KAREN CLARK & COMPANY

Building a Robust Framework for Managing Catastrophe Risk

32nd Annual Caribbean Insurance Conference

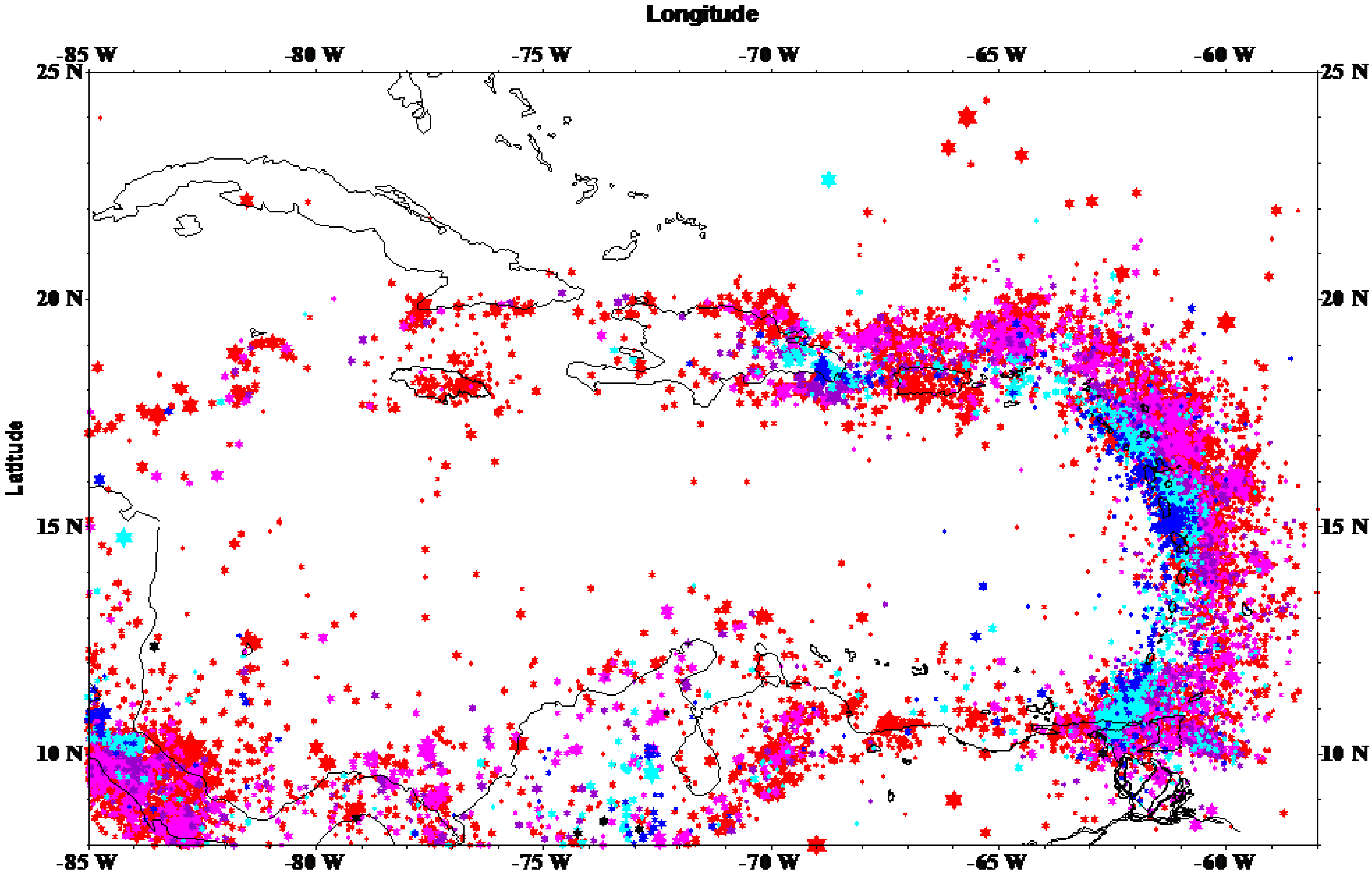
June 5, 2012

Discussion Agenda

- Earthquake and hurricane risk in the Caribbean region
- The limitations of catastrophe models
- Building a robust risk management framework that is informed by the models but not based on the models

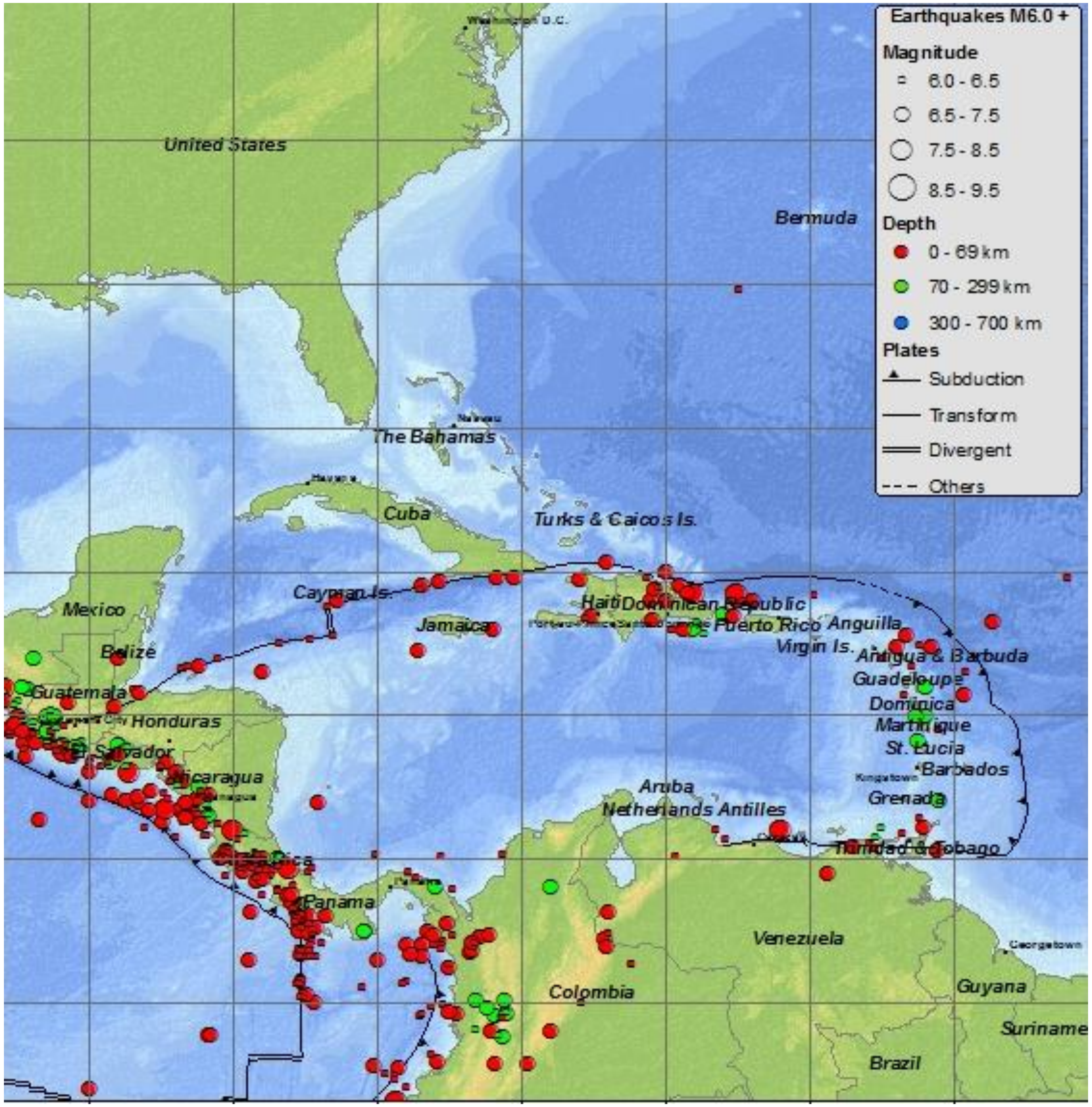
Caribbean Region is Impacted by the Complex Interaction Between the Caribbean and North American Plates

Where There is Frequent Seismic Activity



Source: Seismic Research Unit, The University of the West Indies

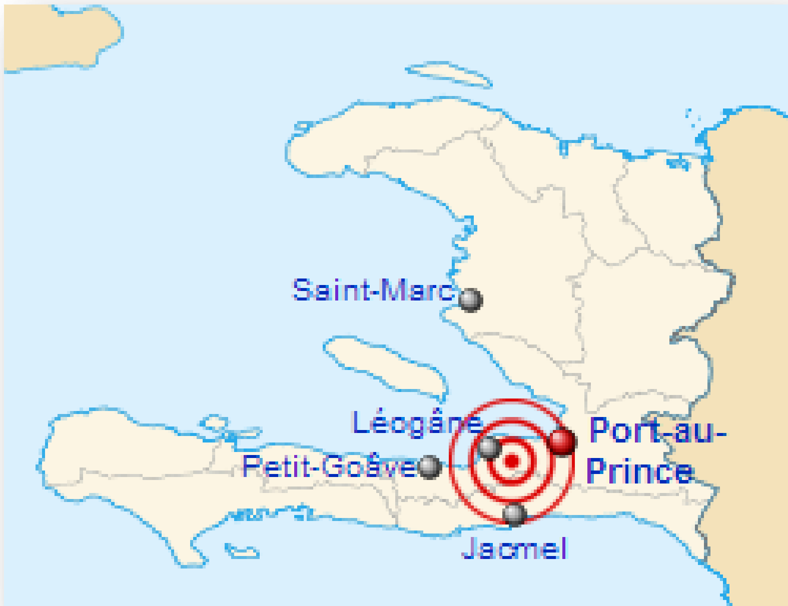
Historical Earthquakes With Magnitudes Greater than 6



Significant Events Over the Last Few Centuries

Year	Location	Magnitude	Fatalities
1692	Jamaica		2,000
1787	Puerto Rico	M 8.0	
1843	Leeward Islands	M 8.3	5,000
1907	Kingston, Jamaica	M 6.5	1,000
1918	Mona Passage	M 7.5	116
1946	Samana, Dominican Republic	M 8.0	100
1969	Guadeloupe, Leeward Islands	M 7.2	
1974	Leeward Islands	M 7.5	
2004	Leeward Islands	M 6.3	1
2004	Cayman Islands Region	M 6.8	
2006	Gulf of Mexico	M 5.8	
2007	Martinique Region, Windward Islands	M 7.4	1

2010 Haiti Earthquake Occurred in Lower Risk Region

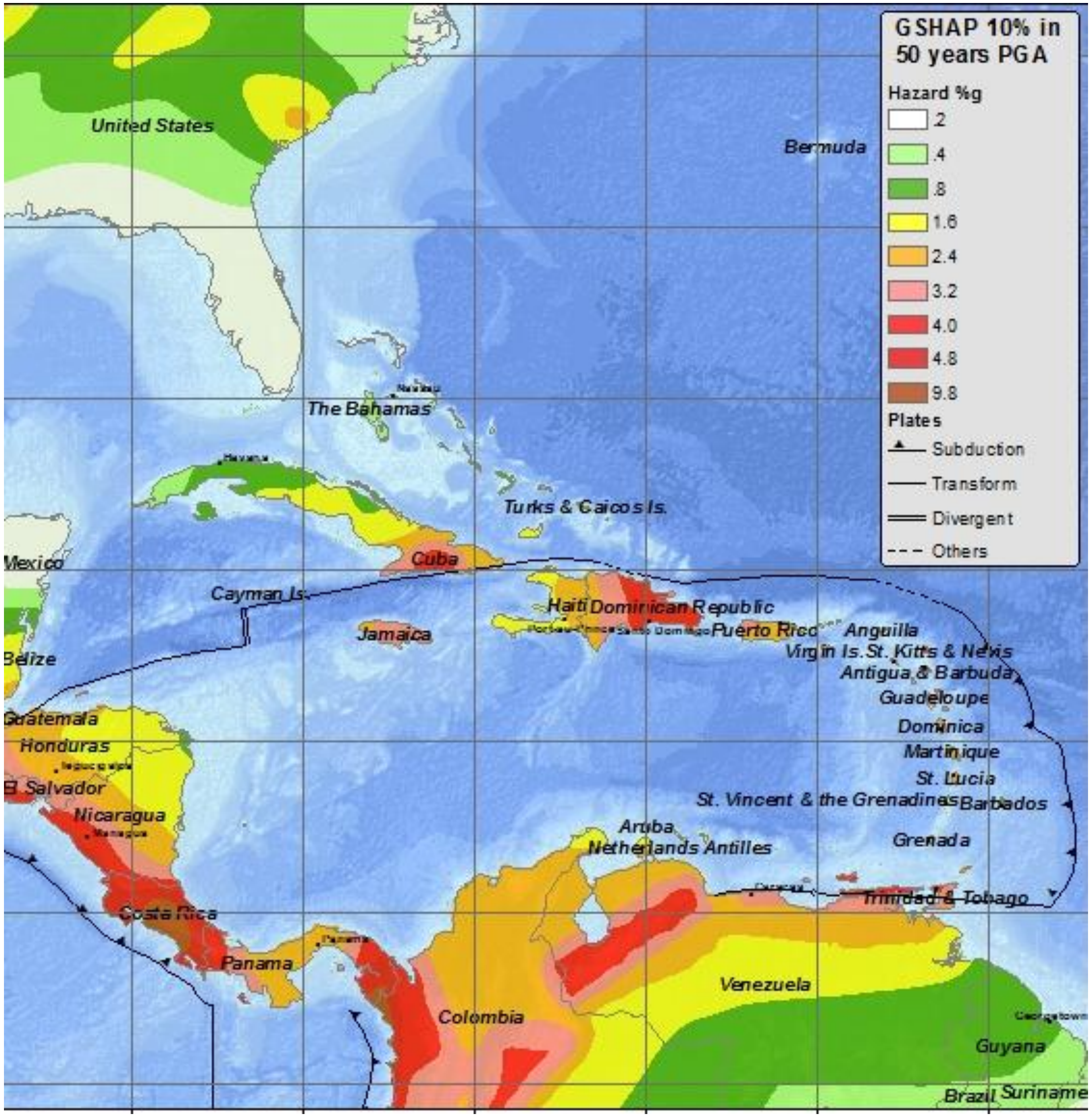


Source: Wikipedia.org

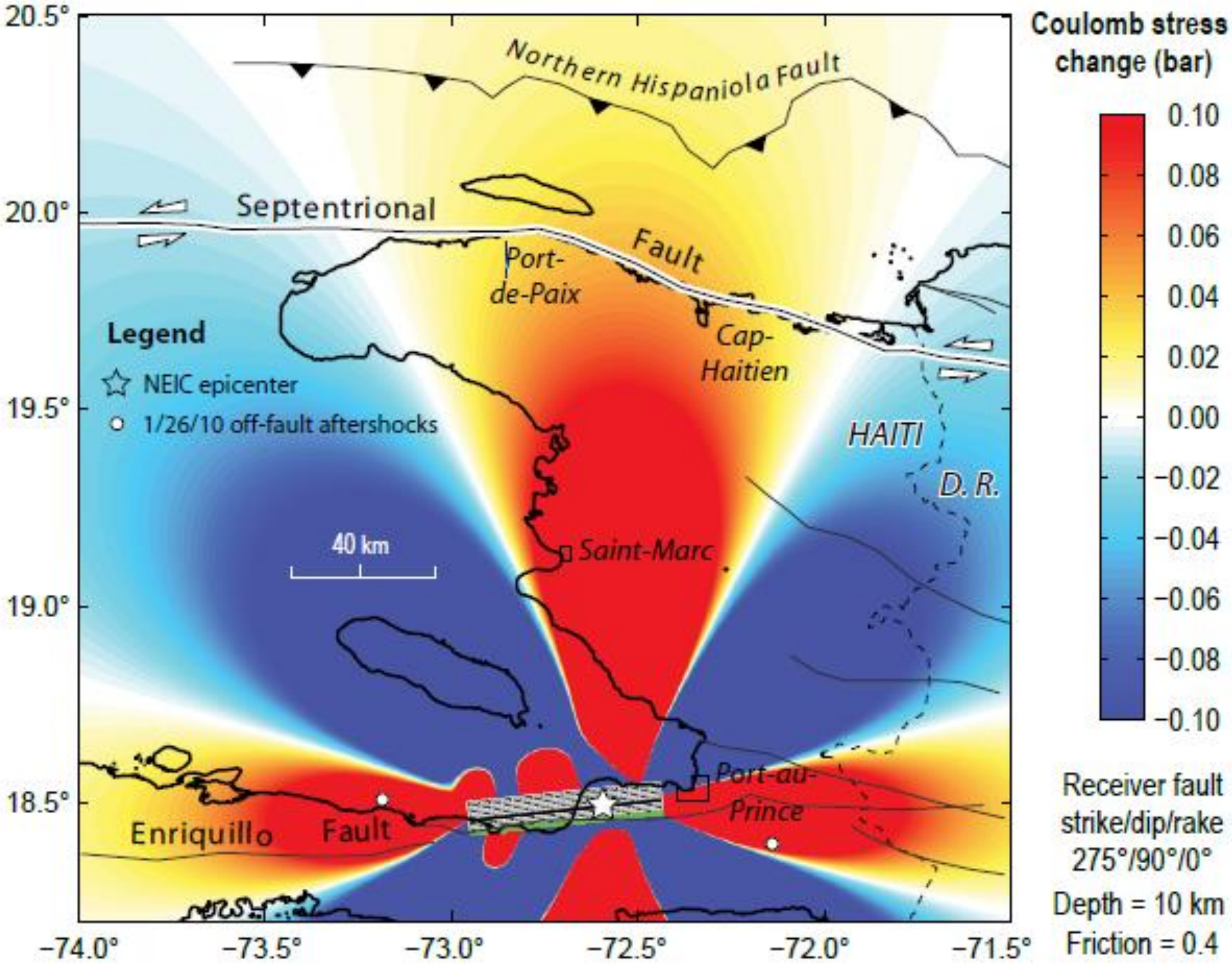
Date:	12 January 2010
Time:	16:53:10 (−05:00)
Magnitude:	7.0 M_w
Depth:	13 km (8.1 miles)

Deaths:	230,000
Injuries:	300,000
Homeless:	1,000,000
Economic Loss:	$8–11 billion

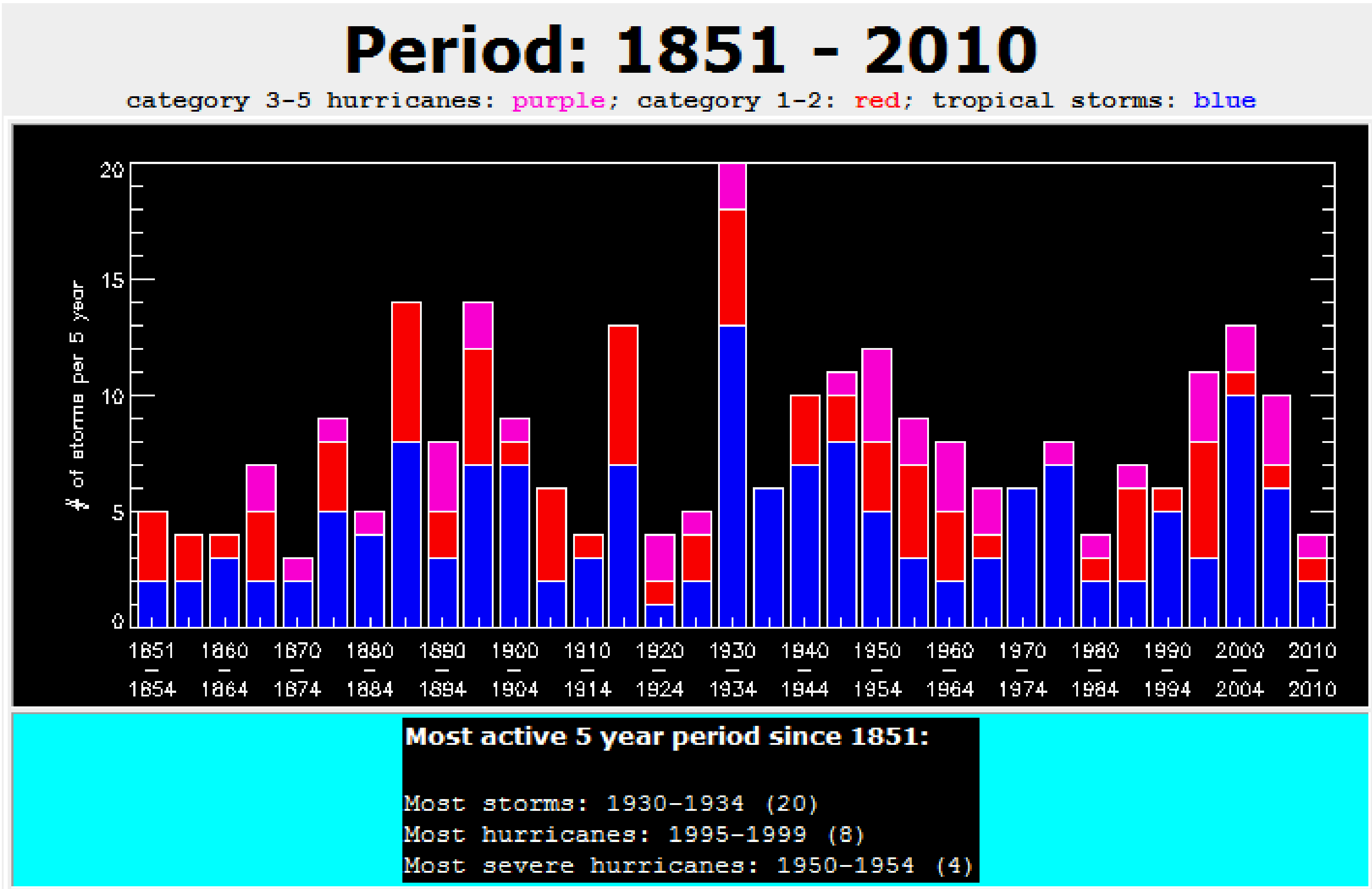
Tectonic Setting and Historical Data Go into Creation of the USGS Seismic Hazard Maps



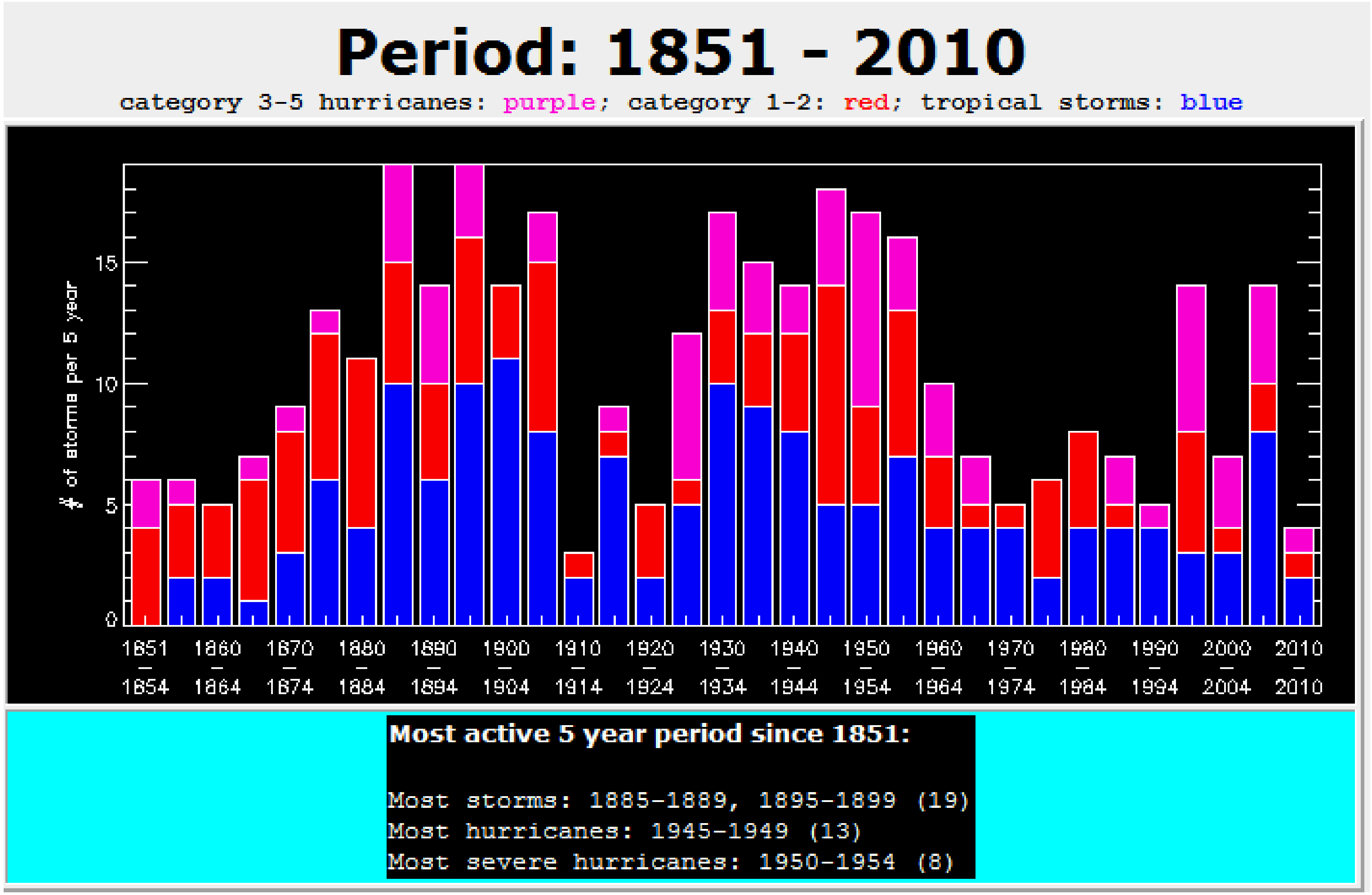
How Has the Haiti Earthquake Affected Stress Build-Up in this and Other Parts of the Seismic Zone?



Tropical Cyclones in the Eastern Caribbean Region



Tropical Cyclones in the Bahamas Turks & Caicos Region

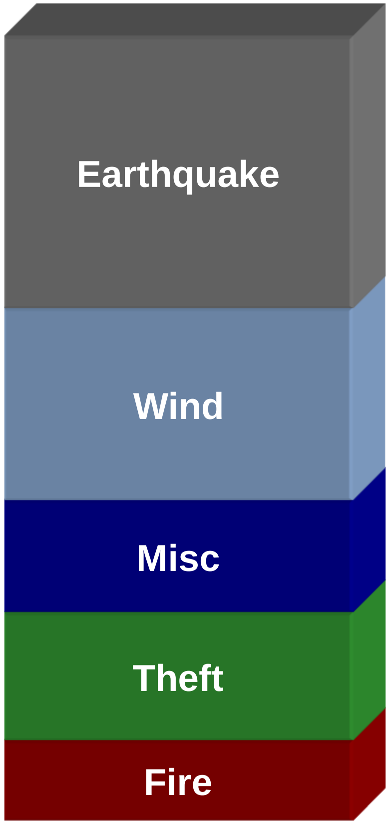


Recent Significant Insured Loss Producing Hurricanes

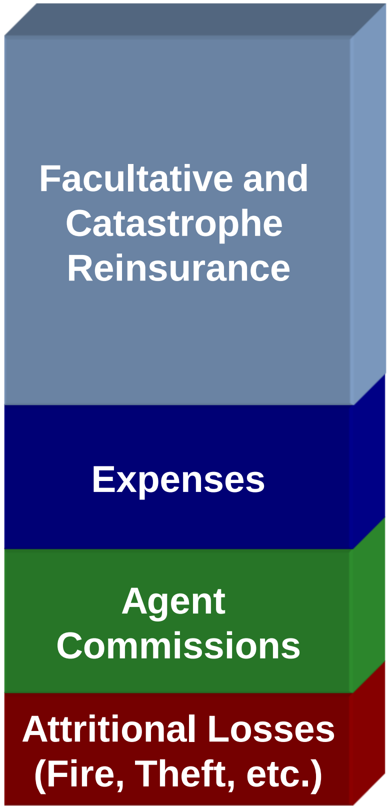
Hurricane: Date	Country Most Affected	Reported Damaged
Mitch: Oct 1998	Honduras	$5-7 billion
Georges: Sep-Oct 1998	Puerto Rico	$3.5 billion
Marilyn: Sep 1995	U.S.V.I.	$3.0 billion
Luis: Aug-Sep 1995	St. Maartin	$2.5 billion
Hugo: Sep 1989	U.S.V.I.	$1.8 billion
Joan: Oct 1988	Nicaragua	$2.0 billion

Catastrophe Risk Dominates in Many Caribbean Countries

Catastrophe Perils Dominate Each Premium Dollar



Reinsurance Costs are Largest Expense Items

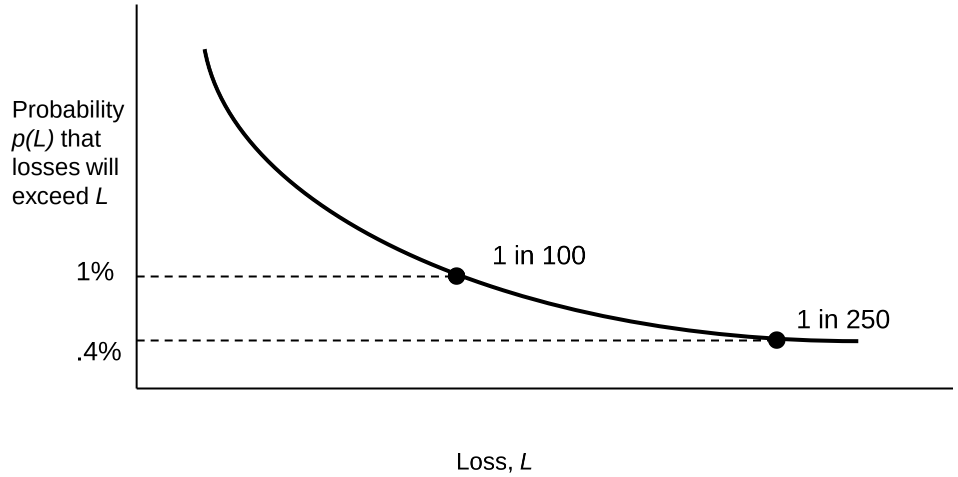


How the Catastrophe Models Work

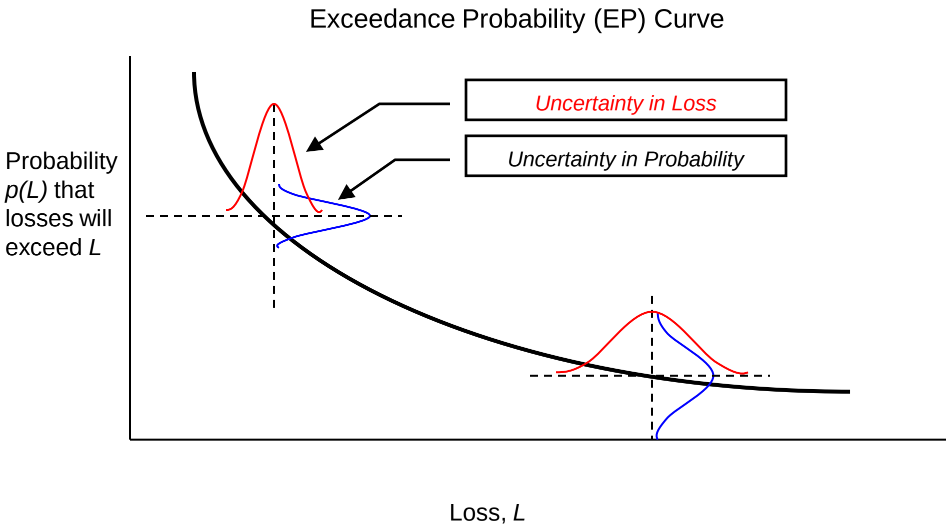
1. Create a large sample of hypothetical events
   Where? How big?
   How frequent?
2. For each event calculate intensity at each location
3. Based on intensity and exposure at each location calculate damage
4. Apply policy conditions to estimate insured losses

Sim Year	Event ID	Loss ($ million)
1	1	253
1	2	41
2	1	5
3	1	1627
.	.	.
.	.	.

Exceedance Probability (EP) Curve

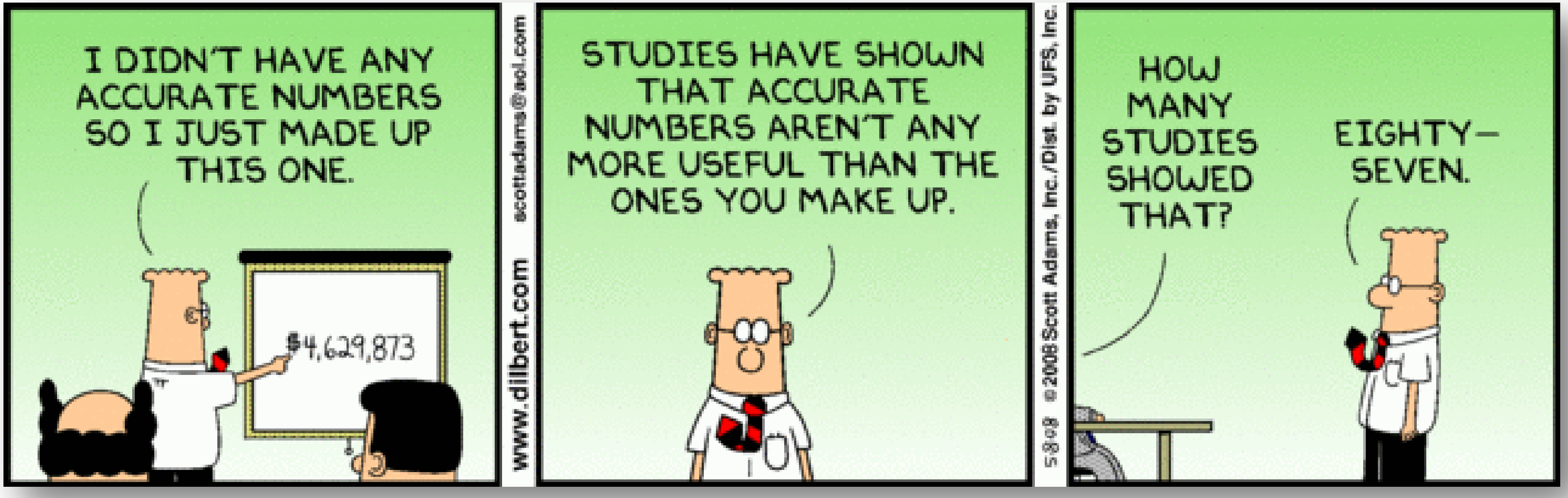


Why Every Model and Every Model Update Gives a Different Number



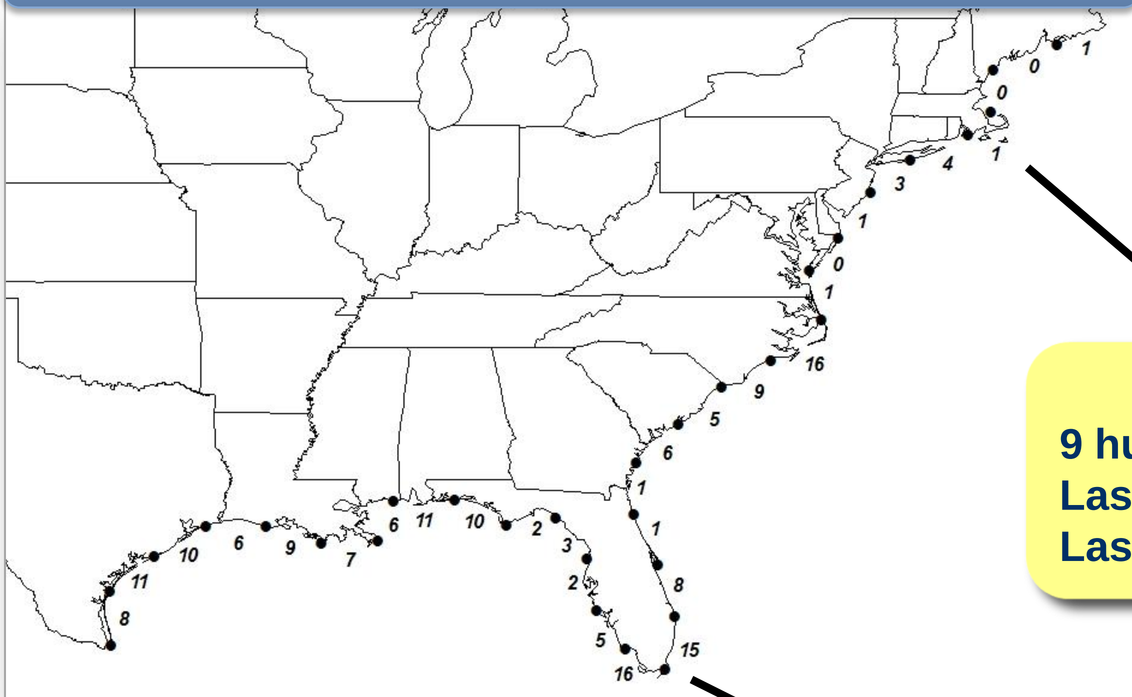
- Uncertainty around scientific estimates of frequency and severity of large magnitude events in specific geographical areas
- "Unknowledge" with respect to ground motion, dynamics of wind speeds
- "Unknowledge" about how structures respond to wind and ground motion intensity
- Model error

If the Models Have So Much Uncertainty Why Do We Try to Base Decisions on a Number (PML)?



Uncertainty and Unknowns Are Due to Paucity of Scientific Data

US Hurricane Landfalls 1900 to 2007



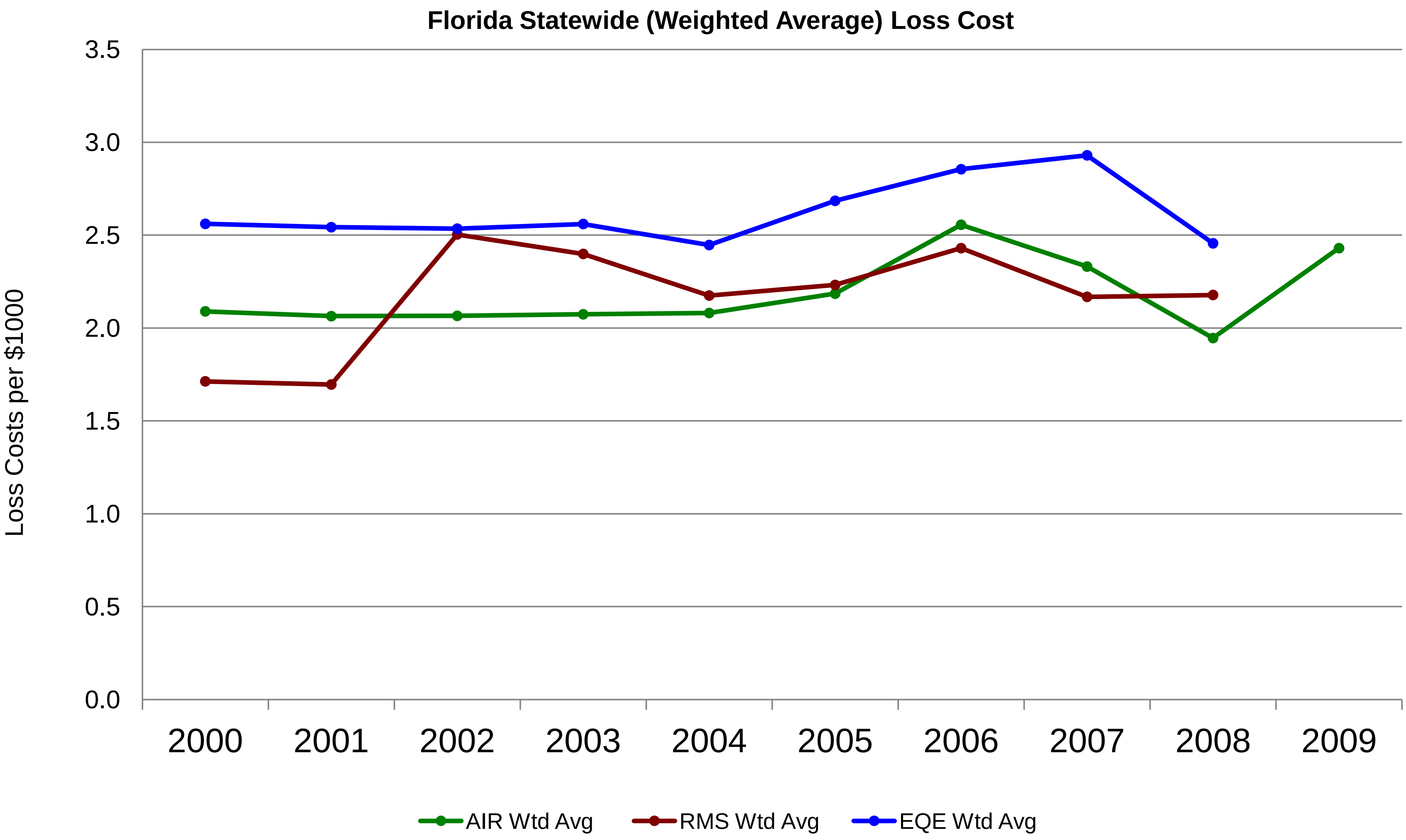
<u>Northeast</u>

9 hurricane landfalls since 1900
Last hurricane was 1991
Last major hurricane was 1938

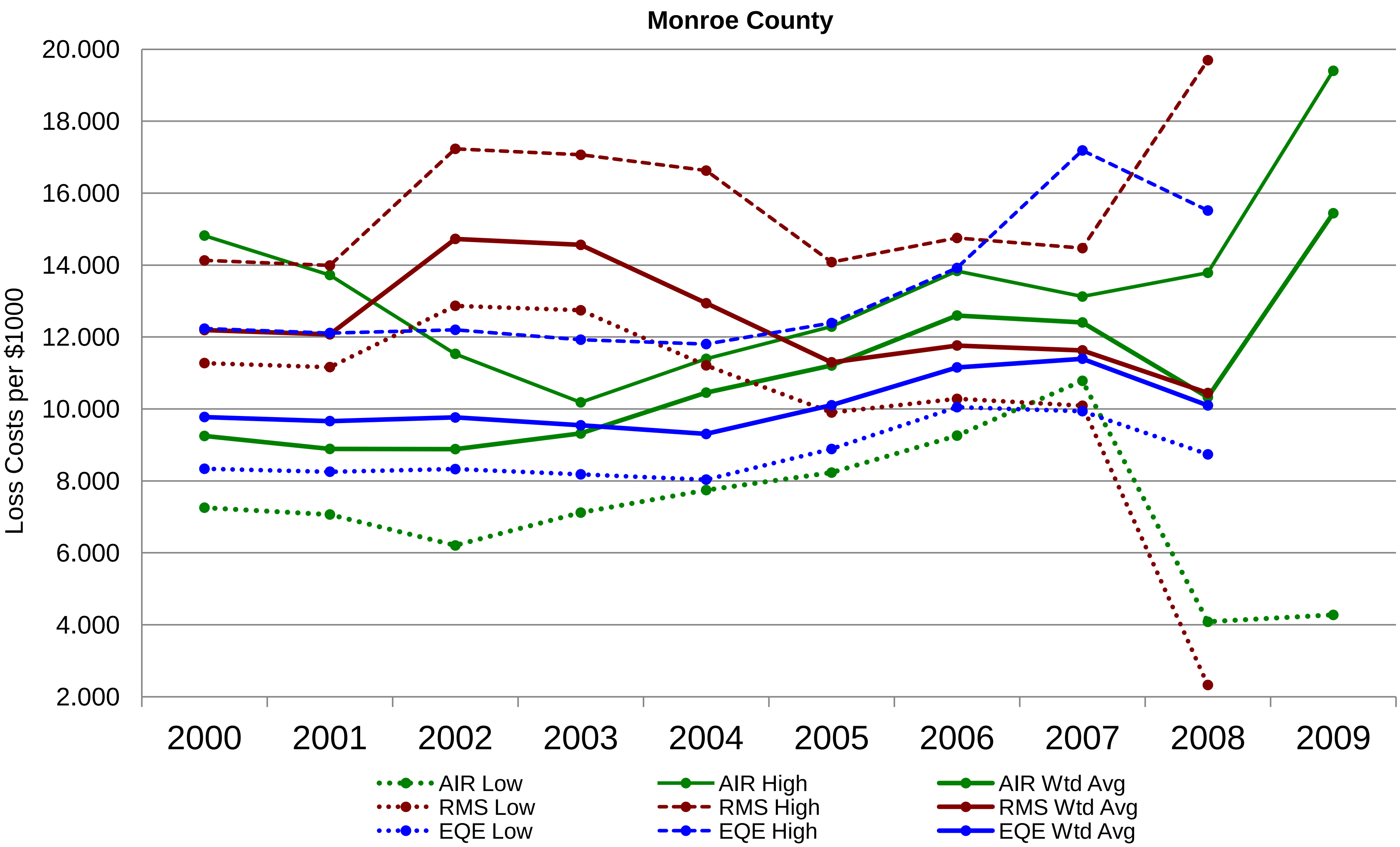
<u>Florida</u>

63 hurricane landfalls since 1900
6 significant hurricanes over 2004 and 05 seasons
Approximately $35 billion in claims data in 04 and 05

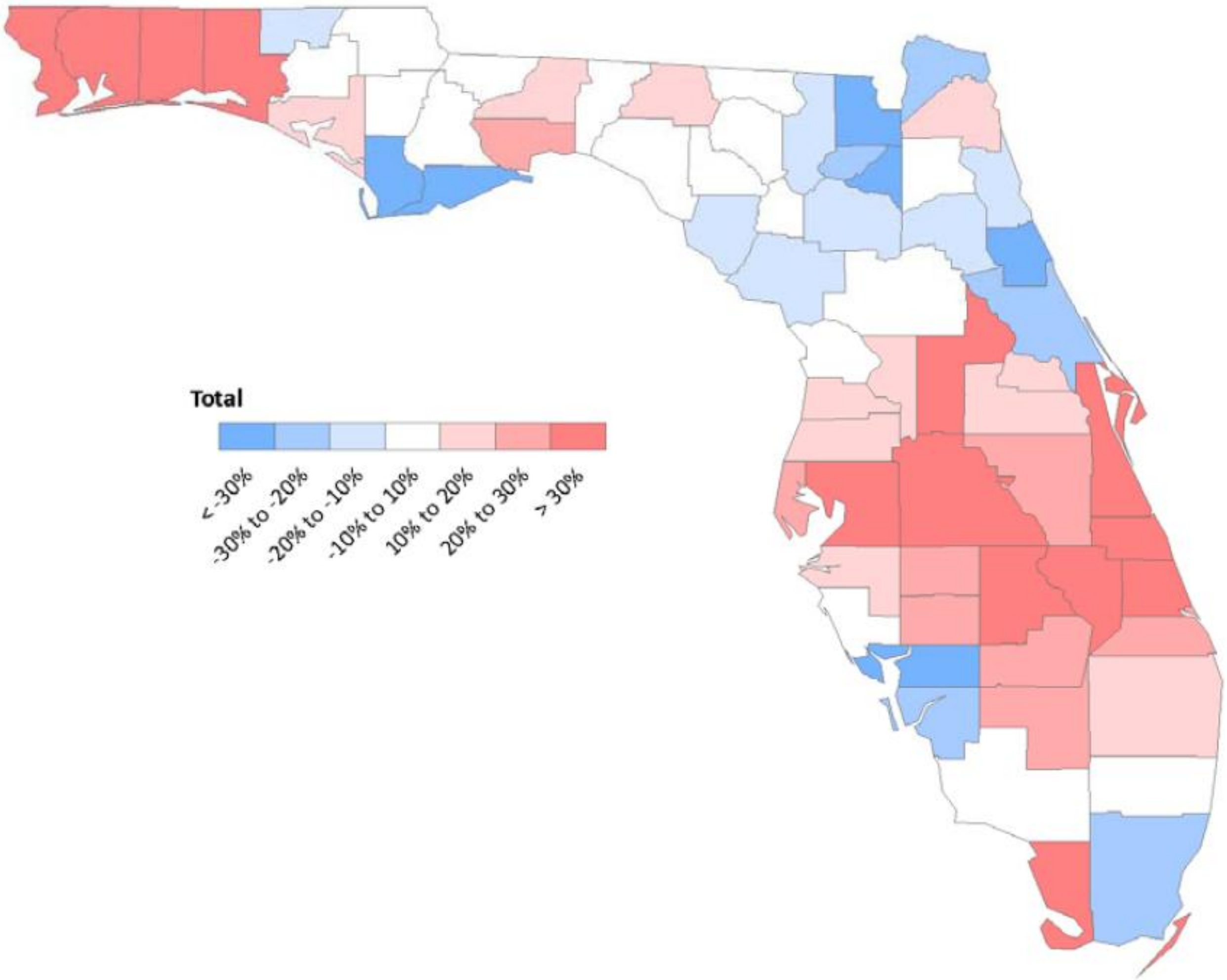
Much of the Volatility in Model Loss Estimates is Due to “Noise” and Not New Scientific Knowledge



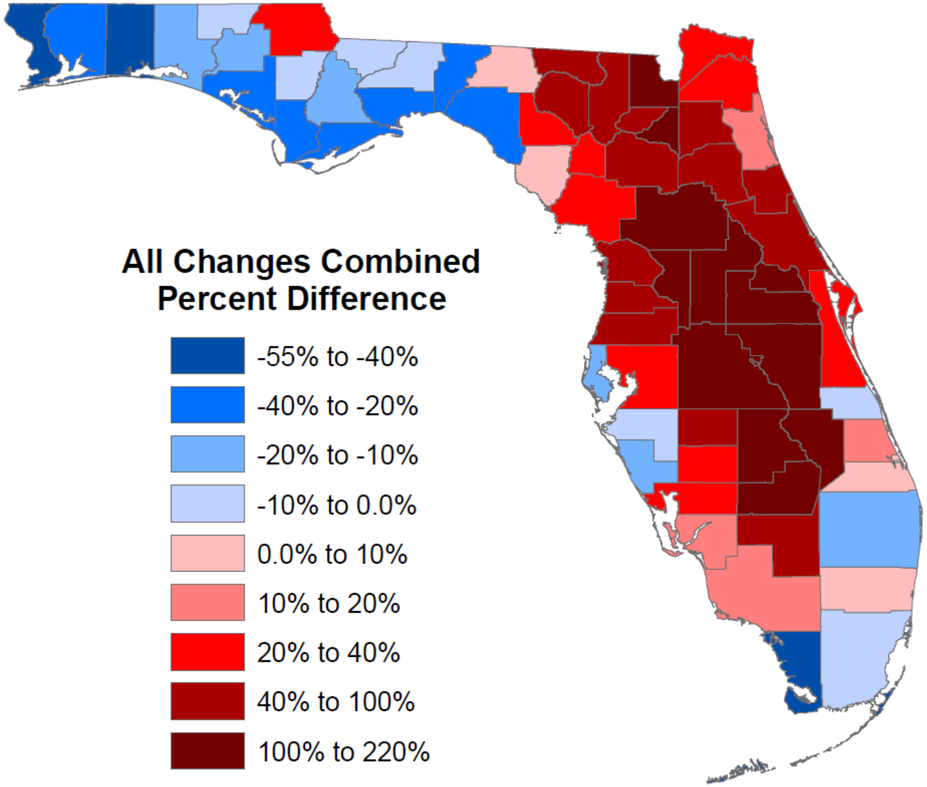
Uncertainty and Noise Are Greater at Higher Resolution



AIR Florida Changes by County in 2010

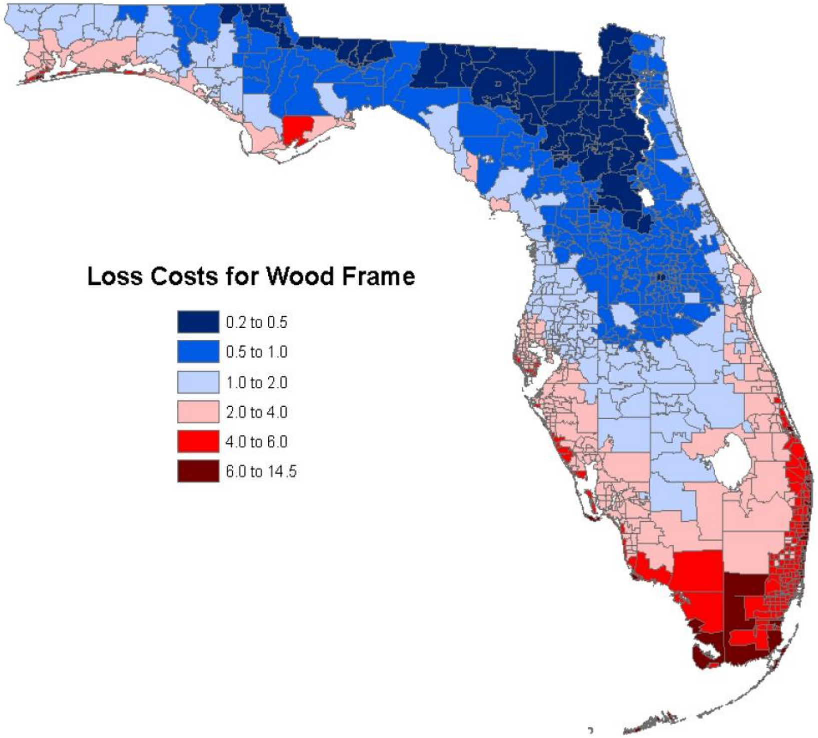


RMS V11 Florida Changes by County

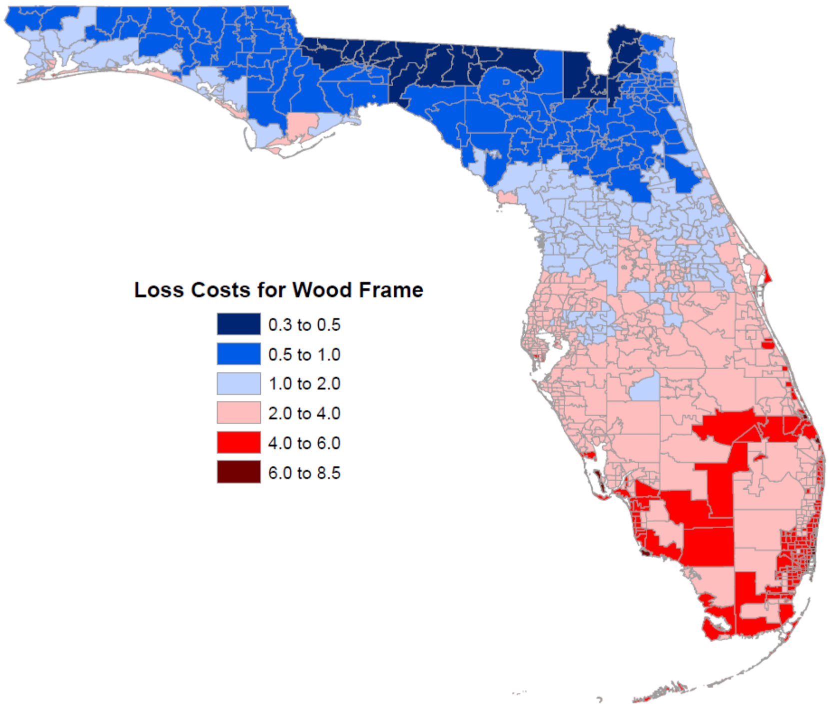


RMS v11.0 SP1

RMS Before and After Picture of Relative Risk by Zip Code



RMS v8.0.1a



RMS v11.0 SP1

RMS V11 is an Outlier in Florida

Top 10 Florida Loss Cost Counties in Descending Order for Wood Frame SFH

AIR v12	EQECAT 2011a	RMS v8.0.1a	RMS v11.0.SP2
MONROE	MONROE	MONROE	MARTIN
PALM BEACH	MIAMI-DADE	MIAMI-DADE	OKEECHOBEE
MIAMI-DADE	BROWARD	BROWARD	HENDRY
BROWARD	PALM BEACH	PALM BEACH	GLADES
MARTIN	MARTIN	MARTIN	MIAMI-DADE
OKALOOSA	OKEECHOBEE	OKEECHOBEE	COLLIER
INDIAN RIVER	INDIAN RIVER	INDIAN RIVER	LEE
SANTA ROSA	SAINT LUCIE	SAINT LUCIE	SAINT LUCIE
ESCAMBIA	HENDRY	HENDRY	BROWARD
COLLIER	COLLIER	COLLIER	MONROE

V11 Helped to Dispel the Myths Surrounding Catastrophe Models

- The models are not getting more accurate over time
  - ✓ Not enough reliable data for any degree of accuracy
  - ✓ Much of the volatility in the loss estimates is due to scientific “unknowns” versus new scientific knowledge

- An updated model is not necessarily a better, more credible model
  - ✓ Over specification combined with high sensitivity of loss estimates to small changes in model assumptions
  - ✓ Over calibration to most recent event(s)

- The catastrophe models are not objective tools
  - ✓ Most model assumptions are based on the subjective judgments of scientists and engineers rather than objective data
  - ✓ Different scientists have their own opinions and biases
  - ✓ Scientists can change their minds

A Chainsaw is a Great Tool, but Probably not for Brain Surgery

Don't worry, this is the most scientifically advanced chain saw. It's version 15.0!

Is Model Blending the Answer?

- Blending model results does reduce the dependence on one model and the volatility in model results

- However, there are several disadvantages of model blending
  - ✓ Ideally model weights would differ by peril region, by occupancy type and possible other factors, but individual accounts span multiple regions and occupancies so very difficult to apply consistently at an account level
  - ✓ Significant ongoing resources as the models have to be re-tested and all of the weights adjusted every time there is a model update
  - ✓ Very expensive and time-consuming to run every account through multiple models
  - ✓ No model may be credible for some accounts/regions

- "The average of multiple wrong numbers still gives a wrong number"

Why It's Time for the New Generation Tools

- Catastrophe modeling technology is 25 years old and hasn't changed fundamentally since the first models introduced in the late 1980s
  - ✓ Models have same components and structure
  - ✓ As the models have become more detailed and complex, they have become more volatile and prone to mistakes and human error
  - ✓ Instead of providing "more for less" over time, models continue to become more expensive and resource intensive

- When problems are detected, takes years to get a model update that "fixes" the problem—why did it take RMS so long to fix their inland filling problem when the market had known about it for a long time? (And is it really fixed?)

- Lack of transparency on underlying calculations
  - ✓ Difficult to distinguish improvements from noise and other problems with the models
  - ✓ Too much valuable time spent trying to decipher model changes
  - ✓ External stakeholders, such as rating agencies, have growing expectations with respect to insurer "ownership" of risk and ability to explain it

- Model loss estimates are highly volatile and subject to large swings between models and model updates
  - ✓ Disruptive to underwriting and business strategies
  - ✓ Cannot monitor effectiveness of risk management strategies over time
  - ✓ PMLs are not robust or operational risk metrics

The Modelers Agree

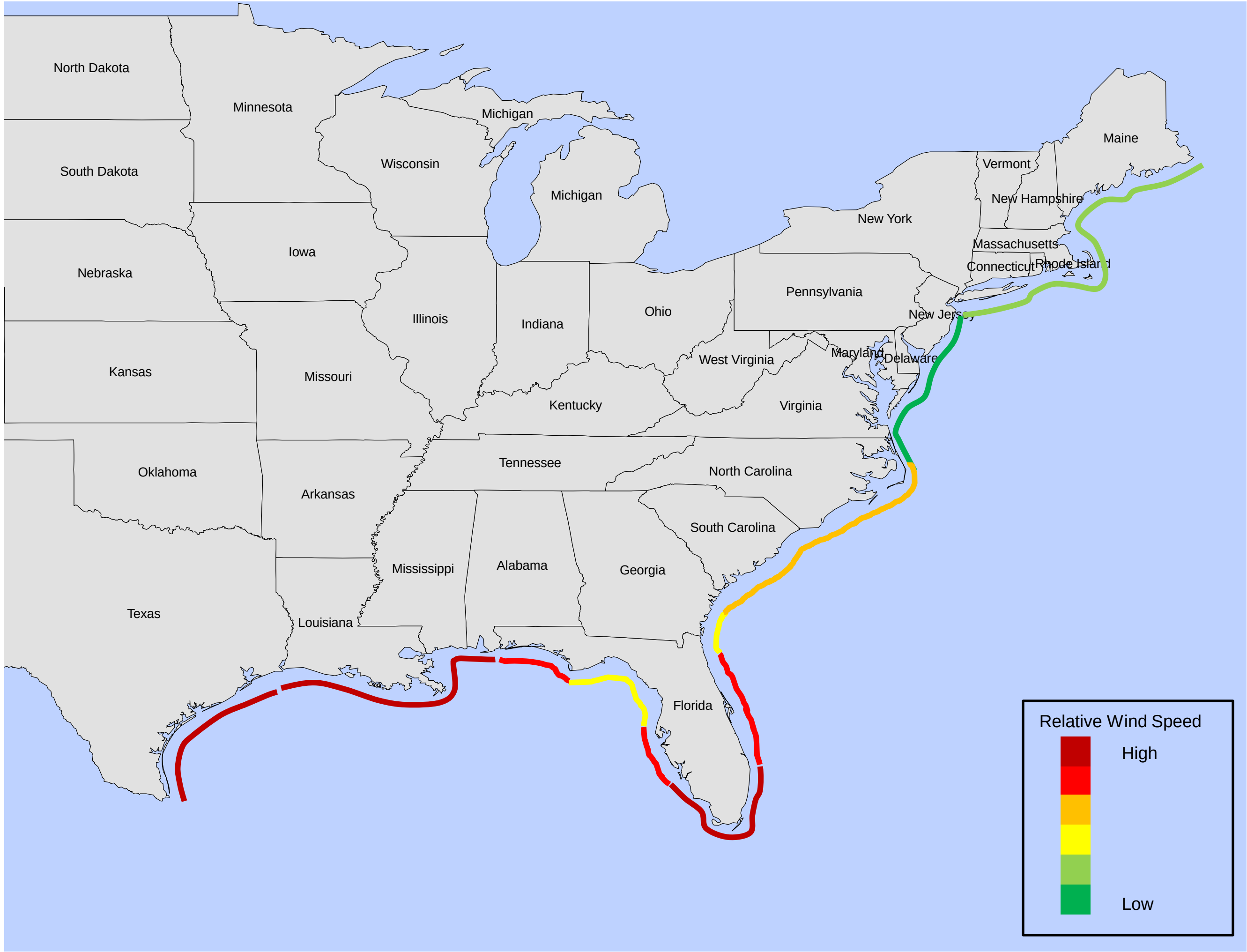
"A catastrophe model is not the only tool and should not be the only tool companies use to assess risk."

Michael Young,
Senior Director for Mitigation and Regulatory Affairs, RMS,
speaking at the NAIC Northeastern Zone Meeting, June 2011

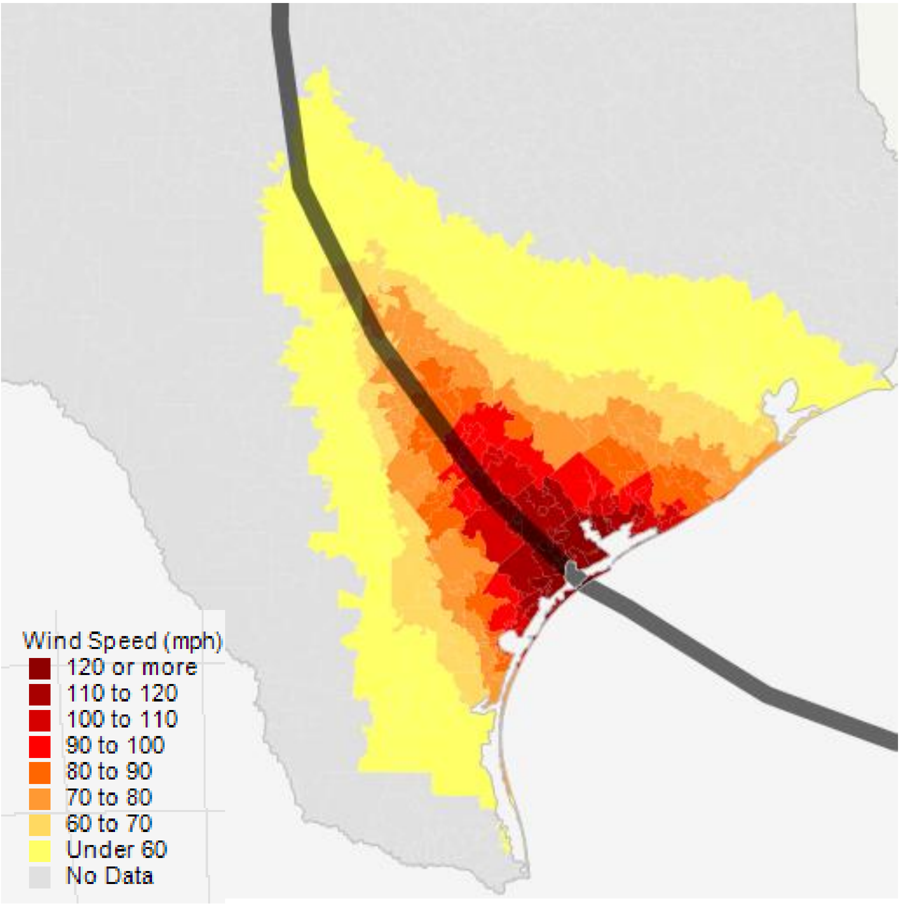
Scientifically-derived, Model-Independent Characteristic Events (CEs) Provide an Additional Tool

- 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
- 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 if desired
  - ✓ The expected CE loss for each region can be compared to model-generated PMLs

CE Parameters Vary by Region



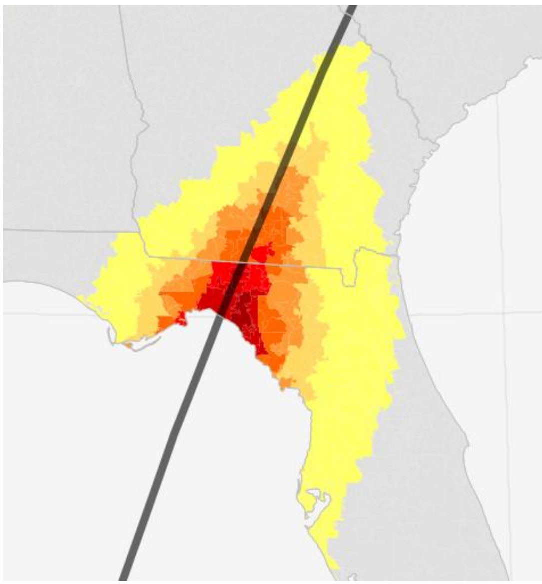
100 Year Texas CE



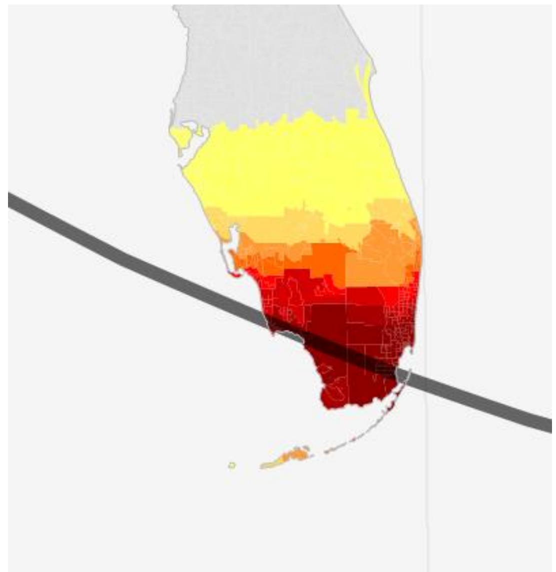
- Footprint is similar to 1900 Galveston event
- Maximum over land wind speed is 167 mph (Category 5 hurricane)
- Typical track for region

100 Year Florida CEs

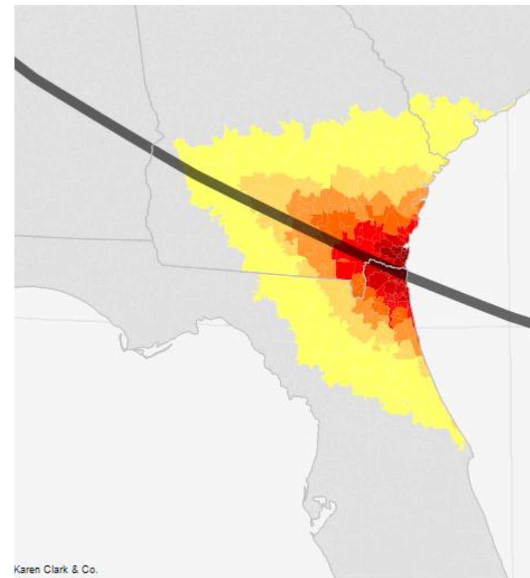
Florida NW



Florida SO



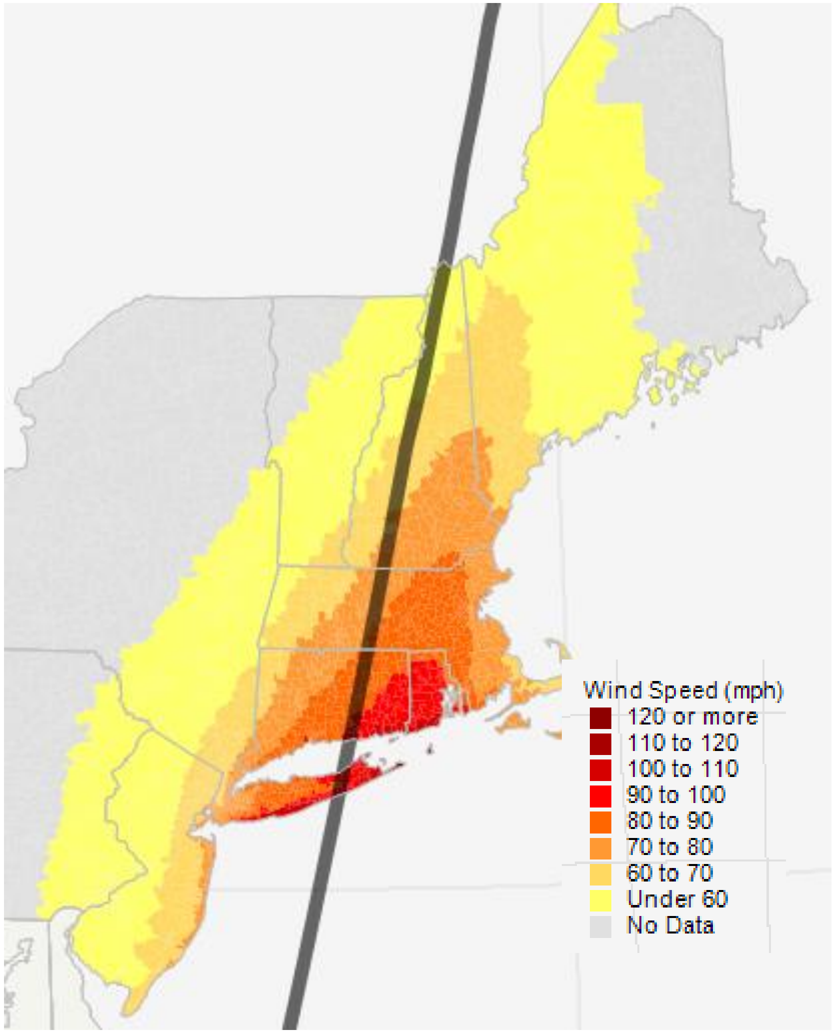
Florida NE



- Max over land wind speed varies from 135 mph to 164 mph
- Max over land wind speed is 167 mph
- Max over land wind speed varies from 135 mph to 164 mph

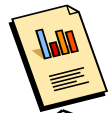
- Storm track varies within each region

100 Year Northeast CE



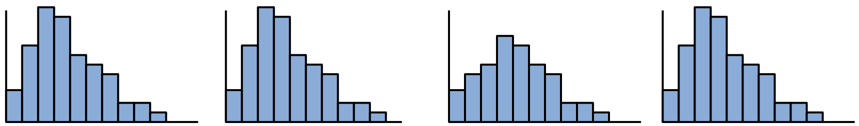
- Intensity footprint is similar to 1938 Great New England
- Maximum over land wind speed is 122 mph
- Large radius as is typical for this region
- Typical track

Differences from Catastrophe Models – Defined Probability versus Randomly Generated Events



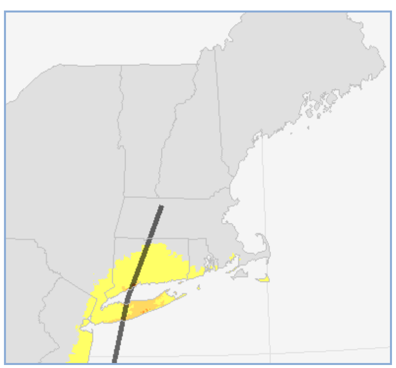
Historical hurricane data from National Hurricane Center…

Catastrophe Models – Random Events

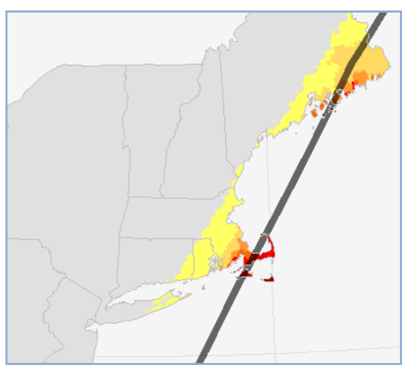


- Wind speed
- Forward speed
- Landfall direction
- Radius of max. winds

Random Event 1
Wind speed = 75 (SS1)
Rmax = 40
…..

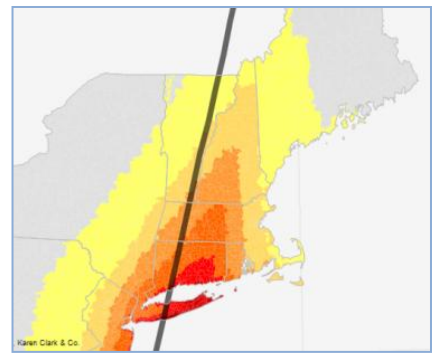


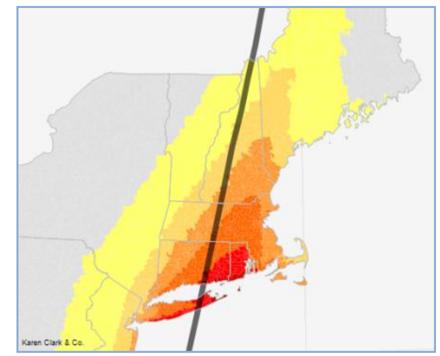
Random Event 2
Wind speed = 152 (SS4)
Rmax = 13
…..

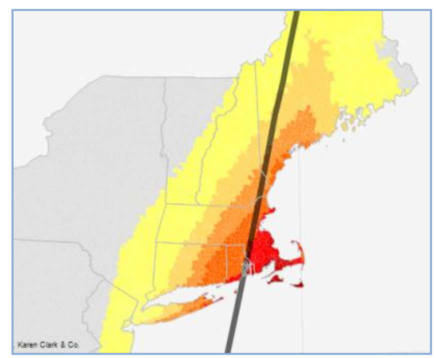


Events are generated by random sampling from parametric distributions.

CEs – Defined Probability Events







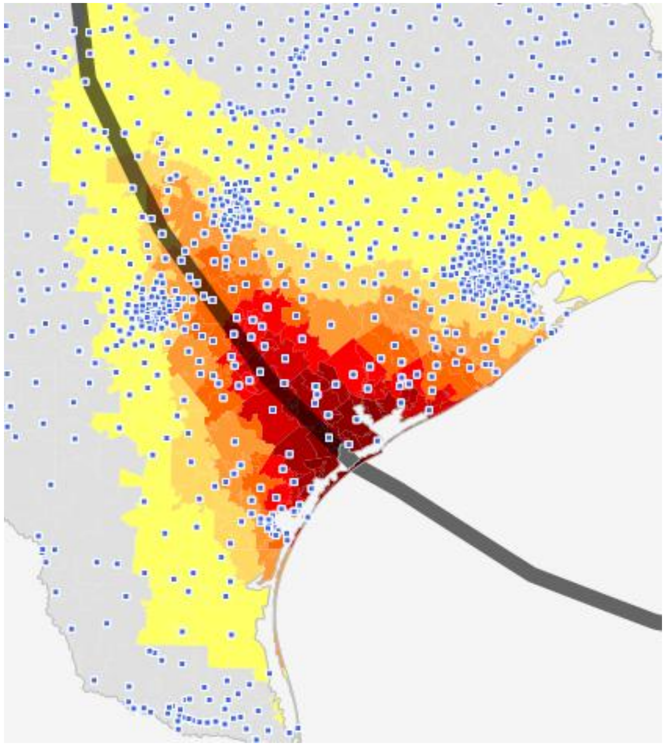
Characteristic Event 1, 2, ….
Wind speed = 122 (SS3)
Rmax = 40
…..

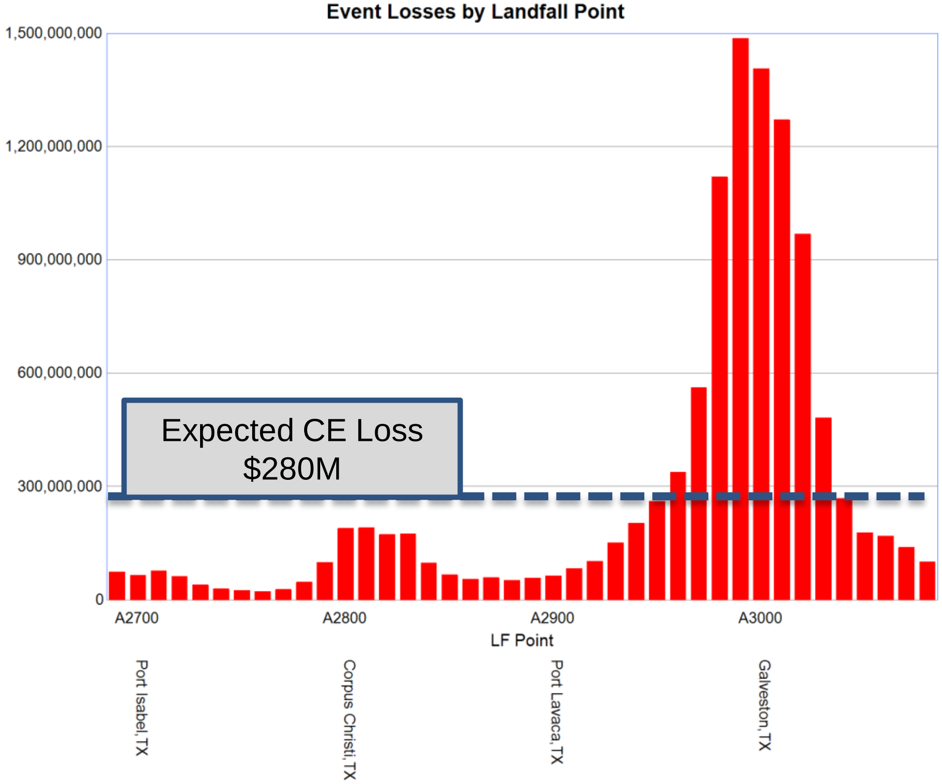
Events are generated by identifying the characteristics with a specific return period.

Sample Company 100 Year CE Results for Texas

1 Losses are calculated by floating the Characteristic Event wind field over the company's exposures.

2 CE losses are estimated at ten mile landfall points and summarized for each event. The resulting regional loss summary identifies the range of potential losses and identifies peak loss scenarios. The expected losses for the region can be compared to model PMLs.

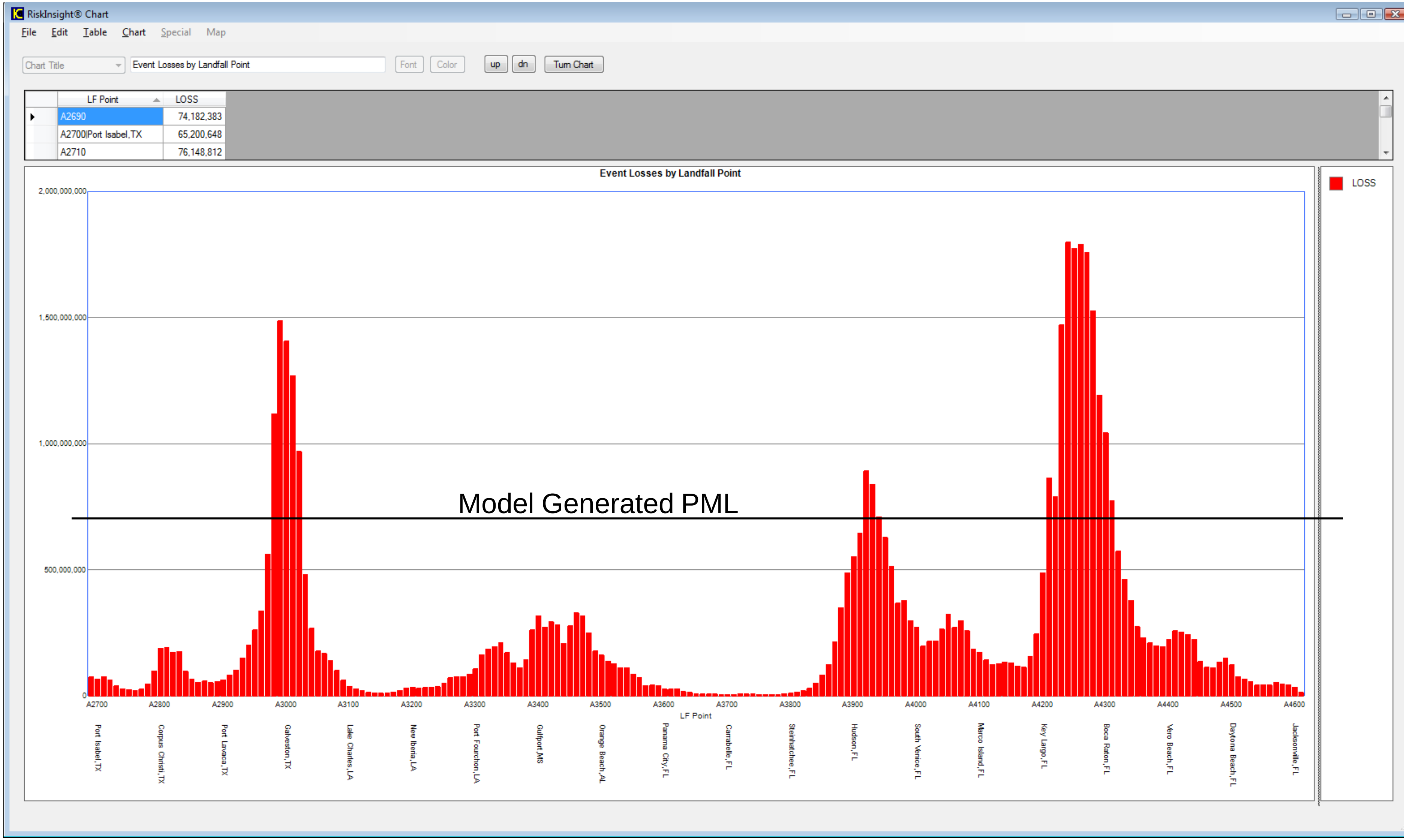




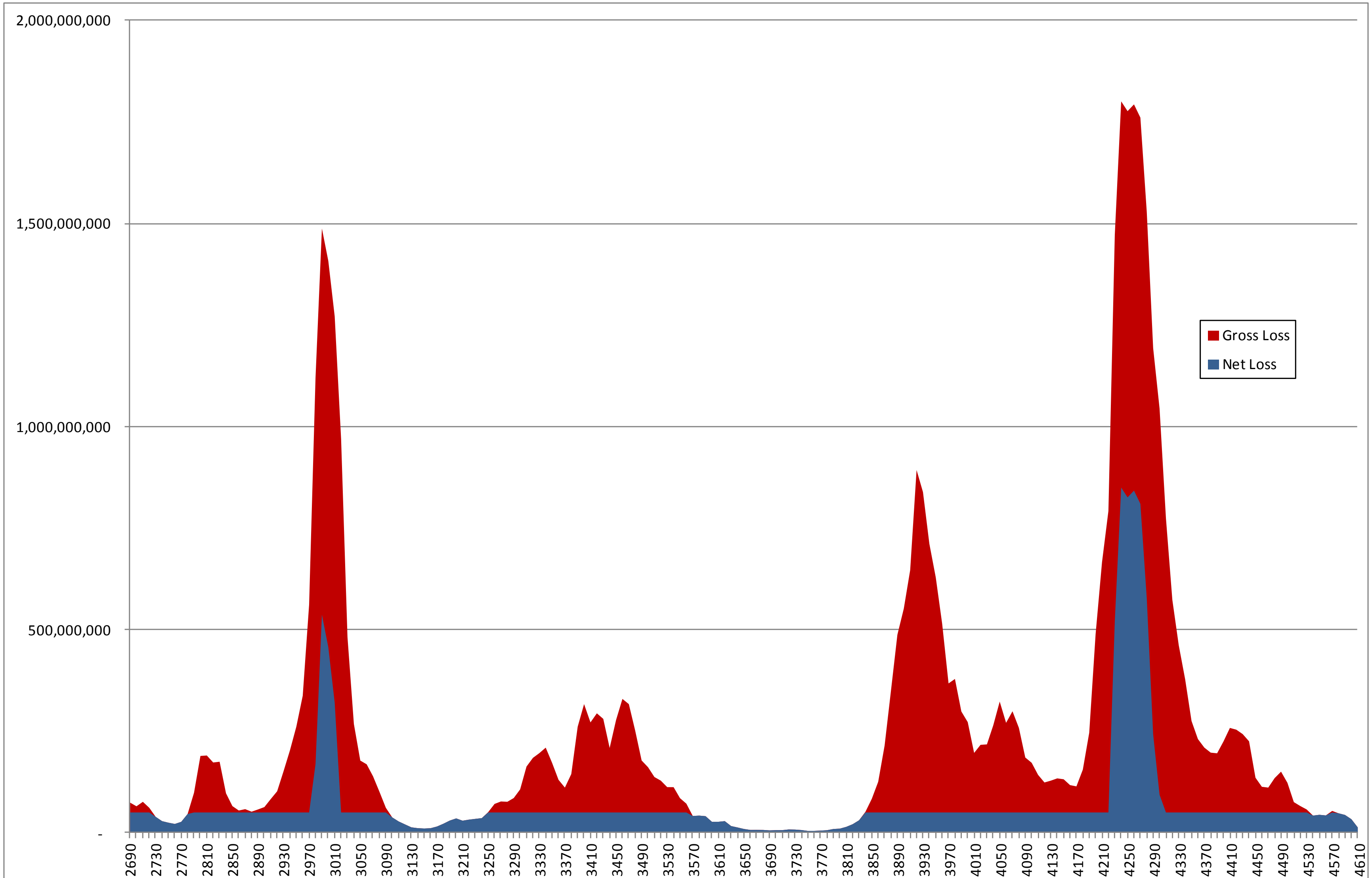
Questions CEs Can Answer

- Where are you exposed to the largest 100 year event losses?
- How does your current reinsurance program cover your 100 year event losses?
- What is the range of your 100 year event losses by region?
- What is your expected loss from the 100 year event by region?
- What are the chances your losses will exceed $X from the 100 year event?

Sample Company 100 Year CE Losses by Landfall Point

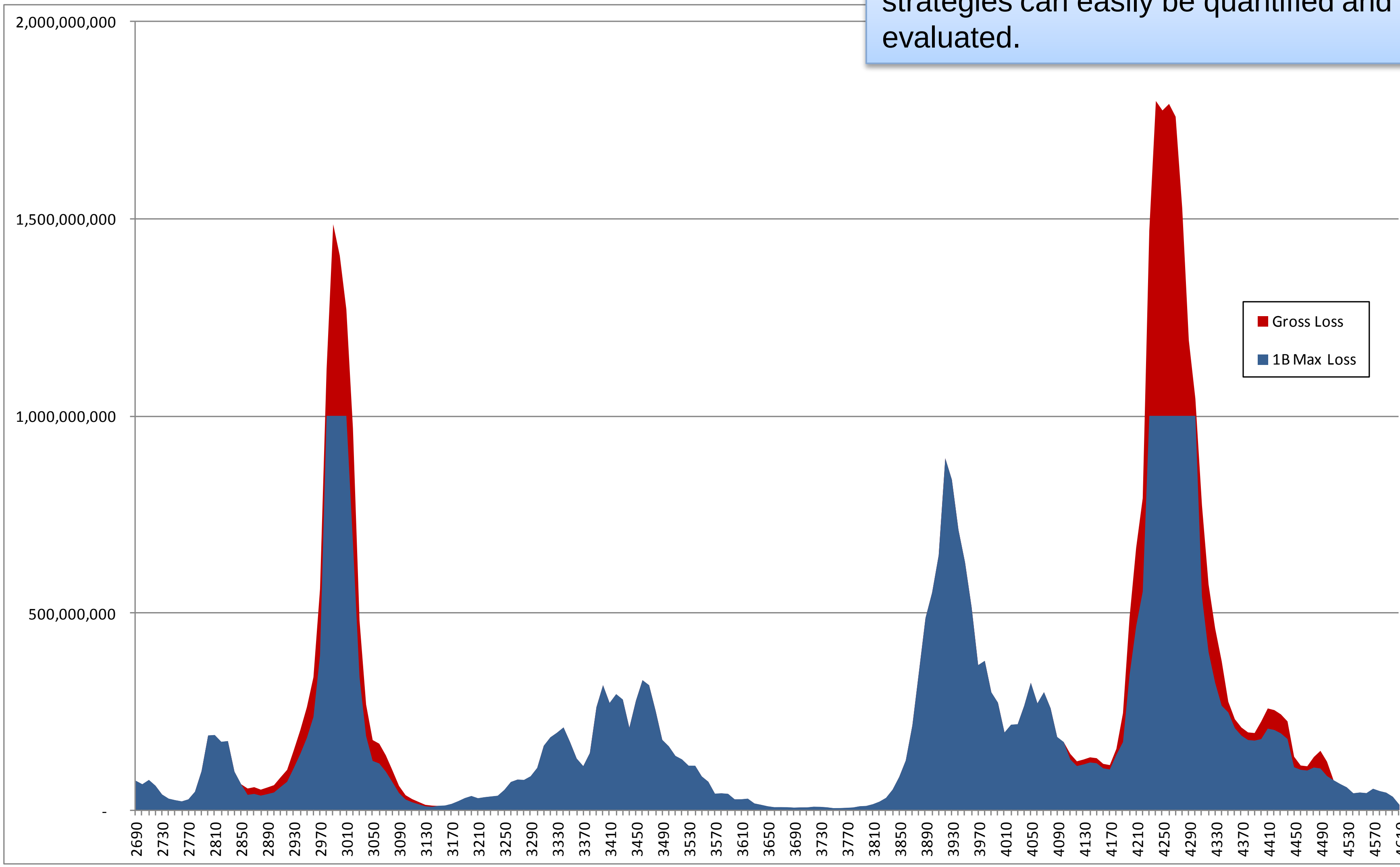


Gross and Net Losses by Landfall Point



Evaluating Loss Potential Before and After Policy Reductions

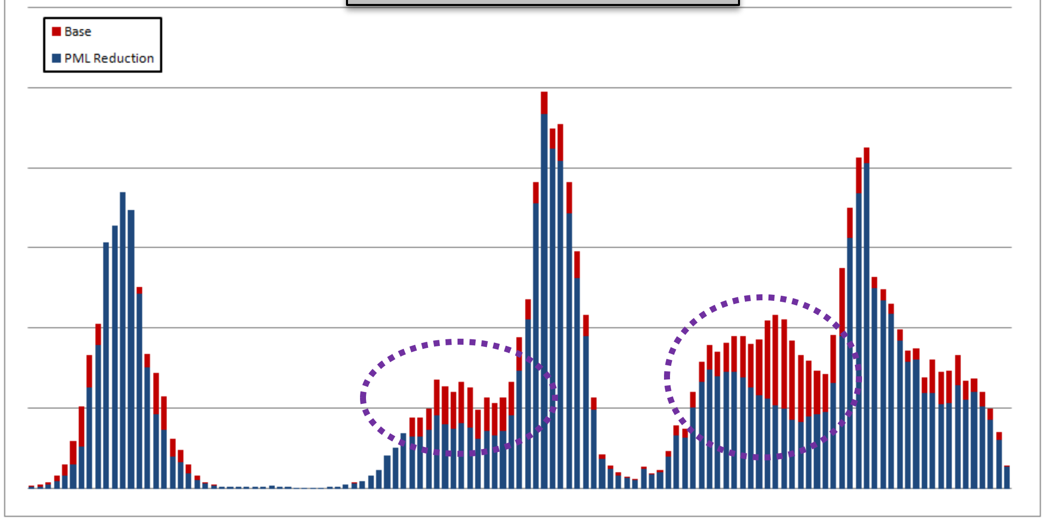
Alternative growth or contraction strategies can easily be quantified and evaluated.



Managing Large Loss Potential – Comparing PML and CE Approaches

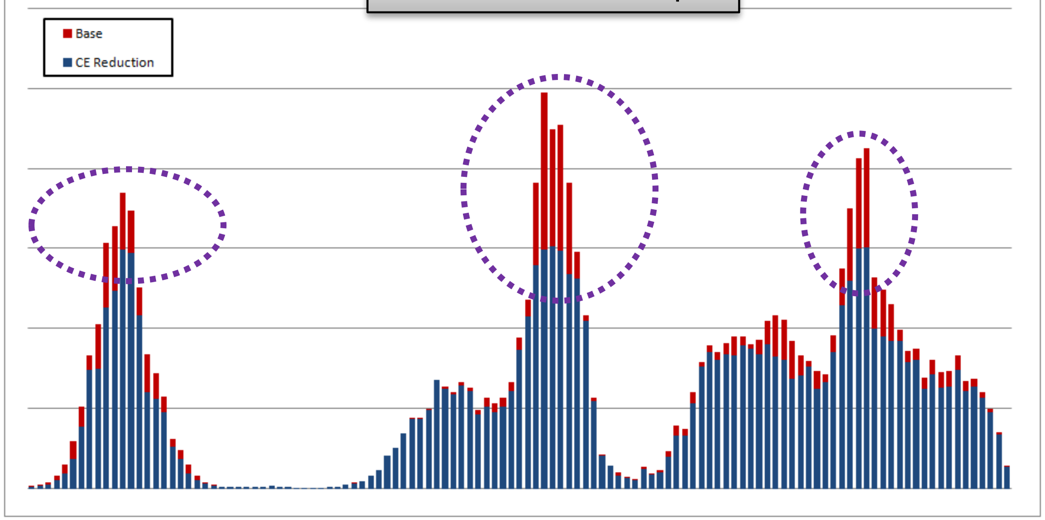
There is not a clear relationship between PML and exposure. PML reduction scenarios can emphasize reductions across a large number of random events, without reducing peak events.

PML Reduction Example



By providing visibility into the relationship between exposure and large losses, CE reduction scenarios focus attention on managing solvency impairing events.

CE Reduction Example



Benefits of CEs

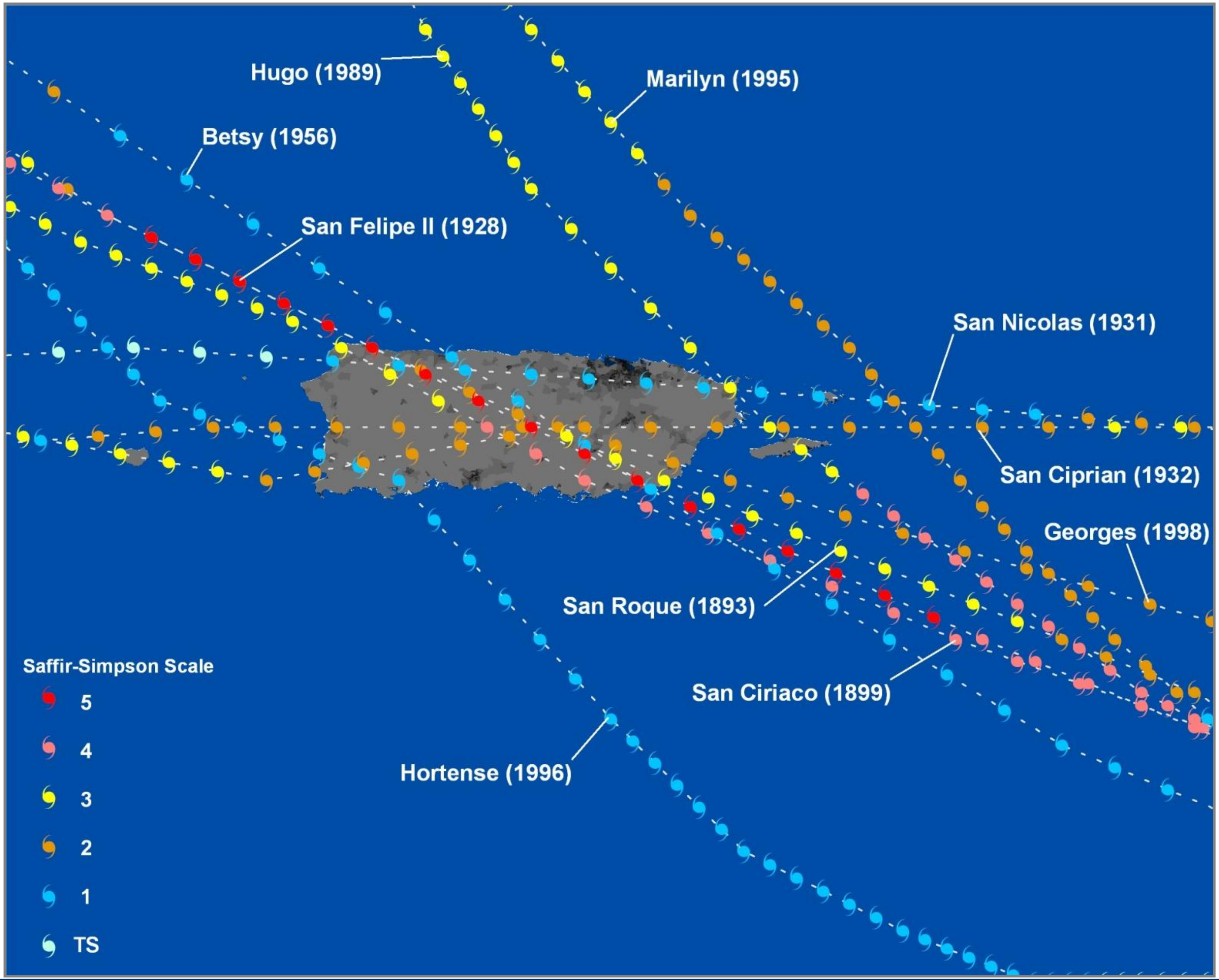
- CEs provide transparent sets of scenario losses for better understanding the risk

- CE scenarios are stable from year to year
  - ✓ Will only change if something happens that significantly changes the hazard in a particular region (e.g. there is a cat 5 hurricane in the Northeast)
  - ✓ Companies can effectively monitor the impacts of pure exposure changes
  - ✓ Companies can plan their risk management strategies and make consistent decisions thereby serving their policyholders better

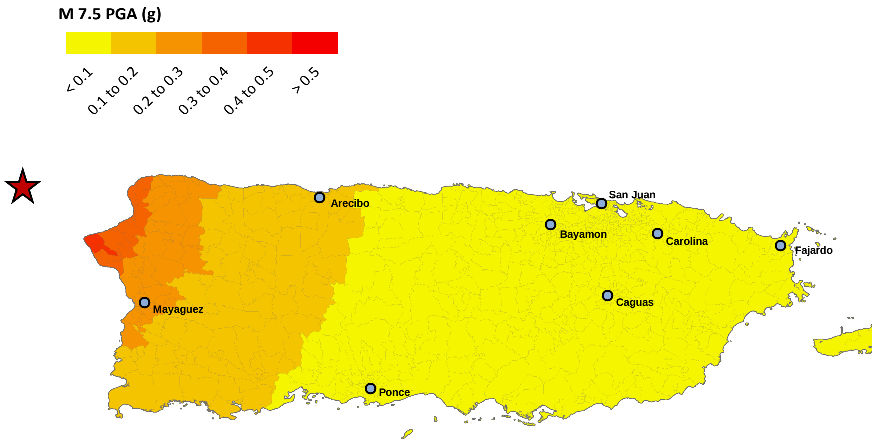
- CEs are operational risk metrics
  - ✓ Because they provide a fixed set of events, they are fully additive across accounts, lines of business, etc.
  - ✓ They can be monitored at the corporate level and drilled down to the resolution desired
  - ✓ Underwriters can clearly see the impacts of adding additional ccounts

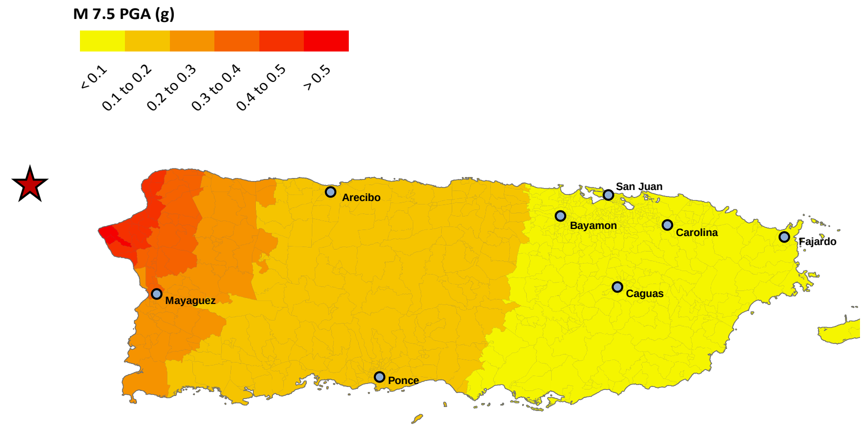
- At high resolution, such as policy level, CEs provide a consistent and logical relation to risk
  - ✓ CEs can provide more events in the tail of the distribution
  - ✓ Because they are “floated” to cover all exposure areas, there is less noise at high resolution

CEs Can Be Developed for the Caribbean Region



CEs Are Developed Using Same Scientific Data Underlying the Cat Models – Potential 100 Year EQ Event in Puerto Rico

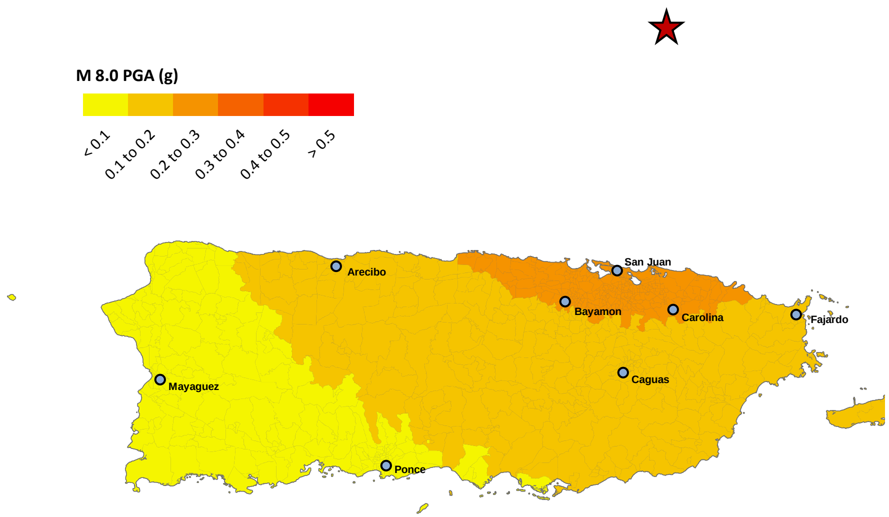


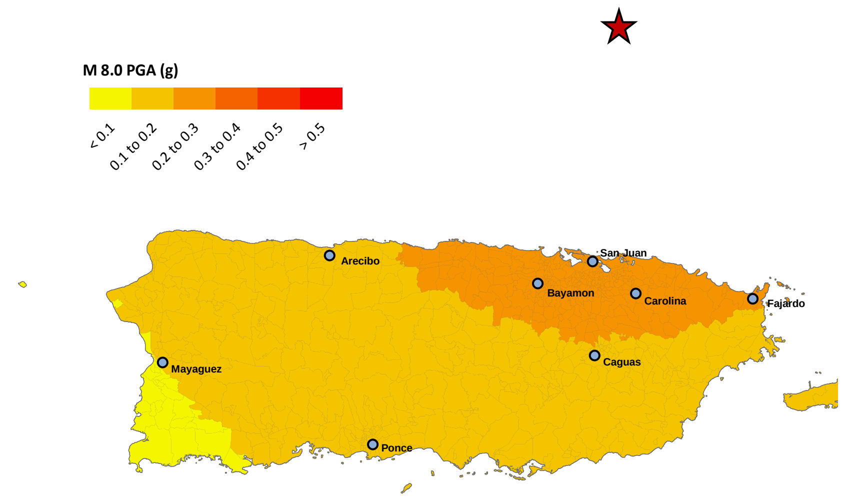


PGA (g)	Property Exposure
0.4 to 0.5	1,051,969,500
0.3 to 0.4	6,469,023,000
0.2 to 0.3	15,044,284,500
0.1 to 0.2	36,242,793,000
< 0.1	199,148,466,000
Total	257,956,536,000
Potential Property Losses:	$2.10B

PGA (g)	Property Exposure
> 0.5	1,051,969,500
0.4 to 0.5	6,469,023,000
0.3 to 0.4	7,085,313,000
0.2 to 0.3	21,119,550,000
0.1 to 0.2	66,072,919,500
< 0.1	156,157,761,000
Total	257,956,536,000
Potential Property Losses:	$5.69B

Lower Probability Event Modeled After the 1787 M8.0 Earthquake





PGA (g)	Property Exposure
0.2 to 0.3	96,995,029,500
0.1 to 0.2	98,871,978,000
< 0.1	62,089,528,500
Total	257,956,536,000
Potential Property Losses:	$6.28B

PGA (g)	Property Exposure
0.2 to 0.3	125,118,594,000
0.1 to 0.2	123,512,199,000
< 0.1	9,325,743,000
Total	257,956,536,000
Potential Property Losses:	$18.31B

Structures in the Caribbean Are Different Than in US

Damage Estimates Could Be Improved With Caribbean Specific Occupancy and Construction Codes

ISO Fire Class	Description
1	Frame
2	Joisted Masonry
3	Non-Combustible
4	Masonry Non-Combustible
5	Modified Fire Resistive
6	Fire Resistive
7	Heavy Timber Joisted Masonry
8	Superior Non-Combustible
9	Superior Masonry Non-Combustible

Existing fire codes are outdated and not appropriate for catastrophe exposures

Reinforced Concrete
Reinforced Concrete Roof

Reinforced Concrete
Wood and/or Metal Roof

A Robust Risk Management Framework

- Stable and operational risk metrics that allow effective risk management strategies to be implemented and monitored over time

- Consistent and comprehensible information—while we cannot eliminate the uncertainty in catastrophe loss estimation, we can eliminate the volatility in the loss estimates caused by “noise” and lack of data

- Fully transparent

- Flexible and customizable to specific regions and construction practices

- More interactive and less resource intensive

About Karen Clark & Company

- KCC was established by insurance industry veterans and pioneers in the area of catastrophe risk assessment and management
  - ✓ Karen Clark developed the first hurricane model and founded the first catastrophe modeling company, AIR
  - ✓ Vivek Basrur architected and led the development of AIR software technology, including CLASIC/2, CATRADER, and ISOHomeValue (now 360Value)
  - ✓ Other senior staff have extensive experience in catastrophe modeling and risk management
- KCC professionals provide insurance and reinsurance companies with expert and unbiased analyses of catastrophe models, risk assessment processes, pricing, underwriting, and portfolio management methodologies
- Through dozens of consulting engagements with global, nationwide and regional companies and covering all three major vendor models, KCC professionals have unmatched expertise in the challenges faced by companies in using the models for various purposes
- KCC is pioneering new approaches and techniques for estimating and managing catastrophe losses to provide additional scientific tools that address the issues surrounding the models