The Evolution of Catastrophe Models and the Regulatory Implications of Their Use

SERA Spring Meeting
April 2015
New Generation of Catastrophe Modeling

- Open loss models for ratemaking
- New risk metrics for monitoring solvency
Fundamental Structure of Catastrophe Models Hasn’t Changed Since First Model Introduced in 1987

Create a large sample of hypothetical events
Where? How big? How frequent?

For each event estimate intensity at each location

Based on intensity and exposure at each location estimate damage

Apply policy conditions to estimate insured losses

<table>
<thead>
<tr>
<th>Sim Year</th>
<th>Event ID</th>
<th>Loss ($ million)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>253</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>41</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>1627</td>
</tr>
</tbody>
</table>

Exceedance Probability (EP) Curve

- 1 in 100
- 1 in 250
Catastrophe Models Provide the Most Robust Framework for Loss Estimation, BUT

- The models will never be accurate

- Much of the model volatility (up and down) driven by modeling companies changing the assumptions NOT new science—scientists don’t know the “truth”

- AIR, RMS, and other first generation models are proprietary so
  - Insurers and regulators can’t see the assumptions driving loss estimates
  - Insurers and regulators have to spend a lot of time and resource trying to understand model updates and volatility in the numbers
  - Insurers have to develop costly processes around the models
  - Regulators have to develop costly processes to “review” the models

- How can the models and modeling processes improve?

- How do we move forward and advance the current state of practice?
RiskInsight® Open Loss Modeling Platform

- Starts with same components as traditional models
- Model components fully transparent
- Model assumptions accessible and can be controlled
  - Eliminate wide swings in loss estimates caused by changing assumptions
  - Fine-tune assumptions to better reflect company-specific books of business

Create a large sample of hypothetical events
Where? How big? How frequent?

For each event estimate intensity at each location

Based on intensity and exposure at each location estimate damage

Apply policy conditions to estimate insured losses

Hazard

Vulnerability

Financial
RiskInsight Hurricane Reference Model

- Grounded in scientific data from the normative sources
  - HURDAT database
  - Tropical cyclone reports
  - Scientific literature

- Detailed windfield simulation for estimating ground level wind speeds at fine location level resolution

- Robust set of 21,000+ damage functions accounts for construction and occupancy types, local building practices, and year built

- Damage functions consider mean damage rates as well as “secondary uncertainty” or variability around the mean
The Open Model Difference—Fully Transparent Events and Damage Functions
In Open Models Insurers Can Test and Control the Model Frequency and Severity Assumptions

<table>
<thead>
<tr>
<th>Name</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unnamed</td>
<td>1904</td>
</tr>
<tr>
<td>Unnamed</td>
<td>1906</td>
</tr>
<tr>
<td>Unnamed</td>
<td>1913</td>
</tr>
<tr>
<td>Unnamed</td>
<td>1916</td>
</tr>
<tr>
<td>Unnamed</td>
<td>1940</td>
</tr>
<tr>
<td>Able</td>
<td>1952</td>
</tr>
<tr>
<td>Hazel</td>
<td>1954</td>
</tr>
<tr>
<td>Gracie</td>
<td>1959</td>
</tr>
<tr>
<td>Cindy</td>
<td>1959</td>
</tr>
<tr>
<td>David</td>
<td>1979</td>
</tr>
<tr>
<td>Bob</td>
<td>1985</td>
</tr>
<tr>
<td>Hugo</td>
<td>1989</td>
</tr>
<tr>
<td>Gaston</td>
<td>2004</td>
</tr>
</tbody>
</table>

Wind Speed (mph)

Return Period (years)
Insurers Can Refine the Reference Damage Functions to Improve Their Loss Estimates

- Actual claims data (proprietary to the insurance companies)
- Knowledge and expertise on specialized books of business
- Site inspections for significant commercial and industrial properties
What This Means for Insurers and Regulators

- The catastrophe models are based on many assumptions and very few facts.

- Open models let you see the model assumptions and how they compare to historical data.

- Open models let you properly test how different sets of credible assumptions impact the loss estimates.

- Open models enable insurers to control the assumptions so their decisions (and homeowners rates) are not driven by volatile model updates.

- You don’t have to establish an expensive review process.

- You’ll better understand the models and, more importantly, the risk in your state.
“Near Term” Hurricane Models Lack Credibility and Have No Demonstrated Skill

Table 1: Number of Atlantic Hurricanes

<table>
<thead>
<tr>
<th>Year</th>
<th>Long-Term Average</th>
<th>Actual</th>
<th>AIR</th>
<th>EQECAT</th>
<th>RMS</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td>5.9</td>
<td>5</td>
<td>8.4</td>
<td>8.0</td>
<td>8.4</td>
</tr>
<tr>
<td>2007</td>
<td>5.9</td>
<td>6</td>
<td>6.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2008</td>
<td>5.9</td>
<td>8</td>
<td>6.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2009</td>
<td>5.9</td>
<td>3</td>
<td>6.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2010</td>
<td>5.9</td>
<td>12</td>
<td>6.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>29.5</td>
<td>34</td>
<td>35.6</td>
<td>40.3</td>
<td>40.4</td>
</tr>
</tbody>
</table>

Table 2: Number of U.S. Landfalling Hurricanes

<table>
<thead>
<tr>
<th>Year</th>
<th>Long-Term Average</th>
<th>Actual</th>
<th>AIR</th>
<th>EQECAT</th>
<th>RMS</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td>1.7</td>
<td>0</td>
<td>2.4</td>
<td>2.3</td>
<td>2.4</td>
</tr>
<tr>
<td>2007</td>
<td>1.7</td>
<td>1</td>
<td>2.0</td>
<td>2.3</td>
<td>2.4</td>
</tr>
<tr>
<td>2008</td>
<td>1.7</td>
<td>3</td>
<td>2.0</td>
<td>2.3</td>
<td>2.4</td>
</tr>
<tr>
<td>2009</td>
<td>1.7</td>
<td>0</td>
<td>2.0</td>
<td>2.3</td>
<td>2.2</td>
</tr>
<tr>
<td>2010</td>
<td>1.7</td>
<td>0</td>
<td>2.0</td>
<td>2.3</td>
<td>2.2</td>
</tr>
<tr>
<td>Total</td>
<td>8.5</td>
<td>4</td>
<td>10.4</td>
<td>11.5</td>
<td>11.6</td>
</tr>
</tbody>
</table>

Table 3: U.S. Insured Losses from Hurricanes ($ Billions)

<table>
<thead>
<tr>
<th>Year</th>
<th>Long-Term Average</th>
<th>Actual</th>
<th>Near Term Predictions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>AIR</td>
</tr>
<tr>
<td>2006</td>
<td>10</td>
<td>0</td>
<td>14.0</td>
</tr>
<tr>
<td>2007</td>
<td>10</td>
<td>0</td>
<td>11.6</td>
</tr>
<tr>
<td>2008</td>
<td>10</td>
<td>15.2</td>
<td>11.6</td>
</tr>
<tr>
<td>2009</td>
<td>10</td>
<td>0</td>
<td>11.6</td>
</tr>
<tr>
<td>2010</td>
<td>10</td>
<td>0</td>
<td>11.6</td>
</tr>
<tr>
<td>Total</td>
<td>50</td>
<td>15.2</td>
<td>60.4</td>
</tr>
</tbody>
</table>
There’s No Cyclical Pattern in Five Year Periods of Hurricane Losses
“There is low confidence in any observed long-term increases in tropical cyclone activity (i.e. intensity, frequency, duration) after accounting for past changes in observing capabilities”

“It is likely that the global frequency of tropical cyclones will either decrease or remain essentially unchanged”

“Average tropical cyclone maximum wind speed is likely to increase, although increases may not occur in all ocean basins—possible 2 to 11 percent increase by the end of the century”
Insurers Can Create a Custom Catalog in RiskInsight to Test the Impacts of Climate Change
Open Model Benefits to Insurers

- Full Transparency
- Lower Modeling Costs
- Enhanced Process Efficiencies
- Control Over Model Assumptions
- More Confidence in Risk Management Decisions
How Regulators Can Evaluate Rate Filings Based on Open Models

- Review the Reference Model
  - How do model frequency and severity assumptions compare to historical data?
  - How do event intensity footprints compare to historical events?
  - How do loss estimates compare to actual for historical events?
  - How does risk change by geography, e.g. coastal versus inland for hurricanes?

- Use open models to test ranges of credible assumptions to get range of credible loss costs

- How do an insurer’s assumptions differ relative to the Reference Model, IF customization has been done?
  - Compare frequencies and severities
  - Compare damage functions
  - Compare loss estimates
Traditional EP Curve Metrics Do Not Address Concentration Risk and Can Give a False Sense of Security

Exceedance Probability (EP) Curve

Probability $p(L)$ that losses will exceed $L$

- 1% for 1 in 100
- .4% for 1 in 250

Loss, $L$
100 Year CE Profile for Hypothetical Company

Event Losses by Landfall Point

© 2014 Karen Clark & Company
PMLs Mask Exposure Concentrations and Potential Out-sized Surprise Losses

100 Year CE Profile

100 Year PML
One Chart Summarizes Multiple Risk Metrics and Provides a Wealth of Information on Large Loss Potential

One CE Chart Summarizes What Boards Need to Know About Catastrophe Losses

Riskinsight® 3G, Karen Clark & Co.
There is not a clear relationship between PML and exposure. PML reduction scenarios can emphasize reductions across a large number of random events, without reducing peak events.

By providing visibility into the relationship between exposure and large losses, CE reduction scenarios focus attention on managing solvency impairing events.
Is It Better for Insurers to Look Like This…

100 Year PML
Or Like This...?

100 Year PML
Possible Metrics to Measure and Monitor Concentration Risk

- The CE-to-PML ratio
  - How does the peak CE spike relative to the PML compare to the industry?
  - How does the peak CE spike relative to the PML vary by insurer?

- The CE > PML metric
  - A measure of the cumulative miles of coastline for which CE > PML
  - Compare to industry and peer companies

- The CE distribution
  - Each CE loss above the PML probability weighted
  - Like a TVaR for the 100 year event losses (can calculate for other return periods)
Conclusions on Regulatory Impact of Model Evolution

- New generation open loss modeling platforms provide significant benefits to insurers and regulators
  - Full transparency on model assumptions
  - Enhanced understanding of loss potential in your state
  - Less volatility in loss estimates
  - More cost effective model review process
  - Higher confidence in regulatory decisions

- New risk metrics can help monitor solvency and insurer concentration risk