The AIR Severe Thunderstorm Model for Europe

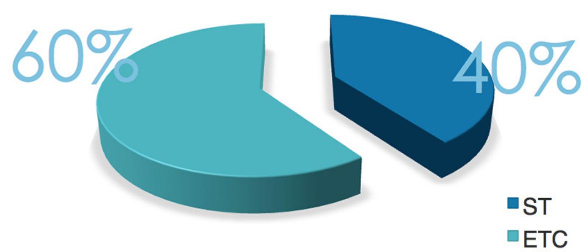
In 2013 Andreas was the costliest severe thunderstorm outbreak to ever strike Europe—and it still is. If Andreas were to recur today, it would cause about EUR 4 billion in insured losses from hail and straight-line wind. European severe thunderstorm losses—whether from a single large event or from multiple events over the course of a year—can be catastrophic. The AIR Severe Thunderstorm Model for Europe can help companies better prepare for the extreme loss volatility posed by this highly localized peril.

While severe thunderstorms usually occur during the summer months, they can strike Europe at any time of the year. Over the course of several days, these storms can produce multiple outbreaks of damaging hail and straight-line winds, affecting several countries. Andreas in 2013, with losses primarily from hail, and Ela in 2014, with a significant portion of losses from straight-line wind, are two recent examples of billion-euro severe thunderstorms in Europe. Insurers can no longer treat severe thunderstorm risk as attritional.

The AIR Severe Thunderstorm Model for Europe accounts for the real-world behavior of severe thunderstorms, allowing users to assess their exposures from the local scale to the macro level across 22 countries and multiple lines of business. The model leverages multiple data sources to realistically capture the risk from hail and straight-line wind in a unique hybrid physical-statistical approach that helps better quantify your risk.

According to the AIR Severe Thunderstorm Model for Europe, convective storms across the model domain of 22 countries account for 40% of insured losses from the atmospheric perils of severe thunderstorms and extratropical cyclones, on average.

Used in concert with the AIR Extratropical Cyclone Model for Europe, the new severe thunderstorm model provides a broader view of atmospheric peril risk in Europe.



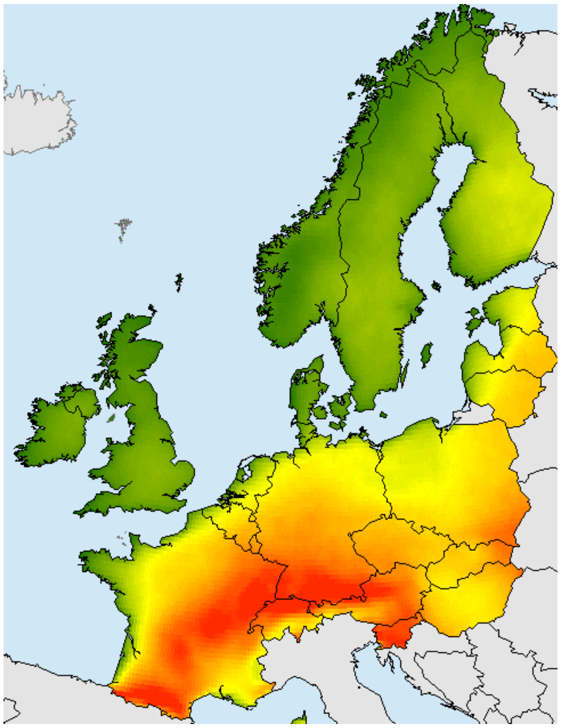
European extratropical cyclone and severe thunderstorm perils by modeled average annual loss. (Source: AIR)

An innovative way to model storm occurrence

Assessing severe thunderstorm risk based solely on historical reporting and claims data can be misleading, as uneven population distribution leads to significant gaps and, due to the highly localized nature of outbreaks of hail and straight-line winds, existing reports may not capture the full potential for losses. For example, a majority of the loss from Andreas came from two severe hail outbreaks in Germany that just skirted the cities of Hannover and Stuttgart; an equally likely direct hit on the city centers would have resulted in far greater losses.

To model areas where atmospheric conditions are conducive to severe storms but historical storm reports are sparse, AIR augments the historical record with multiple weather data sources and accounts for population bias in a unique hybrid physical-statistical approach that leverages the best of each data source. This approach creates a more complete picture of historical events, and it allows the generation of a spatially complete stochastic catalog of simulated events to give companies a probabilistic view of their severe thunderstorm risk.

AIR's model leverages historical weather data from a range of sources, including local storm report databases such as European Severe Weather Database (ESWD); Europe weather radar data from the Operational Programme for the Exchange of Weather Radar Information (OPERA) and the Deutscher Wetterdienst (DWD); and atmospheric reanalysis data from the European Centre for Medium-Range Weather Forecasts (ECWMF).



Simulated average annual hail days in the AIR model; warmer colors represent higher risk, and cooler colors represent lower risk. (Source: AIR)

Accounting for highly localized effects

Thunderstorms can last for several days and affect multiple countries, but individual occurrences of hail and straight-line winds that make up an outbreak may last for just minutes and devastate highly localized areas. To capture the localized effects, AIR developed high-resolution event footprints specific to each sub-peril.

The model groups events that are close in space and time using clustering algorithms to create realistic individual outbreak patterns of hailstorms, and straight-line winds in a given location—patterns that would not be possible using random sampling alone. AIR's event footprints, whose realistic shape and size are based on historical observation rather than on an artificially imposed grid size, are the key to the model's ability to generate a robust tail of the exceedance probability curve.

Daily simulation captures large and small loss-causing events

The AIR model simulates daily severe thunderstorm activity based on historical occurrence rates and weather patterns for a particular location and season, generating storms with appropriately correlated lengths, widths, and intensities. The daily simulation enables the model to capture both large outbreaks that last several days and impact multiple countries and smaller events that may only last one day but could still impact a company's portfolio significantly.

AIR offers a 10,000-year stochastic catalog that captures both highly localized effects of individual storms and spatial extents of combined storms. The range of simulated events in tandem with our physical-statistical approach allows for a more granular view of the risk, making the model ideal for use in ratemaking and underwriting. The stochastic catalog is supplemented by six marquee historical events and five extreme disaster scenarios.

Sub-peril-specific damage functions reflect unique damage mechanisms

Because hail and wind inflict damage differently, the model's damage functions are sub-peril–specific to provide the most accurate estimates of loss. For straight-line winds, damageability is modeled as a function of the 3-second gust wind speed. Hail damage is a function of hail impact energy, which takes into account the density of individual hailstones, the distribution of hailstone sizes within an area, and the accompanying wind speed.

The model's damage functions are based on engineering analyses of construction practices, country-specific building codes, and claims data. Detailed analyses of these claims data also reveal that the uncertainty around the mean damage is also sub-peril– and region-specific, a feature captured in the model. Touchstone® allows companies to analyze results for each sub-peril individually, as well as for both sub-perils combined, thereby giving further insight into a highly complex risk.

The AIR Severe Thunderstorm Model for Europe estimates losses caused by hail and straight-line wind at location, postal code, and CRESTA levels to residential and commercial buildings, large industrial facilities, and agricultural exposures (including greenhouses). Specialty lines, including forestry, inland and oceangoing marine cargo, marine hull, personal automobiles and commercial auto fleets, builder's risk, and wind turbines, can also be modeled.

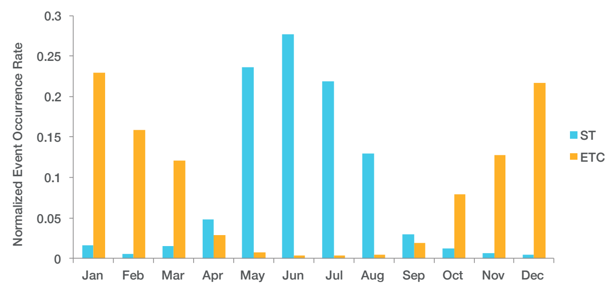
Automotive hail vulnerability

The damage hail causes to automobiles is significant—typically in the form of broken windows and dented metal panels. AIR's research shows an elevated hail vulnerability for many European countries compared to the U.S., which is a result of more prevalent street parking. The model captures this increased hail vulnerability explicity.

For commercial auto fleets such as dealerships, car rentals, and carpools, the model's vulnerability module explicitly captures their increased hail vulnerability due to large numbers of vehicles in the same location, with unique damage functions developed for accumulated risks.

Seasonality of European storms

Severe thunderstorm is the dominant peril during the summer months, whereas extratropical cyclones are dominant October through March, underscoring the importance of using both models to get a broader view of your European risk.



Seasonal distribution of modeled storm activity by peril over a year in Europe. Source: AIR

Reflecting regional and temporal variations in vulnerability

The model's damage functions incorporate findings from AIR's comprehensive study of the adoption and enforcement of building codes throughout each country, changes in building materials and construction practices, structural aging and mitigation features, as well as other factors that affect vulnerability such as roof cover and roof slope. Accounting for the year of construction provides highly granular differentiation of vulnerability across regions and time.

Other highlights of the AIR model's vulnerability module include:

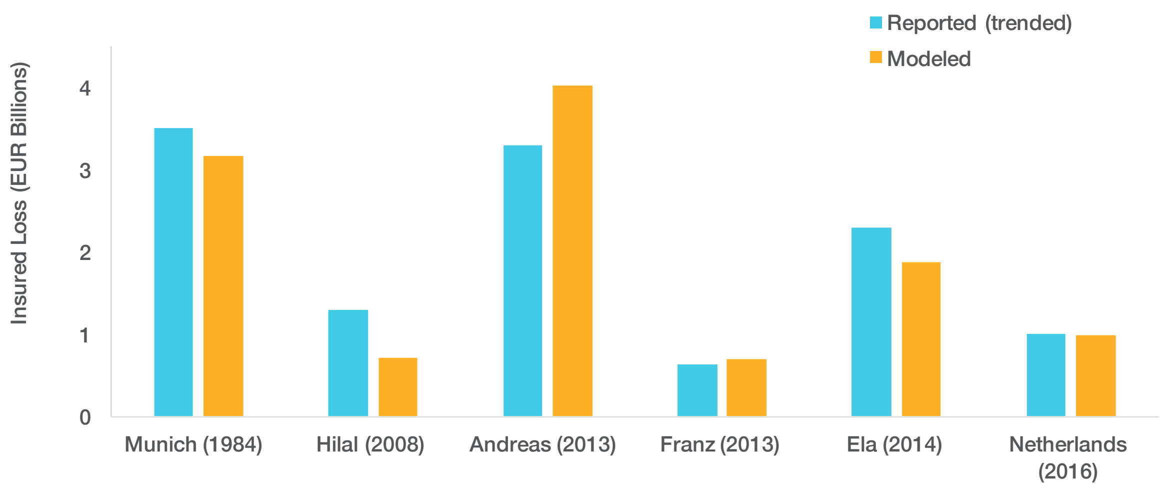
- Supports 47 construction classes and 117 occupancy classes
- Uses year built and building height to further differentiate vulnerability
- Unknown damage functions vary by CRESTA to account for the regional distribution of building stock

Leveraging AIR's detailed industry exposure database for Europe

For all 22 modeled countries, AIR has developed a high-resolution 1-km^2 industry exposure database (IED) that is based on the latest available information on risk counts, building characteristics, and construction costs from a wide variety of local sources. The benefits and uses of AIR's IED are numerous. It provides a foundation for all modeled industry loss estimates and supports loss-based model validation. Risk transfer solutions, such as industry loss warranties that pay out based on industry losses, rely on the IED. Using AIR's detailed modeling application, companies can also leverage the IED for Europe to better estimate the vulnerability of unknown exposure and disaggregate the exposure data in their own portfolios to a highly detailed level, for improved loss estimates.

Comprehensive approach to model validation

To ensure the most robust and scientifically rigorous model possible, the model is carefully validated against actual loss experience. However, validation is not merely limited to final model results. Each component is independently validated against multiple sources; for example, the distribution of each storm characteristic in the stochastic catalog is carefully compared with historical storm data, and modeled wind fields and hail outbreaks are validated against observations from actual storms. Modeled losses have been validated against claims and actual loss data sourced from some of the largest insurers in Europe with a significant combined market share, and against industry loss estimates. The combined data spans 14 countries and several historical events from the Munich Hailstorm (1984) to more recent storms such as Hilal (2008), Andreas (2013), and Ela (2014).



Historical Events Loss Evaluation: Industry Losses

Model at a Glance

Modeled Perils	Straight-line wind and hail
Model Domain	Austria, Belgium, Czech Republic, Denmark, Estonia, Finland, France (including Monaco), Germany, Hungary, Ireland, Latvia, Liechtenstein, Lithuania, Luxembourg, Netherlands, Norway, Poland, Slovakia, Slovenia, Sweden, Switzerland, United Kingdom
Supported Geographic Resolution	CRESTA, INSEE, postal code, location level (lat/long)
Stochastic Catalogs	10,000-year catalogs, six historical events, and five Extreme Disaster Scenarios (EDS).
Supported Construction Classes, Occupancy Classes and Specialty Lines	— 47 construction classes and 117 occupancy classes are supported for straight-line wind and hail — Personal automobiles and commercial auto fleet — Large industrial facilities — Agricultural (including greenhouse), forestry, inland and oceangoing cargo, marine hull, builder's risk, and wind turbines

Model Highlights

- Integrates statistical modeling with the latest meteorological research
- Captures the highly localized effects of straight-line winds and hail
- Daily simulation captures the impact of both large and small loss-causing events
- Accounts for regional and temporal variations in sub-peril vulnerability—which capture the local building practices and characteristics (such as age and height)
- Unknown damage functions vary by CRESTA to account for the regional distribution of building stock
- Supports the modeling of specialized risks, including large industrial facilities, agricultural (including greenhouse), forestry, inland and oceangoing cargo, marine hull, builder's risk, personal automobiles and commercial auto fleets (including dealerships and rental lots), and wind turbines.
- Calibrated and validated through extensive claims data, including detailed claims sourced from some of the largest insurers in Europe
- Shares a model domain of 22 countries with the AIR Extratropical Cyclone Model for Europe model domain, allowing clients a broader view of European atmospheric peril risk

ABOUT AIR WORLDWIDE

AIR Worldwide (AIR) provides risk modeling solutions that make individuals, businesses, and society more resilient to extreme events. In 1987, AIR Worldwide founded the catastrophe modeling industry and today models the risk from natural catastrophes, terrorism, pandemics, casualty catastrophes, and cyber incidents. Insurance, reinsurance, financial, corporate, and government clients rely on AIR's advanced science, software, and consulting services for catastrophe risk management, insurance-linked securities, site-specific engineering analyses, and agricultural risk management. AIR Worldwide, a Verisk (Nasdaq:VRSK) business, is headquartered in Boston, with additional offices in North America, Europe, and Asia. For more information, please visit www.air-worldwide.com.

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