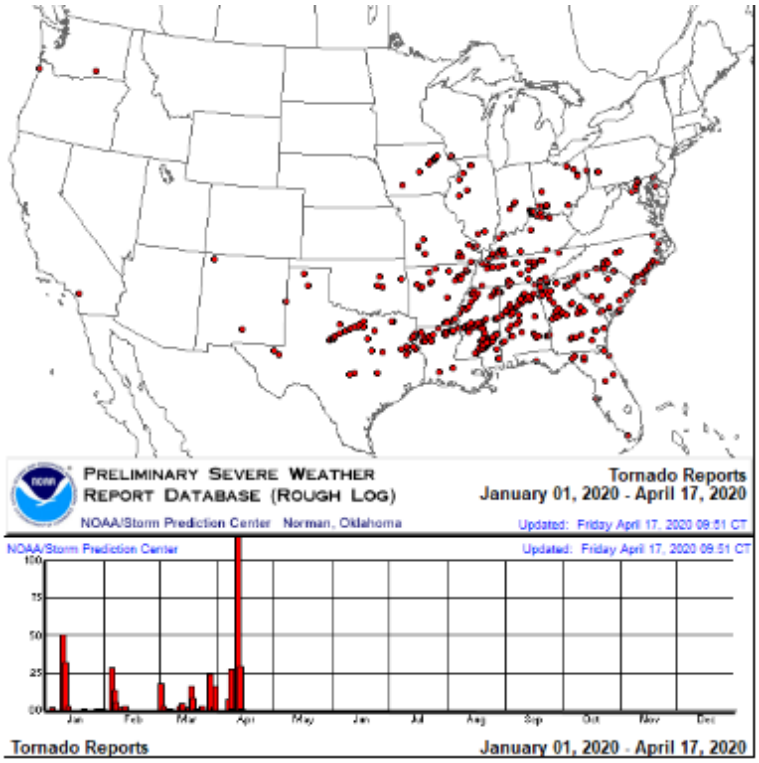
2019 trailed 2008 (like 2011 a La Nina) and 2011.



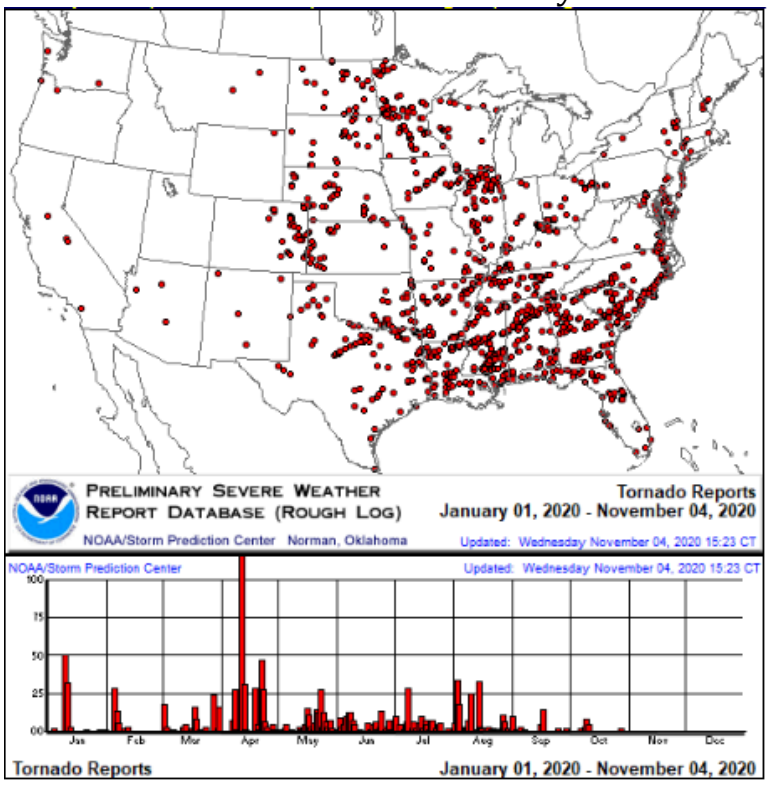
2020 WAS SIMILAR IN MID-APRIL

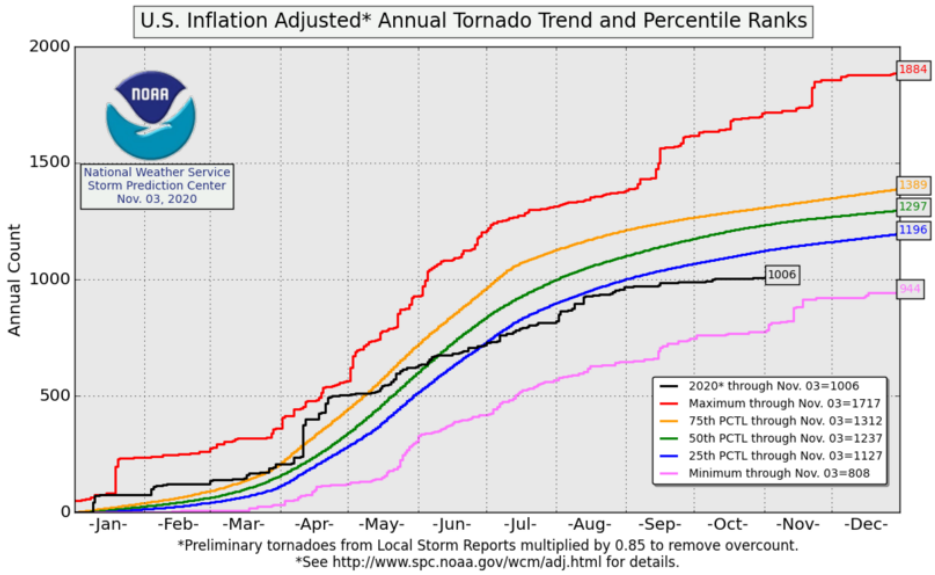






As the temperature contrast diminished activity diminished.

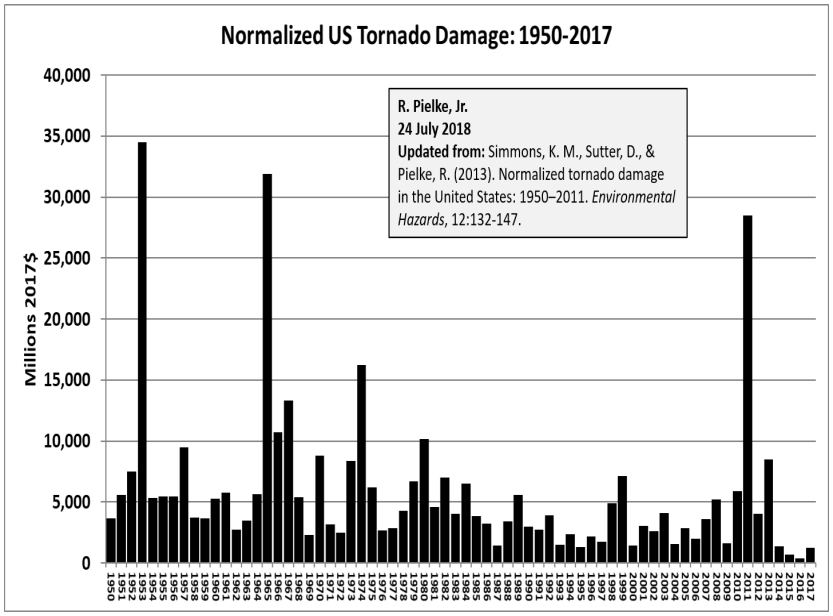




It dropped below the 25th percentile.

NORMALIZED DAMAGE HAS DECLINED

In terms of damage, Roger Pielke Jr. has shown the normalized U.S. tornado damage continues to decline and has been at exceptionally low levels for the last 5 years. The past 5 years have 2nd lowest normalized tornado damage of any 5-yr period since 1950 (1997 #1). 2016 had least, 2015 2nd least, 2017 3rd least, 2018 near record-low tornadoes.



Clearly, there is no expectation that we will see a return to the active years with more tornadoes and stronger tornadoes until the Pacific returns to its multidecadal cold mode as we saw from the 1940s to 1970s. Nevertheless we would expect if the current La Nina that has developed continues into 2021, activity would increase as it did in 2019.

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