

The Devil is in the Differences

Exploring Sources of Variability in Catastrophe Models

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ICA Conference April 2014



Fill in the Blank:

Why Are Catastrophe Models so _____?

Logical

Complicated

Wrong

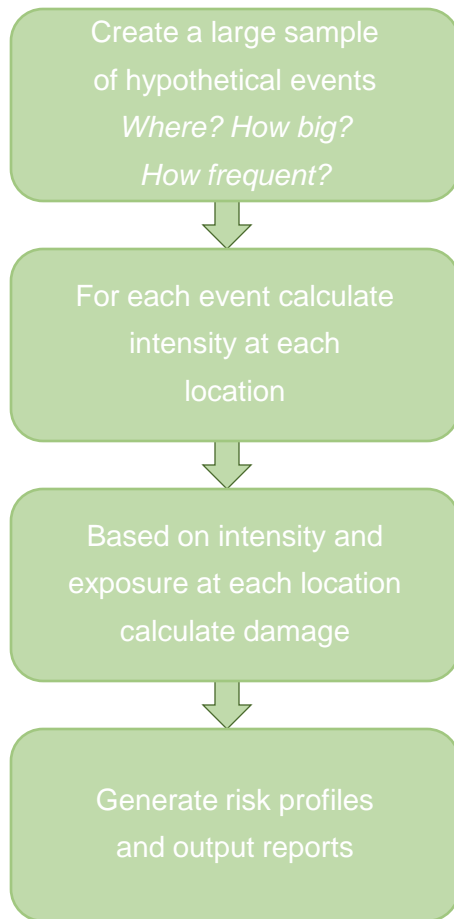
Different

Critical

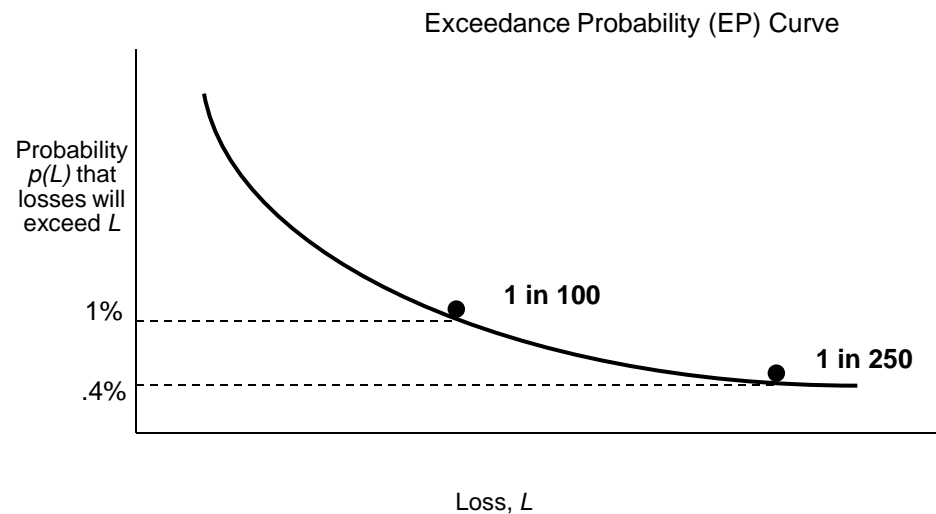
Expensive

Useful

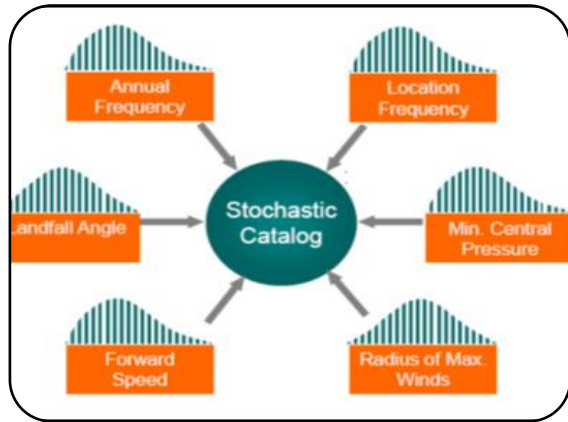
Catastrophe Models Help to Better Quantify the Risk and Potential Losses



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

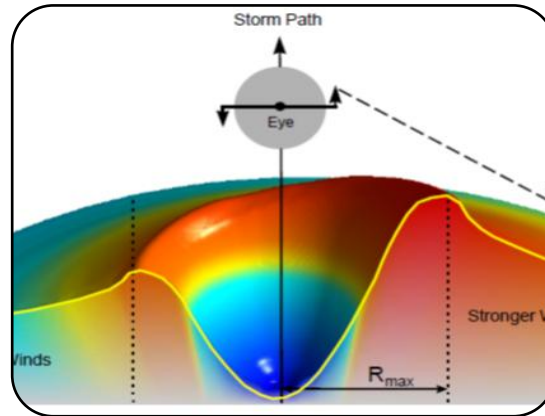


Simulate Parameters To Create a Catalog of Synthetic Events

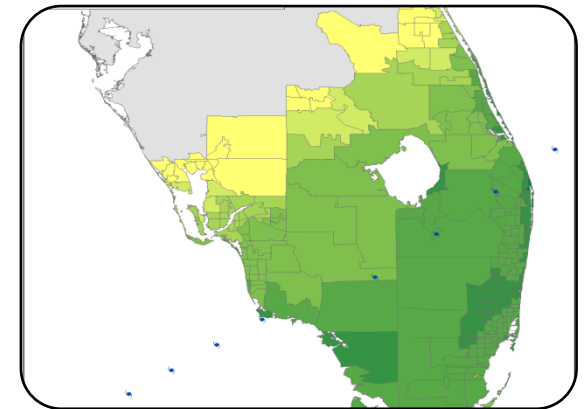


- Windfield parameters estimated from historical data

- Parameters used in analytical windfield model



- Windfield propagated over exposures to generate damage

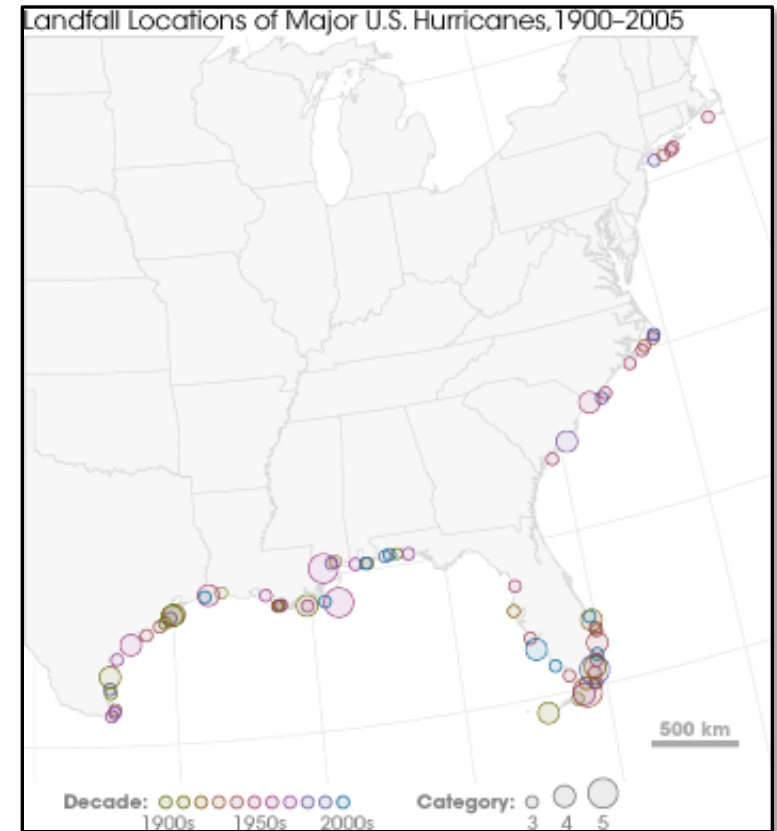


Historical Events are Sparse in Time and Space



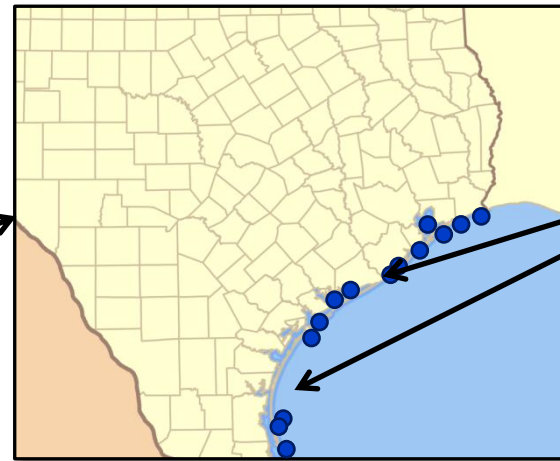
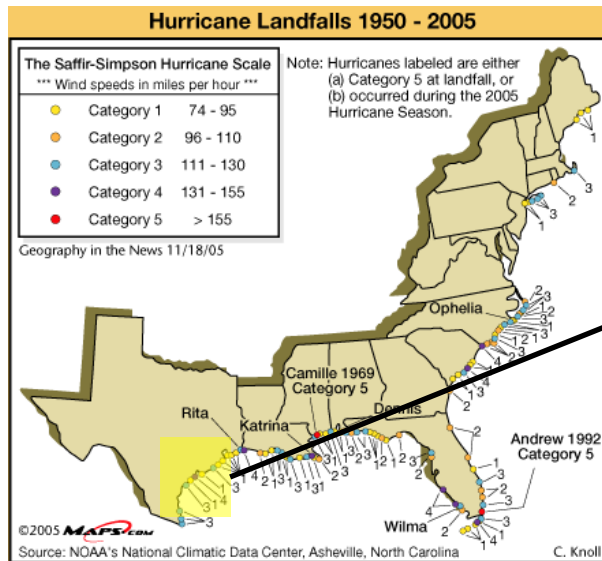
www.weather.com

- On average, roughly 12 storms form in the Atlantic Basin each year
 - Only 6 hurricanes, and 2-3 major hurricanes (CAT 3-5)
 - Fewer than 2 landfalls, with only 0.6 major landfalls per year

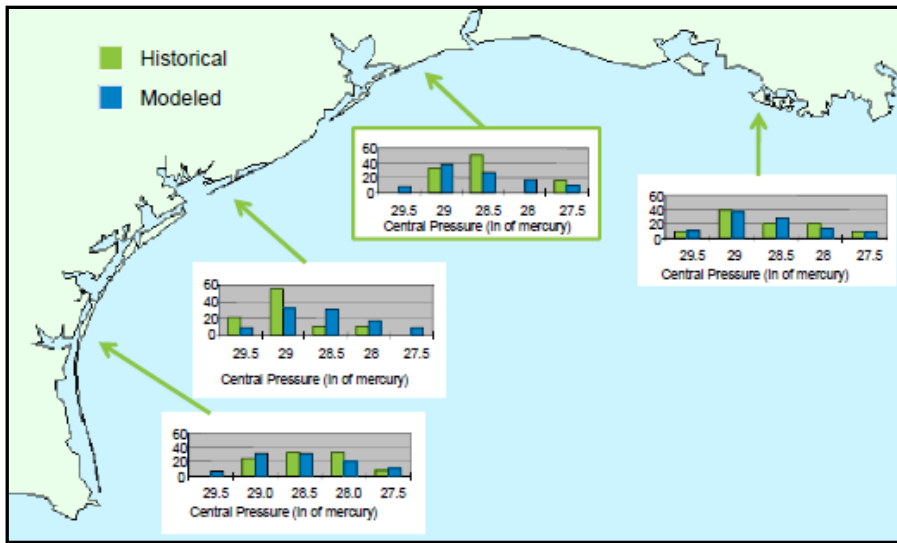


Earthobservatory.nasa.gov

How Do the Modelers Handle the Data?



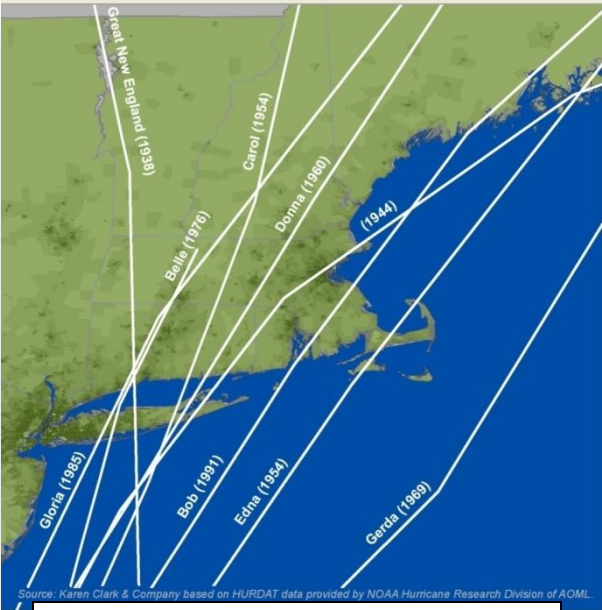
Is the risk lower here?



AIR Worldwide

- Smoothing techniques applied to historical data
 - Landfall rates vary by geography and intensity
 - Smoothing methodologies can be different
 - Results in different risk profiles along the coast
- Similar issues arise with other model parameters

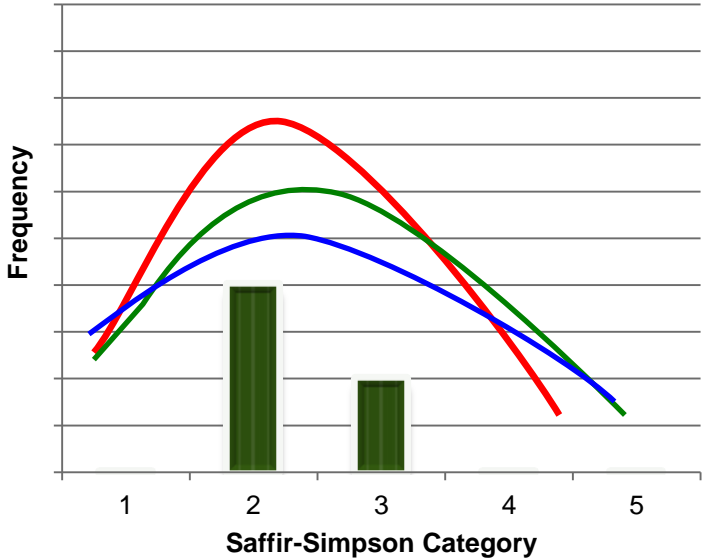
Model Volatility is Driven Largely By Lack of Credible Data and Not New Scientific Knowledge



Tracks of Landfalling Hurricanes Since 1900

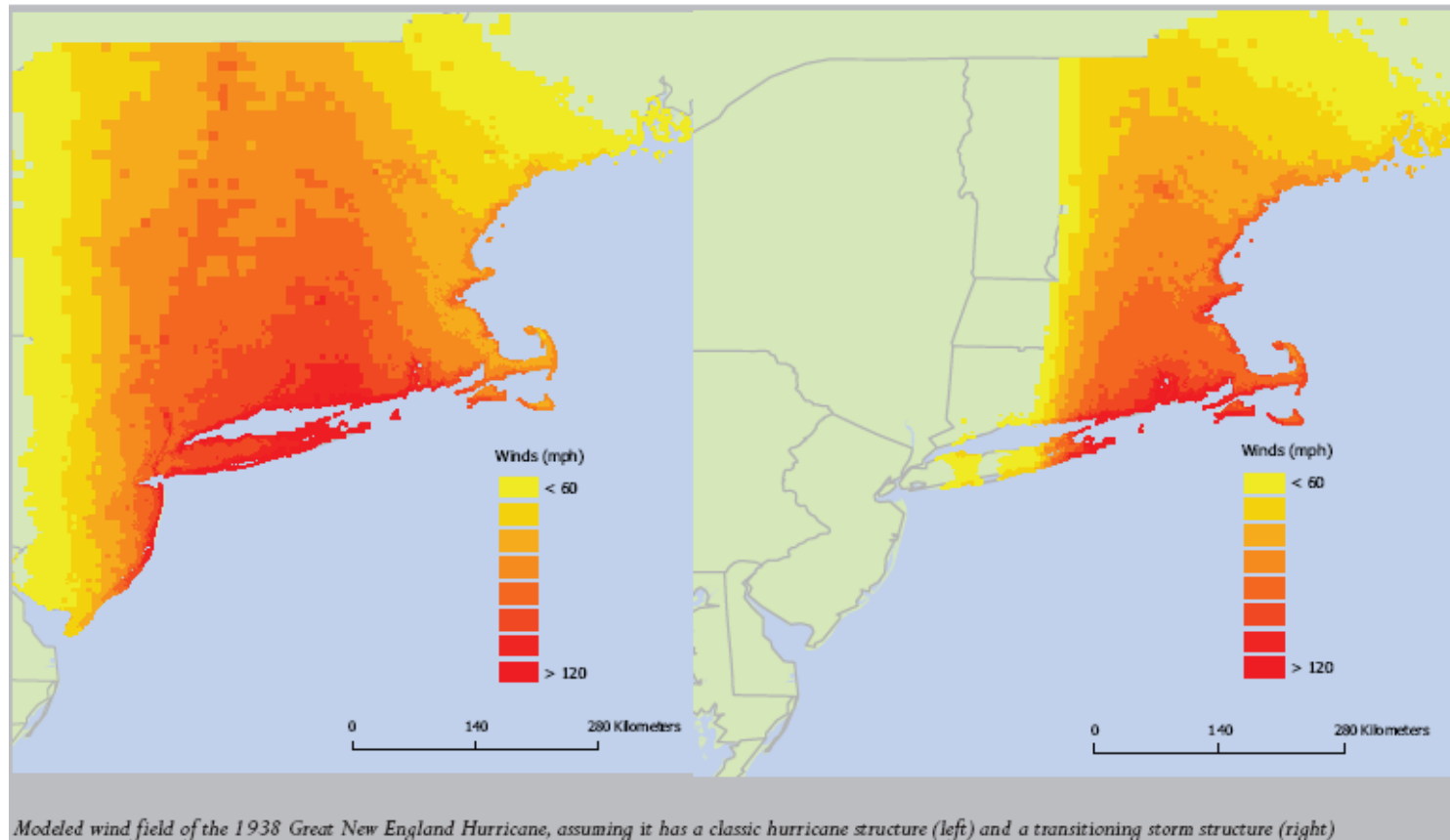
Year	Maximum Wind Speed* (mph)
1938	121
1944	----
1954	----
1954	----
1960	----
1969	----
1976	----
1985	104
1991	104

Source: NOAA HURDAT
*Overland



Because There is So Little Data Scientists Can Disagree and Change Their Minds and Make Mistakes

RMS Wind Footprint for the Same Storm in Two Model Versions



What Happened on December 16, 1811?



- A violent shock of an earthquake was accompanied by a very awful noise resembling loud but distant thunder
- Complete saturation of the atmosphere with sulphurous vapor causing total darkness ...
- The cries of fowls and beasts of every species and the crackling of trees falling ...
- The roaring of the Mississippi ...

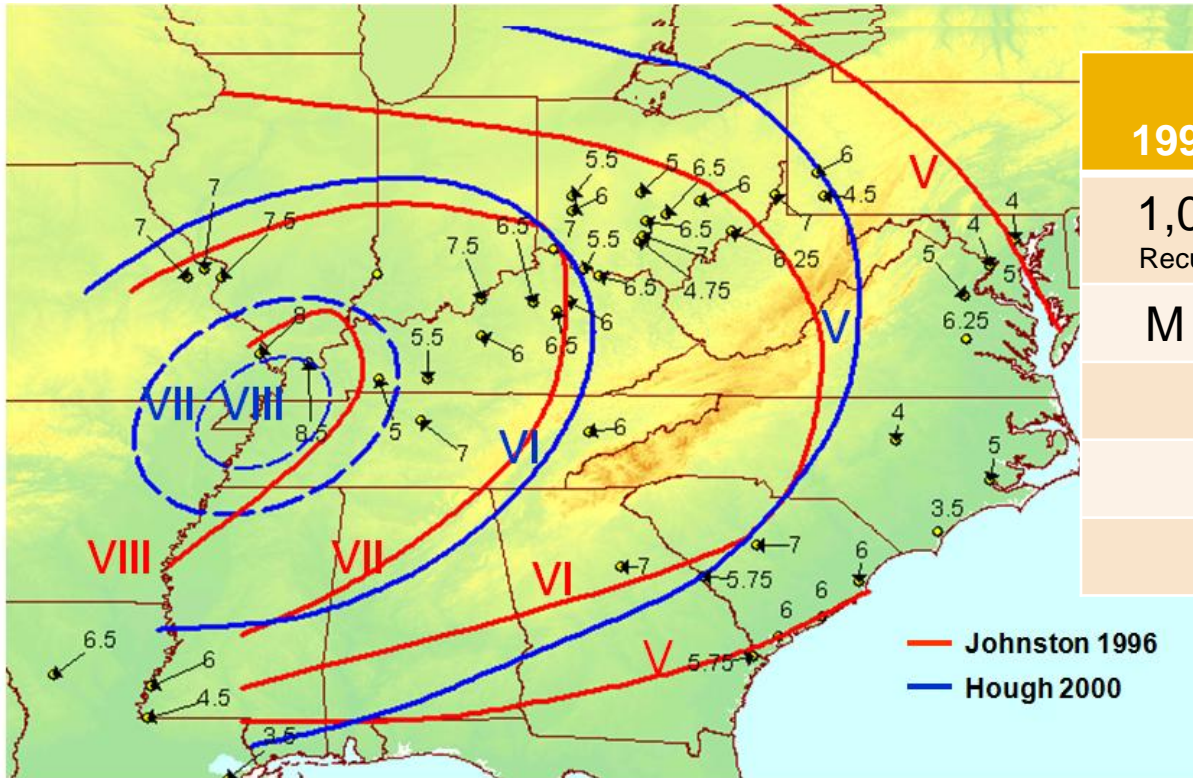
From Eliza Bryan's personal account in *Lorenzo Dow's Journal*, published by Joshua Martin in 1849.

Whatever We Know About the Damage is from Newspaper Accounts

INTENSITY VALUES FOR EARTHQUAKE OF FEBRUARY 7, 1812 AT 09h45m GMT

Locality	MM Intensity	Source of Information
New Madrid, Mo.	X-XI	<i>Penn. Gaz.</i> , Mar. 18, 1812
Cape Girardeau, Mo.	IX	<i>La. Gaz.</i> , Feb. 29, 1812
Cahokia, Ill.	IX	McDermott (1949, p. 317)
St. Louis, Mo.	VIII-IX	<i>La. Gaz.</i> , Feb. 8, 1812
Savannah, Ga.	IV-VI	<i>N.Y. Post</i> , Mar. 5, 1812
Richmond, Va.	V-VI	<i>N.Y. Post</i> , Feb. 18, 1812
Pittsburgh, Pa.	V-VI	<i>Pitt. Gaz.</i> , Feb. 14, 1812
New Orleans, La.	V	<i>N.Y. Post</i> , Mar. 5, 1812
Augusta, Ga.	V	<i>N.Y. Post</i> , Mar. 5, 1812
Washington, D.C.	V	<i>N.Y. Post</i> , Feb. 11, 1812
Alexandria, Va.	IV-V	<i>N.Y. Post</i> , Feb. 12, 1812
Baltimore, Md.	IV-V	<i>Penn. Gaz.</i> , Feb. 12, 1812
New York, N.Y.	IV-V	<i>Penn. Gaz.</i> , Feb. 12, 1812

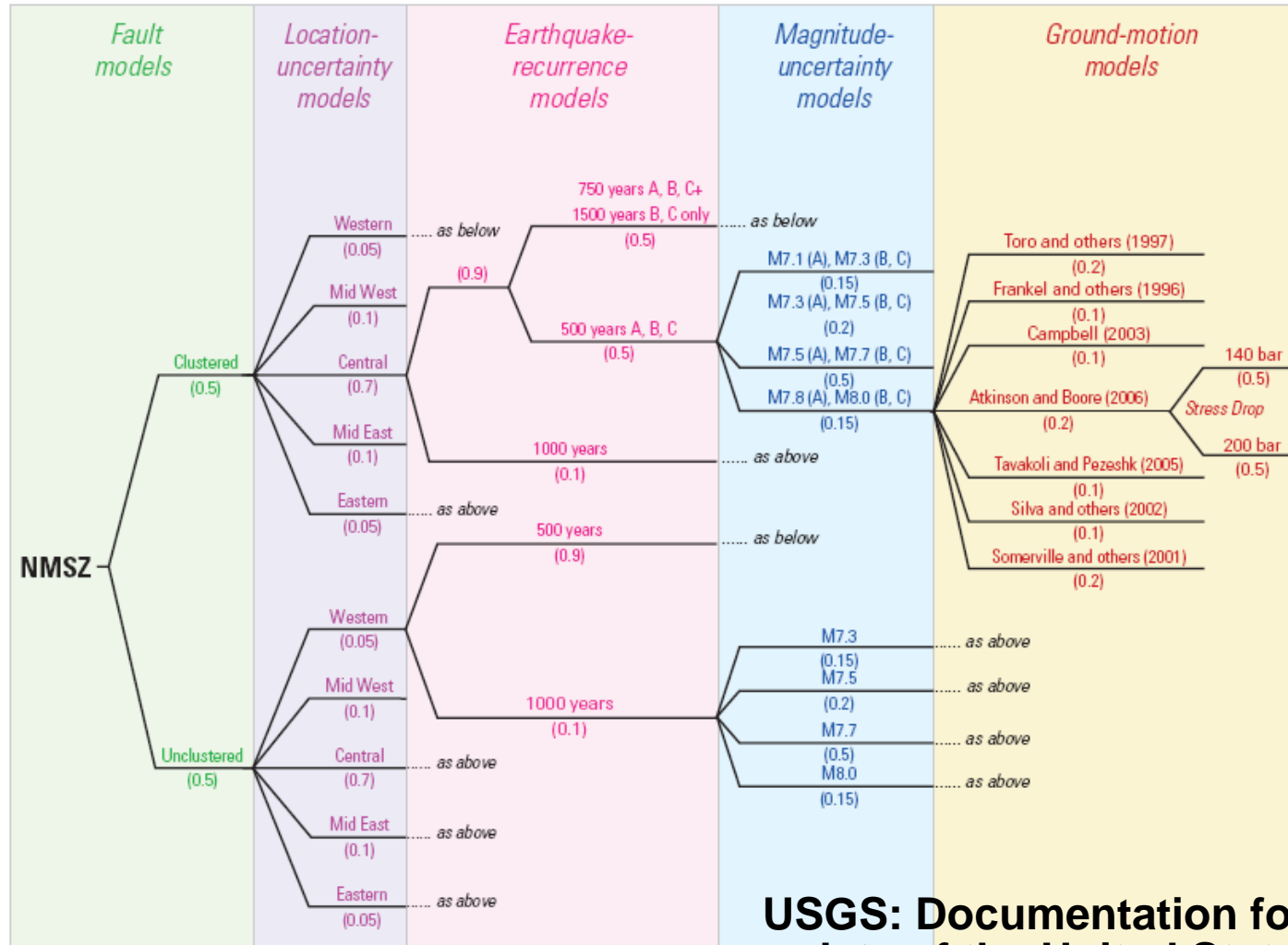
There is Scientific Disagreement on the Magnitudes of the Earthquakes and the Return Periods



USGS 1996 Report*	USGS 2002 Report*
1,000 years Recurrence Interval	500 years Recurrence Interval
M 8.0 (1.0)	M 7.3 (0.15)
	M 7.5 (0.20)
	M 7.7 (0.50)
	M 8.0 (0.15)

* Magnitudes (Weights)

Logic Tree for New Madrid Seismic Zone (NMSZ) from the USGS 2008 Report – *What We Know We Don't Know*



USGS: Documentation for the 2008 update of the United States National Seismic Hazard Maps

Vulnerability Module Converts Intensity to Damage



How Are Damage Functions Developed?

- Claims Data
 - Majority of claims are for residential policies
 - Mostly for recent events (Florida, Texas) where wind was a significant cause of loss
 - Each modeler interprets the results differently
- Published engineering studies
- Post disaster surveys



- Large scale model tests are becoming more common

Variability Within and Across Occupancies Presents a Challenge



Hotels



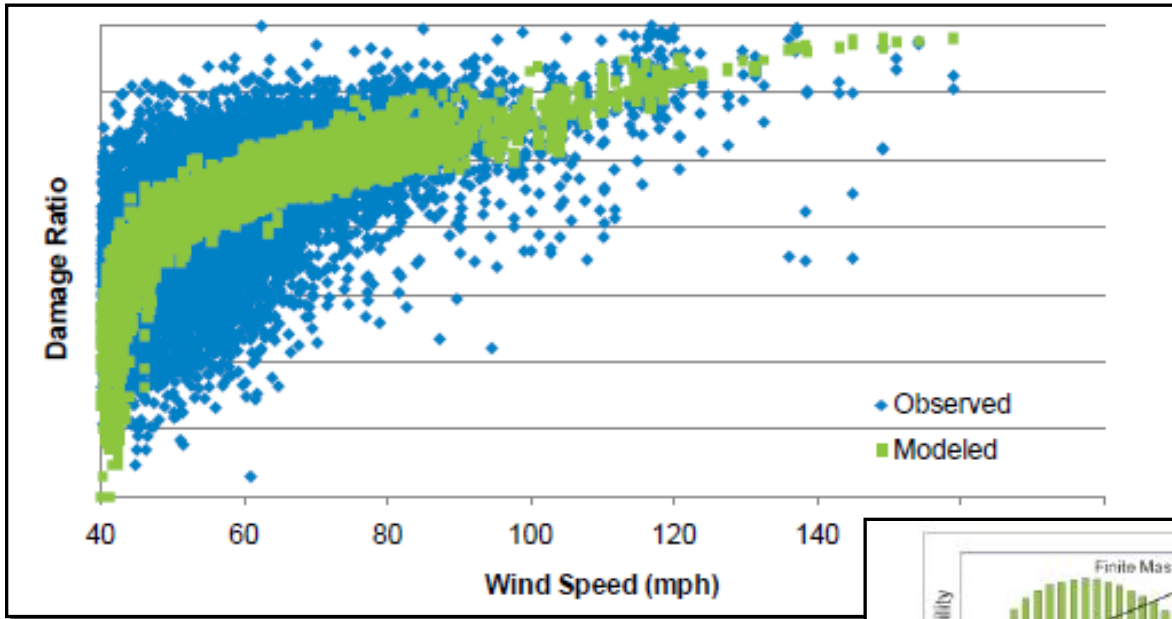
Office



Retail

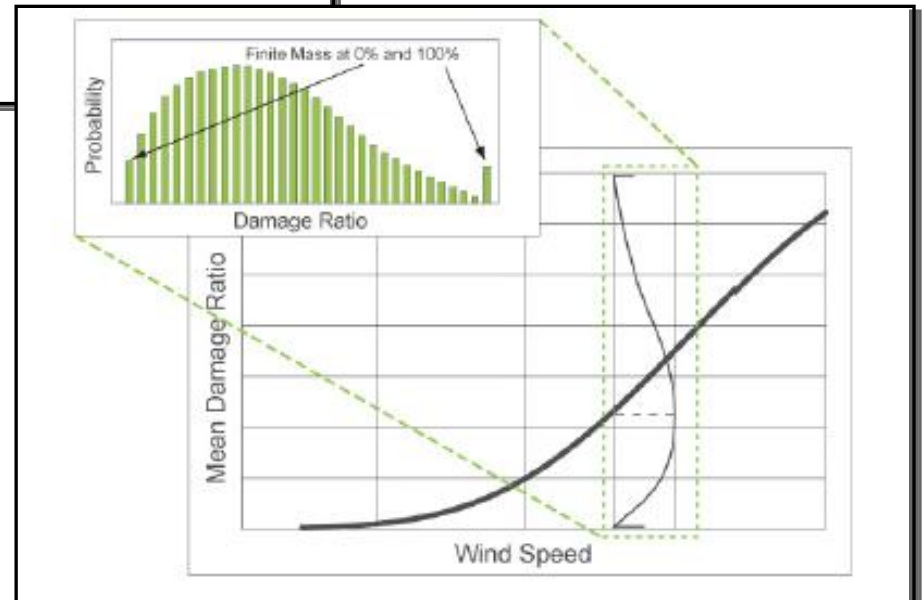


There is Significant Variability around the mean Damage Ratio

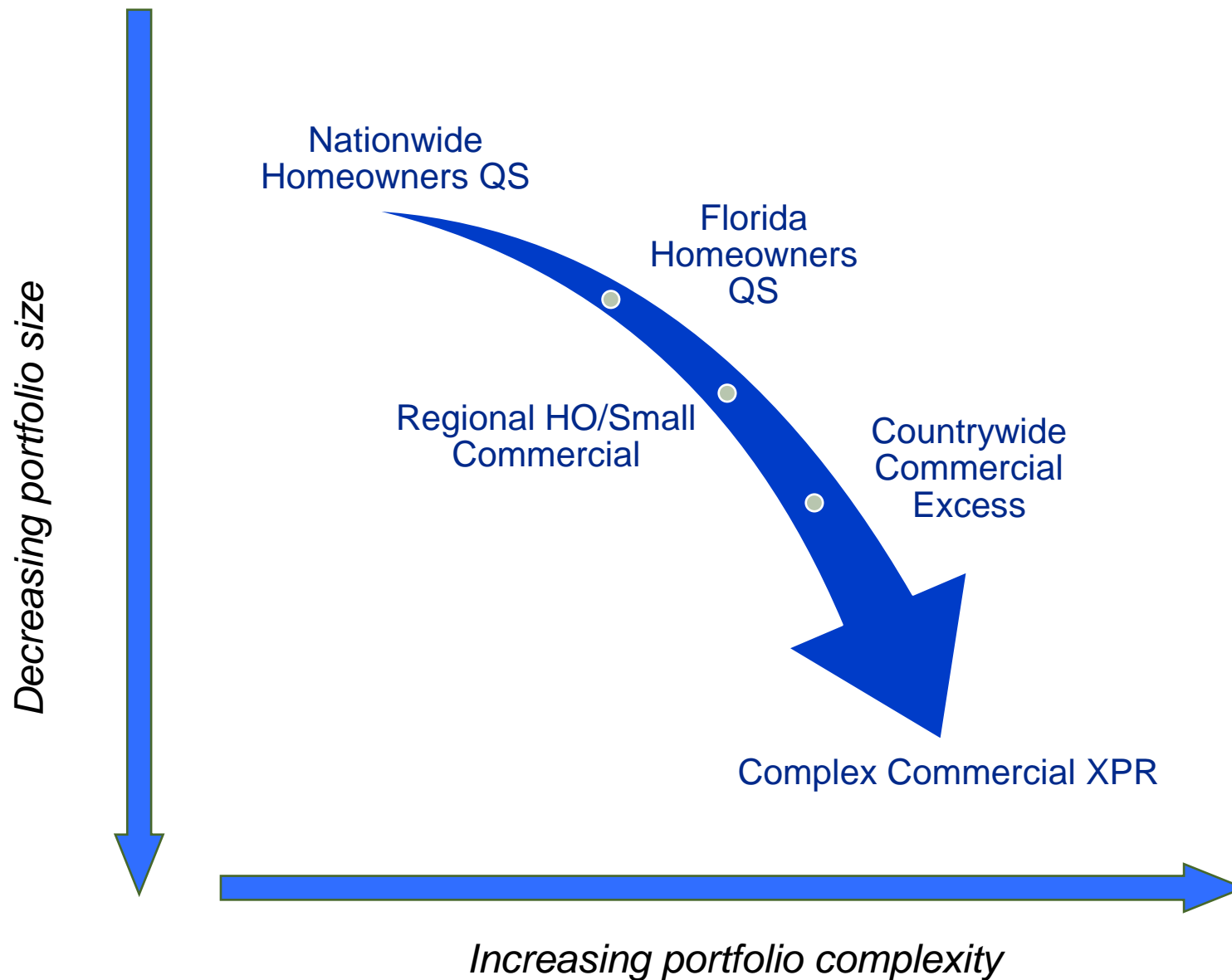


Similar buildings subjected to same intensity can have different amounts of loss

Modelers account for this using a distribution around the mean damage ratio



Generally, Results are Less Reliable for Small, Complex Exposures



Sanity Checks

- Historical Results
 - Modelers provide historical event catalogs to allow as-if analyses
 - Understand exposure change to interpret results
 - +/- 20% reasonability threshold; look for bias
- Market share of loss
 - Compute market share of industry loss (vs exposure/premium)
 - Aggregate models are useful for this purpose
- Old-fashioned aggregates
 - Useful on their own, and are a good benchmark for model assessment
 - PML/Limit ratios, regional and historical trends become good methods for tracking results over time

Models Provide a Rational Framework, but have Limitations

- There's not as much data as you think
 - Limited historical data
 - Requires many assumptions
- Model components include science and art
 - Generally accepted techniques, but few prescribed rules
 - Modeler judgment and methodologies have a material impact on results
- Lack of transparency and internal consistency
- Alternative tools are critical to a robust risk management process

Industry Trend: Deeper Analytics, Greater Transparency

