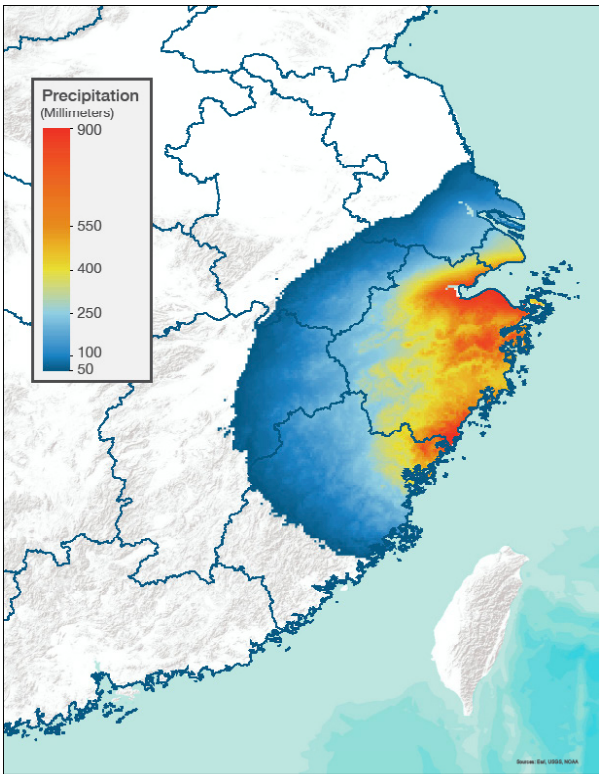
AIR Typhoon Model for China

China is impacted by more tropical cyclones than any other country. On average, 11 affect China annually, either as direct hits or damaging bypasses. Only 5% arrive as major typhoons, but slower, weaker storms can impact a region over a longer period, producing flooding that can last for days or even weeks. (Re)insurers need a robust model to assess and manage their risk from typhoon winds and rain.

AIR

An important characteristic of typhoons in the Asia-Pacific region is that even those with relatively low wind speeds can be accompanied by catastrophic flooding, which can extend hundreds of kilometers inland and persist for several days after landfall. The AIR Typhoon Model for China captures the risk from both wind and flood—a critically important feature, given that both perils are covered in standard residential, commercial, and construction all risks/ erection all risks (CAR/EAR) policies.



Modeled accumulated precipitation fromTyphoon Fitow (2013) captures terrain and extratropical cyclone transitioning.

Developed through collaboration with leading China research organizations

The model's stochastic catalog was developed in conjunction with the Shanghai Typhoon Institute (STI). Typhoon track data provided by the STI extends well beyond the point where the storm is no longer a typhoon—long after other meteorological organizations stop tracking it. This information is essential for accurately modeling the flood risk associated with these systems.

AIR engineers collaborated with the Beijing Institute of Architectural Design to better understand local building designs and construction materials and practices.

The AIR Typhoon Model for China accounts for the geographic and meteorological factors that influence typhoon-induced flood, including:

- Coastal mountains that enhance precipitation on the north side of typhoons approaching the mainland
- The annual South China Sea Monsoon, which pumps tropical moisture northward across China's southeastern provinces in summer and fall
- Extratropical cyclone transition, which can rejuvenate precipitation after landfall

Separate Damage Functions for Wind and Flood

Damage functions capture the relationship between wind speed or accumulated precipitation runoff and the vulnerability of affected structures.

Highlights of the vulnerability module include:

- Separate damage functions for the wind and flood perils
- Both wind and flood damage functions vary by height, construction, and occupancy
- Damage functions account for duration of wind and rain
- Separate damage functions have been developed for building, contents, and time element coverage
- Damage functions that support specialized risks, including marine cargo, marine hull, large industrial facilities, and infrastructure
- Damage functions for the construction all risks/erection all risks (CAR/EAR) line of business capture the time dependence of both vulnerability and replacement costs

Damage Functions for Buildings under Construction

China is growing at a rapid pace, and new construction can be seen everywhere. As a result, the construction all risks/erection all risks (CAR/EAR) line of business comprises a higher portion of business in China than in many other regions. Unlike existing buildings, the vulnerability and replacement cost of a building under construction vary over time.

To properly model CAR/EAR typhoon risk, AIR engineers have analyzed both wind and flood vulnerability of buildings in various phases of construction. Results from these studies are used to develop the damage functions that take into account the time-dependent aspect of buildings under construction.

The model separately considers wind and flood vulnerability when determining the vulnerability of CAR/EAR risks, since these can vary by construction phase. In the earliest phases of construction, for example, building vulnerability to flood is the highest among all phases, while building vulnerability to wind is the lowest among all phases.

The AIR China typhoon model's damage functions incorporate the results of engineering research and damage surveys. They have been validated using actual losses from several typhoons, including Fitow (2013), Rammasun (2014), Mujigae (2015), and Meranti (2016).

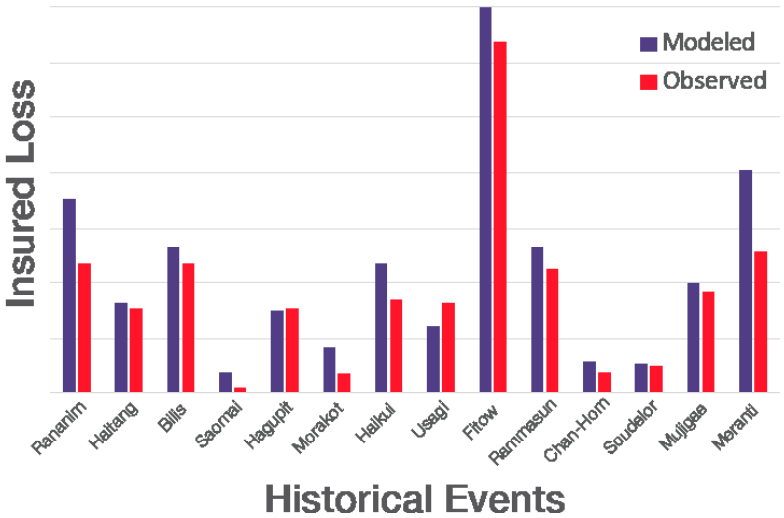
Validating Insured Losses Using Extensive Claims Data

To produce realistic and robust model results, AIR builds its models from the ground up, validating each component independently against multiple sources. AIR modeled wind speeds from the Japan Meteorological Agency and precipitation totals are validated using data from the Shanghai Typhoon Institute of China Meteorological Administration (STI-CMA) Tropical Cyclone Yearbooks and NASA's Tropical Rainfall Measuring Mission (TRMM) and Global Precipitation Measurement (GPM) satellite products.

AIR also validates from the top down, comparing modeled losses to industry loss estimates and company data. Modeled losses for the AIR Typhoon Model for China have been validated against actual loss and claims data from major typhoons since 2004, from companies representing 60-70% of China premium. AIR's comprehensive approach to validation confirms that overall losses are reasonable and that the final model output is consistent with both basic physical expectations of the underlying hazard and unbiased when tested against historical and real-time information.

Supports a Wide Array of Policy Terms and Conditions

The AIR Typhoon Model for China supports a wide array of policy terms and conditions, including location limits and deductibles, policy limits and deductibles, and facultative (assumed and ceded) and treaty reinsurances. In addition, the model explicitly includes the maximum of site or percent-of-loss deductible type, a commercial policy condition commonly used in the China insurance market.



Modeled losses for select events compare well to observed losses based on individual company data.

The AIR Typhoon Model for China is available in AIR's Touchstone®, Touchstone Re™, and CATRADER®. Touchstone, which is AIR's detailed modeling application, takes full advantage of the construction, occupancy, age, and height of each structure, as well as location-specific geographical characteristics (e.g., land use/land cover, elevation, topography), geological information (e.g., soil type and permeability), and insurance policy and reinsurance treaty terms. Touchstone also enables companies to disaggregate province-level aggregate exposure data for catastrophe analysis at a highly detailed level.Touchstone Re is AIR's catastrophe modeling analytics software application and evolution of CATRADER, designed for modeling the loss potential of reinsurance contracts and portfolios, industry loss warranties, and insurance-linked securities.

Model at a Glance

Modeled Perils	Tropical cyclone winds and precipitation-induced flood
Stochastic Catalog	10,000-year catalog includes 294,206 simulated events. Nine historical events are also included.
Supported Geographic Resolution	Touchstone Re and CATRADER: Province, county Touchstone: Province, county, and postcode resolution, plus user-provided latitude and longitude
Supported Construction Classes and Occupancies	18 construction classes are supported for wind and precipitation-induced flood 52 occupancy classes are supported for wind and precipitation-induced flood
Supported Policy Conditions	The model supports a wide variety of location, policy, and reinsurance conditions, as well as the maximum of site or percent-of-loss deductible type.

Model Highlights

- Developed in cooperation with the Shanghai Typhoon Institute
- Accounts for typhoon-induced flood loss by explicitly modeling China-specific geographic and meteorological features such as mountain effects, South China Sea monsoon, and extratropical cyclone transition
- Provides separate damage functions for the wind and flood perils; damage functions vary by occupancy, construction, and height
- Utilizes special damage functions for CAR/EAR exposures that capture the time-dependent vulnerability of buildings under construction
- Damage functions that support specialized risks, including marine cargo, marine hull, large industrial facilities, infrastructure, and buildings under construction
- Features a disaggregation tool in Touchstone that enables clients with aggregate (province-level) exposure data to incorporate additional knowledge (e.g., occupancy or construction) using AIR's detailed modeling application

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, longevity modeling, 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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