ANTITRUST Notice

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It is the responsibility of all seminar participants to be aware of antitrust regulations, to prevent any written or verbal discussions that appear to violate these laws, and to adhere in every respect to the CAS antitrust compliance policy.

Actuarial Standard of Practice # 38

USING MODELS OUTSIDE THE ACTUARY'S AREA OF EXPERTISE (PROPERTY AND CASUALTY)

ASOP 38, 3.2 Appropriate Reliance on Experts

- Request and review…
  - curriculum vitae for modeling company experts
  - peer reviews by external experts
  - Florida Commission submissions are good sources for these on hurricane
- Modelers* at reinsurance intermediaries should be good sources but you may need to make special request

*Unless otherwise noted, “modeler” means a model user at an insurance company, reinsurance intermediary or modeling company

ASOP 38, 3.3 Understanding of the Model

- Actuary should*…
  - Study all modeling company documentation provided to clients, or to Florida Commission
  - Dialog with modeler to close any gaps in understanding
  - Agree with modeler on how to map company data to model data fields, including how unknowns and miscodes will be handled
  - Understand what additional input may be needed, e.g., ITV assumptions, secondary features
  - Dialog with modeler which model outputs are best suited for intended use

* Actuary may rely on another actuaries' work, per 3.7

ASOP 38, 3.4 Appropriateness of the Model for the Intended Application

- Actuary should make a reasonable effort to understand implications of…
  - significant developments in relevant fields of expertise
  - various viewpoints in using all vs. portions of the historical peril record in developing model
  - Various viewpoints on effects of climate change
- Actuary should consult with modeler on how to best model lines of business not directly modeled, e.g., boats

ASOP 38, 3.5 Appropriate Validation

- Comply with ASOP 23, *Data Quality*
  - *DO NOT DROP DATA! Map unknowns or miscodes into valid model codes*
  - *Compare control totals to alternate internal data sources across zip codes, counties, construction types, etc.*
  - *Compare current data with prior data and seek explanations of significant differences*
  - *Request and compare control totals from modeler after they import your data into model*

ASOP 38, 3.5 Appropriate Validation (cont.)

- *Model output*
  - *Compare current outputs with prior outputs*
  - *Compare stochastic model outputs with model outputs using historical events*
  - *Logical relation to risk,“all other things being equal”*
  - *If using reinsurance modules, compare net to gross modeled losses with manual calc’s on either side of retentions and limits, for events and for annual periods*

ASOP 38, 3.6 Appropriate Use of the Model

- Model outputs may not be appropriate for actuarial use without adjustment, if based on data as of past date; most actuarial uses are projections of future periods
  – Alternative is to adjust past data into forecast period and then input into model
- Additionally, model outputs may need to be adjusted for particular policy features or conditions (e.g., limits and sublimits)
- Document adjustments and reasons
  – Adjustment into forecast or ratemaking period of model outputs or prior exposure data
  – If data had to be dropped at input, make appropriate adjustments to outputs
  – Loss adjustment expenses

Brick chimneys can double as strong-motion sensors in earthquakes

- 

ASOP 38, 3.7 Reliance on Model Evaluation by Another Actuary

- Actuary should conduct extensive discussion with other actuary and review documentation to confirm latter has complied with ASOP 38
- Actuary should document the extent of such reliance in accordance with section 4.1
- This applies whether other actuary is with same employer, with reinsurance intermediary or with modeling company

Different Uses for the Model Output

Ratemaking - Loss and Profit Components

Overview

- A brief history of catastrophe ratemaking
  - Traditional ratemaking approaches
  - The introduction of models
- The transition to modeling
  - Loss
  - Profit
  - Reinsurance Costs

A Brief History of Catastrophe Ratemaking

- Traditional Catastrophe Loss Loads
  - Long-term averages
  - Account for trends
    - Changes in exposure
    - Policy changes

A Brief History of Catastrophe Ratemaking

- A model makes an appearance
- The “wake-up call”
  - Hurricane Andrew, Northridge earthquake

The Transition to Modeling

- Increased use of models
- Florida Commission (FCHLPM)
- Actuarial Standard of Practice 38
  - Using Models Outside the Actuary's Area of Expertise
- Actuarial Standard of Practice 39
  - Treatment of Catastrophe Losses in Ratemaking
  - Acknowledges historical data, noninsurance data and models

Loss

- Standard model output
  - Average annual loss - in the aggregate
    - As of a certain portfolio date
  - Average annual loss – at a refined level, e.g.,
    - Location
    - Age of construction
    - Deductible
    - Limits / Attachments
      - Net loss / expected recoveries

Loss

- Adjusting the Output
  - Exposure growth
    - Internal
    - External
  - Out of model terms or conditions
    - Or changes in terms or conditions

Reinsurance Costs

- Considerations - Cost
  - Recent contract prices?
  - Longer-term average?
  - Projected price?

Reinsurance Costs

- Considerations - Allocation issues
  - What is the basis for allocation?
    - Loss / Risk
    - Premium / Exposure

Profit

- Capital allocation
  - How much and basis?
- Rate of return
  - How much and basis?

Different Uses for the Model Output

Classification Ratemaking

Loss

- Standard model output
  - Average annual loss - in the aggregate
  - Average annual loss – at a refined level, e.g.,
    - Location
    - Age of construction
    - Deductible
- Not as standard (in some cases)
  - Secondary characteristics

Territory

- Zip
  - Administratively straightforward
  - Subject to the whim of the USPS
- Census tract
  - Static longer than zip
  - More refined boundaries than zip
  - But, not drawn with catastrophe risk in mind

Territory

- Geocode / Site specific
  - Needed for model input
  - Can be create a refined, more homogeneous system
    - Acceptability
    - Affordability

Other Classification Factors

- Age of construction
- Type of construction
- Secondary features
  - Roof
  - Foundation
  - Retrofitting / mitigation features

Regulating Insurance Loss Costs Produced by Computer Models

HURRICANE

1. Florida Commission on Hurricane Loss Projection Methodology
2. Hawaii Hurricane Model Review Committee
3. Insurance Rate Filings and Hurricane Loss Estimation Models

FCHLPM

- Establish by Florida Legislature in 1995
- to adopt findings relating to the accuracy or reliability of particular methods, principles, standards, models, or output ranges used to project hurricane losses
- eleven member statutorily defined board

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

Acceptability Process

- **Prior to November 1, each year, FCHLPM produces new standards, forms and submission requirements**

Acceptability Process

- **Prior to March 1, modeler must notify the FCHLPM that it is ready for review, including:**
  - **Submission document**
  - **Required Forms must be completed**
  - **Description of Trade Secret information to be presented to the Professional Team**

Commission Members

- **CHAIR: Randy Dumm, Ph.D. - Finance - FSU**
- **VICE CHAIR: Larry Johnson, FCAS – Actuary, FHCF**
- **Kristen Bessette, FCAS, MAAA – Industry Actuary**
- **Jack Nicholson, Ph.D., CLU, CPCU - CEO, FHCF**
- **Howard Eagelfeld, FCAS – Actuary, OIR**
- **Craig Fugate – Director –Div. of Emergency Mgmt.**
- **Sean Shaw - Insurance Consumer Advocate**
- **Scott Wallace – Exec Director of Citizens Prop Ins Co**
- **Jainendra Navlakha, Ph.D. – Comp Syst Design – FIU**
- **Hugh Willoughby, Ph.D. – Meteorologist - FIU**
- **Vacant – Statistics**

Professional Team

- **Meteorologist - Dr. Jenni Evans**
- **Structural Engineer – Fred Stolaski**
- **Actuary – Martin Simons**
- **Statistician – Dr. Mark Johnson**
- **Computer Scientist – Dr. Paul Fishwick**

(Backup members available for each member)

Professional Team Review

- **Due diligence review of submitted information and proprietary information**
- **On-site testing under control and supervision of the professional team**
- **Verification of information submitted in forms, disclosures, etc.**
- **Review of standards for compliance**
- **(Professional Team Reports - www.mmsimons.com**

Standards

- **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, the model will not be found to be acceptable.**

2009 Standards

http://www.sbafla.com/methodology/Currentyear.asp?FormMode=Call&LinkType=Section&Section=2

- **General (5 standards)**
- **Meteorology (6 standards)**
- **Vulnerability (2 standards)**
- **Actuarial (11 standards)**
- **Statistical (6 standards)**
- **Computer (7 standards)**

General Standard

- **G-2 – Qualifications of Personnel**
- ***A** - Model construction, testing, and evaluation shall be performed by modeler personnel or consultants who possess the necessary skills, formal education, and experience to develop the relevant components for hurricane loss projection methodologies.*

General Standard

G-2 – Qualifications of Personnel

B - . . reviewed by either modeler personnel or consultants in the following disciplines:

1) structural engineer (licensed P.E.)

2) statistics (advanced degree)

3) actuarial science (FCAS or ACAS)

4) meteorology (advanced degree)

5) computer science (advanced degree)

General Standard

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.**

Meteorological Standard M-1

- ***A. Annual frequencies used in the model and model validation shall be based upon the National Hurricane Center HURDAT starting at 1900 as of June 1, 2008 (or later). . . .***

Meteorological Standard M-1

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

Meteorological Standard

- **M-6 – Logical Relationship of Hurricane Characteristics**

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

  B – The wind speed shall decrease with increasing surface roughness (friction), all other factors held constant.

V-1 Vulnerability

- ***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.

V-1 – A Vulnerability
(continued)

- **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 Vulnerability

- **F - *Vulnerability functions shall be separately derived for building structures, mobile homes, appurtenant structures, contents, and additional living expense.***

V-2 – Mitigation Measures

Mitigation 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.***

Actuarial Standard

A-1 - Modeled Loss Costs and Probable Maximum Loss Levels

- ***Modeled loss costs and probable maximum loss levels shall reflect all insured wind related damages from storms that reach hurricane strength and produce minimum damaging windspeeds or greater on land in Florida* from that event.**

Actuarial Standard

- **A-2 – 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 modeler shall be based upon accepted actuarial, underwriting, and statistical procedures.**

Actuarial Standard

- **A-4 Demand Surge**
- ***A.* Demand surge shall be included in the model's calculation of loss costs and probable maximum loss levels using relevant data.**
- **B. The methods, data, and assumptions used in the estimation of demand surge shall be actuarially sound.**

Actuarial Standard

- **A-5 – Logical Relationship to Risk**

  A – Loss costs shall not exhibit an illogical relation to risk, nor shall loss costs exhibit a significant change when the underlying risk does not change significantly.

Actuarial Standard

- **A-5 – Logical Relationship to Risk**

  C – Loss costs cannot increase as friction or roughness increase, all other factors held constant.

  D- Loss costs cannot increase as the quality of construction type, materials and workmanship increases, all other factors held constant.

Actuarial Standard

- **A – 6 – Deductibles and Policy Limits**
- **A – The methods used in the development of mathematical distributions to reflect the effects of deductibles and policy limits shall be actuarially sound.**
- **B – The relationship among the modeled deductible loss costs shall be reasonable.**
- **C – Deductible loss costs shall be in accordance with s. 627.701(5)(a)1., F.S.**

Statistical Standards

- **S-1 Modeled results and goodness of fit**
- ***The use of historical data in develop-ing the model shall be supported by rigorous methods published in currently accepted scientific literature.***
- ***Modeled and historical results shall reflect agreement using currently accepted scientific and statistical methods in the appropriate disciplines.***

Statistical Standards

- **S-2 Sensitivity analysis for model output**

  The modeler shall have assessed the sensitivity of temporal and spatial outputs with respect to the simultaneous variation of input variables using currently accepted scientific and statistical methods and have taken appropriate action

Statistical Standards

- **S-4 County level aggregation**

At the county level of aggregation, the contribution to the error in loss cost estimates attributable to the sampling process shall be negligible.

Statistical Standards

- **S-5 Replication of Known Hurricane Losses**

  The model shall reasonably replicate incurred losses in an unbiased manner on a sufficient body of past hurricane events from more than one company, including the most recent data available to the modeler. . . .

Computer Standards

- **C-1 Documentation**
- **C-2 Requirements**
- **C-3 Model architecture and component design**
- **C-4 Implementation**
- **C-5 Verification**
- **C-6 Model maintenance and revision**
- **C-7 Security**

Hawaii Hurricane Model Review

- **Initiated in 2001**
- **Updated June 30, 2003**
- **Based on FCHLPM reviews**
- **Composition –**
  - **Actuary**
  - **Engineer**
  - **Meteorologist**

Objective

- **to ensure that models used to produce property insurance loss costs in Hawaii appropriately consider Hawaii hurricane characteristics and frequencies, Hawaii construction types and Hawaii land use and land cover data in their development.**

Hawaii Model Review Questions

http://www.mmsimons.com

Is the model the same as that which has been accepted by the Florida Commission on Hurricane Loss Projection Methodologies (FCHLPM)?

If not, describe the major differences.

Hawaii Model Review Questions

Provide details of the impact of each of the following criteria on the creation of the stochastic storm set:

- **Hurricanes vs. tropical storms, Pacific vs. Atlantic storms, historical time period, central pressure, wind speed, land friction, surface roughness, weakening, topography, atmospheric conditions, by-passing storms**

Hawaii Model Review Questions

. . . Provide maps at two-and-a-half degree latitude and longitude grid resolution, showing the storm frequencies generated by the model for the domain bounded by the equator and 30N latitude and 140W longitude and the International Dateline.

Hawaii Model Review Questions

Provide details (both written and graphic) of the process used to develop the expected landfall frequencies of storms by hurricane strength for each area of Hawaii.

Hawaii Model Review Questions

- **What is the minimum central pressure for all hurricanes in the stochastic storm set used for Hawaii?**
- **What is the source for verification of the minimum central pressure?**
- **What is the maximum wind speed associated with this hurricane in the model?**

Hawaii Model Review Questions

- **Describe the basis of vulnerability function development relative to Hawaii construction characteristics.**
- **Describe the studies and methods used in the development, validation and verification of the building stock.**

Hawaii Model Review Questions

- **Provide the total aggregate zero deductible personal residential (homeowners plus dwelling policies) losses produced by your model for Hurricane Iniki.**

Hawaii Model Review Questions

Provide the two dimensional instantaneous windfield for the island of Kauai at the time of landfall for Hurricane Iniki as developed by the model at a one-mile grid resolution.

Insurance Rate Filings and Hurricane Loss Estimation Models

- ***Journal of Insurance Regulation, 4/2004***
- ***By Charles C. Watson, Jr., Mark E. Johnson, and Martin Simons***
- ***927 Public Domain Model Combinations***

Public Windfield Models

Wind Field

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

Public Friction
(Boundary Layer Models)

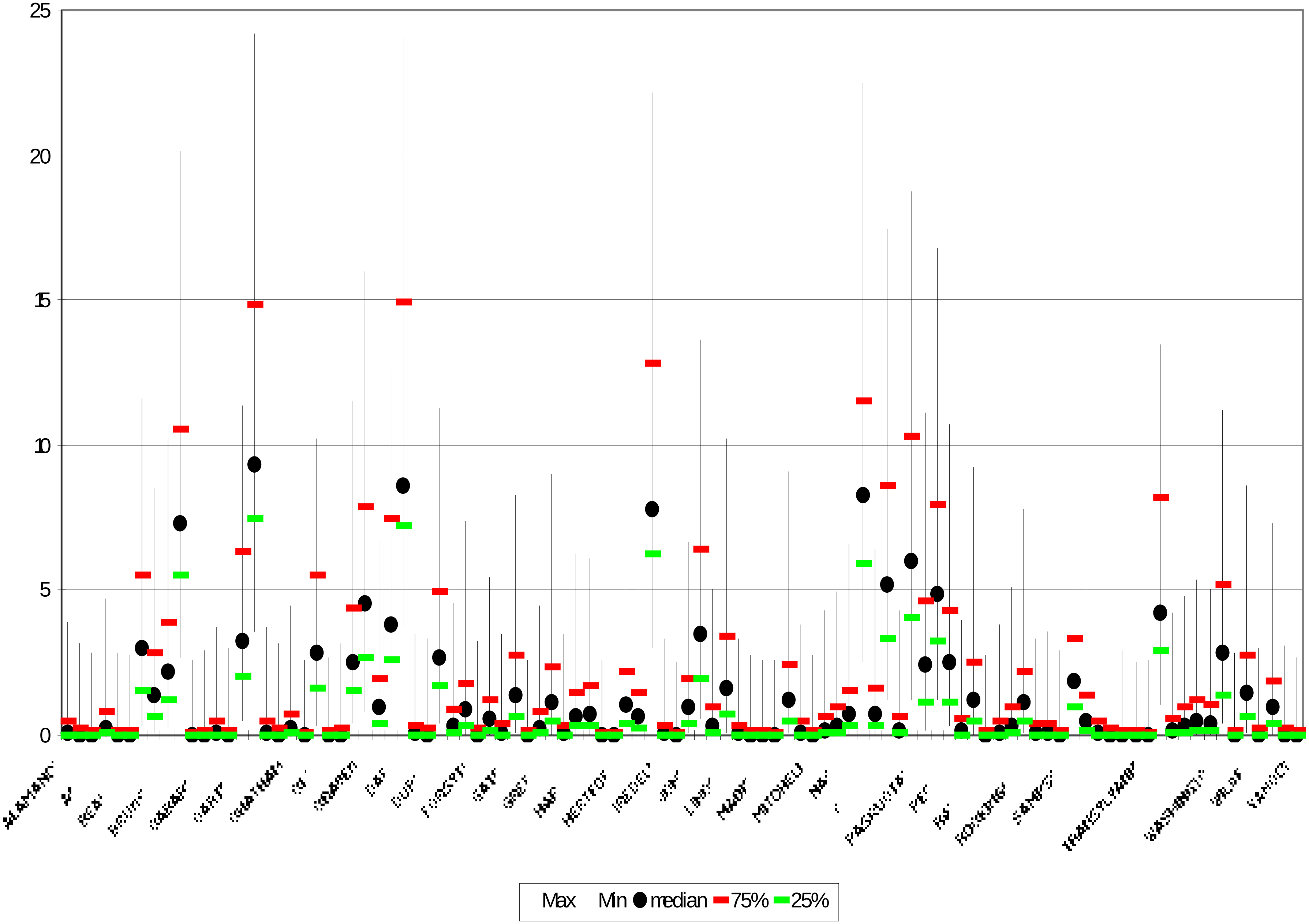
- None (Schwerdt, et al., 1979)
- Cell-based (Cook, 1985)
- ASCE (2000)
- Trajectory (Watson, 1995)

Public 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)

Study Criteria

- **Topography: US 90 meter DEM from USGS**
- **Land Cover: NASA/UMD 250m Global Land Cover data set (Spring 2003)**
- **Track: 1851-2002 revised HURDAT data from NHC**
- **Exposure: Census 2000 Block Group data (the STF3 data set).**



25
20
15
10
5
0
Max
Min
median
75%
25%

Other Hurricane Prone States

- **Model review committee**
  - **Meteorologist**
  - **Structural Engineer**
  - **Actuary**
- **Determination that the model being reviewed appropriately considers individual state criteria**

Individual State Criteria

- **Meteorology**
  - **Hurricane frequencies**
  - **Hurricane tracks**
  - **Hurricane strengths**
  - **Land Use**
  - **Land Cover**
- **Vulnerability**
  - **Construction Characteristics**
  - **Building Codes and Enforcement**
- **Actuarial**
  - **Policy Language**
  - **Insurance Company Practices**

Historical Hurricane Frequencies

- **Hurdat – available data (1850-present)**
  - **Data prior to 1900 is less reliable**
  - **Data subsequent to 1950 is most reliable**
  - **Long term re-evaluation currently in process**

Historical Hurricane Frequencies

Cyclical Patterns

AMO - Atlantic Multi-Decadal Oscillation

ENSO – El Nino & La Nina

QBO – Quasi Biennial Oscillation

Earthquake Models

- Includes seismology in lieu of meteorology
  - California
  - Washington State – Alaska
  - Hawaii
  - New Madris Fault – midwestern U.S.
  - Charleston South Carolina

Terrorism Models

- Counter-intelligence
- Biochemical Engineering
- Nuclear Destruction
- All insured Coverages Affected
  - Property
  - Workers' Compensation
  - Life and Health

Solvency - Rating Organizations

- A.M. Best
- Moodys
- Standard and Poors

A. M. Best

- “Catastrophes are the No. 1 threat to solvency in the industry”
- BCAR treatment of catastrophe risk
  - Greater of
    - 100-year wind net PML
    - 250-year earthquake net PML
    - Or a recent, large loss
  - Net PML loss recognizes 35% tax rate
  - Amount of loss determined from company’s exposure

A. M. Best

- A.M. Best's assessment of the basis risk in catastrophe bonds relies primarily on data and information obtained from the three leading peril modelers (AIR Worldwide Corp., EQECAT Inc. and Risk Management Solutions Inc.) & the insurance/ reinsurance sponsors of the catastrophe bonds.

  October 23, 2006 newswire from A.M. Best

Moody's

- "Catastrophes are the most significant and volatile risk to capital over the short term"
- Evaluates company's
  - Ability to monitor and manage risk exposure
  - Reliance on reinsurance
  - Gross and net risk relative to earnings and capital
  - Incorporates views of
    - Company's 3rd party vendors, internal surveys, relative market share analysis and stress scenarios.

Standard & Poors

- Evaluates
  - Exposure management
  - Liquidity strains from stressed loss scenarios
  - Reliance on reinsurance and viability

Enterprise Risk Management

Enterprise Risk Management – 1

- **Robust implementation and integration of ERM into (re)insurance company operations has become a requirement of rating agencies**

Enterprise Risk Management – 2

- **P&C (re)insurers are increasingly using ERM processes to estimate capital required by each business and in total**

Enterprise Risk Management – 3

- **Catastrophe exposure is a major "consumer" of capital; therefore a very important input into ERM processes**

Enterprise Risk Management - 4

- **ERM requires selection of risk tolerance measures of survivability/failure likelihood**

Enterprise Risk Management - 5

- **Typical risk tolerance measures identify number of times enterprise survives/fails out of many simulations**
  - Rating agency credit ratings set in part on historical failure rates of similarly rated bonds, e.g., “AAA” rated implies less than 2 failures out of 10,000 rated bonds over specified period

Enterprise Risk Management - 6

- **Rating agency requirements for CAT model inputs and outputs used in ERM modeling**
  - **≥25,000 annual simulations**

Enterprise Risk Management - 6

Rating agency requirements for Cat Models (cont'd)

– Must include…

- **All perils, businesses, data exposed to CAT losses**
- **Demand surge/ "Loss Amplification"**
- **Secondary coverages: building and ordinance, emergency evacuation ALE, etc.**
- **Expected Loss Adjustment Expenses**
- **"Secondary Uncertainty"**
- **"Intermediate term" (AMO, medium term) model outputs**

Enterprise Risk Management - 7

- May use outputs from more than one model. Need to ensure consistent…
  - User inputs and selections
  - Exposure mappings to model fields/codes
  - Sampling of outputs to populate CAT events in annual simulation periods
- Using outputs from more than one model may improve uncertainty testing of CAT exposure component of ERM processes

Capital Management & Allocation -1

- With robust ERM modeling, can determine capital required to exceed internal survivability measures and rating agency capital adequacy measures

Capital Management & Allocation -2

- Can evaluate…
  - **Capital level to maintain ratings, in relation to existing and internal required capital**
  - **How each CAT-exposed business adds to required and “rating” capital**
  - **Historical and expected returns on required and “rating” capital**
  - **How reinsurance scenarios change returns, and required and “rating” capital**
  - **How to manage each CAT-exposed business to achieve acceptable returns, to control reinsurance costs, to reduce required and “rating” capital**

Reinsurance Issues -1

- **Most CAT reinsurers evaluate their clients on their…**
  - **Data quality, including resolution of location and building components**
  - **Skill in using data in CAT models**
  - **Skill in utilizing CAT modeled outputs in selecting, mitigating and pricing CAT risks**

Reinsurance Issues -2

- Most CAT reinsurers use multiple models, including proprietary in-house models

- **(Exceptions – Warren Buffett: "Beware of geeks bearing formulas")**

Risk Mitigation

- Reducing the loss to the policyholder and the insurer
  - Hurricane
    - Previously discussed features
    - Rate requirements
  - Earthquake
    - Bolt, brace, strap
    - Rate effect

Risk Mitigation

- Reducing the loss to the insurer
  - Exposure management