Catastrophe Modeling

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Webinar—November 9, 2018

Today's Speakers

- Kay Cleary, MAAA, FCAS, FCA
  - Chairperson, Academy Extreme Events and Property Lines Committee
- Howard Kunst, MAAA, FCAS
  - Chief Actuary, CoreLogic
- Minchong Mao, MAAA, FCAS, FSA
  - Managing Director, Catastrophe Analysis, Aon

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Genesis of Paper

- Academy monograph, April 2017, *The National Flood Insurance Program: Challenges and Solutions*
  http://www.actuary.org/files/publications/FloodMonograph.04192017.pdf
- Questions arose in response to paper
- Lack of documentation within the actuarial framework around natural catastrophe models

Members of Drafting Subcommittee

- Kay Cleary, MAAA, FCAS, FCA, Chairperson
- Minchong Mao, MAAA, FCAS, FSA
- Trevar Withers, MAAA, ACAS
- Edward Ford, MAAA, FCAS
- Howard Kunst, MAAA, FCAS

Today's Agenda

- Overview of paper, July 2018
  - *Uses of Catastrophe Model Output*
  - http://www.actuary.org/files/publications/Catastrophe_Modeling_Monograph_07.25.2018.pdf
- Some additional information about models
- Practical considerations
- Traditional Actuary / Catastrophe Actuary

What’s in the paper

Practical Focus

- Explanation of the need for this paper
- Structure of the paper
  - Focus on output, not natural sciences
- Examples
  - Four perils
  - Representative portfolios

Structure of the paper

- Focus on providing a basic description of natural catastrophe model design and uses
  - Basic structure of a model
  - Major use cases
    - Includes examples to illustrate

Focus on Output, not Science

- Science varies between models
- Focus on Probabilistic/Stochastic model, as outputs (Average Annual Losses (AALs), Probable Maximum Losses (PMLs)) are relatively similar between models
  - Event set, with frequencies and event characteristics
  - Damage model
  - Financial calculations

Perils covered

- Selected a varied set of perils to demonstrate some of the similarities and differences
  - Hurricane
  - Inland Flood
  - Coastal Flood (tropical storm surge)
  - Hail (Severe Convective Storm)

Representative Portfolio

- Developed a random set, based on the population by ZIP code in Florida
  - 100,000 locations
  - Random parcels selected
  - Same set used for all perils

Main Areas Covered in the Paper

- Model Governance
- Ratemaking
- Underwriting and Risk Selection
- Mitigation
- Reinsurance
- Advantages and Limitations of the Models

Probabilistic and Deterministic Models

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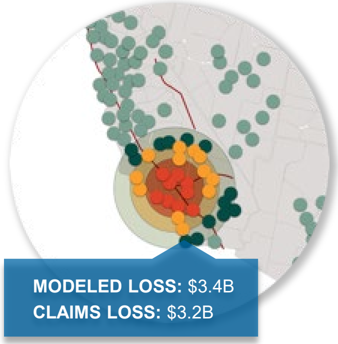
Types of Models

EXTREME
VERY HIGH
HIGH
MODERATE
LOW



DETERMINISTIC
What could happen?

PROBABILISTIC
What if it happened?

FORENSIC
What did happen?

Natural Catastrophe Offerings to Insurers

A complete suite of products to cover the insurers' needs

Insurance Activity

Screening → Pricing → Portfolio Risk

Products & Value Proposition

Deterministic Risk Scores

Single dimensional evaluation of risk: Easily implemented into U/W Process and Pricing

Probabilistic Models

Comprehensively include mitigation credits, U/W info and policy terms into enterprise risk

Catastrophe Model Use in Insurance

Screening (Underwriting / Risk Selection)

- Deterministic Risk Scores (most common)
  - Hazard risk scores provide a good representation of relative risk, i.e., the higher the score the greater the risk. Depending on their risk appetite, an individual company can set its own thresholds for underwriting decisions
  - Score can be easily implemented/imported into U/W work stream, especially for homogenous lines of business
  - No need to run more sophisticated model
- Probabilistic model results
  - More complicated risks (e.g., larger commercial structures) may require more information
    - Understanding impacts of tail events
    - Impact on reinsurance placement / capital management

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Catastrophe Model Use in Insurance

Pricing

- Deterministic Risk Scores
  - Hazard risk scores provide a good representation of relative risk; a risk score can be translated into a rate relativity (relativity factor increases as score increases)
  - Score can be easily implemented/imported into a rating algorithm, especially for homogenous lines of business (law of large numbers)
- Probabilistic model results
  - More complicated risks (e.g., larger commercial structures) may require more information
    - Understanding impacts of tail events
    - Impact on reinsurance placement

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Catastrophe Model Use in Insurance

Portfolio Risk / Capital Management / Reinsurance

- **Deterministic Risk Scores**
  - Hazard risk scores provide a method to look at the distribution of risk across various geographies
- **Probabilistic model results**
  - AALs and PMLs provide necessary information for senior management at companies to make a number of financial decisions
  - Based on a selected return period (100-year loss), it can advise as to how much reinsurance to purchase, to cover potential large-event losses extending beyond what the company can retain
  - Scenario testing – identifying the events that have the highest potential impact to the company's financials, and making decisions that impact the company's portfolio of insureds
  - Capital allocation is sometimes based on the potential for extreme losses; i.e., portfolios with higher PMLs for a selected return period may draw more capital to support

Catastrophe Model Use in Insurance

Claims / Fraud identification

- Forensic Models
  - Identifying the impacts of an event across the entire geographic footprint of the event
  - Understanding where the event occurred relative to insured portfolio allows company to triage claims resources
  - Can be used to verify coverage (i.e., did hail actually occur at a specific address)
  - In conjunction with vulnerability information from the probabilistic models, a reasonable first estimate of the total losses from an event can be made

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Catastrophe Model Use Considerations

Access to Model Output

- Model Software
  - Various – specified perils, platform, etc.
  - Employer/Principal leases software
  - Reinsurance Broker leases software
- Specifically designed analysis by Modeling Firm
- Related Services
  - Documentation, Training

Data and Model Settings

- Under Analyst's Control
  - Input Data
  - Analysis Selections
- Within Secure Model Software
  - Everything Else

Input Data (Under Analyst Control)

- Properties insured
  - Location
  - Characteristics (construction, occupancy, year built)
  - Insurance terms (deductibles, limits, values, reinsurance)

Analysis Selections

- Peril and Subperil (Shake, Fire Following, Sprinkler Leakage)
- Event Set (long-term hurricane frequency or medium/near-term/warm sea surface temperature hurricane frequency)
- Granularity/Degree of Detail
- Demand Surge (Post-Loss Amplification)
- Sensitivity Testing (for example, set characteristic to unknown)

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Within Secure Model Software

- Can’t be changed by analyst
  - Meteorology
  - Seismology
  - Vulnerability Curves
  - Distributions or parameters used

Avoid Gaps; Avoid Double Counting

- Peril Definition
- What is not included in model

Peril Definition Example

- Hurricane Event Definition Requirement from Florida Commission Loss Projection Methodology (FCHLPM)

…***shall reflect all insured wind related damages from storms that reach hurricane strength and produce minimum damaging windspeeds or greater in land in Florida.***

- Tropical storms not included

What is not included in model

- Hurricane examples
  - Damage in non-coastal states
  - Included implicitly but not explicitly
    - Contained in loss experience used as basis, but not considered separately or projected as an additional potential loss that could have a range of outcomes
    - Examples: Tree fall, Mold

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Variability and Uncertainty

Model	A	B	C	D	E
AAL	4,331	6,000	3,816	4,659	3,781
Median	99	133	58	824	31
InterQ Range	2,544	3,032	2,211	3,141	1,984
SD	13,240	16,144	10,831	10,267	12,272

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Variability and Uncertainty

How Many Models to Use

- One
- More than one
  - How to combine output
- How to decide

One Model or More Than One?

- One
  - Required by regulator
  - Recommend in Own Risk and Solvency Assessment (ORSA)
  - Deep and thorough knowledge
  - Resources needed
- More Than One
  - More views may be superior
  - Belief that different models are better in some perils
  - May provide more insight and areas to delve into deeper
  - Smooth out single-model changes

How to Combine Results

- Use Combined Results
  - Straight average
  - Weighted average
  - Other
    - Event by Event or Year by Year
    - Florida Hurricane Catastrophe Fund (see ratemaking report)

How to Combine Results

- One Plus
  - Compare results on a high level & adjust or ask questions if appropriate
  - Use one model for detailed work
  - Required by Florida with its public model

Cat and Non-cat Components

- Expenses
  - Loss Adjustment Expense
  - Underwriting/Inspection Expense
- Trending
- Territories
- Rating Factors (for example, year built)

Industry Experience With Models

- Common and Well-Understood
  - Earthquake
  - Hurricane (and surge, to a degree)
- Newer or Less Common
  - Severe Convective Storm/Tornado-Hail
  - Flood (especially inland)
  - Wildfire
  - Winter Storm

Cat Actuary vs. Traditional Actuary

Catastrophe Actuary vs. Traditional Actuary

- Catastrophe Actuaries have different skillsets
  - Actuarial exam curriculums don’t cover catastrophe modeling extensively.
  - Actuarial programs in universities lack catastrophe modeling components.
  - Traditional reserving and pricing techniques have limited use in catastrophe practice.

Catastrophe Actuary vs. Traditional Actuary

- Catastrophe Actuaries have different skillsets (cont'd)
  - Catastrophe modeling work involves a certain level of knowledge on meteorology, engineering, seismology, statistics, simulations, computer programming, database and finance
  - Catastrophe modeling work is less structured, more unpredictable
  - ASOP No. 38, *Using Models Outside the Actuary's Area of Expertise,* and ASOP No. 39, *Treatment of Catastrophe Losses in Property/Casualty Insurance Ratemaking,* provide good guidance for actuaries working in catastrophe related field

Catastrophe Actuary vs. Traditional Actuary

- Catastrophe Actuaries have a different mindset
  - Catastrophe modeling work involves more uncertainties
    - Source of the uncertainties
      - Hazard (event frequency, severity, characteristics)
      - Vulnerability –the biggest source of uncertainty and the most complicated
      - Quality of exposure data
      - Financial calculation – cause of loss, wind vs. storm surge
      - Non-modeled losses – tree damage in Hurricane Wilma, Hurricane Rita, mudslide following wildfire
    - Some uncertainties can be mitigated, but other uncertainties are systemic
    - It is important for Catastrophe Actuaries to understand the source of uncertainties and live with the uncertainties

Catastrophe Actuary vs. Traditional Actuary

- Catastrophe Actuaries have a different mindset (cont'd)
  - Balance the Precision vs. Accuracy
    - Precision and accuracy are two ways that scientists think about error
      - Accuracy refers to how close a measurement is to the **true or accepted value**
      - Precision refers to how close measurements of the same item are to each other
    - Precision is independent of accuracy. It is possible to be very precise but not very accurate, and it is also possible to be accurate without being precise. The best-quality scientific observations are both accurate and precise. Being precise and accurate is a traditional actuary's goal
    - With the level of uncertainties around cat modeling, accuracy is hard to achieve because true value is unusually unknown. Catastrophe actuaries want to avoid busy work to make things "precisely wrong"

Catastrophe Actuary vs. Traditional Actuary

- Catastrophe Actuaries have a different mindset (cont'd)
  - Balance the Precision vs. Accuracy (cont'd)
    - Example of being "precisely wrong": use models to calculate average annual hurricane loss, then adjust model results to match the historical results.
    - Example 2: PML = $2,876,543,212.5
  - May require heavy reliance on non-actuarial expertise as well as actuarial expertise, especially in non-traditional areas.
  - Other practical considerations
    - Balance the complexity and practicality
    - Avoid overfitting

Catastrophe Actuary vs. Traditional Actuary

- Continue to learn
  - iCAS/ISCM Cat Risk Management Certificate
  - Think outside of the traditional actuary box

Questions

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Catastrophe Models – November 2018

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