The AIR Hurricane Model for Offshore Assets

The combined insured losses to offshore assets caused by hurricanes in 2004 and 2005 alone were estimated at the time to be about USD 16 billion. Today, the Gulf of Mexico's platforms and rigs produce 1.23 million barrels of oil and 3.67 billion cubic feet of gas per day, representing a significant portion of the nation's energy supply that is at risk from hurricanes.

AIR

More than 135 hurricanes have formed or entered into the Gulf of Mexico since 1900. In 2004 and 2005 alone, Hurricanes Ivan, Katrina, and Rita inflicted unprecedented damage to offshore assets. Together, Katrina and Rita collapsed 117 major platforms and rigs. Many minor platforms, such as freestanding caissons and well protectors, were destroyed and more than 2,000 additional platforms suffered lesser degrees of damage. Today, more than 4,500 platforms and rigs operate in the Gulf of Mexico, making it essential for companies operating in this market to have the tools that will effectively mitigate the impact of the next catastrophe.

Managing Hurricane Risk to Offshore Assets

Managing hurricane risk to offshore assets requires companies to understand four basic components of the risk: the exposure at risk, the hazard, the vulnerability of the exposed inventory, and how to appropriately model the complex policy conditions that prevail in this market.

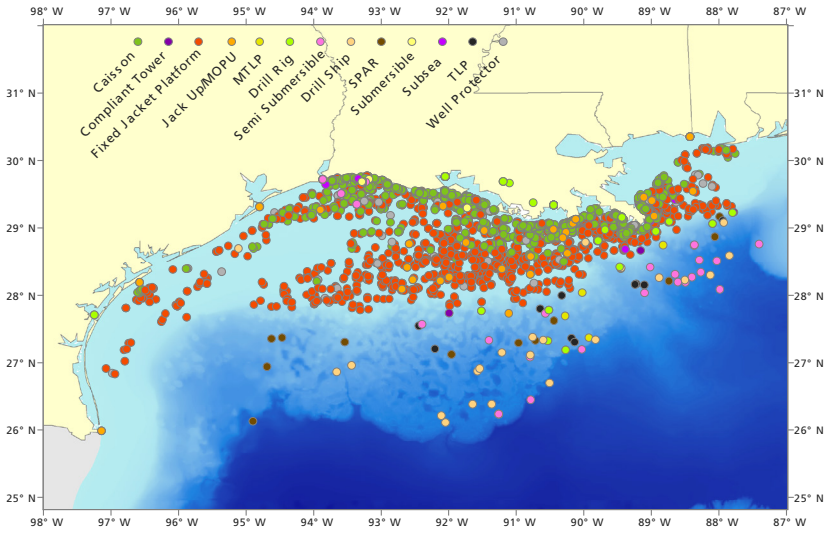
To help companies better understand their risk, the AIR U.S. Hurricane Model for Offshore Assets features:

- An annually updated database of platforms and rigs that contains the detailed characteristics necessary to make realistic assessments of their vulnerability and loss potential
- A catalog of tens of thousands of simulated storms capable of causing damage and loss—scenarios representing the entire spectrum of potential storm experience in the Gulf of Mexico
- Separate damage functions for wind and wave for each of 14 supported platform types

The AIR model also accounts for the most important insurance coverages in the offshore energy market. These four components are described in more detail below.

AIR's Comprehensive Exposure Database

More than 4,500 platforms and rigs currently operate in the Gulf of Mexico. The majority are located in federal waters, while the rest are in the state waters of Louisiana and Texas. Using public and private data obtained from the Bureau of Ocean Energy Management, Regulation, and Enforcement



Location of platforms and rigs currently operating in the Gulf of Mexico, by type, as of November 2014

(formerly, the Mineral Management Service), the Louisiana Department of Natural Resources, private vendors such as RigZone, and platform operators, AIR's exposure database contains detailed characteristics necessary to make realistic assessments of their vulnerability and loss potential.

Replacement costs—an essential input for accurate loss estimates—are included for each platform and rig. The replacement cost of the entire fleet exceeds USD 100 billion, with unit replacement costs varying from a few million dollars for a typical caisson in shallow water to more than USD 2.4 billion for the large floating platforms in operation.

In addition to the name, location, installation data, type, and replacement cost of each platform, AIR's exposure database also contains critical information for assessing the vulnerability of each structure, such as the deck height, the number of legs and framing system, the number of wells in operation, the number of decks, and oil and gas production rates.

A Comprehensive View of Hurricane Risk to Offshore Assets

The U.S. Hurricane Model for Offshore Assets shares 10,000-, 50,000-, and 100,000-year stochastic catalogs—both the standard and the warm sea-surface temperature conditioned (WSST) catalog—with the AIR Hurricane Model for the U.S., the AIR Tropical Cyclone Model for the Caribbean, and the AIR Tropical Cyclone Model for Mexico. The catalogs contain tens of thousands of events capable of causing damage and loss—scenarios representing the entire spectrum of potential storm experience in the Gulf of Mexico.

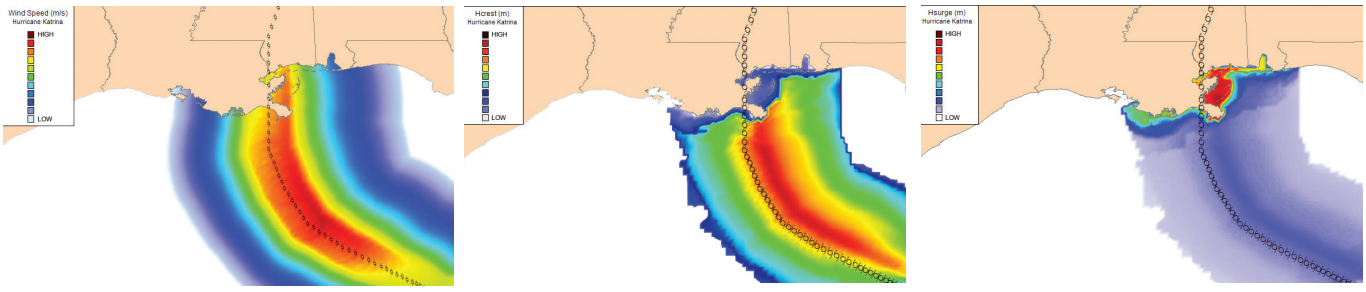
The model's simulated wind field—which has been extensively validated against observations, detailed claims data, and other sources—calculates the maximum 1-minute and 3s-gust wind speeds at various altitudes above mean sea level to account for different platform deck heights.

A key component of the model is the wave module. Maximum wave crest height, the best predictor of physical damage to platforms and rigs, is calculated using an empirical parametric model that includes the effects of storm surge. The model considers the storm's forward velocity, maximum wind speed, and water depth—all of which play an important role in determining both the magnitude and spatial distribution of waves. The model has been validated against observations and historical wave height data from NOAA and other sources.

Separate Damage Functions for Wind and Waves Provide the Most Accurate Loss Estimates

The AIR model features separate damage functions for wind and waves for each of 14 supported platform types. The wave damage functions account for the age of the structure and important characteristics such as deck height, number of legs, and bracing system. The wind damage functions consider both deck height and the number of decks installed on the platform topside.

For fixed platforms, deck and topside equipment typically bear the brunt of hurricane-force winds, while waves generate most of the damage to the structure and foundation. But for intense storms, wave crests can be high enough to hit the deck, causing extremely high impact loads that most platforms are not designed to sustain.



Modeled wind speeds (left), wave crest heights (middle), and surge heights (right) for Hurricane Katrina

Floating platforms, which are tied to the seafloor by mooring systems or tethers, are designed to "ride" the waves. These typically suffer minor damage until combined forces of the elements break the restraining lines or sever the tethers. When that happens, the platform either floats away from its original site, colliding with whatever is in its path, or capsizes.

BI, Debris Removal, Well Restoration, and Redrilling—Also Significant Drivers of Insured Loss

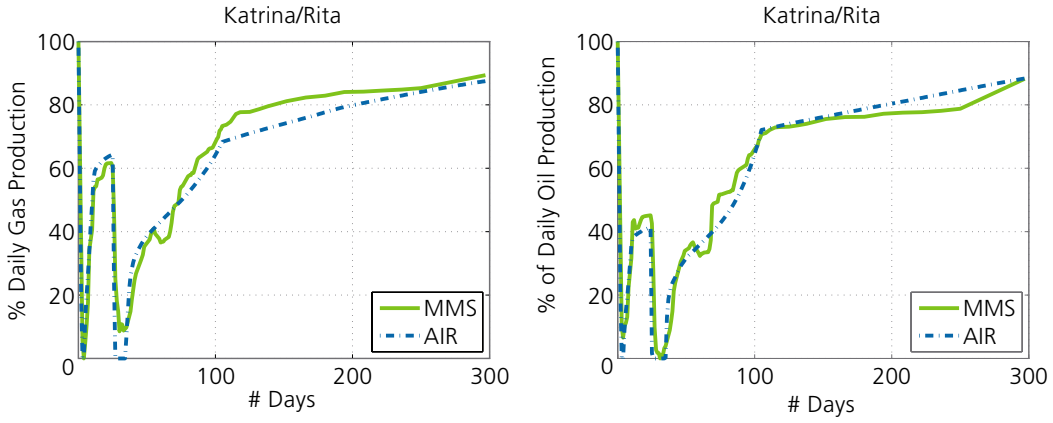
In addition to physical damage, business interruption, debris removal, and well restoration or redrilling are also significant drivers of insured loss. In fact, business interruption losses from large and intense storms can be a multiple of the losses resulting from physical damage. A realistic estimate of such losses requires an in-depth understanding of the activities needed for repairing damaged platforms, clearing debris from the site, and restoring or redrilling damaged wells—and how these activities are impacted by water depth. The model's BI damage functions for producing platforms account for pre-storm shutdown time, the level of physical damage, the size of the operating company, and the percentage of platforms impacted by the storm to estimate the level of demand surge.

Explicitly Handles Policy Conditions and Terms Specific to This Unique Market

The AIR model handles policy conditions that include Combined Single Limits, Assured Interest, and Working Interest. Combined Single Limits are applied at the policy level, with limits and attachment points applied to an ordered set of coverages. Sublimits can be applied to all or some locations in a policy, by coverage. Both Combined Single Limits and Sublimits can be applied on a 100% participation basis or Assured Interest basis. The coverages the model accounts for include: physical damage (PD), direct and contingent business interruption (BI + CBI), operator's extra expense (OEE), and removal of debris (ROD).

Validation of Modeled Losses

Modeled loss estimates for all coverages have been extensively validated against data representing nearly 50% of claims filed for Hurricanes Ivan, Katrina, and Rita. The modeled oil and gas loss of production for these storms were validated against Mineral Management Service official shut-in data. The losses were computed using the exposure and production rates at the time of the storms, since oil and gas production rates per platform fluctuate and, on average, more than 100 new platforms are built and more than 100 old platforms are decommissioned every year.



Comparison of AIR-modeled and actual shut-in data for Katrina and Rita

Using the Model Within Touchstone and CATRADER

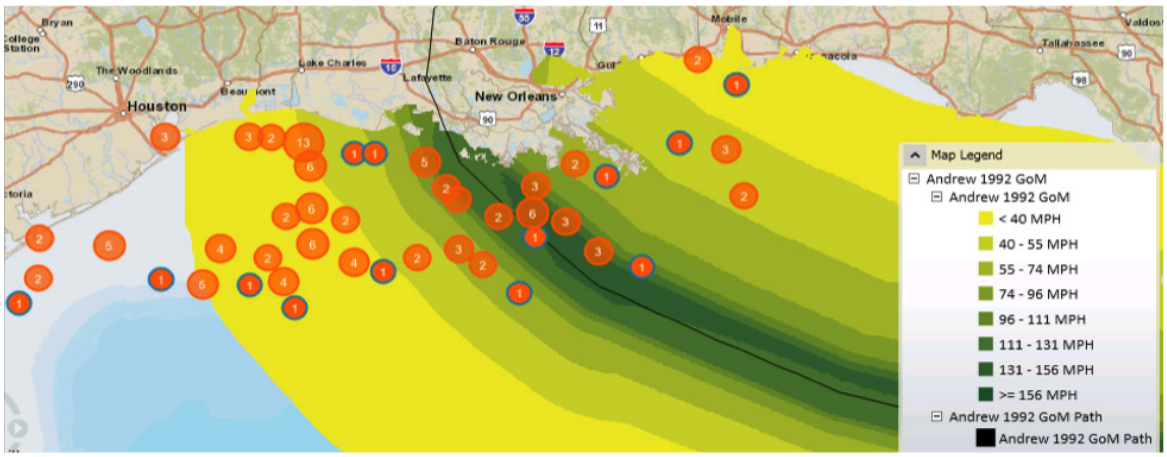
One of the unique features of the model's implementation in Touchstone® is its data validation and enhancement capabilities. Upon import, platform and rig information is validated. Warnings are generated when there are inconsistencies between input data and the data in the AIR industry exposure database. Invalid combinations of data are identified. For example, if the input platform type is not compatible with a certain location due to the water depth at that location, an error message is generated with suggestions on how to fix the problem.

In many cases, detailed platform characteristics are missing from policy data. In those cases, Touchstone can augment the data using AIR's industry exposure database, for a more accurate analysis of the risk. AIR's exposure database contains up-to-date information on the detailed characteristics of the more than 4,500 platforms and rigs in both state and federal waters. Touchstone also contains information on decommissioned or destroyed platforms to enable more accurate historical "as-if" analyses.

Because AIR's offshore model uses the same stochastic catalog as the North Atlantic basinwide tropical cyclone models, users can easily assess correlations between onshore and offshore properties in the U.S., the Gulf of Mexico, and the Caribbean. And because a single, unified event catalog is used, onshore and offshore losses can be easily combined. Reinsurance programs can be analyzed for all or just selected coverages. Losses can be accumulated for the Gulf of Mexico, or for specific regions within the Gulf using the 'Applies to Areas' or 'Zone' features.

CATRADER® users can enter their exposures either on a sums-insured or number-of-risks basis, or import a CLF containing both onshore and offshore losses from Touchstone. (AIR strongly encourages the use of CLFs rather than sums insured or number of risks when analyzing offshore risk in CATRADER. Detailed modeling is recommended due to the variability in types of platforms, platform-specific construction details, coverages, and policy terms characteristic of this line of business.)

Reinsurance programs can be analyzed in CATRADER for all or selected coverages.



Visualization of exposure in Touchstone with the footprint of Hurricane Andrew (1992) overlaid

Model at a Glance

Modeled Perils	Hurricane wind and waves
Model Domain	State and federal waters of the Gulf of Mexico
Supported Geographic Resolution	**Touchstone:** Protraction area and block; latitude/longitude **CATRADER:** Protraction area
Stochastic Catalogs in Touchstone	Shares the AIR U.S. Hurricane Model for the United States standard and WSST 10,000-, 50,000-, and 100,000-year catalogs
Stochastic Catalogs in CATRADER	Supports 10,000- and 50,000-year tropical cyclone standard and WSST catalogs
Supported Construction and Occupancy Classes in Touchstone	**Supported Construction Classes:** Separate wind and wave damage functions for 14 types of platforms and rigs: caisson; compliant tower; fixed jacket platform; jackup; mini tension leg platform; drill rig; semi submersible floating production system; drill ship; SPAR floating production system; underwater production units, completion units, and templates; tension leg platform; well protector; and unknown **Supported Occupancy Classes:** Oil production only, gas production only, no production, oil and gas production, drilling, workover, ready stacked, waiting on location, and unknown
Supported Policy Conditions	Supports complex policy terms, including Combined Single Limits, Sublimits, and Assured Interest

Model Highlights

- Features separate modules for wind and wave hazard calculations, and separate damage functions to estimate the physical damage from wind and wave forces
- Losses validated against detailed claims data for Ivan, Katrina, and Rita—representing close to 50% of total claims paid
- Touchstone implementation supports extensive data validation and data augmentation based on AIR's detailed industry exposure database
- Shared AIR North Atlantic hurricane standard and WSST catalogs of simulated events enable users to easily create a combined distribution of losses for onshore and offshore properties in the U.S., the Gulf of Mexico, and the Caribbean.

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.

AIR
A Verisk Business