Thinking Outside the Black Box: New Approaches for Estimating Catastrophe Losses and the Impacts of Climate Change

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Houston, TX
Problems with Catastrophe Models from Regulatory Perspective

- Models are “black boxes” and don’t provide transparency on the underlying assumptions and calculations

- Model loss estimates are highly volatile between models and model versions from same modeling company

- No readily available methods for testing the loss estimates for credibility

- Can’t explain logic behind numbers and changes in numbers to consumers
KCC Consulting Engagements Reveal Consistent Themes and Challenges

- Insurance companies want more consistent and operational risk metrics for managing large loss potential
  - Model loss estimates are too volatile for effective risk management strategies
  - PMLs are not operational and are backward looking

- Insurance companies want more transparency around key drivers of loss
  - Too much time trying to decipher model differences and updates
  - No visibility on key model assumptions and loss drivers

- Insurance companies want more efficient and flexible platforms for building their own proprietary views of risk
What Everyone Would Like

- Consistency
- Transparency
- Efficiency
- Flexibility
- Open approach
New Approach: Scientifically-derived, Model-Independent Characteristic Events (CEs)

- CEs are defined-probability scenario events

- CEs are defined for different regions for return periods of interest such as 100, 250, and 500 year

- Wind footprints for the CEs are “floated” along the coast to estimate a range of loss estimates for each return period (similar to the USGS methodology of floating rupture zones along faults)

- CEs are comparable to model-generated events and have additional benefits
  - They are based on same scientific data but eliminate the fluctuations in loss estimates due to noise in the hazard component of the models
  - They are transparent and easily peer-reviewed by independent, external experts
  - They provide a set of scenario losses that can be monitored at the corporate level and drilled down to individual policies for marginal impact analyses
CEs Provide Transparent, Consistent Risk Metrics and a New Perspective on Risk
100 Year Texas CE

- Maximum over land wind speed is 167 mph (Category 5 hurricane)
- Typical track and other parameters for region
100 Year Florida CEs

- Max over land wind speed varies from 135 mph to 165 mph
- Max over land wind speed is 165 mph
- Max over land wind speed varies from 135 mph to 165 mph
- Storm track varies within each region
100 Year Northeast CE

- Intensity footprint is similar to 1938 Great New England
- Maximum over land wind speed is 122 mph
- Large radius as is typical for this region
- Typical track
Model-generated PMLs Mask Exposure Concentrations of Insurance Companies
CEs Enable Companies to More Effectively Monitor and Control Large Loss Potential

Alternative growth or contraction strategies can easily be quantified and evaluated.
Managing to PMLs Does Not Address Likely Solvency-impairing Events

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.
The CE Approach versus the Catastrophe Models – Defined Probability versus Event Sampling

Catastrophe Models – Event Sampling

- Wind speed
- Forward speed
- Landfall direction
- Radius of max. winds

Generated Event 1
Wind speed = 75 (SS1)
Rmax = 40

Generated Event 2
Wind speed = 152 (SS4)
Rmax = 13

Events are generated by sampling from parametric distributions.

CEs – Defined Probability Events

- Historical hurricane data from National Hurricane Center…

Characteristic Event 1, 2, ….
Wind speed = 122 (SS3)
Rmax = 40

Events are generated by identifying the characteristics with a specific return period.
Thinking Outside the Black Box

- The cat models will never produce accurate EP curves or PMLs
  - Scientists don’t know with a high level of confidence the return periods of large magnitude events in most peril regions—model assumptions are based on subjective opinions
  - There is little or no data on the vulnerabilities of different types of structures in most peril regions—model assumptions are based on engineering best guesses
  - Much of the model volatility is caused by “noise” and changing model assumptions not new scientific knowledge (can also be caused by errors and mistakes in the model)

- Characteristic Events (CEs) do not eliminate the uncertainty but they do lead to better, more consistent decisions in light of the uncertainty

- Using stratified sampling techniques and the floating methodology, a consistent, robust sample of events can be derived for risk management purposes
Insurance Companies Are Using the CE Approach for Catastrophe Risk Assessment and Management

- Estimate losses from 100 year and other return period events (and market shares of losses)
- Identify and manage exposure concentrations
- Develop growth templates to maximize profitability for a given loss level (using marginal impact analysis and efficient frontier analytics)
- Implement new risk transfer strategies to manage “spikes”
- Price with more robust policy-level loss results
- Monitor and manage loss potential over time
- Create customized and proprietary view of risk
Some Scientists Have Argued that North Atlantic Tropical Cyclone Activity is Increasing

Fig. 1. Time series of unadjusted HURDAT Atlantic basin TC counts over the period 1878–2006. Black line shows the annual count of tropical and subtropical storms, and hurricanes in the HURDAT database. Dashed lines indicate the linear least squares trends computed over the periods 1878–2006 and 1903–2006.

Paradox: No Such Trend in Landfalling Hurricanes

U.S. Hurricane Landfalls by Year

Other Scientists Have Argued Apparent Increases in Activity Are Due to Advances in Detection Technology.
Advances in Detection Technology Have A Dramatic Impact on Increasing Frequency of Short Duration Storms

Correcting for the “Tiny Tims” Removes the Perceived Trend in Storm Counts

Moderate to Long Lived Storm Frequency

Adjusted Long Duration Storm Frequency
No Trend in Hurricane Losses if Based on Today’s Property Values

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
<th>Region</th>
<th>Insured Loss ($B)</th>
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<tbody>
<tr>
<td>1926</td>
<td>Unnamed 7 (Great Miami)</td>
<td>Florida South</td>
<td>125</td>
</tr>
<tr>
<td>1928</td>
<td>Unnamed 04 (Lake Okeechobee)</td>
<td>Florida South</td>
<td>65</td>
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<tr>
<td>1900</td>
<td>Galveston</td>
<td>Texas</td>
<td>50</td>
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<tr>
<td>1947</td>
<td>Unnamed 04 (Fort Lauderdale)</td>
<td>Florida South</td>
<td>50</td>
</tr>
<tr>
<td>1992</td>
<td>Andrew</td>
<td>Florida South</td>
<td>50</td>
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<tr>
<td>1915</td>
<td>Unnamed 02 (Galveston)</td>
<td>Texas</td>
<td>40</td>
</tr>
<tr>
<td>2005</td>
<td>Katrina</td>
<td>Gulf</td>
<td>40</td>
</tr>
<tr>
<td>1938</td>
<td>Unnamed 04 (Great New England)</td>
<td>Northeast</td>
<td>35</td>
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<tr>
<td>1960</td>
<td>Donna</td>
<td>Florida, Northeast</td>
<td>25</td>
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<tr>
<td>1954</td>
<td>Hazel</td>
<td>Southeast</td>
<td>20</td>
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<tr>
<td>1965</td>
<td>Betsy</td>
<td>Gulf</td>
<td>20</td>
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<tr>
<td>1921</td>
<td>Unnamed 06 (Tampa Bay)</td>
<td>Florida Northwest</td>
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<tr>
<td>1945</td>
<td>Unnamed 9 (Homestead)</td>
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</tr>
<tr>
<td>1949</td>
<td>Unnamed 02</td>
<td>Florida Northeast</td>
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<tr>
<td>1954</td>
<td>Carol</td>
<td>Northeast</td>
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<td>1969</td>
<td>Camille</td>
<td>Gulf</td>
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<td>Wilma</td>
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<tr>
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<tr>
<td>1932</td>
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<td>1944</td>
<td>Unnamed 07</td>
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<tr>
<td>1944</td>
<td>Unnamed 11 (Pinar del Rio)</td>
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<td>1961</td>
<td>Carla</td>
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<td>Frederic</td>
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<td>1983</td>
<td>Alicia</td>
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<td>1989</td>
<td>Hugo</td>
<td>Southeast</td>
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<td>2004</td>
<td>Charley</td>
<td>Florida Northwest</td>
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<tr>
<td>2008</td>
<td>Ike</td>
<td>Texas</td>
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The period 2000 to 2009 was an *average* period with respect to catastrophe model average annual loss estimates – even with 2004 and 2005

<table>
<thead>
<tr>
<th>Year</th>
<th># Landfalls</th>
<th>Loss ($B)*</th>
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<tr>
<td>2000</td>
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<tr>
<td>2001</td>
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<td>2004</td>
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<tr>
<td>2005</td>
<td>5</td>
<td>66.2</td>
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<tr>
<td>2006</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>2007</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>2008</td>
<td>3</td>
<td>13.3</td>
</tr>
<tr>
<td>2009</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Average 1.7 10.1

Long-Term Average 1.8 10

* Adjusted to 2008 dollars  
Source: III, PCS
Most Recent IPCC Findings and Projections

- Best estimate range of projected temperature increase by the end of this century is 3.1 to 7.2 degrees Fahrenheit (total range is 2 to 11.5)

- Tropical cyclones are likely (>66%) to become more intense, with higher peak wind speeds and heavier precipitation (most likely range 2 to 5 percent increase in peak wind speeds over next 20 years)

- Most climate models project global decrease in tropical cyclone frequency
How Insurance Companies Can Think About Climate Change and Catastrophes

- No scientist or model can tell you what is going to happen
- Many scientists can give you many scenarios of what might happen
- A scientific approach, based on IPCC projections, would reflect gradual increases in hurricane intensity over time
- Use most likely scenarios for sensitivity and “what-if” analyses
  - A 2 percent increase in maximum wind speeds can result in a 10 percent increase in hurricane losses
  - A 5 percent increase in maximum wind speeds can result in an 25 percent increase in hurricane losses
  - Intensity increases occur over time, not in one year
Increases in Hurricane Losses Under Different Climate Change Scenarios

- Increases in losses due to more and higher values properties (no climate change)
- Increases in losses if 2% increase in storm intensity over 20 years
- Increases in losses if 5% increase in storm intensity over 20 years
### Some Significant Historical Tornado Events

#### 1896 St. Louis-East St. Louis tornado

- **Date of tornado outbreak**: May 27–28, 1896
- **Duration**: Unknown
- **Maximum rated tornado**: F4
- **Tornadoes caused**: Unknown
- **Damages**: $3.8 billion (2009 US$)

#### Tri-State Tornado

- **Date of tornado outbreak**: Wednesday, March 18, 1925
- **Duration**: 3.5 hours
- **Maximum rated tornado**: F5
- **Tornadoes caused**: 9 known
- **Damages**: 747+ (695+ from one tornado)

#### Palm Sunday (1965) Tornado Outbreak II

- **Date of tornado outbreak**: April 11–12, 1965
- **Duration**: ~11 hours
- **Maximum rated tornado**: F4
- **Tornadoes caused**: 47
- **Damages**: $1.6 billion (2007 dollars)[1]
Annual Number of Strong Tornadoes Since 1950
Key Points on Climate Change

- Large loss years are random years driven by a major event striking a populated area or high frequency of events
  - Will happen periodically
  - Do not indicate trends
  - Should always be prepared for

- Apparent trends in tropical cyclone frequency are due to better detection technology—particularly for short duration “Tiny Tims”

- According to scientific consensus, global warming is likely to cause fewer but potentially more intense storms—gradually over the next 20 years

- No scientific correlation between global warming and tornado activity
New Approaches Provide Regulators with Important Benefits

- CE approach provides new scientific perspective on cat risk
  - Transparent risk metrics
  - Credible and consistent loss estimates
  - More cost effective than building an NAIC catastrophe model

- Regulators can develop credible, scientific, a priori view of catastrophe loss potential for the entire state and at high resolution
  - For better understanding the hurricane risk within each state
  - For benchmarking and testing the model-generated loss estimates
  - For effective communication with consumers and other stakeholders

- Can test potential climate change scenarios