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Why catastrophe models do not handle tornadoes effectively

As a result of undersampling the models can miss areas of exposure, which can lead to large losses

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Tornadoes, hailstorms and other severe winds are frequent occurrences in the US, particularly in the states between the Rocky and Appalachian mountain ranges. These severe weather events form along frontal boundaries where warm, moist air collides with colder, dry air. The central states provide a large flat alleyway between the Rockies and the Appalachians, perfect for allowing cold polar air to clash with warm air from the Gulf region.

On an annual aggregate basis, insured losses from severe thunderstorm outbreaks are comparable to hurricane losses at close to $15bn. Every year significant individual occurrence losses exceed $1bn and major tornadoes such as occurred in Joplin, Missouri in 2011 and recently in Moore, Oklahoma can cost insurers several billions of dollars in claims.

Underestimate

In any given year in the US there are more than 1,000 tornado touchdowns. Despite this high frequency, the traditional catastrophe models do not handle this peril very well. Specifically, the models tend to underestimate the loss potential of individual insurance companies.

There are a few reasons for this. First, the historical data used to develop the cat models are incomplete and subject to reporting bias. Because tornadoes are such localised events, they are only reported when there is visual confirmation. Therefore, in cities and suburban areas, the data are much better than in rural areas where many touchdowns may occur but go unreported.

Since tornado wind speeds are typically not measured, tornado severity is inferred from the actual damage, so even getting good estimates of the frequency and severity by location is problematic for the model vendors. Decisions have to be made as to whether the apparent "hot spots" are real or the result of under-reporting and, if so, what is the extent of the under-reporting. The historical data must then be subjectively smoothed and augmented for a more realistic view of likely future occurrences.

Small footprints

Additionally, because tornadoes are localised events with very small footprints, tens of millions of simulated events are needed for a converged sample using the traditional vendor model approach. The models can do an adequate job of estimating the exceedence probability (EP) curve for the industry as a whole but not for specific insurance companies, particularly small and medium-sized companies.

Every few years, insurance companies can experience losses greater than the 100-year loss estimates generated by the models. As a result of undersampling, the models can miss areas of exposure, which can lead to large losses. Because the largest losses for an individual insurance company are likely to come from large, violent tornadoes striking areas where the company has exposure concentrations, insurers are finding newer tools that help them identify such areas are more valuable than the vendor models for the tornado and severe thunderstorm perils.

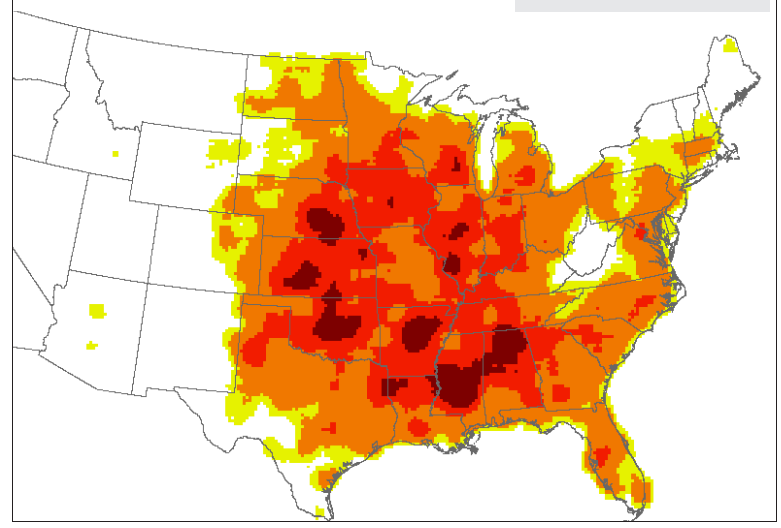
Floating process

The largest tornadoes on record had track lengths of more than 100 miles. The path of a hypothetical large, violent tornado can be created and then "floated" within the appropriate geography to estimate a specific company's losses from this type of event. The floating process will identify where the company has exposure concentrations that may lead to larger losses than anticipated by the cat models.

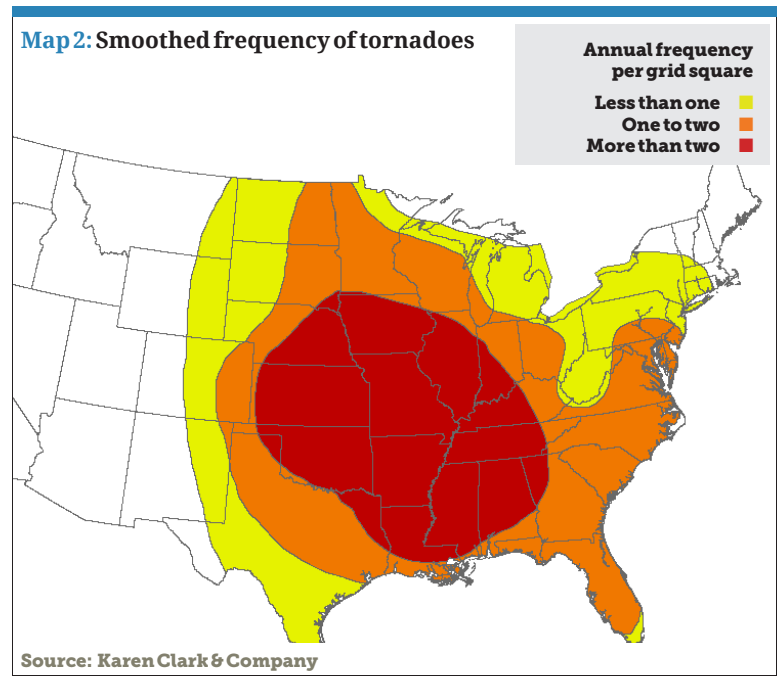
Likewise, extreme "occurrences" of many tornadoes, hailstorms and other wind events can be created and floated across various regions to conduct a similar type of loss analysis. While it is not possible to assign specific probability estimates to these occurrences, it is possible to create realistic scenarios for estimating the likely losses for individual insurers. This information is intuitive and transparent and is likely to be more reliable than the tornado EP curves generated by the vendor models.

After relying almost exclusively on the vendor models for the past 20 years, insurers and reinsurers are starting to use newer technology and tools to give them different perspectives on the risk and their potential losses. These new approaches provide highly effective tools for better understanding and managing catastrophe risk. ■

Map 1: Reported tornadoes



Map 2: Smoothed frequency of tornadoes



Source: Karen Clark & Company