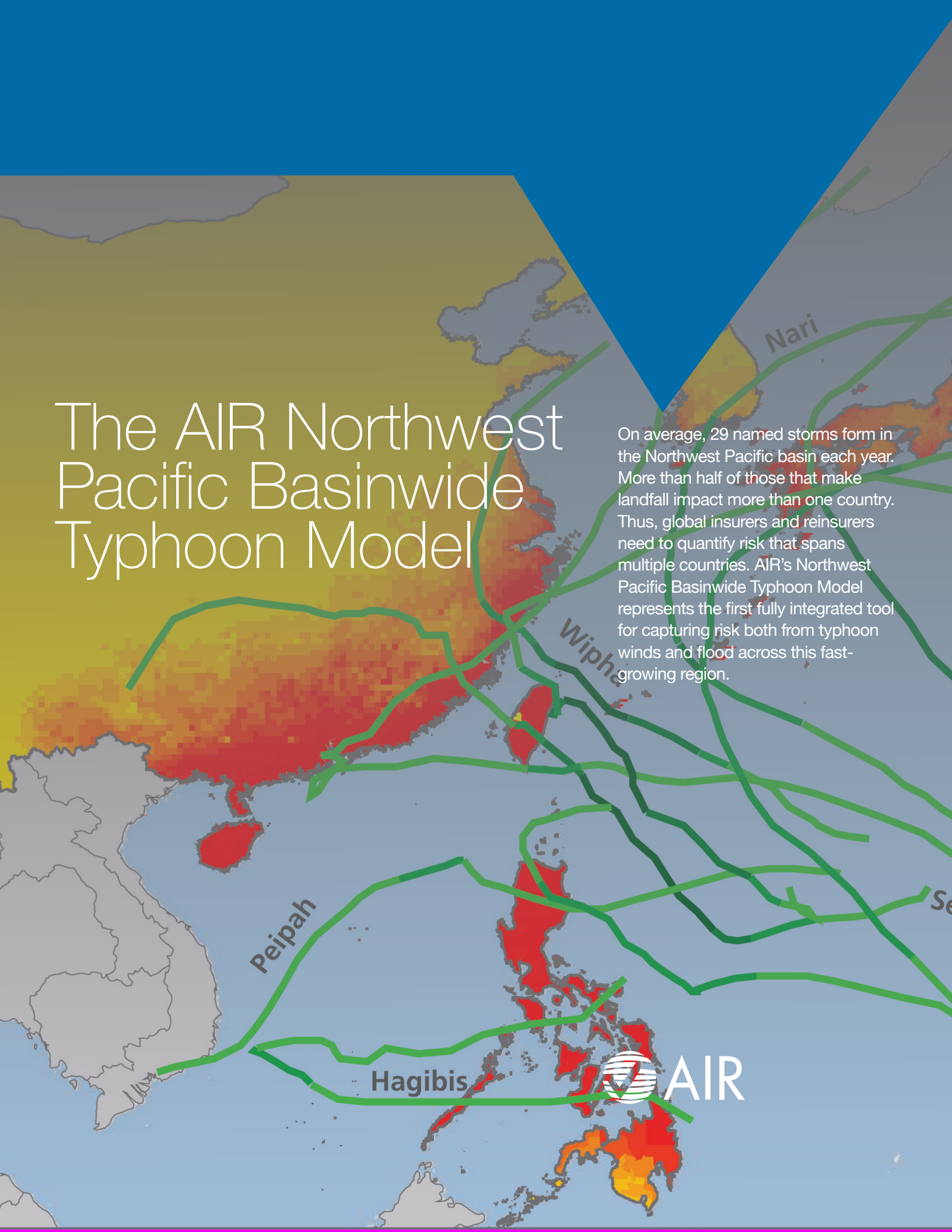


The AIR Northwest Pacific Basinwide Typhoon Model

On average, 29 named storms form in the Northwest Pacific basin each year. More than half of those that make landfall impact more than one country. Thus, global insurers and reinsurers need to quantify risk that spans multiple countries. AIR's Northwest Pacific Basinwide Typhoon Model represents the first fully integrated tool for capturing risk both from typhoon winds and flood across this fast-growing region.

The vast expanse of warm water in the Northwest Pacific basin spawns large and intense typhoons that cause billions of dollars in damage each year. The AIR Northwest Pacific Basinwide Typhoon Model features a unified catalog of nearly 300,000 simulated events that realistically represent the frequency, tracks, and meteorological evolution of potential storms affecting Japan, mainland China, Hong Kong, Taiwan, South Korea, and the Philippines.

And because the catalog generation process starts by determining how many events occur in each simulated year, the model faithfully preserves the seasonal patterns in the annual occurrence of storms, ensuring accurate modeling of both occurrence and aggregate losses—without cumbersome post-processing.

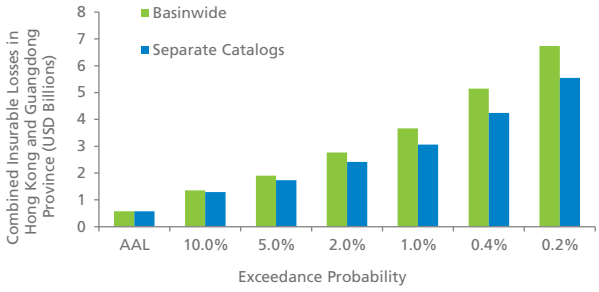
Capturing Hazards from Typhoons That Make Multiple Landfalls

Nearly six out of every ten landfalling tropical cyclones in the Northwest Pacific Basin affect multiple countries. Some storms are able to maintain their strength from one landfall to the next to cause significant wind damage in multiple regions. More often than not, however, second and subsequent landfalls tend to represent a more significant threat from precipitation and flooding. Several effects—sometimes acting together—contribute to this phenomenon.

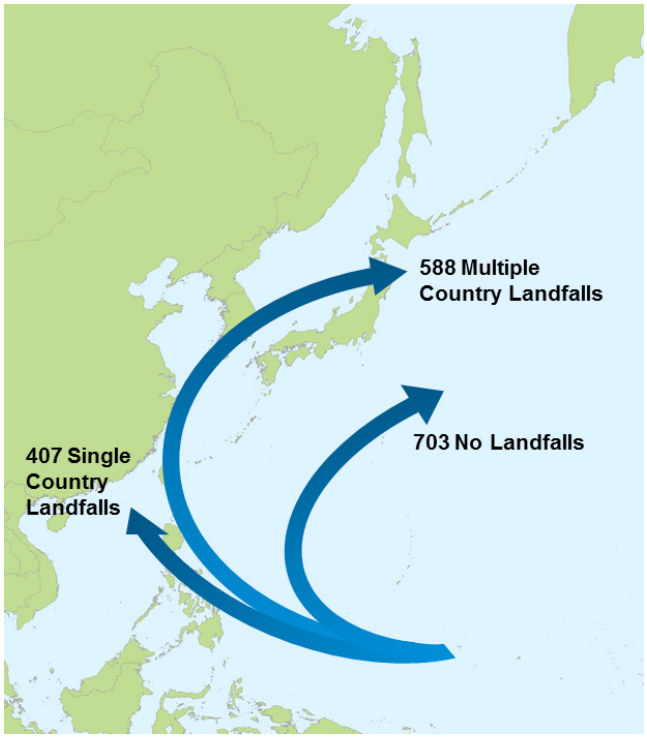
During initial landfall, the effects of coastal mountains and the transition between winds traveling over water to traveling over land forces air to rise, causing clouds and precipitation. This enhanced precipitation can linger even after the typhoon has moved back offshore, on track to its next landfall.

THE ADVANTAGE OF A BASINWIDE APPROACH

The AIR model allows local direct insurers to analyze country-specific risk and, at the same time, allows global insurers and reinsurers to seamlessly assess the risk to policies and portfolios that span multiple countries. Only a basinwide catalog can provide a unified and robust view of typhoon risk in the Northwest Pacific, while preserving the correlation in losses between regions for storms that make multiple landfalls.



Due to their physical proximity, storms that impact Hong Kong are very likely to go on to make landfall in mainland China's Guangdong province. Using separate catalogs, a company that insures properties in both regions may underestimate their typhoon risk.



An AIR analysis of 1,690 typhoons from 1951 to 2008 revealed that more than half of all landfalling typhoons in this region make landfall in multiple countries.

In addition, storms tend to have a greater chance of interacting with other weather systems as they turn northward and weaken in cooler ocean conditions, which increases precipitation.

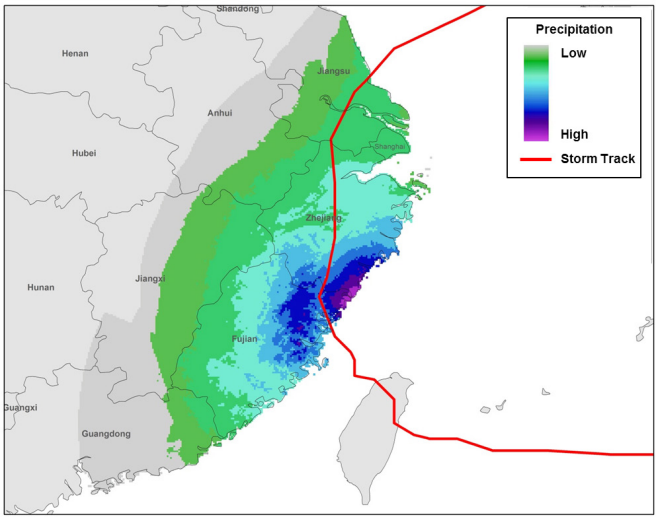
Typhoons also may undergo extratropical transition as they move northward, which can enhance the asymmetry of the storm and increase the size of the precipitation footprint. Even systems that do not come ashore can cause significant flood damage because their precipitation footprints can extend hundreds of kilometers from the storm track.

Modeling Typhoon-Induced Flood, a Significant Source of Loss Covered Under Most Policies

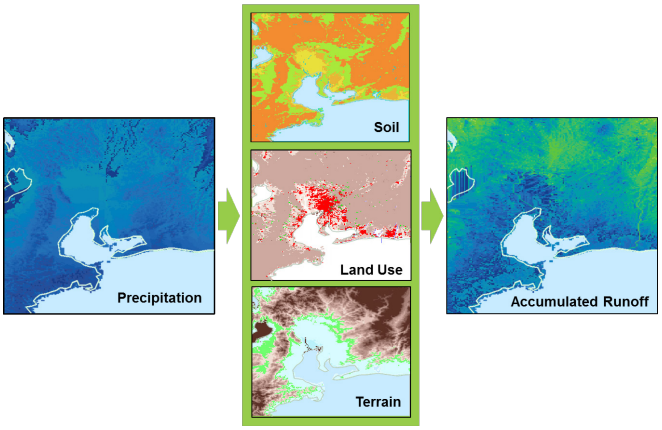
Typhoon losses can be significant even in the absence of strong winds. In 2009, Typhoon Morakot made a first landfall in Taiwan at Category 1 strength, delivering a record-breaking 2,777 millimeters (109.3 inches) of rain in four days—an entire year's worth of precipitation in central Taiwan's Gaoping River basin. Morakot then weakened as it moved across the Taiwan Strait. It was a

ACCOUNTING FOR THE UNIQUE CHARACTERISTICS OF NORTHWEST PACIFIC TYPHOONS

Numerous studies have documented that typhoons in the Northwest Pacific exhibit some unique characteristics. The critical relationship between central pressure and wind speed, for example, is different in this basin as compared to North Atlantic hurricanes. Typhoons that occur in the Northwest Pacific basin typically have lower peripheral pressures and are larger than their North Atlantic counterparts. Thus, for the same central pressure, Northwest Pacific typhoons tend to have lower wind speeds. The AIR model recognizes and accounts for these differences, which are critical to reliable loss estimation.



After hitting Taiwan in August 2009, Typhoon Morakot made a second landfall in southeastern China. Although its wind speeds were not sufficient to cause significant damage at that point, the storm brought high levels of precipitation that caused catastrophic flooding and landslides in Zhejiang and Fujian provinces. Shown here is Morakot's modeled accumulated precipitation in China. (Source: AIR)



The AIR model uses high resolution information on soil type, land use/land cover, and topography to determine flood risk

severe tropical storm when it slammed China's eastern provinces of Zhejiang, Fujian, Jiangxi, and Anhui. Though less intense than it had been at its first landfall, Morakot brought catastrophic flooding and damaged roughly 10,000 homes. Economic losses are estimated at USD 1.4 billion in mainland China, with another several billion in Taiwan.

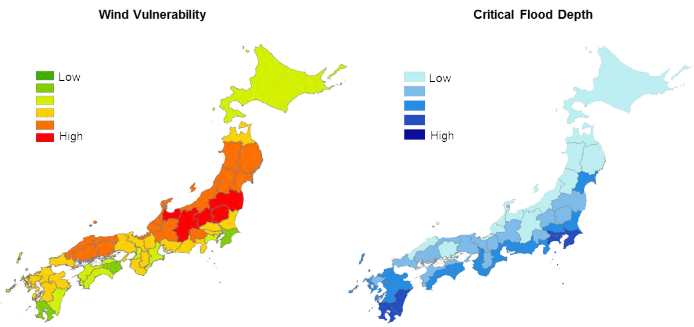
Understanding where precipitation travels after it hits the ground is essential to modeling flood risk. The AIR Northwest Pacific Basinwide Typhoon Model takes into account the porosity of the soil and its saturation level, and the slope of the terrain to spatially distribute water over the model domain.

The model also accounts for the current quality and sophistication of existing flood defense systems, which vary among and even within countries. Modeled flood defense mechanisms include river embankments, reservoirs, sea dikes, underground cisterns, and super levees.

Comprehensive Understanding of How Structures Respond to Wind and Flood

The AIR model incorporates the latest research on wind and flood vulnerability to estimate losses to structures and their contents, and losses from business interruption. AIR engineers collaborate with local governments, research institutions, and insurance companies to develop a detailed understanding of the building inventory—including construction type and occupancy distributions—as well as regional variations in construction practices, building codes, and underwriting practices. For example, in Japan, the AIR model's vulnerability module supports fire classes for residential and commercial risks, which are widely used by underwriters.

In addition, AIR explicitly captures the vulnerability of buildings under construction (the construction all risks/erection all risks, or CAR/EAR, line of business) to both wind and flood in Japan, China, and South Korea. AIR's time-dependent damage functions for the CAR/EAR line capture both damage to the partially constructed buildings themselves and to construction equipment, machinery, and other contents, based on a comprehensive analysis of wind and flood vulnerability at various phases of construction.



The AIR model captures regional variations in wind vulnerability and critical flood depth (the amount of flooding current defense systems can mitigate). Because wind and flood damage are fundamentally different, the model features separate damage functions for wind and flood.

Touchstone Supports a Broad Range of Country-Specific Policy Conditions

Insurance markets in the Northwest Pacific region have experienced dramatic growth in the past decade, leading to the adoption of a wide variety of policy types. Using the model in Touchstone®, clients can model a wide range of complex policy conditions and coverages in effect in each modeled country.

Touchstone is also the only catastrophe modeling platform currently capable of accurately modeling complex step policies, which are commonly used by Japanese mutual companies. AIR's custom functionality for step-payment policies enables clients to model the payment for flood damage as it occurs under a comprehensive policy for wind and flood, and also to model risks covered by cooperatives. The function applies policy conditions probabilistically to provide more accurate estimates of potential insurance payments.

Comprehensive Approach to Validation

To ensure that final model results are realistic and robust, AIR builds its models from the ground up, validating each component independently. For example, AIR validates that the model produces realistic patterns of simulated winds by comparing modeled wind fields to observations from actual storms.

As a final test, AIR validates the model from the top down by comparing modeled losses to industry loss estimates and company data. AIR's comprehensive approach to validation ensures that the overall losses make sense and that the final model output is both consistent with basic physical expectations of the underlying hazard, and unbiased when tested against both historical and real-time information.

Model at a Glance

Modeled Perils	Wind, typhoon-induced flooding
Model Domain	Japan, mainland China, South Korea, Taiwan, Hong Kong, and the Philippines
Supported Geographic Resolution	Touchstone: CRESTA/Province, district (county in China), post code, and city for China, Taiwan, Hong Kong and the Philippines Prefecture, Ku/JIS code, Yubin/post code, Sonpo code for Japan User-specific latitude/longitude for all countries CATRADER®: CRESTA and sub-CRESTA for China, CRESTA for South Korea and Taiwan, sub-CRESTA for Hong Kong and the Philippines, country and CRESTA for Japan
Supported Construction Classes and Occupancies	Supports 39 construction classes in Japan, 23 in South Korea, 18 in mainland China, and 25 in Taiwan, Hong Kong, and the Philippines In all countries, supports 52 occupancy classes

Model Highlights

- Unified basinwide catalog of more than 293,000 simulated tropical cyclones provides a truly comprehensive view of Northwest Pacific typhoon risk essential for global companies that underwrite policies and manage portfolios spanning more than one country
- Captures the unique meteorological characteristics of storms that make multiple landfalls, including precipitation-enhancing effects that can cause significant flood losses even in the absence of strong winds
- Flood risk is captured by taking into account detailed information on soil type, land use/land cover, and topography
- Because wind and flood damage are fundamentally different, includes separate damage functions for wind and flood vulnerability
- Takes into account the current state of flood defense systems, which varies widely among and within countries
- Accounts for business interruption losses for both wind and flood
- Supports the CAR/EAR line of business, which is a significant component of the building stock in this region
- Includes damage functions for "unknown" construction, occupancy, and height classes
- Accounts for complex flood policy conditions, which are typically different from wind policies
- Supports marine cargo, marine hull, auto and railway lines of business in Japan
- Model is carefully validated using observations from past events, industry reported loss, and company claims data

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 attacks, globally. 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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