MODEL PREVIEW

Modeling Severe Thunderstorm Risk in the United States

The AIR Severe Thunderstorm Model for the United States was first released in 1987 as the industry's first probabilistic model to help companies proactively manage severe thunderstorm losses. Since then, the model has undergone several updates. In the summer of 2014, AIR will release the latest comprehensive update to the model that features significant enhancements to all three model components—hazard, engineering, and financial. These improvements are based on a decade's worth of new data and scientific research, including damage data collected and analyzed by AIR engineers following major outbreaks in 2008, 2011, and 2013, as well as approximately USD 3 billion in insurance company claims and over USD 38 billion in claims from AIR sister company, Xactware®. The model also underwent an extensive peer review by Timothy Marshall, P.E., of Haag Engineering and Dr. Harold Brooks of the National Severe Storms Laboratory. The culmination of this new data, research, and nearly 15,000 person-hours of development time is a model that provides the most robust view of U.S. severe thunderstorm risk available.

CAPTURING RISK BEYOND THE LIMITED HISTORICAL RECORD

Severe thunderstorms occur relatively frequently in comparison to other natural catastrophes, such as earthquakes and hurricanes. However, despite plenty of recent data on supercell thunderstorms, derechos, and their main sub-perils (i.e., tornadoes, hailstorms, and straight-line winds), shortage of historical data is one of the biggest challenges to developing a model that provides full spatial coverage of simulated events throughout the continental United States.

The 2014 model update addresses this challenge by combining statistics with the latest meteorological research. AIR began by analyzing data collected since 1979[1] by the Storm Prediction Center (SPC), whose database comprises storm reports called in by local authorities and trained weather spotters. To create a spatially complete catalog of simulated events, AIR "smart-smoothed" the SPC reports to physically realistic locations. Smart-smoothing combines statistical and physical methods that leverage high-resolution meteorological parameters (i.e., significant hail parameter, significant tornado parameter, and energy helicity index) to determine when and where conditions were favorable for severe thunderstorm formation.

Smart-smoothing allows the model to account for risk in areas that may not have experienced major activity in the brief historical record. They also enable the model to capture major outbreaks very similar to those that occurred prior to or after the historical record used in model development, such as the 1974 Super Outbreak, during which over 60 EF-3 or greater tornadoes struck, or the late season EF-4 tornado that struck Illinois in November 2013.

CAPTURING THE RISK FROM LARGE AND SMALL LOSS-CAUSING EVENTS

To produce a complete picture of risk from the severe thunderstorm peril, a model should not only capture the large outbreaks that produce insured losses in excess of USD 25 million,[2] but also the smaller events that may last only one day and produce much lower losses—but still impact a company's portfolio on an aggregate basis.

The 2014 model update solves this challenge by simulating daily severe thunderstorm activity based on realistic historical occurrence rates and weather patterns for a particular location and season. The output of the model's daily simulation is used to generate 10,000-year, 50,000-year, and 100,000-year stochastic catalogs that include all severe thunderstorm events regardless of size of loss.[3]

[1] AIR only includes SPC data starting in 1979 because of more severe underreporting in the older data and the fact that the Climate Forecast Systems Reanalysis data used in model development begins in 1979.
[2] Thus triggering the issuance of a PCS catastrophe serial number.
[3] AIR will also make available a 10,000-year catalog consisting of just those events that meet the PCS-defined trigger of USD 25 million.

Key to the model generating robust tails of the exceedance probability curve are event footprints whose dimensions are based on historical observation rather than on an artificially imposed grid size. In real life, tornadoes cause narrow bands of high damage, not large swaths of minor damage, an important feature preserved by using physically realistic swath sizes that cannot be captured on a grid.

Given the considerable uncertainty in the spatial extent of hail and straight-line wind events in the SPC data, AIR researchers developed a clustering algorithm that groups events that are close in space and time to produce more realistic damage footprints for simulated events. Further refinement of hail footprints was achieved by using radar data from the major outbreaks of 2010 and 2011. (Unlike hail and straight-line wind, the SPC provides damage footprints for tornadoes.)

DIFFERENTIATING RISK

To capture the risk that severe thunderstorms pose to insured properties across the United States, a catastrophe model must differentiate the risk to various assets by sub-peril and by primary and secondary building characteristics. In the absence of detailed building characteristics, a structure's location and year-built can be used to account for local building practices based on building code requirements and their enforcement levels. AIR met this challenge by implementing a comprehensive approach to modeling spatial and temporal variations in vulnerability as well as developing sub-peril–specific damage functions.

The model's damage functions are based on the latest published research, claims data, engineering principles, and AIR's own post-disaster surveys. Significant studies that AIR has incorporated include the Roofing Industry Committee on Weather Issues, Inc. (RICOWI) damage survey following the 2011 Dallas/Fort Worth hailstorm—in which AIR was a participant—and detailed damage survey data from 2011 tornado outbreaks collected and analyzed by Texas Tech University. AIR's approach was also informed by results from detailed reports that the Institute for Business and Home Safety (IBHS) released to its member companies summarizing the findings from their analysis of insurance claims from the 2003 hailstorms in North Texas and the 2011 hailstorms in Dallas-Fort Worth.

The model captures spatial and temporal variations in vulnerability by way of damage functions for "model buildings" appropriate to the building's location and year-built. The model buildings and their damage functions are the culmination of an extensive peer-reviewed study that AIR researchers undertook to understand the large number of building codes and design wind standards that exist across the continental United States.

New elements in AIR's Touchstone® platform allow companies to further tailor analysis to their individual portfolios and better understand their risks. For example, companies can now enter many secondary risk features based on their own exposure information, such as roof characteristics, hail impact rating category of the roof cover, and details on building envelope.

The efficacy of the model's damage functions was validated through the analysis of billions of dollars of detailed insurance company claims data and damage surveys conducted in the aftermath of severe thunderstorms, including those conducted by AIR researchers in 2008, 2011, and 2013. Detailed claims data was also used to develop sub-peril–specific probability distributions around the mean damage ratio that capture the secondary uncertainty unique to each sub-peril.

Companies can also analyze results for each sub-peril individually as well as for all three combined to gain further insight into how the modeled sub-perils impact their risks.

Finally, all severe thunderstorm models are developed based on assumptions about complex physical phenomena, of which there is an imperfect understanding. However, different assumptions made during model development can lead to differences in model output. AIR follows a rigorous validation process, for which every model component is validated independently. Just as critical, AIR scientists spend significant time validating the model as a whole from various loss perspectives to ensure that model results make sense.

MANAGING CHANGE

At a very high level and for most return periods, modeled losses have increased on an industrywide basis as a cumulative result of model enhancements. It is important to note, however, that the magnitude of the change is highly dependent on the geographic distribution of a portfolio and its constitution. A detailed analysis is needed to assess the impact to any particular portfolio.

As with any model change, AIR understands that there are important implications for your risk management operation. AIR is committed to helping you understand and navigate these changes so that you can continue to make confident business decisions. Please contact your AIR representative for further details.