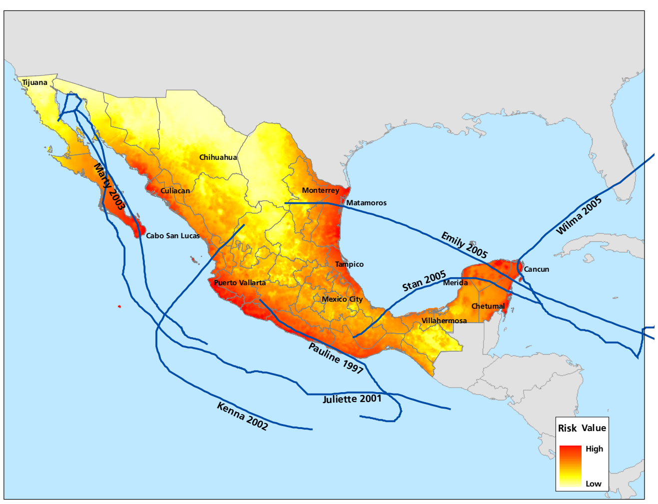
The AIR Tropical Cyclone Model for Mexico

In September 2014, Hurricane Odile made landfall near Cabo San Lucas, Mexico, as a Category 3 hurricane, then moved up the center of Baja California, bringing strong winds and heavy rain. Odile caused insured losses of USD 1.7 billion—second only to the USD 2.1 billion in insured losses caused by Hurricane Wilma in 2005. As insured properties on Mexico's coastlines proliferate, companies need a robust model to estimate their potential tropical cyclone losses.

AIR

Capturing a Complex Hazard Setting that Encompasses Two Ocean Basins

Mexico experiences tropical cyclones from both the Atlantic and Pacific basins. While activity on the Pacific side is higher overall, both basins produce similar numbers of major hurricane landfalls (Saffir-Simpson Category 3 and higher). The AIR Tropical Cyclone Model for Mexico includes more than 43,000 storms that cause loss in Mexico, ranging in intensity from tropical storms to Category 5 hurricanes. Of these, roughly 29,500 are Pacific storms and 13,500 are from the Atlantic.



The AIR model captures hurricane risk from two ocean basins.

BASINWIDE CATALOG ALLOWS MODELING ACROSS MULTIPLE REGIONS

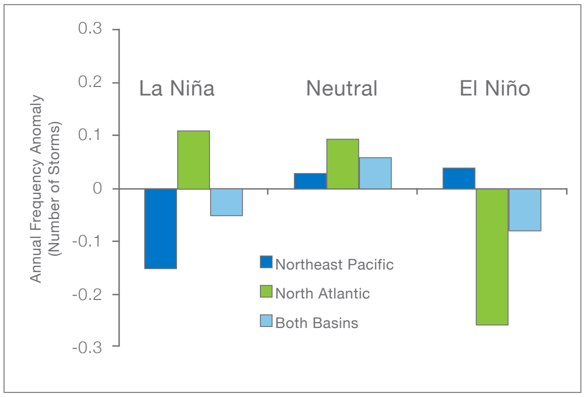
On the Atlantic side, the AIR Tropical Cyclone Model for Mexico shares its catalog with the AIR Hurricane Model for the U.S., the AIR Tropical Cyclone Model for the Caribbean and the AIR U.S. Hurricane Model for Offshore Assets. This is critical because a significant percentage of storms in the North Atlantic impact multiple model domains. Hurricane Wilma, for example, affected Haiti and Jamaica in the Caribbean, pounded Mexico's Quintana Roo for the better part of two days, and finally went on to make landfall in south Florida as a Category 3 storm. AIR's basinwide catalog allows model users to more accurately account for losses to policies and portfolios that span multiple countries.

The model's basinwide catalog allows companies to assess risk to portfolios that span multiple countries.

It's not only landfall risk that Mexico faces; the orientation of the country's coastline, combined with dominant storm track patterns, means that a significant number of bypassing hurricanes impact Mexico. These storms can track up, but just off, long stretches of the coastline, bringing damaging winds to coastal exposures and heavy precipitation and flooding well inland. The AIR Tropical Cyclone Model for Mexico estimates insured losses from both wind and flood to a wide variety of coverages, construction types, and occupancies.

Climate Teleconnections and their Effect on Mexico Tropical Storm Activity

The El Niño-Southern Oscillation (ENSO) is a coupled ocean-atmosphere climate signal characterized by the cyclic warming (El Niño) or cooling (La Niña) of ocean waters in the eastern equatorial Pacific. Research indicates that a statistically significant negative correlation exists between tropical storm activity in the North Atlantic and East Pacific basins during warm and cold ENSO events—that is, during El Niño conditions, tropical storm activity in the Atlantic is typically depressed, while activity in the East Pacific is elevated. During La Niña conditions, the situation is reversed. The AIR model explicitly accounts for this complex relationship, appropriately reflecting the negative correlation between tropical storm genesis in the two basins.



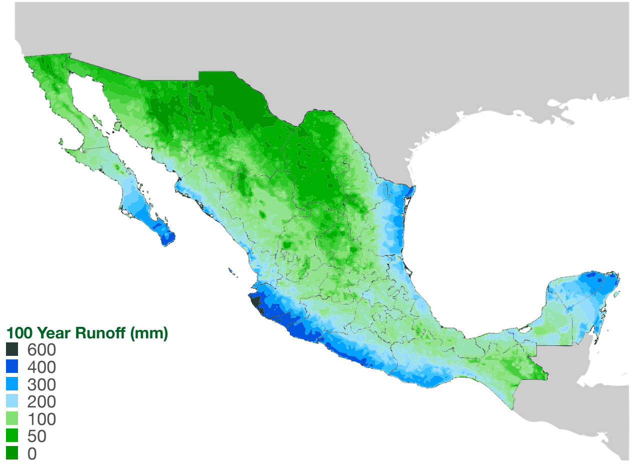
The AIR model explicitly accounts for the negative correlation in tropical cyclone activity between the Northeast Pacific and the North Atlantic.

Accounting for Mexico's Mountainous Topography

Mexico's coastal mountain ranges have a considerable impact on both the meteorological and hydrological aspects of landfalling cyclones. Mountains act as barriers to the flow of storms and impact the rate at which a landfalling storm dissipates. In addition, as winds from the cyclone are forced over the mountains, the lifting of the air increases rainfall.

This means that tropical cyclones in Mexico—even those with relatively low wind speeds—can be accompanied by significant flooding, which is typically covered under both residential and commercial policies. Because the precipitation shields associated with tropical cyclones can extend hundreds of kilometers inland, weak slow-moving storms that impact vast areas and generate substantial rainfall have the potential to produce significant insured losses.

The AIR Tropical Cyclone Model for Mexico incorporates a high-resolution flood module to estimate the probability and severity of a flooding event and the extent of damage. Total rainfall is determined by accumulating the hourly precipitation at each location over the entire duration of the storm. And because rainfall is accumulated over time, the forward speed of the storm is also an important factor; slow-moving storms will subject any given location to higher rainfall totals. After calculating total precipitation, the model then re-distributes this runoff over the model's domain based on soil type, land use/land cover, and topography.



The AIR model captures the impact of Mexico's mountainous terrain, which can increase the risk of flooding, even well inland.

Modeling the Vulnerability of Mexico's Building Stock

Mexico's insured residential building stock is dominated by masonry and concrete construction—both relatively wind resistant. Within the masonry class, confined masonry is the most common and performs better than plain masonry under lateral wind loads. Commercial construction is quite heterogeneous and varies from poorly constructed low-rise masonry to well-maintained steel structures. To reflect the vulnerability of the Mexican building stock, AIR engineers have developed more than 60 separate damage functions for wind and flood for a wide range of occupancies and construction types, as well as contents and time element coverage.

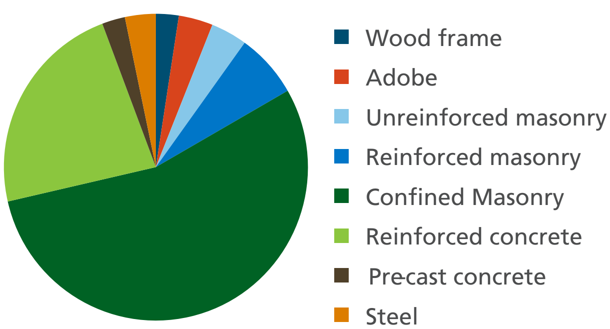
The model's wind damage functions have been developed based on engineering analyses of different building types subjected to wind loads and have been modified to reflect labor and materials costs, local building construction practices, and claims adjustment practices in Mexico. AIR's damage functions capture storm duration, taking into account the increased levels of damage that result from prolonged exposure to wind.

Flood damage functions were developed using an objective engineering-based approach. For different combinations of building occupancy, construction, and height, multiple factors influencing flood vulnerability— including building material and construction quality—are appropriately captured.

To estimate business interruption losses—both direct and contingent—damage functions were developed that account for the level of property damage, building size and complexity, and business characteristics, such as resiliency and the ability to relocate.

Validating Insured Losses Against Extensive Claims Data and Post-Disaster Surveys

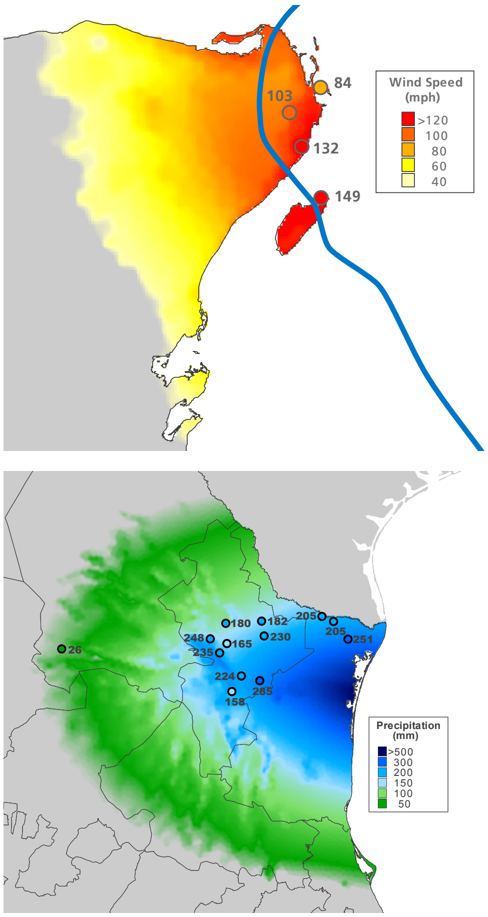
Every component of the model has been validated against data from historical events. While observation data for Mexico is limited, the AIR modeled wind speeds and precipitation totals are consistent with observations and reproduce the appropriate patterns of wind and rain within storm systems.



The AIR model features more than 60 damage functions to capture the wide range of construction types and occupancies in Mexico.

To validate modeled loss estimates, AIR analyzed claims data for recent storms from some of the largest insurance companies in Mexico, representing nearly 30% of industry premium. In the case of Hurricane Wilma (2005), the model was validated using data representing more than 50% of total claims from that storm, which caused the largest insured hurricane loss in Mexico's history.

Additional validation of the damage functions has been undertaken through analysis of findings from detailed post-disaster surveys conducted in the aftermath of hurricanes. The relative vulnerabilities of different construction/occupancy/height combinations in the model have been systematically borne out by observation.



AIR modeled wind speeds (top) and flood depths (bottom) consistently reproduce observed patterns.

AIR modeled losses for historical hurricanes are consistent with reported losses, and show no bias.

Model at a Glance

Modeled Perils	Tropical cyclone winds and precipitation-induced flood
Supported Geographic Resolution	CATRADER®: CRESTA Touchstone®: CRESTA, Muncipio, locality, and postcode resolution; can also accept user provided latitude and longitude
Stochastic Catalogs	Catalog includes 10,000 simulated years containing more than 43,000 loss-causing events, both landfalling and bypassing. The catalog is shared with other AIR regional hurricane models, allowing companies to accurately estimate losses to portfolios that span multiple countries.
Vulnerability Module	Separate wind and flood damage functions for 22 construction types and 42 occupancy classes that estimate losses to building, contents, and time element coverages. Accounts for the impact of height and year of construction on building vulnerability.

Model Highlights

— Accounts for landfalling and bypassing tropical cyclones originating in two ocean basins and provides an integrated view of the risk, reflecting the negative correlation in annual storm frequency between the Atlantic and Pacific basins

— Includes the impact of Mexico's coastal mountain ranges on both the meteorological and hydrological aspect of landfalling cyclones

— Explicitly models rain-induced flood loss by assessing the accumulated runoff from a storm's total precipitation

— Wind and precipitation fields were validated against observations from more than a dozen historical Mexico hurricanes

— Validated with detailed loss experience data for both residential and commercial lines from companies representing approximately 30% of the industry

ABOUT AIR WORLDWIDE