BMS

Introspect – Severe Weather in a Warming World and It's Impact to the Insurance Industry

May 31 2013

Years of Extremes:

Following horrific disasters such as the Moore, OK tornado of May 20, 2013, there always seems to be much debate on what role climate change might be having on severe weather and if the tornadoes like the one that occurred in Moore, OK are a result of climate change. However, the severe thunderstorm season in the U.S. is close to its seasonal peak, which usually occurs the first week of June and the Moore, OK tornado occurred in a climatological zone where a significant EF3-5 tornado is to be expected for this time of year. So instead of debating the issue it might be of more value to understand why the Moore, OK tornado occurred in a year we are having what could be called a meteorological tornado drought and if more of these types of events could be expected in a warming world.

This present tornado drought stands in sharp contrast to 2011, which was one of the most active years for severe weather, with devastating consequences for life and property. The past two years have been one of the most erratic periods in terms of observations of severe weather. In fact, according the Storm Prediction Center and to Harold Brooks, Senior Scientist at the National Severe Storms Laboratory (NSSL), the 12 month period from June 2010 – May 2011 set a record for the most EF1+ tornadoes over a 12 month period, and according to Patrick Marsh, also at NSSL, one might expect this frequency of tornadoes to occur only once every 62,500 years. However, less then two years later during the 12 month period from May 2012 – April 2013 the estimated record low is at 197 tornadoes rated EF1 or stronger which Patrick estimates to have a return period of 3,731 years.

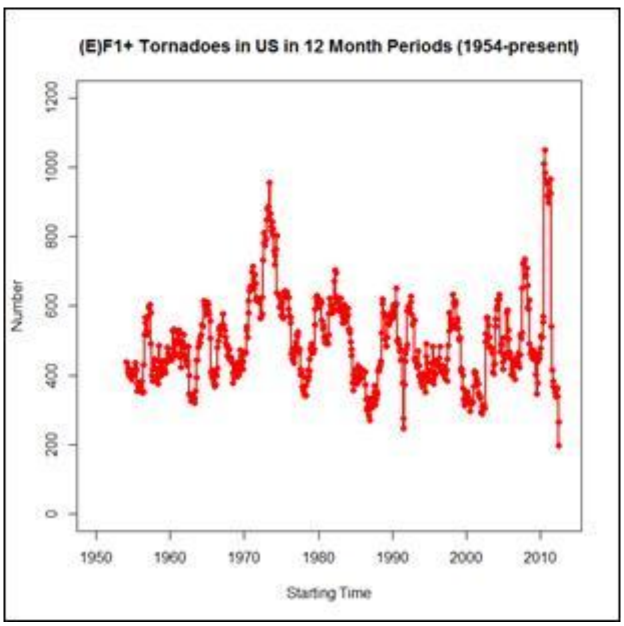

Figure 1 The time series showing the evolution of the number of (E)F1+ tornadoes since 1954 is below. The number of (E)F1+ tornadoes in the 12 months beginning with the time on the x-axis plotted for every month starting in January 1954 and ending in May 2012. Source: NSSL

Given this wild pendulum shift from the 'year of the tornado' to the tornado drought, with $26 billon of insured wind and thunderstorm event losses in 2011 and the relatively low $14 billon of insured wind and thunderstorm event losses in 2012 according to Property Claims Services, a trending topic in the insurance industry is that maybe climate change is driving the record tornado occurrences and/or the current tornado drought which has a profound impact on insurance industry losses.

In reality, the latest research shows the connection between climate change and severe weather is neither well-established nor well-understood. For the most part severe weather, in particular tornadoes, has so much natural variability and so many different causes that connection to climate change can backfire without a convincing explanation and natural climate variability is often forgotten when examining one climate period to another.

The Basic Facts:

The U.S is not a stranger to tornadoes, it sees the majority of the world's tornadoes. The heart of "Tornado Alley" — where warm, moist air from the south collides with cooler, drier air coming from the West — runs right through Moore, OK. The town was severely damaged by a tornado in 1999, as well as by less damaging twisters since. In fact, tornado statistics show that the Oklahoma City metro area has had the most direct tornado hits of any American city, with at least 100 since 1890.

There will always be fringe voices on all sides of the climate debate. Looking at the basic facts related to tornadoes we can address some of the questions raised by the recent tornadoes.

1. There is no long-term increase in tornadoes, especially the strongest ones.
2. There is a long-term decline in loss of life (the past year saw a record low total for more than a century).
3. There is no long-term increase in losses, with hints of a decrease when normalized.
4. So far to date 2013 has been remarkably inactive.
5. The Moore, OK tornado may have been the strongest one this year, which tracked through a populated area that has seen substantial development in the last decade.

Figure 2 Like many Midwest cities, Moore, OK, a suburb of Oklahoma City, has seen substantial development. Here is just one example of over 175 homes (orange outline area) that have been constructed around the Briarwood Elementary School in Moore, OK since 1995.

The Research:

Since questions about severe weather and its connection to climate change keep arising, the BMS Analytics team has attempted to provide an explanation on what to expect in a warming climate and what the current research is saying. To start, we need to examine the "State of Knowledge" according to lead climate scientists and meteorologists in the industry, who published a "Monitoring and Understanding Trends in Extreme Storms: State of Knowledge" in the Bulletin of the American Meteorological Society. The key excerpts from this study conclude that there are no good long-term records for thunderstorms and tornadoes. This present's a problem when trying to determine if there is a change in frequency and severity of severe weather events.

Key study excerpts:

- *Due to the changing [observing] practices and the nature of rare events, we have little confidence in the accuracy of trends in the meteorological occurrence of severe thunderstorms (including hailstorms) and tornadoes.*
- *Although some ingredients that are favorable for severe thunderstorms have increased over the years, others have not, so that overall changes in the frequency of environments favorable for severe thunderstorms have not been statistically significant.*

It may be premature to conclusively link climate change to severe weather phenomenon such as tornadoes or hailstorms, and since discussion about climate change will be around for several more decades it is important to understand what the models actually conclude from a warming climate.

Models and theories point to an increase in severe thunderstorms as the climate warms and the general reasoning points to two severe thunderstorm primary ingredients:

1) Energy or fuel supplied from hot, humid air to feed violent vertical storm motions (updrafts and downdrafts). A common metric for this is a quantity called Convective Available Potential Energy, or CAPE.
2) Turning winds with altitude, often called wind shear, helps storms spin. Wind shear is driven by temperature contrasts and is a necessary ingredient for tornado formation.

As the atmosphere warms up, climate models predict an uptick in CAPE. But they also simulate decreasing wind shear because high latitudes are forecast to warm more than mid-latitudes, reducing temperature contrasts. A research article published in April 2013 by Harold Brooks concludes if CAPE, which can be viewed as fuel for thunderstorms, increases, but shear, which helps thunderstorms spin, decreases, the U.S. should see an occurrence of more severe thunderstorms, but tornadoes are much less likely to increase, and in fact are more likely to decrease since the models are predicting a decrease in the mean wind shear.

Brooks' research also concludes damaging winds in thunderstorms, in a warming world, would come more from non-tornadic storms (i.e. straight line winds and microbursts), but that if favorable environments increased enough, tornadoes might not decrease.

A 2007 study in the Proceedings of the National Academy of Sciences developed some maps geographically describing the general increase in CAPE, decrease in wind shear, and overall increase in severe thunderstorms days projected for the end of the 20th century (Figure 3

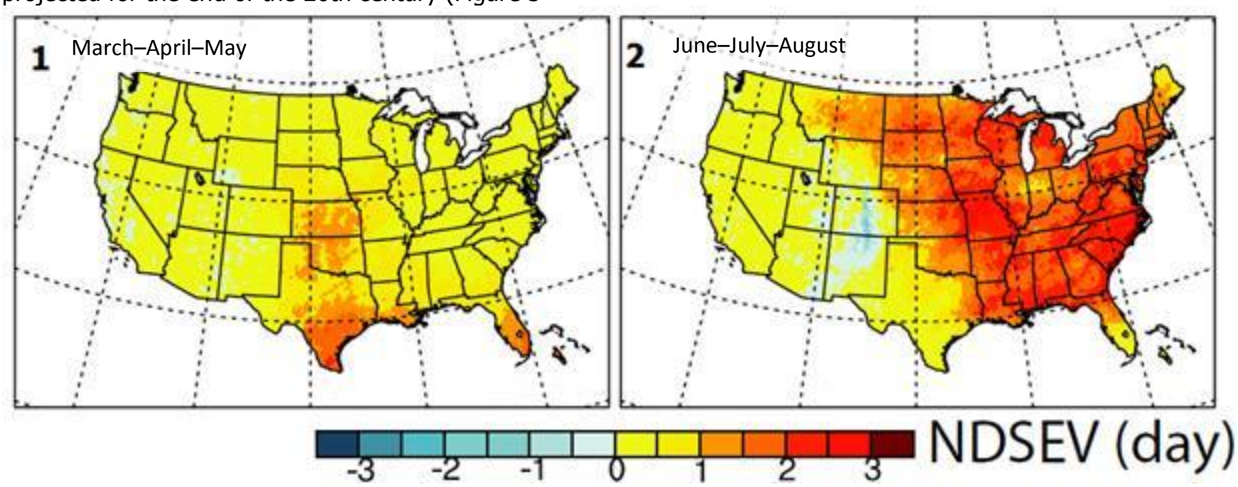

Figure 3 Map 1 is for the months for March–April–May and Map 2 is for June–July–August. Both maps above show the results of a model calculated change in the number of days in which severe thunderstorm environmental conditions (NDSEV) are favorable for development. The model compares the summer climate in 2072–2099 with the climate from 1962–1989. There is a general increase in severe thunderstorms. There appears to be an increase, especially during the later summer months in Missouri and coastal North and South Carolina of NDSEV days. The western part of the country could see a decrease and the eastern U.S. will see more of an increase, which is unfortunate due to the population and exposure distribution across this area. Source: PNAS

Conclusion:

BMS does not claim to know what will happen to the number of severe storm reports in the coming years and anyone who does is just guesstimating. The best answer might come from the National Science and Technology Council's *Scientific Assessment on Climate Change*.

"Trends in other extreme weather events that occur at small spatial scales–such as tornadoes, hail, lightning, and dust storms–cannot be determined at the present time due to insufficient evidence."

Severe thunderstorms are short-fused weather events, on the time scale of seconds and minutes, and a space scale of a mile across. In contrast, climate trends take many years, decades, or millennia, spanning vast areas of the globe. The numerous unknowns dwell in the vast gap between those time and space scales. Climate models cannot resolve tornadoes or individual thunderstorms. They can indicate broad-scale shifts in three of the four favorable ingredients for severe thunderstorms (moisture, instability and wind shear), but as any severe weather forecaster can attest, having some favorable factors in place doesn't guarantee severe weather. Our physical understanding indicates mixed signals – some ingredients may increase (CAPE), while others may decrease (wind shear), in a warmer world. This would possibly mean a shift to more hail and wind related events and less tornadoes. Finally, the severe weather recordkeeping itself also has been prone to many errors and uncertainties, it also doesn't exist for parts of the world, and even in the U.S. the records only cover several decades in detailed form. Changes in population and urbanization also need to be considered and an attempt to normalize losses from the active tornado seasons in the 1950's – 1970's should be incorporated into historical loss analysis.

Insurers should understand the local severe weather climatology where they intend to do business. They should understand historical loss ratios over several different time periods for similar businesses. Seasonal climate predictions are improving and it might be possible to underwrite based on the yearly trends related to climate forcers, which could lead to more profitable underwriting for severe weather risks.

References:

U.S. Tornado Climatology

State of the Science Tornado Fact Sheet

Severe Weather Probabilities

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