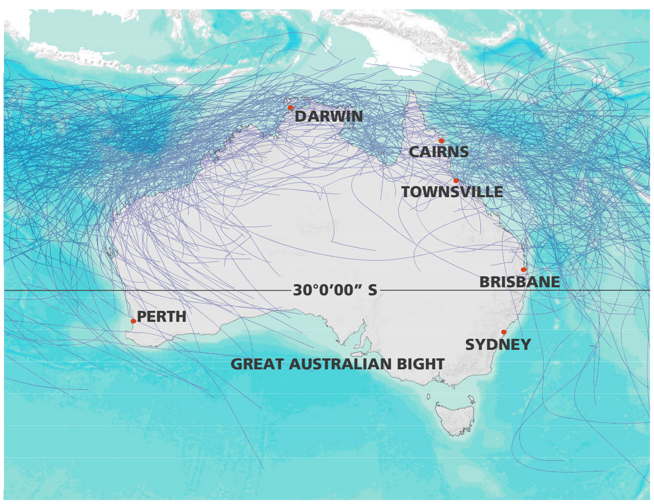
AIR Tropical Cyclone Model for Australia

Australia's most damaging tropical cyclone, Tracy, devastated the city of Darwin in December 1974. AIR estimates that Tracy would cost insurers just over AUD 6.1 billion were it to recur today. In February 2011, Cyclone Yasi battered Queensland's coastline, causing insured losses that reached nearly AUD 1 billion. Companies writing business in Australia need robust tools to support better risk selection and risk transfer decisions.

Robust Model Provides Full Spatial Coverage and Incomparable Detail

Australia is affected by tropical cyclones forming in both the southwest Pacific and the southeast Indian ocean basins. The effects of these cyclones are usually restricted to coastal areas above 30° southern latitude, but areas farther south are not entirely immune. Cyclones such as Alby in 1978 and Vance in 1999 have impacted Perth and other cities along the southwestern coast of Australia; Vance's cyclone-strength winds reached as far as the Great Australian Bight.



Historical storm tracks reveal that most of Australia's coastline is exposed to tropical cyclone risk.

The AIR Tropical Cyclone Model for Australia simulates the risk across the entire country. The model's stochastic catalog is based on data from the Australia Bureau of Meteorology on more than 600 historical cyclones, covering 54 seasons between 1955 and 2009. Incorporating the latest meteorology, high-resolution hazard data, and local expertise in country-specific building practices, the model provides an incomparable level of detail, enabling more precise risk differentiation based on such factors as geography, construction, occupancy, year built, and individual building characteristics.

Region-Specific Wind Field Formula Ensures Realism in Wind Speeds at the Location Level

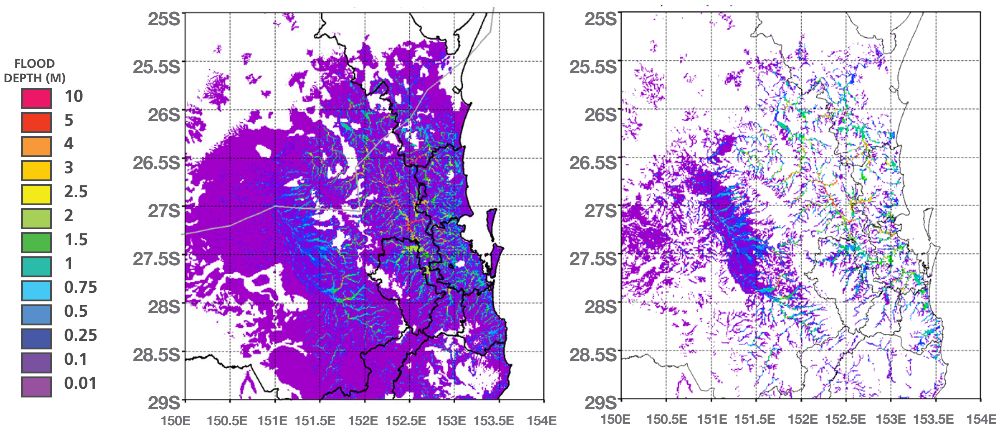
Of the three tropical cyclone–related perils that contribute to property loss in Australia, wind is dominant. In the AIR model, the primary determinant of wind intensity is central pressure. The model's central pressure to wind speed relationship is specific to the southern Indian and Pacific Ocean basins, where observations have shown that, given the same central pressure value, tropical cyclones tend to have lower wind speeds compared to their North Atlantic counterparts.

The model explicitly accounts for the directional effects of surface roughness on local wind speeds. Rather than using a single surface friction factor that reflects the average land (or water) surface surrounding a location, the wind field model uses high-resolution vegetation and land use/land cover data to estimate the roughness in eight wind directions. Topographical effects—that is, the tendency of wind speeds to increase on the windward slopes of coastal mountains—are based on high-resolution elevation data.

Flood Component Incorporates Detailed Information on Soil Type, Vegetation, and Topography

Intense precipitation from Australia's tropical cyclones can cause significant flood damage. The worst case on record occurred in 1974 when Cyclone Wanda inundated the Brisbane metropolitan area; despite relatively weak winds, Wanda's 500-900 mm of rainfall submerged large parts of the city. Virtually 100% of the insured losses from this storm were flood-related.

The AIR model incorporates a dynamic flood module that estimates the severity of flooding and its associated damage. Maximum flood depth is calculated using information on historical hourly precipitation; hourly precipitation is provided to the flood module from a parametric precipitation model developed from NASA's Tropical Rainfall Measuring Mission data. The flood module then routes the (overland) flow based on soil characteristics, local elevation, and vegetation.



The severity of flooding is estimated using hourly precipitation rates and detailed data on elevation, vegetation, and soil. Here, the modeled flood depth for Cyclone Wanda at 12 GMT on January 25, 1974 (left), and the depth exactly 24 hours later are shown. (Source: AIR)

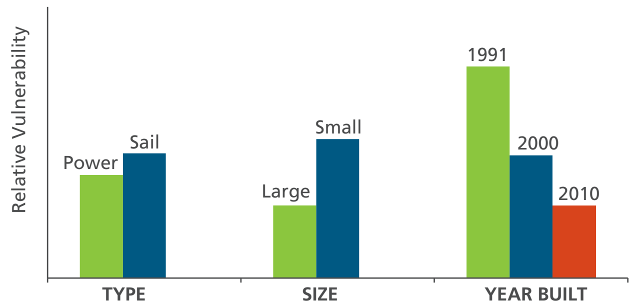
Surge Component Leverages Sophisticated Numerical Model to Capture Local Effects

Storm surges, such as the 5 meter surge at Cardwell brought by Cyclone Yasi in 2011, can be extremely damaging. AIR researchers have developed a method that dynamically models storm surge. Based on the Princeton Ocean Model (POM)—a highly sophisticated, three-dimensional, numerical model widely used in ocean and coastal research today—the AIR model accounts for local factors such as near-shore bathymetry, tidal height, coastal geometry, and land elevation. These factors are used in addition to the standard meteorological intensity parameters to estimate storm surge height, the primary determinant of surge damage.

Sub-Peril–Specific Damage Functions Account for Regional Building Codes and Construction Practices

Because wind, precipitation-induced flood, and storm surge inflict damage differently, the model's damage functions are sub-peril–specific in order to provide the most accurate loss estimates. To capture varations in building vulnerability across Australia, AIR engineers have developed separate damage functions for each of Australia's four wind design regions as defined by Standards Australia. Highly granular age bands accommodate the constant updating of standards and building practices. Damage functions are provided for the full range of construction types (including homes constructed with cavity double brick walls and lightweight fiber cement cladding, both of which are unique to Australia) and occupancy classes.

In Australia, building age is an important factor in determining building vulnerability. Here, a newer building in Cardwell was left standing by 2011's Cyclone Yasi, while an older one beside it was destroyed. (Source: AIR)



When calculating the vulnerability of pleasure boats and yachts, the AIR model accounts for the type of vessel as well as its size and year built.

A Component-Based Approach To Modeling Complex Industrial Facilities

Many of Australia's mining communities and sugar processing plants are located in coastal areas, and thus highly exposed to cyclone risk. AIR assesses the overall vulnerability of these and various other kinds of industrial facilities based on the vulnerability of the individual assets they comprise. This component-based approach implicitly accounts for more than 550 distinct industrial components based on detailed, site-specific engineering-based risk assessments conducted through AIR's Catastrophe Risk Engineering (CRE) service. Separate component-based damage functions are available for wind, flood, and storm surge damage. Damage functions are also available (by sub-peril) for losses from business interruption.Leveraging AIR's Detailed Industry Exposure Database for Australia\

AIR has developed a high-resolution industry exposure database (IED) for Australia 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. 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 Australia to disaggregate the exposure data in their own portfolios to a highly detailed level for improved loss estimates.

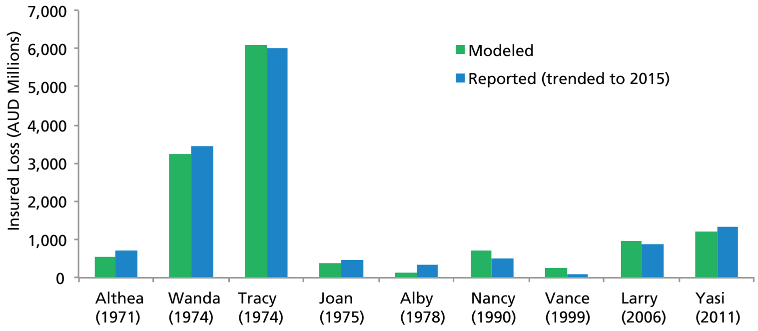
The IED is also used to estimate damage functions for exposures with one or more primary building features missing—for example, when the building occupancy is known, but the construction material and/or building height is missing. The model uses regional building inventory data to estimate the damage functions for risks with unknown features as a weighted average of damage functions for buildings with known features and weights calculated from the regional demographics of the building stock, leveraged from the IED. Each CRESTA in Australia has damage functions that account for regional differences in the building stock.

ACHIEVING MORE ACCURATE MODEL RESULTS BY SEPARATING WIND, FLOOD, AND STORM SURGE LOSSES

Cyclone winds, precipitation-induced flooding, and storm surge can contribute to total insured losses in widely varying amounts. Determining the contribution by sub-peril is vital to overall tropical cyclone risk assessment. The AIR model enables companies to estimate losses to policies that contain multiple terms and conditions. Using AIR's detailed modeling software, companies can generate loss estimates separately for wind, flood, or storm surge—or for any combination of these. When information about policy-level coverage is not available for any one of the three sub-perils, the software allows users to apply industry-average, sub-peril–specific take-up rates to the portfolio. The ability to model the three sub-perils separately and to apply sub-peril–specific policy conditions leads to more accurate model results and a better understanding of tropical cyclone risk.

AIR Validates Its Models from the Bottom Up and Top Down

To ensure the most robust and scientifically rigorous results possible, the model is carefully validated against actual loss experience. But validation is not limited to final modeled losses. Each component is independently validated against multiple sources and data from historical events. For example, the AIR modeled wind speeds and precipitation totals are validated against observation data from actual storms.



AIR modeled losses compare well with observed losses, which are based on data from the Insurance Council of Australia.

Model at a Glance

Modeled Perils	Tropical cyclone winds, precipitation-induced flood, and storm surge
Model Domain	Longitude: 90°E – 175°W Latitude: 50°S – Equator Encompassing Australia and surrounding islands
Supported Geographic Resolution	CRESTA, postcode, geocode (when Trillium Software® Global Locator is licensed).
Supported Lines of Business	Residential, commercial/industrial, agricultural, automobile, and pleasure boats and yachts
Vulnerability Module:	– Supported Construction Classes: Separate wind and flood damage functions for 47 construction types that account for the impact of height and year built on building vulnerability. – Supported Occupancy Classes: 110 – Unknown Damage Function: When detailed exposure data (e.g., construction type or height) are unavailable, the model applies an “unknown” damage function that takes into account CRESTA-specific construction characteristics.
Industry Exposure Database	Provides a foundation for all modeled industry loss estimates: can be leveraged to disaggregate exposure data to a highly detailed level for improved loss estimates.

Model Highlights

- Wind, precipitation-induced flood, and storm surge are explicitly and separately modeled
- Topographical effects on wind are based on high-resolution elevation data, and directional surface friction effects are based on high-resolution land use/land cover and vegetation data
- Precipitation is modeled hourly and the resulting runoff is routed using a dynamic overland flow module and local land characteristics
- Storm surge is modeled using the Princeton Ocean Model and local factors such as bathymetry, tidal height, and land elevation
- Building damage functions are provided for each sub-peril, for different height and age bands, and for the full range of construction and occupancy types
- Damage to pleasure boats and yachts is modeled based on type and size of vessel, as well as year built
- Damage to large industrial facilities is modeled using a component-based engineering approach
- Losses are extensively validated against data from the Insurance Council of Australia (ICA); wind and precipitation fields were validated against regional observation 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.