Catastrophe Models

Do they produce rates that are not excessive, inadequate or unfairly discriminatory?

Casualty Actuaries of the Southeast
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Hugo (1989), Andrew (1992) and Iniki (1992)

Florida Commission on Hurricane Loss Projection Methodology

Maryland Catastrophic Risk Planning Model Evaluation

Hawaii Model Review Committee

Lessons learned from Hurricanes Hugo, Andrew & Iniki

– Previous estimates of loss potentials from hurricanes were seriously inadequate

– Insurance industry claim data is not a credible basis from which to produce hurricane insurance costs for rare events

Aftermath

- Insurer insolvencies

- Increased insurer exposure management

  - Coastal market curtailments

  - Availability shortages

Hurricanes Hugo, Andrew and Iniki signaled the need to quantify the levels of risk associated with providing hurricane insurance separately from other perils.

Hurricane models are designed to utilize our scientific knowledge of hurricanes and our engineering knowledge of how properties are damaged by hurricanes


Insurer input
BLACK BOX
Loss costs

Florida Commission on Hurricane Loss Projection Methodology

Commission Members

- Insurance Consumer Advocate
- Fla. Hurricane Catastrophe Fund Exec Director
- Executive Director of Citizens P.I.C.
- Director of Emergency Management
- FHCF Advisory Council
- Actuary Florida OIR
- P & C Company Actuary
- Professor of Insurance & Finance
- Professor of Statistics
- Professor of Computer Science
- Professor of Meteorology

Accurate

Designed and constructed in a careful, sensible, and **scientifically acceptable** manner such that they correctly describe the critical aspects needed to project loss costs

Reliable

Consistently produce dependable results and that there is **no inherent or known bias** which would cause the model or technique to overstate or understate the results

- **To be determined acceptable, the model must have been found acceptable for all Standards.**

- If the model fails to be found acceptable, by a majority vote, for any one Standard or part of a Standard, the model will not be found to be acceptable for producing loss costs in Florida.

The commission shall consider any actuarial methods, principles, standards, or models that have the potential for improving the accuracy of or reliability of projecting probable maximum loss levels.

Professional Team

- Meteorologist – Dr. Jenni Evans
- Structural Engineer – Dr. Masoud Zadeh
- Actuary – Martin Simons
- Statistician – Dr. Mark Johnson
- Computer Scientist – Dr. Paul Fishwick

AIR Worldwide Corporation

1996,97,98,99,00,01,02,03,04,05,06,07,08,09

Applied Research Associates, Inc.

1999,00,01,02,03,04,05,06,07,08,09

E.W. Blanch Co.

1998, 1999, 2000

EQECAT, Inc.

1997,98,99,00,01,02,03,04,05,06,07,08,09

Florida Public Hurricane Loss Model

2006,07, 08,09

Risk Management Solutions, Inc.

1997,98,99,00,01,02,03,04,05,06,07,08,09

Tillinghast–Towers Perrin

1998

General Standards reflecting the scope of the model, the independence of its component models and the professional status of the model designers and testers

There are currently (2011 ROA)
5 General Standards

Meteorological Standards covering all aspects of this infrequent weather phenomenon

There are currently (2011 ROA)
6 Meteorological Standards

Vulnerability Standards assessing the impact of the hurricane winds on residential property

There are currently (2011 ROA)
3 Vulnerability Standards
with a total of 13 sub-parts

Actuarial Standards assessing the damage impact in insurance terms

There are currently (2011 ROA) 6 Actuarial Standards

Statistical Standards addressing the statistical foundation of the model and the sensitivity and uncertainty assessment of model outputs as a function of model inputs

There are currently (2011 ROA)
6 Statistical Standards

Computer Standards providing the overall design, construction, and execution of the model

There are currently (2011 ROA)
7 Computer Standards

In addition to the Standards, Modelers are required to fill out specified forms prescribed by the Commission and based on the Florida Hurricane Catastrophe Fund exposures;

These forms are designed to provide the Commission with substantial information related to the performance of the model under consideration for conditions relevant to Florida.

G-1 Scope of the Computer Model and Its Implementation

The computer model shall project loss costs and probable maximum loss levels for residential property insured damage from hurricane events.

G-2 Qualifications of Modeling Organization Personnel and Consultants

A. Model construction, testing, and evaluation shall be performed by modeling organization personnel or consultants who possess the necessary skills, formal education, and experience to develop the relevant components for hurricane loss projection methodologies.

G-2 Qualifications of Modeling Organization Personnel and Consultants

B. The model or any modifications to an accepted model shall be reviewed by either modeling organization personnel or consultants in the following professional disciplines: structural/wind engineering (licensed Professional Engineer), statistics (advanced degree), actuarial science (Associate or Fellow of Casualty Actuarial Society), meteorology (advanced degree), and computer/information science (advanced degree). These individuals shall be signatories on Forms G-1 through G-6 as applicable and shall abide by the standards of professional conduct if adopted by their profession

G-4 Independence of Model Components

The meteorological, vulnerability, and actuarial components of the model shall each be theoretically sound without compensation for potential bias from the other two components.

M-1 Base Hurricane Storm Set

A. Annual frequencies used in both model calibration and model validation shall be based upon the National Hurricane Center HURDAT starting at 1900 as of June 7, 2009 (or later). Complete additional season increments based on updates to HURDAT approved by the Tropical Prediction Center/National Hurricane Center are acceptable modifications to these storm sets. Peer reviewed atmospheric science literature can be used to justify modifications to the Base Hurricane Storm Set.

M-1 Base Hurricane Storm Set

B. Any trends, weighting, or partitioning shall be justified and consistent with currently accepted scientific literature and statistical techniques. Calibration and validation shall encompass the complete Base Hurricane Storm Set as well as any partitions.

M-2 Hurricane Parameters and Characteristics

Methods for depicting all modeled hurricane parameters and characteristics, including but not limited to windspeed, radial distributions of wind and pressure, minimum central pressure, radius of maximum winds, strike probabilities, tracks, spatial and time variant windfields, and conversion factors, shall be based on information documented in currently accepted scientific literature.

M-3 Hurricane Probabilities

B. Modeled hurricane landfall strike probabilities shall reflect the Base Hurricane Storm Set used for category 1 to 5 hurricanes and shall be consistent with those observed for each coastal segment of Florida and neighboring states (Alabama, Georgia, and Mississippi).

Saffir-Simpson Hurricane Scale

Category	Winds (mph)	Damage
1	74-95	Minimal
2	96-110	Moderate
3	111-130	Extensive
4	131-155	Extreme
5	over 155	Catastrophic

M-4 Hurricane Windfield Structure

A. Windfields generated by the model shall be consistent with observed historical storms affecting Florida.

B. The translation of land use and land cover or other source information into a surface roughness distribution shall be consistent with current state-of-the-science and shall be implemented with appropriate geographic information system data.

C. With respect to multi-story structures, the model windfield shall account for the effects of the vertical variation of winds if not accounted for in the vulnerability functions.

M-5 Landfall and Over-Land Weakening Methodologies

A. The hurricane over-land weakening rate methodology used by the model shall be consistent with historical records and with current state-of-the-science.

B. The transition of winds from over-water to over-land within the model shall be consistent with current state-of-the-science.

M-6 Logical Relationships of Hurricane Characteristics

A. The magnitude of asymmetry shall increase as the translation speed increases, all other factors held constant.

B. The mean windspeed shall decrease with increasing surface roughness (friction), all other factors held constant.

V-1 Derivation of Vulnerability Functions

A. Development of the vulnerability functions is to be based on a combination of the following:

(1) historical data,
(2) tests,
(3) structural calculations,
(4) expert opinion, or
(5) site inspections.

Any Development of the vulnerability functions based on structural calculations or expert opinion shall be supported by tests, site inspections, and historical data.

V-1 Derivation of Vulnerability Functions

E. Vulnerability functions shall be separately derived for building structures, mobile homes, appurtenant structures, contents, and time element coverages.

F. The minimum windspeed that generates damage shall be reasonable.

V-1 Derivation of Vulnerability Functions

G. Vulnerability functions shall include damage due to hurricane hazards such as windspeed and wind pressure, water infiltration, and missile impact. Vulnerability functions shall not include explicit damage due to flood, storm surge, or wave action.

V-2 Mitigation Measures

A. Modeling of mitigation measures to improve a structure's wind resistance and the corresponding effects on vulnerability shall be theoretically sound. These measures shall include fixtures or construction techniques that enhance:

- ***Roof strength***
- ***Roof covering performance***
- ***Roof-to-wall strength***
- ***Wall-to-floor-to-foundation strength***
- ***Opening protection***
- ***Window, door, and skylight strength.***

V-2 Mitigation Measures

B. Application of mitigation measures shall be empirically justified both individually and in combination.

A-1 Underwriting Assumptions

A. When used in the modeling process or for verification purposes, adjustments, edits, inclusions, or deletions to insurance company input data used by the modeling organization shall be based upon accepted actuarial, underwriting, and statistical procedures.

A-1 Modeling Input Data

B. All modifications, adjustments, assumptions, inputs and/or input file identification, and defaults necessary to use the model shall be actuarially sound and shall be included with the model output report. Treatment of missing values for user inputs required to run the model shall be actuarially sound and described with the model output report.

A-3 Loss Cost Projections and Probable Maximum Loss Levels

A. Loss cost projections and probable maximum loss levels shall not include expenses, risk load, investment income, premium reserves, taxes, assessments, or profit margin.

B. Loss cost projections and probable maximum loss levels shall not make a prospective provision for economic inflation.

A-3 Loss Cost Projections and Probable Maximum Loss Levels

C. Loss cost projections and probable maximum loss levels shall not include any provision for direct hurricane storm surge losses.

D. Loss cost projections and probable maximum loss levels shall be capable of being calculated at a geocode (latitude-longitude) level of resolution.

Statistical Standards provide the Commission with methods designed to determine that the loss costs produced by the model are statistically reasonable for the geographical area being considered

Computer Standards are designed to allow the Commission to examine the computer code inside the model to ensure that the model is actually performing in a manner consistent with what we are being told during our review of the model.

At this point in the process, we have determined that the model version after having been reviewed by the Florida Commission, has been determined to produce accurate and reliable loss costs for hurricane insurance in the State of Florida.

Additional information is needed to determine whether the Florida acceptance may be extended to determine the efficacy of the modeled loss costs for the State under review.

Maryland Review Procedure

Martin M. Simons –Public Actuarial Consultant

Dr. Jenni Evans – Professor of Meteorology, The Pennsylvania State University Specializing in hurricane evolution and windfield structure (including ET*)

Dr. Masoud Zadeh – Civil Engineer, Specializing in natural hazard risk management for property insurance

***ET is "extratropical transition" of the hurricane, which is important to Maryland**

Interrogatories for Modelers

Determination of model acceptability for producing loss costs for the state under review.

Specify the model version for each model used in developing the insurer's loss costs.

Requests for specific modeler information applicable to each of the individual models used in the filing and specific to the state under review.

Provide the date of acceptance by the Florida Commission on Hurricane Loss Projection Methodology (FCHLPM) of the model version.

Document any differences (regardless of the level of their expected impact on insurer's loss costs) between

(1)the model used to develop the loss costs for the state under review, and

(2) the model that has been found to be acceptable by the FCHLPM.

Identify the publication date of the National Hurricane Center HURDAT database used in developing the model.

Identify the set of historical storms (i.e. hurricanes, tropical storms, etc.) used in developing or validating the model.

Specify the storm characteristics used in the model.

Describe the source of any historical data used in the model to produce insurer's loss costs (other than the version of HURDAT already identified).

Justify the use of this data.

Identify the time period of historical data available and used in the creation of the stochastic storm set used in the model to produce the loss costs.

Describe any adjustments, exclusions or edits made to the cited historical source data.

Describe any frequency adjustments to account for effects of climate change, including multi-decadal oscillation or temporal changes in sea surface temperatures.

Describe any frequency adjustments used to modify the historical data just described.

Provide detailed justification for each of these adjustments.

Describe how the model defines a "hurricane" causing losses in the state under consideration

Describe (in detail) the process used to incorporate the effects of bypassing storms in the modeled loss costs.

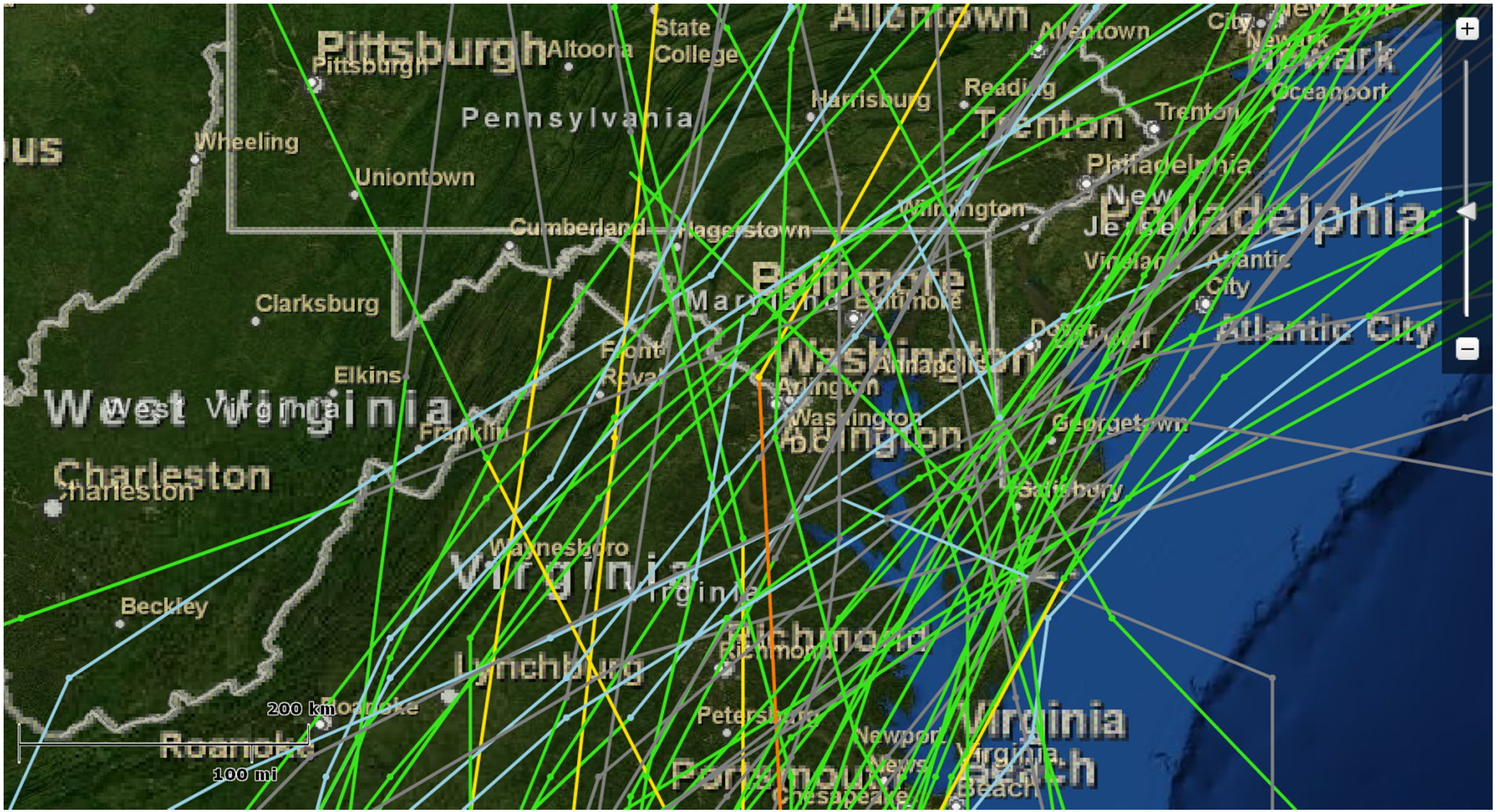
Describe how the model incorporates important modeled storm characteristics (e.g. intensity, radius of maximum winds, translational velocity) and effects of the environment (e.g. topography, over-land weakening) on the storm

Describe how the model incorporates the effects of changing spatial distribution of damaging winds due to extratropical transition of the hurricane.

Describe how the model incorporates the effects of topography on modeled storm characteristics or loss costs produced in the state under consideration

Provide a map showing all historical storms used in the model that produced damaging winds on land in the state under consideration

within the specified domain bounded by xx° N to yy° N.


Pittsburgh
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Cumberland
Hagerstown
Wilmington
Baltimore
Baltimore
Clarksburg
Atlantic City
Atlantic City
Elkins
Washington
Annapolis
Arlington
Washington
Georgetown
West Virginia
Charleston
Charleston
Waynesboro
Virginia
Beckley
Richmond
Lynchburg
Roanoke
Newport News
Virginia Beach
200 km
100 mi

Provide a table and corresponding histogram showing the distribution of hurricanes by Saffir Simpson category in the stochastic storm set at first landfall for the specified domain.

Justify the relevance of this distribution with reference to the historical storm set previously identified.

Provide separate maps for each of four random 110 year sample periods from the stochastic storm set for storms that produce damaging winds on land within the specified domain.

Provide a table and corresponding histogram showing the distribution of hurricanes by Saffir Simpson category for each of the four 110 year periods.

Document the following storm characteristics at first landfall for the strongest stochastic storm in the specified domain:

- maximum wind speed at landfall
- translational velocity
- minimum central pressure
- radius of maximum winds
- radius of damaging winds
- whether the storm is an extratropical transition event

Provide the source, collection and publication dates of land use/land cover data used in the model to develop friction factors (or other measures of surface roughness) for the development of the insurer's loss costs.

Provide description of categories of occupancies used by the model. Include statements on personal and commercial residential property occupancy and all sub-categories of these occupancies.

Describe the building classifications (including mobile homes, MH) for personal and commercial residential properties and the basis for the building stock used in each model relative to the state under consideration

Provide a list of main building characteristics used in each of the above building classifications for the state under consideration

Provide a list of secondary building characteristics (if used in the model) which might influence the assessed damage due to hurricane hazards for buildings in the state under consideration

Justify the relevance of the model building vulnerability functions for construction practices in the state under consideration

List each of the hurricane hazards that might impact performance of a building in the state under consideration

Describe how each of these has been treated in the model.

Describe how the building code development in the state under consideration is addressed by the model.

Describe any regional variations used in the model for building characteristics within the state under consideration and provide the basis for those variations.

Specifically as it applies to the state under consideration:

Provide a detailed description of vulnerability function development for each building class.

Describe how vulnerability functions are developed and used by the model when any of the building characteristics used by the model for that building type are not known or are missing.

Provide a description of validation and verification of appropriateness of building vulnerability functions used by model for the state under consideration

Provide a detailed description of building classes for appurtenant structures used by model.

Provide a description of vulnerability function(s) and associated uncertainty for contents.

Provide a detailed description of categories of additional living expense (ALE) (or loss of use) considered in the ALE as modeled.

Provide data used to perform any comparison of model loss cost outputs with historical data if such data is available, especially relative to any available historical data in the region between xx° N and yy° N latitude, or for construction types that are similar to those that are found in the state under consideration

Describe any changes made to the model from the previous two versions.

Describe how these changes have affected the loss costs.

Provide a table indicating the hurricane loss costs and percentage change in the insurer's hurricane loss costs as produced by the model by rating territory from those that were produced previously by the model for the insurer

Identify and explain any differences.

Provide a description of the techniques and data used to develop estimates of demand surge incorporated in the loss costs produced for the insurer, including a description of the implicit inclusion of demand surge in the historical data used in the development, validation or verification of model results, as well as any explicit inclusion of demand surge.

Describe and justify the process used when adjustments are made to the input exposure data.

Demonstrate the adequacy of the number of storms generated in the stochastic storm set to produce convergence of loss cost projections at county levels in state under consideration

Sources of additional information

1. Report of Activities
http://www.sbafla.com/methodology/CommissionDocuments/ReportofAcitivities/tabid/820/Default.aspx

2. Modeler Submissions to FCHLPM
http://www.sbafla.com/methodology/ModelerSubmissions/tabid/785/Default.aspx

3. Professional Team Reports
http://www.sbafla.com/methodology/CommissionDocuments/ProfessionalTeamReports/tabid/824/Default.aspx

4. Maryland Model Review (Available at www.mmsimons.com)
File - Property Insurance - Hurricane - Maryland Catastrophic Risk Planning Model Evaluation August 23 2011.pdf

5. Hawaii Modeler Questionnaire (Available at www.mmsimons.com)
File - Property Insurance - Hurricane - Hawaii Insurance Division Hurricane Modeler Questionnaire 2003.pdf

6. Another Approach (Available at www.mmsimons.com)
File - Property Insurance - Hurricane - Journal of Insurance Regulation 2006 - Insurance Rate Filings and Hurricane Loss Estimation Models

7. Hawaii Mitigation Grant Program (Available at www.mmsimons.com)
File - Property Insurance - Hurricane - Report to Hawaii Legislature - Wind Resistive Grant Program 2001.pdf