

## North Atlantic Hurricane Model

The North Atlantic Hurricane Model is part of WORLDCATenterprise™, EOECAT's global multi-peril catastrophe modeling platform. The North Atlantic Hurricane Model is updated biennially and continues to set standards of scientific rigor in tropical cyclone risk modeling.

Key Features of the North Atlantic Hurricane Model include:

- **Broad Geographic Coverage:** The model covers 20 states along the US coastline, the Caribbean, Bermuda, and the Gulf of Mexico. For the US, model results can be calculated for wind only, or wind and hurricane induced flooding. Hurricane flooding consists of high resolution characterization of storm surge and the incremental damage due to hurricane induced rainfall and associated flooding.
- **Comprehensive Probabilistic Event Set:** EOECAT's North Atlantic Hurricane Model is a probabilistic model that uses the National Hurricane Center's HURDAT data set from 1900 to 2009. Its robust probabilistic set includes approximately 130,000 events. In addition, 150,000 simulation years cover gaps in the historical data set to provide a consistent, credible, and realistic view of hurricane risk, particularly for low-probability, high-consequence events. The model also accounts for temporal clustering of hurricane events. The probabilistic set is evaluated against the historical data set for completeness and validation.
- **Near-Term AMO Model:** The model provides a near-term view of risk based on warm Atlantic multi-decadal oscillation (AMO) time series. EOECAT research has identified a strong link between the cycles of the AMO and the risk of catastrophic hurricane winds onshore for the mainland US. Partitioning the historic data set into "warm" and "cold" years has enabled us to develop a conditional "near-term" model that reduces the uncertainty in the assessment of tropical storm risk. The strong increase in major Atlantic storms that are formed and supported by the warm AMO phase preferentially affect the US Atlantic Coast, most notably, Florida, the Southeast, and Mid-Atlantic states. Currently, the North Atlantic hurricane activity is in the warm AMO cycle, and the model will be attuned to reflect the cool AMO time series when the cool phase of the AMO sets in.
- **Detailed Wind Field Model:** The North Atlantic Hurricane Model uses NOAA/NWS methods enhanced by a number of additional state-of-the-art components to calculate the geographic pattern of peak gust winds and their accompanying probabilistic distributions for each event. The model incorporates all of the key hurricane parameters probabilistically, including the maximum sustained winds, the radius to maximum winds, the forward speed (which drives left-right asymmetry), the outer profile of the storm, and the inland decay rate. The wind field model is a high-resolution time-stepping model, computing the wind field at 15-minute intervals and capturing 16 wind directions, providing refined treatment of land use and land cover information. The model calculates the wind speed at specific latitudes and longitudes in coastal areas. The surface roughness modifications applied are based on land use/land cover data at a 30-meter resolution, and topographic roughness is applied based on data at a 500-meter resolution. The gust factor is dependent on surface roughness conditions and is also applied probabilistically.
- **Storm Surge Hazard:** The storm surge model is a numerical finite-element model, considering bathymetry and wind stress. For each historical or stochastic event, the probabilistic distribution of storm surge inundation depth is calculated for each location using the probabilistic distributions of all significant storm and location parameters. Inundation is modeled in two zones: the high-velocity zone where wave action and debris can severely damage structures, and farther inland, where the primary concern is flooding as opposed to structural damage. Flooding as a result of hurricane rainfall is included. The rainfall footprint is based on the parameters of the storm, distance to coast, location, and historical flood damage data. The storm surge impact in flood-prone zones such as New Orleans, Houston/Galveston has been updated to account for the new flood defense systems in New Orleans, as well as modeling refinements to the treatment of the sea wall in Galveston.
- **Post Event Inflation/Demand Surge Model:** EOECAT's demand surge model is based on the demand and supply for construction materials and labor in the affected region. It is defined

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as the response of the construction labor and materials market (supply) to a massive increase in the need for materials and labor for immediate repairs (demand). In addition, the economic factors undergo constant change. EOECAT regularly updates the supply-side database for demand surge. The demand surge model has been updated to reflect the storm surge impacts in flood prone zones in New Orleans and Galveston.

- **Comprehensive Vulnerability Functions:** EOECAT uses an engineering approach, claims data, and expert opinion to develop the vulnerability functions within the model. Damage from wind and storm surge is calculated using a series of vulnerability functions specific to

construction type and occupancy. Vulnerability functions are created to calculate damage impacts for different building heights (low-, mid-, and high-rise). EOECAT vulnerability functions are based on historically observed damage, experimental research conducted by Professors Kishor Mehta and James McDonald at Texas Tech, and structural calculations performed by EOECAT engineers. Claims data is from all major storms including Hugo (1989), Andrew (1992), Charley (2004), Frances (2004), Ivan (2004), Jeanne (2004), Katrina (2005), Rita (2005), Wilma (2005), Gustav (2008) and Ike (2008). The model explicitly includes regional impacts of the 2001 Florida Building Code as required by Florida Commission on Hurricane Loss Projection Methodology certification.

The North Atlantic Hurricane peril accounts for the largest portion of catastrophe insurance premiums in the world. In 2003, EOECAT introduced the first comprehensive basin-wide model covering the US, the Caribbean, Bermuda, and the Gulf of Mexico to address regional risk quantification and correlation for this peril.

## MODEL SPECIFICATIONS

- **Coverage Types:** Separate, independent vulnerability functions are used for calculating losses for each coverage type. Time-element vulnerability functions are a function of structural and contents damage. The model calculates damage to building, contents, and time element (e.g. business interruption or loss of use), and additional living expenses.
- **Importing Resolution:** Includes detailed risk differentiation, enabling importation and evaluation of risks geocoded to: lat/long coordinate pairs, street address, ZIP Code, city, and county level. When input data is provided at aggregate levels, model calculations are based on a weighted disaggregation specific to each line of business, providing a degree of refinement to loss results.
- **Model Validation/Review:** EOECAT regularly updates the quality of information captured for structure types and building design codes to ensure that they are accurately represented in the model. The North Atlantic Hurricane Model incorporates claims data from over 13 million policies, with a total exposure of about \$2.2 trillion, for 18 hurricanes since 1983. The model also leverages claims data from all major storms 1954 – 1994, via the Natural Hazard Research Service (NHRS). In addition, the model incorporates new observations from post-disaster field surveys to calibrate the model. The hazard and vulnerability modules have undergone stringent review by internationally-recognized scientific experts. Old Dominion University NOAA visiting scientist Robert Tuleya, formerly with the Geophysical Fluid Dynamics Laboratory Hurricane group and presently developing and upgrading the next generation Hurricane Weather and Research Forecast system (HWRF), reviewed EOECAT's hurricane wind field model.
- **Model Certification:** The model is certified by the Florida Commission Hurricane Loss Projection Methodology (FCHLPM) since the inception of the certification process in 1997.
- **Model Output:** Model output includes event loss tables, loss exceedance curves including OEP and AEP, AAL, TVAR, and includes simulations of historic events. Reporting of results supports multiple levels of refinement such as: total aggregate portfolio, postal code, county, state, and detailed output by policy and site. The landfall series reports provide risk exposure and loss estimates based on storm severity. Different peril components (wind only, wind and flood) can be modeled to obtain model results with or without the demand surge component. The model is usable for risk differentiation and pricing, risk aggregation, and portfolio risk management, with suitable output and reports.
- **Lines of Business:** Lines of business include Residential, Commercial, Industrial, and Automobile.
- **Structure Type and Occupancies:** The model differentiates risk across hundreds of combinations of 96 structure types, and 12 occupancy categories for each line of business.
- **Financial Modeling:** All major insurance policy structures and reinsurance treaty types are modeled, based on WORLDCATenterprise™ platform functionality.

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