AIRCURRENTS

SETTING THE NEW STANDARD IN MODELING HURRICANE RISK

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EDITOR'S NOTE: In this article, AIR Director of Atmospheric Science Dr. Peter Dailey and AIR Principal Engineer Dr. Vineet Jain provide a high-level overview of the many enhancements slated for release in Version 12.0 of the AIR Hurricane Model for the United States. Several of these topics will be discussed in much greater detail in upcoming issues of AIR Currents. To help clients better understand the full breadth of enhancements scheduled for release in Version 12.0 and their impact on modeled losses, AIR will be offering several focused sessions at the 2010 AIR Client Conference in San Francisco in April, including an executive summary of the model update, a technical discussion of the updated wind field formulation, a detailed explanation of the model's vulnerability update and loss changes, and a question and answer session with key members of the model development team.

By Dr. Peter S. Dailey and Dr. Vineet Jain

INTRODUCTION

In spring 2010, major enhancements will be released in the AIR Hurricane Model for the United States—enhancements that encompass virtually every component of the model. Because AIR's model has long been considered the industry standard, some may wonder why AIR is undertaking such a substantial update now. The answer has multiple dimensions, but first and foremost, it should be said that to maintain its position as the industry standard, the model must incorporate the latest science and engineering research, and take into account recent loss experience. As new scientific findings lead to consensus within the scientific community and engineering principles are thoroughly tested by damage observations and actual claims, a certain "critical mass" is reached in the model development process. AIR's research and modeling team has spent over three years developing the upcoming release, even incorporating research published as recently as 2009. Of course, models must be judged by how they perform in the real world for real decision-makers—and incorporating significant changes while maintaining model stability is an enormous challenge. With that in mind, the AIR team is confident that the updated hurricane model is not only state-of-the-art, but will provide clients with a robust and accurate view of probabilistic risk for the entire spectrum of exposure and geography subject to U.S. hurricane risk.

STATE-OF-THE-SCIENCE APPROACH TO MODELING HURRICANES IN 4-D

Recent research in atmospheric science has enabled wind modeling with unprecedented fidelity and accuracy. Improved knowledge of the full 4-D structure of hurricanes—from the temporal evolution of the storm footprint, to the radial wind profile, to the vertical relationship between winds aloft and winds at the surface—has been integrated into the hazard model to more accurately estimate wind speeds. Additionally, Version 12.0 of the AIR Hurricane Model for the United States will feature a unified basinwide stochastic catalog of events common to the Caribbean Islands, Mexico (Atlantic and East Pacific), and offshore assets in the Gulf. Because a significant percentage of storms in this region impact more than one model domain, this comprehensive event set will allow clients to more accurately model losses to portfolios that span multiple countries.

Wind Profiles Based on Latest Research

Because of the spotty nature of exposure along the coast, it is critical to be able to estimate the location and intensity of the most damaging winds in a hurricane. The radial (cross-sectional) structure of winds has been well understood conceptually: winds are calm (or nearly calm) within the center of the eye, then increase to some maximum value (Rmax) at the eyewall of the storm, and then slowly decrease from that point outward to the periphery of the storm. Within this general structure, however, actual cross sections can take on vastly different shapes, as illustrated in Figure 1. Existing methodologies for formulating hurricane surface wind fields were based on the structure of a "typical" hurricane and do not fully capture this observed storm-to-storm variability. Based on the latest available scientific research and flight- and surface-level observations, the AIR hurricane model will allow for more detailed modeling of a wider range of wind field types, ultimately resulting in more robust loss analyses.

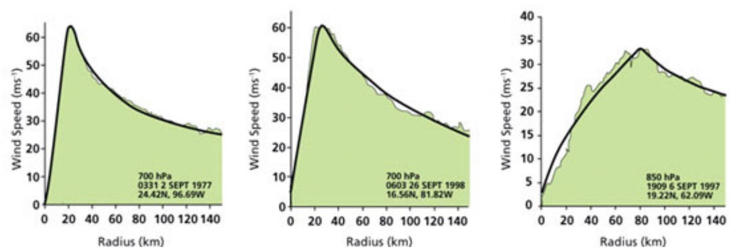

Figure 1. Variations in hurricane cross sections are accurately captured in the updated wind field formulation (Source: H.E. Willoughby, R.W.R. Darling, & M.E. Rahn, 2006)

Advanced Methodology for the Downscaling of Winds to the Surface from Aloft

Similarly, while the mean vertical structure of hurricane winds has been well understood, the methodology for translating flight-level winds to the surface will be far more robust in Version 12.0. In the past, the model assumed a constant ratio for all storms and for all locations within a storm in accordance with what is used operationally at the National Hurricane Center. Based on recent research, however, this ratio can now be modeled stochastically to account for the variability observed across all storms types and can be modeled for a given storm as a function of distance to the eye. Furthermore, most hurricanes have a funnel-shaped eye, meaning that the location of maximum winds at the surface are not located directly below the maximum winds aloft.

Directional Effects Using the Latest Land Use / Land Cover Data

In addition to considering the vertical and horizontal structure of hurricanes, modeling surface wind fields requires properly accounting for the effects of the local environment on wind speeds. Along the coast of southern Florida, for example, where smooth swampy surfaces, rough urban surfaces, and smooth ocean surfaces are located alongside each other, winds speeds can vary quite dramatically as a result of surface friction. The Version 12.0 model will incorporate the latest USGS Land Use Land Cover (LULC) data, published in 2007. It will capture the directional effects of surface friction by explicitly considering the direction of the wind at each location.

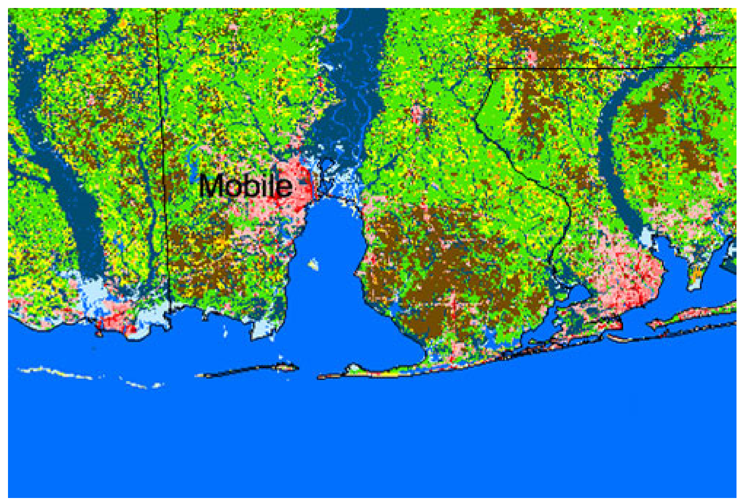

Figure 2. The updated model uses the most recent USGS Land Use Land Cover data (Source: AIR)

Continuous Time History of Winds

What about the 4th dimension: time? Conventional parametric models simulate either the maximum wind speed by location or, as AIR has always done, the full time history of the winds. Because the duration of winds (and not just the wind speeds) can have a significant impact on damage, AIR's current model uses a time-step approach that simulates maximum winds at intervals of one hour or, for fast moving storms, 30 minutes. While there is some accuracy lost in using fixed intervals, finer time steps require longer model run times. For Version 12.0, AIR has developed a proprietary algorithm to model the continuous time history of maximum winds. This will more accurately capture the effects of wind duration, while reducing the computation time for fast-moving storms.

New Visualization Tools

Ultimately, the ability to effectively visualize a hurricane simulation can mean the difference between a firm comprehension of a very complex natural phenomenon and a complete lack of connection with the science. In conjunction with the release of the upcoming model, the AIR Loss Estimation in Real Time (ALERT™) service will be as state-of-the-art as the model itself. For example, in addition to providing projected wind footprint maps for an approaching hurricane, ALERT postings will include KML files (for use with the free GoogleEarth™ application) that animate the storm's history and future projections based on the National Hurricane Center's forecast.

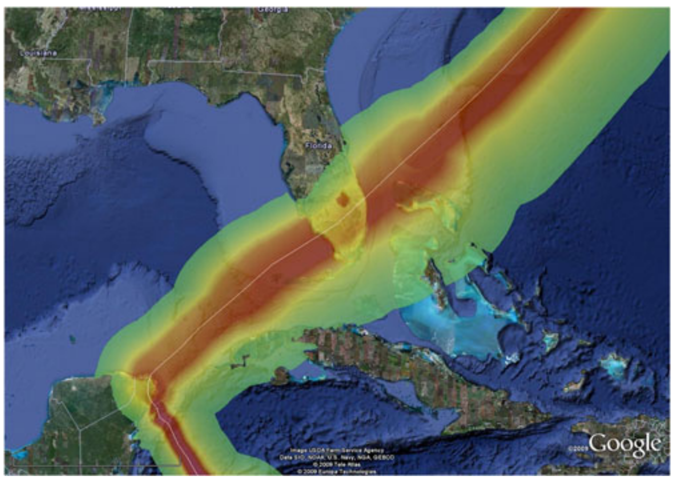

Figure 3. Enhancements to ALERT will include state-of-the-art storm visualization capabilities (Source: AIR and Google Earth)

ENHANCEMENTS IN THE VULNERABILITY MODULE OF U.S. HURRICANE MODEL

AIR wind engineers are continuously analyzing findings from published engineering studies, detailed claims data and damage surveys, and incorporate those findings into the model's damage functions as appropriate.

Regional and Temporal Variability in Vulnerability

During the last several years, AIR wind engineers have undertaken an exhaustive study of the quality and enforcement of building codes through time, changes in building materials and construction practices, structural aging, as wells as other factors that affect vulnerability. The results of that research will be incorporated into the Version 12.0 model release, which will more accurately reflect regional and temporal variability to better determine the evolution of vulnerability across and within states.

Enhanced Secondary Risk Modifiers

While it has long been known that building features can affect building vulnerability, empirical data has not been available at sufficient resolution to quantify the impact of individual building features until very recently. In 2009, as part of a ground-breaking study for the Mississippi Department of Insurance, AIR engineers undertook an extensive analysis of the performance of various mitigation measures using detailed damage and claims data, as well as engineering data generated from full-scale testing of structures. Based on the results of this study, Version 12.0 of the U.S. hurricane model includes an enhanced set of secondary risk modifiers that more accurately capture the effects of these characteristics.

Figure 4. Information about secondary risk modifiers, such as the percentage of glass in a building envelope, can be very significant for accurately estimating losses. Source: AIR

Enhanced Damage Functions for "Unknown" Construction

Despite significant improvements in the data available to catastrophe models users, detailed construction and/or height information is still often unavailable. Recognizing this and recognizing the fact that building inventory can vary significantly from region to region, the updated model will support region-specific "unknown" damage functions. For example, because the proportion of masonry construction is significantly higher in Florida than in Mississippi, and because masonry construction is less vulnerable to hurricane winds than wood-frame construction, the "unknown" damage function in Florida should (holding all else constant) be less vulnerable.

CONCLUSION

AIR's approach to modeling remains what it has always been—to use the best data and the latest science to develop the best models. Model updates are warranted only if they improve the model, are credible and defensible, and can be validated with actual experience. For Version 12.0 of the AIR Hurricane Model for the U.S., the modeling team has carried out the most extensive validation effort in the company's history. As a part of the validation of the new wind methodology, AIR scientists gathered an unprecedented amount of observed wind data, capturing the full life cycle of a storm over a wide range of surfaces, over a range of averaging times (e.g., sustained and gusts), at upper levels and at the surface, and over a long history of Atlantic activity. Thousands of individual observations were geocoded and checked for quality and consistency before making their way into the final validation dataset. The resulting database of wind observations is likely the highest quality and the most comprehensive in the industry. The same holds for validation of the new vulnerability module. Claims and loss data were extensively checked for quality and consistency, and include experience from the full spectrum of building occupancy, construction, coverage, and line of business.

With the release of a major model update, the work is far from complete. AIR will be working closely with companies as they begin to assess the impact of the updated model on decision-making. While change can be a significant challenge, AIR is confident that this model will soon set the next-generation industry standard.

ABOUT AIR WORLDWIDE CORPORATION

AIR Worldwide Corporation (AIR) is the scientific leader and most respected provider of risk modeling software and consulting services. AIR founded the catastrophe modeling industry in 1987 and today models the risk from natural catastrophes and terrorism in more than 50 countries. More than 400 insurance, reinsurance, financial, corporate and government clients rely on AIR software and services for catastrophe risk management, insurance-linked securities, site-specific seismic engineering analysis, and property replacement cost valuation. AIR is a member of the ISO family of companies and 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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