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Proposal to conduct an assessment of computer generated loss costs in Florida

Introduction

Due to the relatively short historical record and the tremendous changes to exposures in recent decades, simulation methods are essential to determine fair and reasonable loss costs for catastrophic wind losses from hurricanes. This is normally accomplished through the use of computer models created by companies for that purpose. However, it is difficult for insurance regulators and other users of this data to evaluate loss costs generated by any single model or small group of models, especially a proprietary model where the internal details of the modeling are not available for scrutiny. The state of Florida has established the Florida Commission on Hurricane Loss Projection Methodology to address the challenges of evaluating proprietary models. However, in spite of a very rigorous, intense review including the Professional Team having access to the proprietary aspects of models under consideration, rather divergent results have been produced from accepted models. Figure 1 shows the state-wide results of the four models accepted under the 2002 standards. As is readily seen, the accepted models produce disparate results having ratios as much as 3 to 1 .

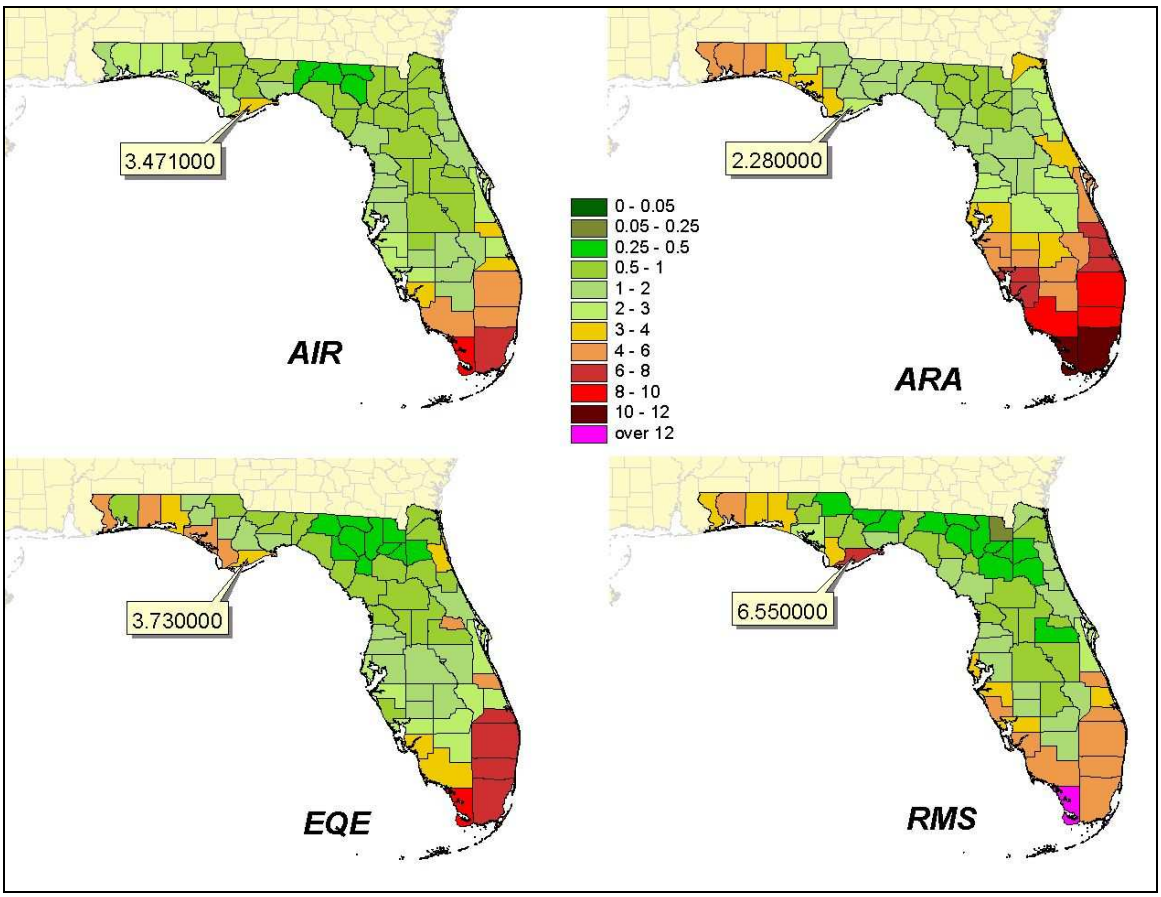

Figure 1: Loss Costs for Florida model submissions (Franklin County highlighted)

In the development of their software, modeling companies, including the developers of the Florida public model, must make specific decisions to capture hurricane phenomena. These decisions reflect the professional judgments of the developers based on their understanding of or contributions to the scientific literature. For hurricane risk modeling, there are not definitive recommendations in the literature regarding wind fields, decay rates, track progressions, water/land transitions, and vulnerability functions. Yet the computational difficulty of storm hazard modeling (a single run may involve trillions of calculations) forces most developers to select a single set of options for these facets of the storm simulation process. Given these facts, companies build models that appear reasonable, and can even pass stringent examinations such as that by the Florida Commission on Hurricane Loss Projection Methodology, yet produce disparate loss cost estimates. Therefore, evaluating loss costs from a limited number of models is extremely challenging even if considering an entirely open, public domain model.

To address this dilemma, Kinetic Analysis Corporation (KAC) proposes to run combinations of model components derived from the open engineering and hurricane research literature, and thus subject to complete disclosure and evaluation. Our Beowulf class supercomputer, one of the first to be used operationally by private industry, allows us to simulate every historical storm since 1851 (over 1200 events) with 324 different models, as well as using fully coupled climate models. The results of these combinations can be used to gauge the range of loss costs that may be expected in Florida, as well as assess some of the underlying reasons for this variability. The North Carolina Department of Insurance commissioned Kinetic Analysis Corporation in August 2003 to perform a comprehensive study of public domain models in support of the analysis of future insurance rate filings. This project was completed in October 2003, and subsequently, two journal articles were prepared and submitted to the Bulletin of the American Meteorological Society and the Journal of Insurance Regulation. The status of these articles will be indicated once editorial decisions have been reached. The study proposed here will build on the North Carolina work, adapting it to Florida as well as considering other areas anticipated to be of particular interest to the Commission.

The proposed methodology is described in the next section. The results from this project should prove invaluable in assessing models submitted to the commission, which heretofore involved assessments of modeler personnel, literature understanding and limited internal sanity checks, yet leave unresolved the ultimate question--how reasonable are the resulting loss costs, how wide a range does the state of the art generate, and what can be done to understand the underlying causes of model to model variability?

Methodology

A hurricane model generally consists of three major components: the wind field component, the topography/surface friction component, and the damage or loss

function. For purposes of this project, we will create an ensemble of three hundred twenty four hurricane damage models based on the following components, all of which are from published research in this field:

Wind Field
- Rankin Vortex (USACE, 1984)
- Holton (1992)
- Miller (1967)
- SLOSH (Jenesnianski, et al., 1992)
- Standard Project Hurricane (Schwerdt, et al., 1979)
- Bretschneider (1972)
- AFGWC (Brand, et al., 1977)
- Holland (1980)
- Georgiou (1985)

Friction (Boundary Layer Model)
- None (Schwerdt, et al., 1979)
- Cell-based (Cook, 1985)
- ASCE (2000)
- Trajectory (Watson, 1995)

Damage Functions
- Australian (Leicester, et al., 1978)
- Foremost (1996)
- Friedman (1984)
- Clemson 1 (Sill, et al., 1997)
- Clemson 2 (Rosowsky, et al., 1999)
- Professional Team (FCHLPM, 2002)
- X-cubed (Howard, et al., 2972)
- Energy (Watson, 2002)
- Stubbs (USAID/OAS, 1996)

By selecting one technique from each area, a set of 324 (9×4×9) models will be created to cover a wide range of plausible simulation choices based on the state of the art of hurricane modeling. These methods are used by a wide variety of researchers (and in some cases publicly cited by the proprietary modeling companies), have been tested by KAC, and have been found to produce reasonable results when compared to actual storm losses. In order to evaluate the impact of aggregation levels, we propose to conduct the analysis at the individual property level and aggregate to census block group, zip code, and county level.

The above combinations can compute the losses from a single given storm event. To determine average annual loss costs, the frequency of occurrence must also be computed. We propose to use three methods:

1) Historical. Each of the storms in the 2003 HURDAT data set will be simulated and the loss cost computed directly from the simulated damages.
2) Statistical. This approach was developed by the authors of this proposal to handle wind, wave and storm surge perils in the Caribbean (Watson and

Johnson 1996, 2003). In validating this approach, it became apparent that the method was applicable throughout the Atlantic basin. The starting point is to use the historical storm set and simulate every storm and record the maximum wind from each storm at each site (for this study every census block group). Next the set of wind values are reduced to the annual maxima, and the Weibull probability distribution is fit by maximum likelihood estimation to the 152 values at each site. The median of the fitted distribution represents next year's most plausible extreme wind that then can be converted to loss costs. For this study we are using the approach solely for a one-year forecast, but the method can be used to estimate return periods, as well.

3) Method three is to use a climate model (NCAR's CCM) to run simulations of the Atlantic basin to produce simulated hurricane track and intensity data that will then be simulated using the 324 models.

Therefore, viewed from the standpoint of commission standards, we will be using 972 different modeling packages (namely, combinations of nine wind, four friction, nine damage, and three frequency models).

Kinetic Analysis Corporation (KAC) has been heavily involved in hurricane modeling for the past two decades, largely from an engineering, disaster planning, and mitigation standpoint. Initial work with Hilton Head Island, S.C., evolved into comprehensive modeling efforts for the Organization of American States, World Bank, and the Florida Department of Emergency Management, among others. These projects have led to the development of several simulation platforms, including the Wind Damage Prediction and Evaluation Program (WDPEP), which is based entirely on public domain methods. Thus, KAC is uniquely positioned for conducting the study proposed here for the FCHLPM.

Deliverables and Anticipated Results

The following five specific deliverables will be provided:

Deliverable 1: Loss costs from the 324 public domain models and three frequency methods (972 total models), along with recommendations for using this data for the analysis of submissions to the Commission (in the form of proposed standards). The deliverable will consist of a report and a CDROM containing the data sets produced by the models.

Deliverable 2: Full FCHLPM style submissions for the top three public domain models with respect to performance against observed storms (designated "Alpha", "Beta", and "Gamma", in the NCDOI study), and a randomly selected model from the full set of 972 model combinations (designated "Chi"). The deliverable will consist of a report for each model in the form of a submission compliant with the FCHLPM standards.

Deliverable 3: Assessment of the impact of different historical data sets (full HURDAT, Commission data set, and detailed 1950-present data set) on loss costs. The deliverable will consist of a report and supporting presentation on this topic.

Deliverable 4: Assessment of the primary drivers of model-to-model variability of computer generated loss costs in Florida, and potential avenues for reducing this variability. The deliverable will consist of a report and supporting presentation on this topic.

Deliverable 5: Assessment of the impact of the spatial distribution and aggregation from individual property level to census block group, ZIP Code, and county level on loss costs. The deliverable will consist of a report and supporting presentation on this topic.

The reports described above may be incorporated into one comprehensive report, depending upon the wishes of the Commission, or distributed as they are completed to speed their discussion and inclusion in various activities such as revision of the standards.

Electronic data sets will be provided on CDROM as Microsoft Excel spreadsheets and ESRI Arc/View compatible shape files, projects, and legends. Aspects of the study that would be of interest to the scientific or regulatory community would be documented and submitted for consideration by suitable peer-reviewed publications.

Time frame and budget

This study would be conducted by the Research and Development Division of Kinetic Analysis Corporation, under the direction of Mr. Charles C. Watson, Jr. Dr. Mark Johnson of the University of Central Florida would conduct the statistical analysis and overview the quality control aspects of the work. The study as proposed can be completed in 120 days for a budget of $130,000 (which includes a $37,000 subcontract to the University of Central Florida), and if initiated in early Spring 2004 would be completed in time to provide support for the 2004 revision of the Standards. Note that this cost estimate includes considerable savings as a result of the experience gained through the North Carolina project, as well as the opportunity to coordinate work with another project KAC and UCF are conducting for the state of Florida (a high resolution update of the Local Mitigation Strategy data sets for the Department of Community Affairs).