KAREN CLARK & COMPANY

Thinking Outside the Black Box: New Approaches for Estimating Catastrophe Losses

BACE Spring Meeting 2013

Columbus, OH

Consulting Engagements Reveal Consistent Themes and Challenges

- 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
- 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
- Companies want more efficient and flexible platforms for building their own proprietary views of risk

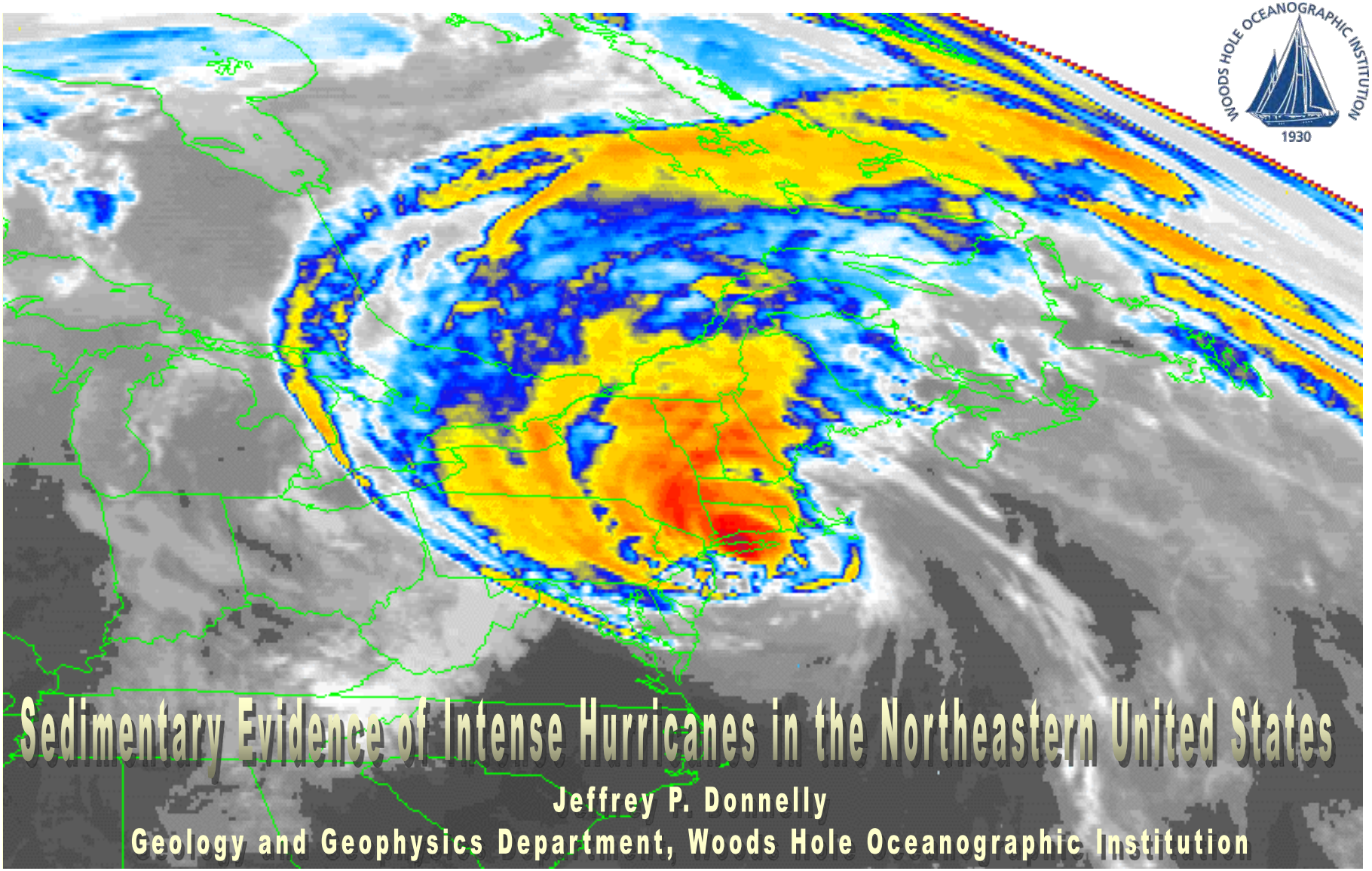
Why Do Insurance Companies Rely Too Heavily on the Catastrophe Models?

- False model precision
- Scientific seduction
- Models give an “answer”

False Precision of Model Output Gives Illusion of Accuracy

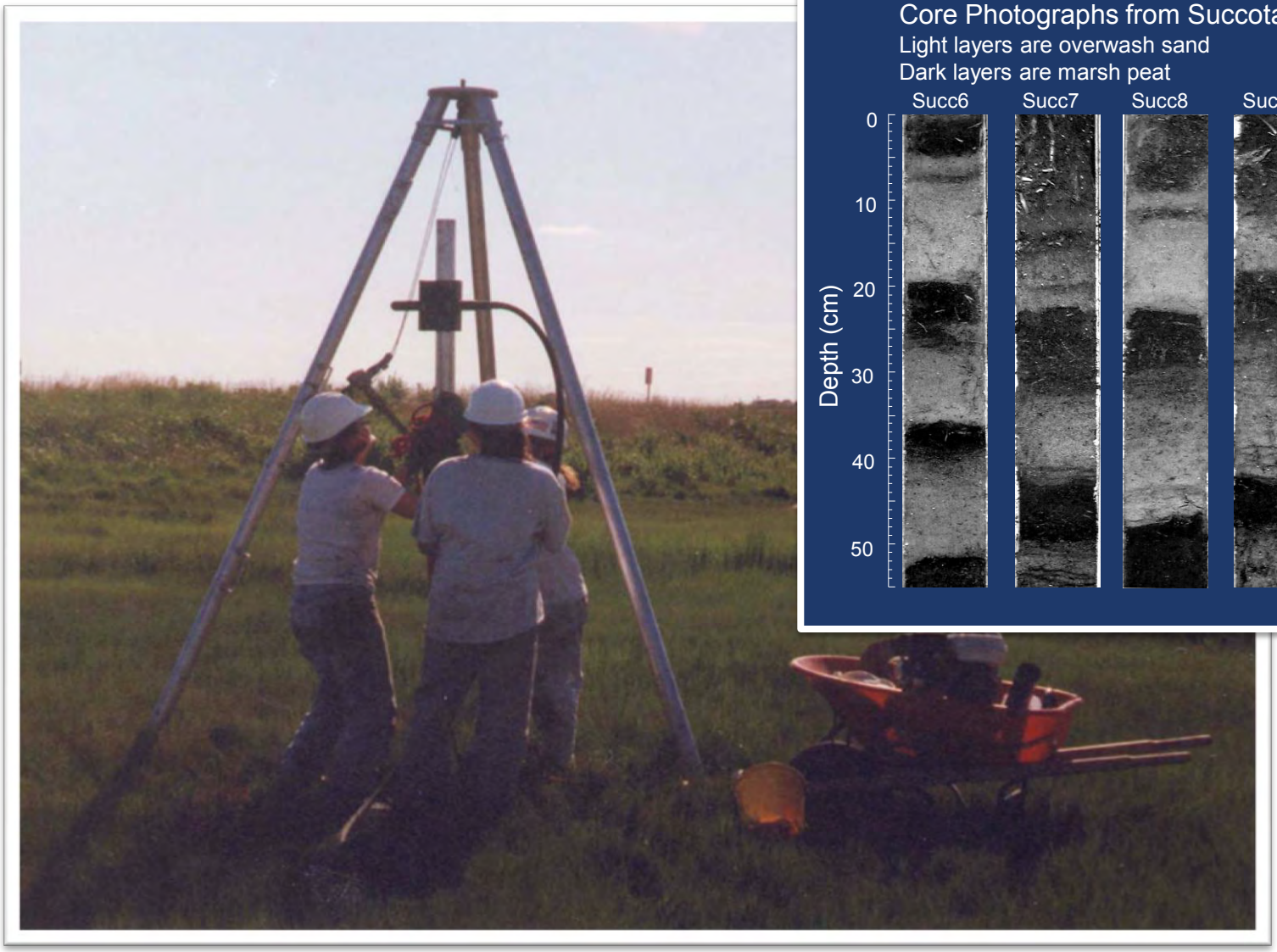
PolicyID	OCC	OCT	BLDGLIMIT	BLDGVALUE	TOTALTIV	EQ DED	WIND DED	HUR AAL	EQ AAL	PREMIUM
COM0104301	ATC	37	$1,025,732	$1,025,732	$1,025,732	$51,287	$20,515	3680.399048	124.636846	$4,832
COM0104301	ATC	37	$1,133,860	$1,133,860	$1,133,860	$56,693	$22,677	7077.480615	621.2282453	$8,143
COM0104301	ATC	37	$56,579	$56,579	$56,579	$2,829	$1,132	353.1345227	30.99863186	$265
COM0104301	ATC	37	$87,115	$87,115	$87,115	$4,356	$1,742	543.7846704	47.72765809	$416
COM0104301	ATC	37	$2,735	$2,735	$2,735	$137	$55	10.69432102	1.012661445	$8
COM0104301	ATC	37	$60,724	$60,724	$60,724	$3,036	$1,214	374.6408144	25.53513905	$295
COM0104301	ATC	37	$85,298	$85,298	$85,298	$4,265	$1,706	526.206591	35.86674254	$694
COM0104301	ATC	37	$91,872	$91,872	$91,872	$4,594	$1,837	410.4342579	31.5165717	$402
COM0104301	ATC	37	$50,178	$50,178	$50,178	$2,509	$1,004	224.1335262	17.21406543	$181
COM0104301	ATC	37	$125,589	$125,589	$125,589	$6,279	$2,512	642.4368285	26.46133051	$592
COM0104301	ATC	37	$111,043	$111,043	$111,043	$5,552	$2,221	568.0313468	23.39567051	$499
COM0104301	ATC	37	$3,519	$3,519	$3,519	$176	$70	21.99003039	1.92769167	$11
COM0104301	ATC	37	$372,764	$372,764	$372,764	$18,638	$7,455	1906.884821	78.53669296	$1,573
COM0104301	ATC	37	$72,200	$72,200	$72,200	$3,610	$1,444	369.3381701	15.21149731	$242
COM0104301	ATC	37	$2,912	$2,912	$2,912	$146	$58	14.90948586	0.612140076	$500
COM0104301	ATC	37	$90,492	$90,492	$90,492	$4,525	$1,810	462.9018725	19.06398733	$301
COM0104301	ATC	37	$37,028	$37,028	$37,028	$1,851	$741	189.3920925	7.802634289	$282
COM0104301	ATC	37	$2,715	$2,715	$2,715	$136	$54	13.90503798	0.571148223	$12
COM0104301	ATC	37	$0	$0	$2,172,733	$108,637	$43,455	9837.051242	88.00015037	$3,851
COM0104301	ATC	37	$3,022,440	$3,022,440	$3,022,440	$151,122	$60,449	18865.82693	1655.958495	$28,770
COM0104301	ATC	37	$2,040,453	$2,040,453	$2,040,453	$102,023	$40,809	12736.35587	1117.937396	$18,646
COM0104301	ATC	37	$9,498	$9,498	$9,498	$475	$190	59.28319005	5.203195946	$82
COM0104301	ATC	37	$330,298	$330,298	$330,298	$16,515	$6,606	2061.692318	180.9656553	$3,102
COM0104301	ATC	37	$391,225	$391,225	$391,225	$19,561	$7,825	1531.734708	145.0454282	$1,643
COM0104301	ATC	37	$449,725	$449,725	$449,725	$22,486	$8,995	1760.77898	166.7339209	$1,890
COM0104301	ATC	37	$470,910	$470,910	$470,910	$23,546	$9,418	2939.397283	258.0027165	$1,981
COM0104302	ATC	37	$1,069,168	$1,069,168	$1,088,256	$54,413	$21,765	4932.307606	209.3249298	$3,362
COM0104302	ATC	37	$791,758	$791,758	$813,400	$40,670	$16,268	2775.847469	91.09844495	$2,514

Scientific Research is Impressive

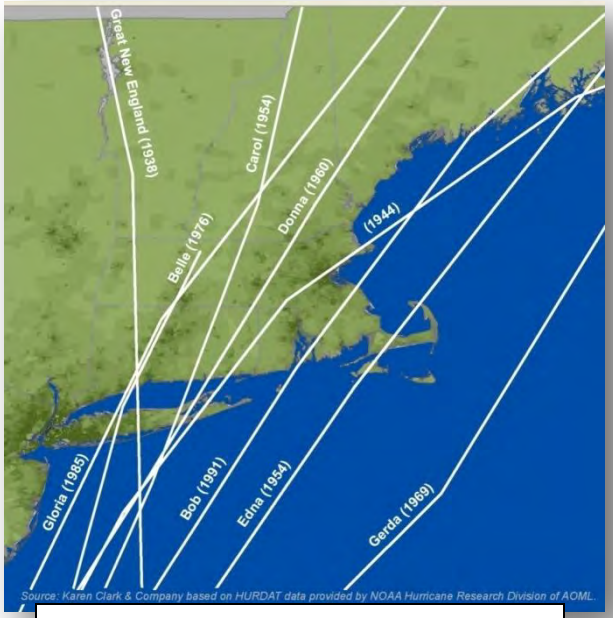


So We Drink the Kool-Aid

Forgetting Most of the Research Does Not Produce Facts



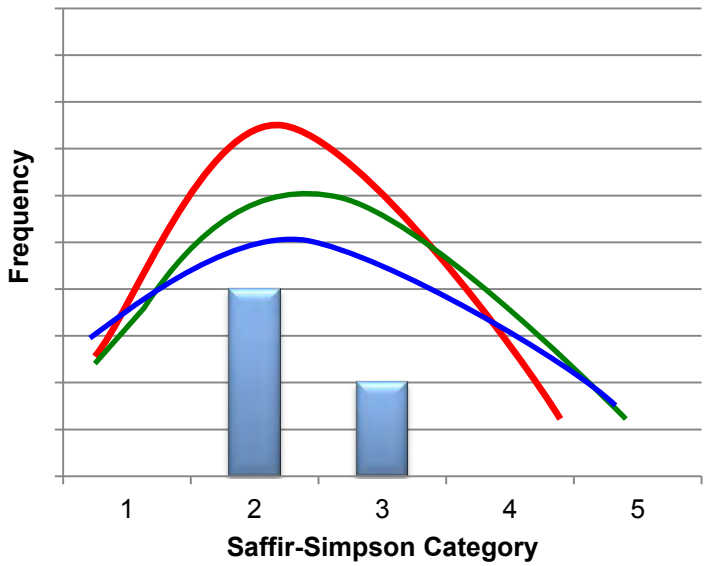
In Most Peril Regions, Scientists Have Very Little Reliable Data and Don't Know the Probabilities of Severe Events



Tracks of Landfalling Hurricanes Since 1900

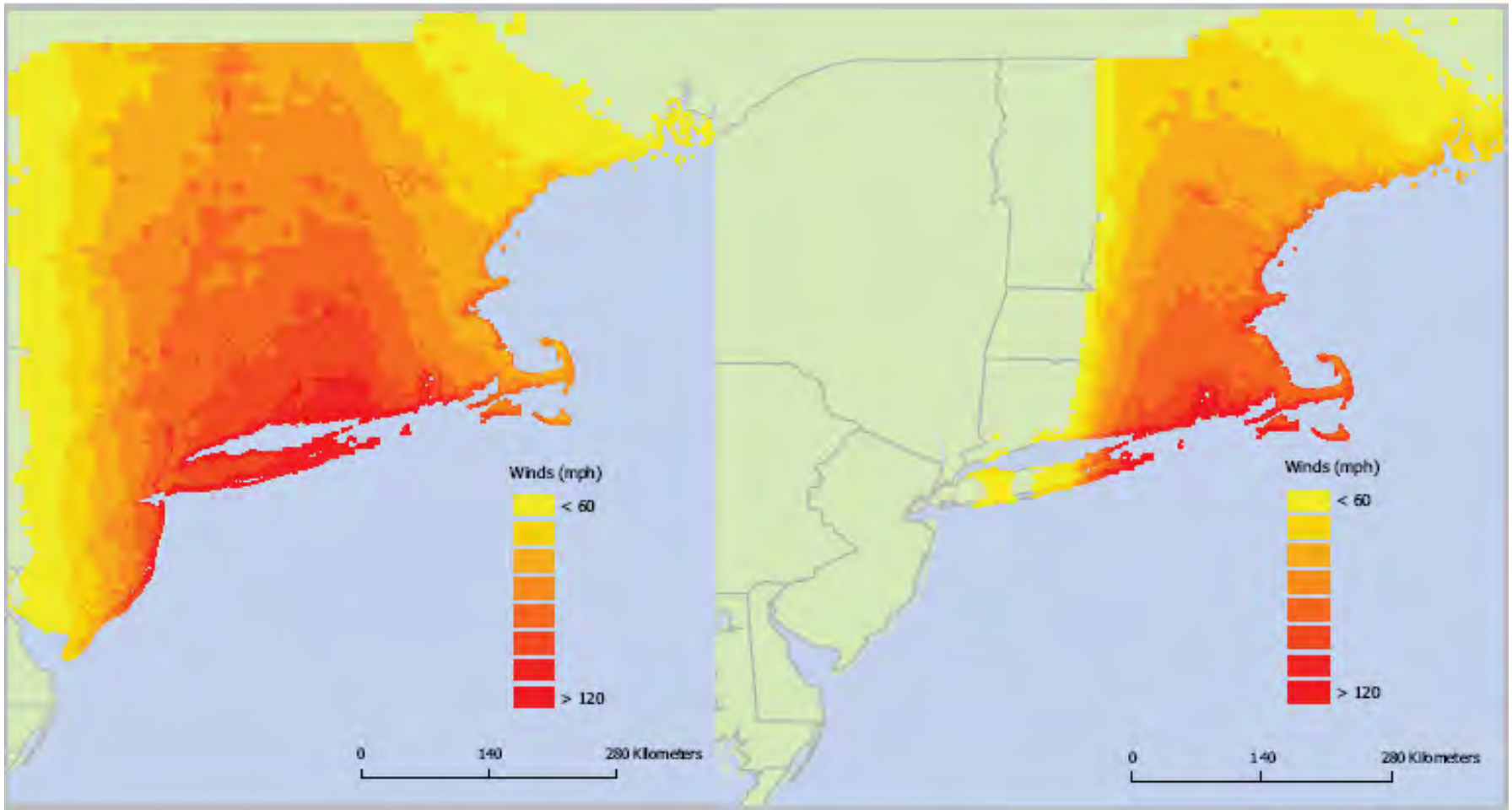
Year	Maximum Wind Speed* (mph)
1938	121
1944	----
1954	----
1954	----
1960	----
1969	----
1976	----
1985	104
1991	104

Source: NOAA HURDAT
*Overland



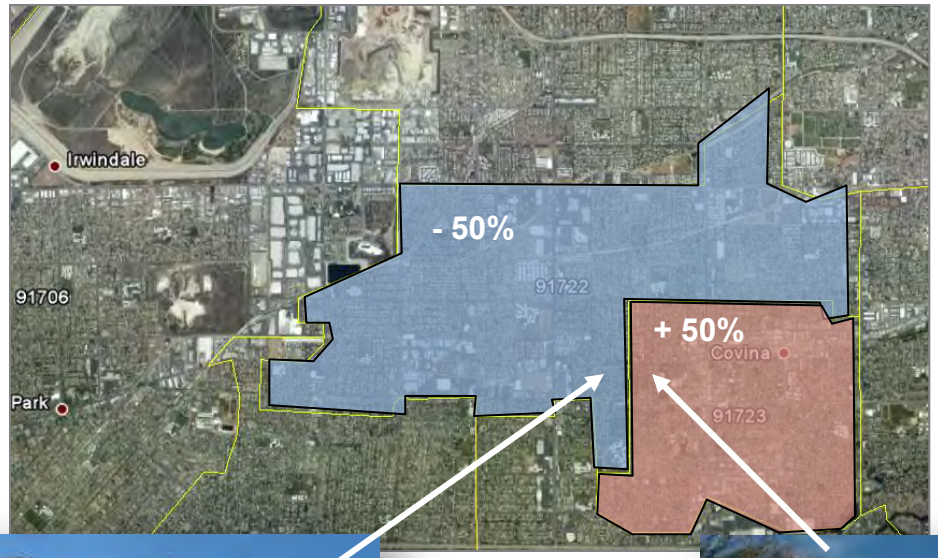
Because There is So Little Actual Data, a Model Vendor Can Make Very Different Assumptions in Model Updates

RMS Wind Footprint for the Same Storm in Two Model Versions

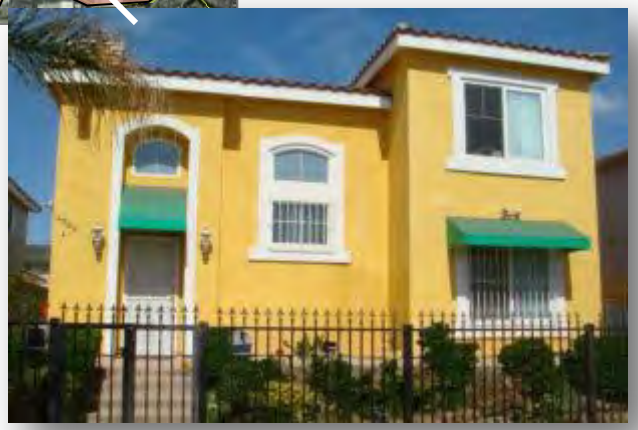


Modeled wind field of the 1938 Great New England Hurricane, assuming it has a classic hurricane structure (left) and a transitioning storm structure (right)

Model Volatility is Largely Driven by "Noise" and So Are Your Price Swings if Based on a Model



AAL = ~~$5,432.15~~ $2,716.08



AAL = ~~$4,133.86~~ $6,200.79

What Do Scientists Know About the 1811-1812 New Madrid Earthquakes?

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

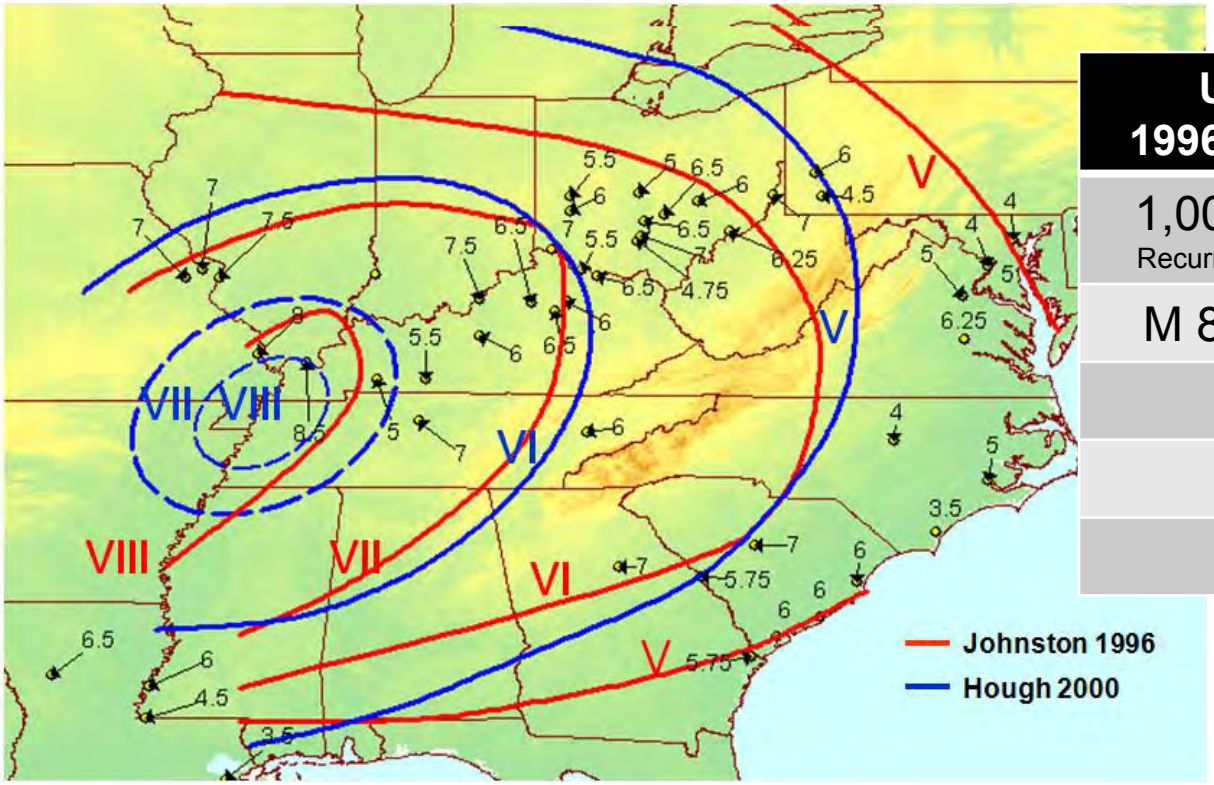
From Eliza Bryan's personal account in *Lorenzo Dow's Journal*, published by Joshua Martin in 1849.

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	*Penn. Gaz.*, Mar. 18, 1812
Cape Girardeau, Mo.	IX	*La. Gaz.*, Feb. 29, 1812
Cahokia, Ill.	IX	McDermott (1949, p. 317)
St. Louis, Mo.	VIII-IX	*La. Gaz.*, Feb. 8, 1812
Savannah, Ga.	IV-VI	*N.Y. Post*, Mar. 5,1812
Richmond, Va.	V-VI	*N.Y. Post*, Feb. 18, 1812
Pittsburgh, Pa.	V-VI	*Pitt. Gaz.*, Feb. 14, 1812
New Orleans, La.	V	*N.Y. Post*, Mar. 5, 1812
Augusta, Ga.	V	*N.Y. Post*, Mar. 5, 1812
Washington, D.C.	V	*N.Y. Post*, Feb. 11, 1812
Alexandria, Va.	IV-V	*N.Y. Post*, Feb. 12, 1812
Baltimore, Md.	IV-V	*Penn. Gaz.*, Feb. 12, 1812
New York, N.Y.	IV-V	*Penn. Gaz.*, Feb. 12, 1812

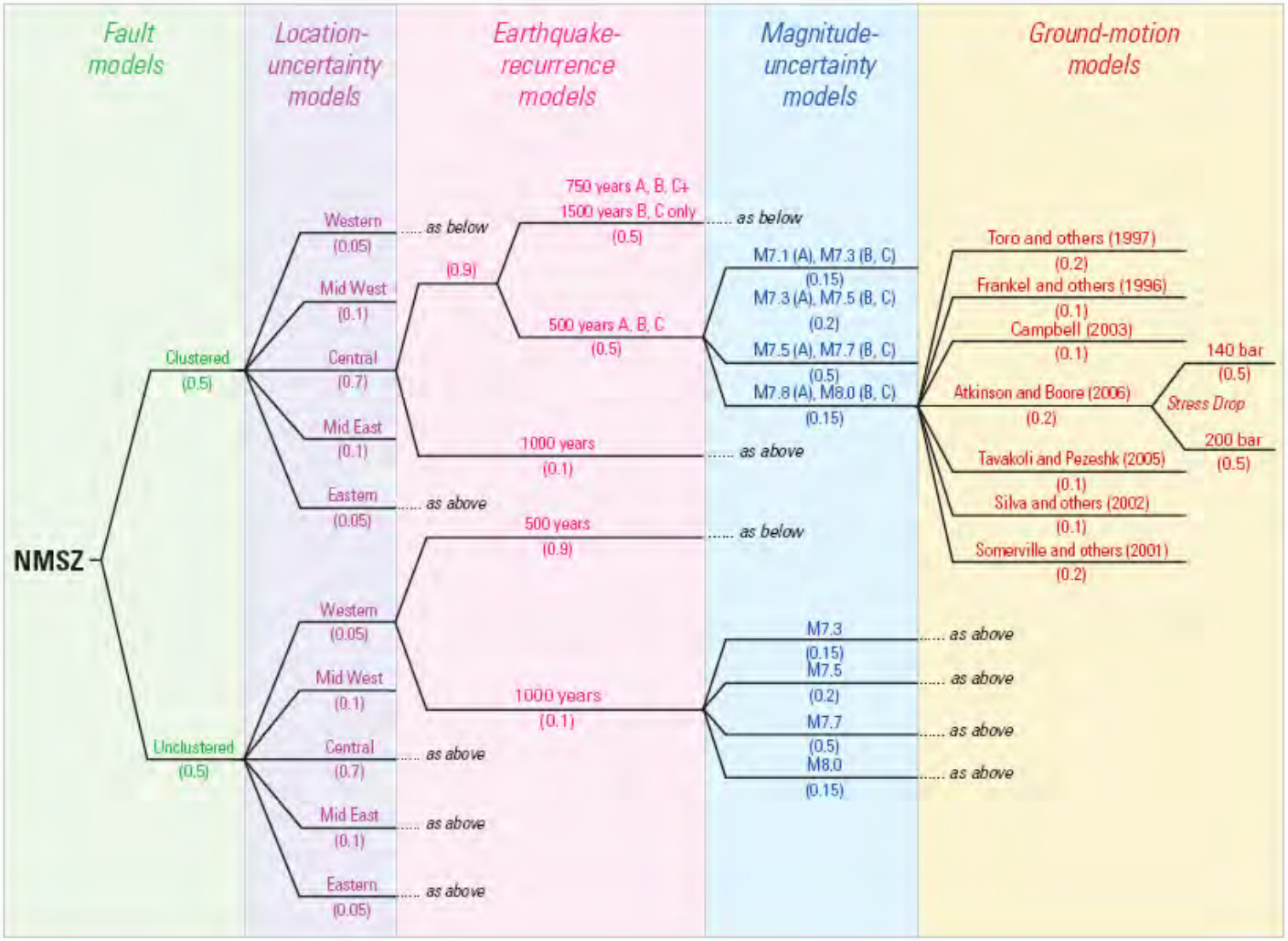
There is Scientific Disagreement on the Magnitudes of the NM Earthquakes and the Return Periods



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



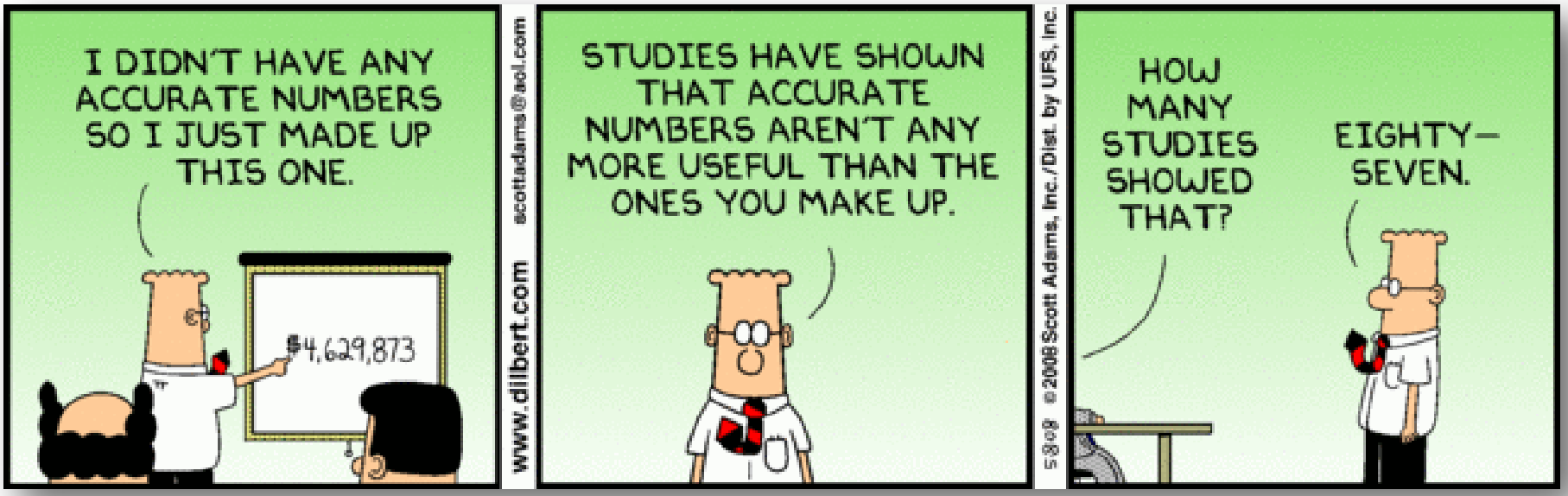
USGS: Documentation for the 2008 update of the United States National Seismic Hazard Maps

An Anonymous Seismologist Once Said…

"The more you know,

The more you know you don't know"

Given All of the Unknowns and Uncertainty Why Do We Still Expect the Models to Give the Answer?



Time to Think Outside the Black Box

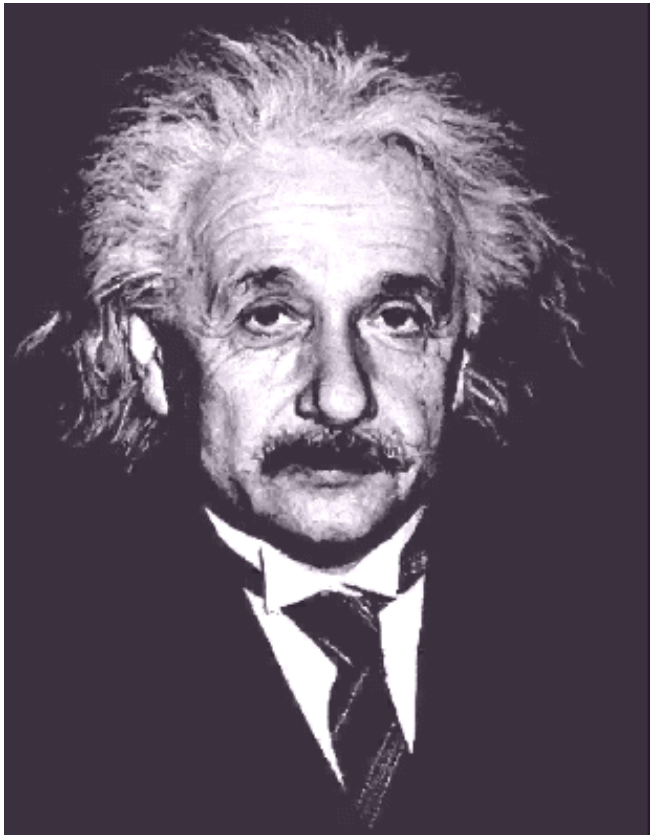
- The cat models will never be able to produce accurate EP curves or PMLs (too many unknowns)

- We can develop other scientific approaches that are
  - ✓ Credible
  - ✓ Consistent
  - ✓ Transparent
  - ✓ Flexible

A Few Risk Management Challenges

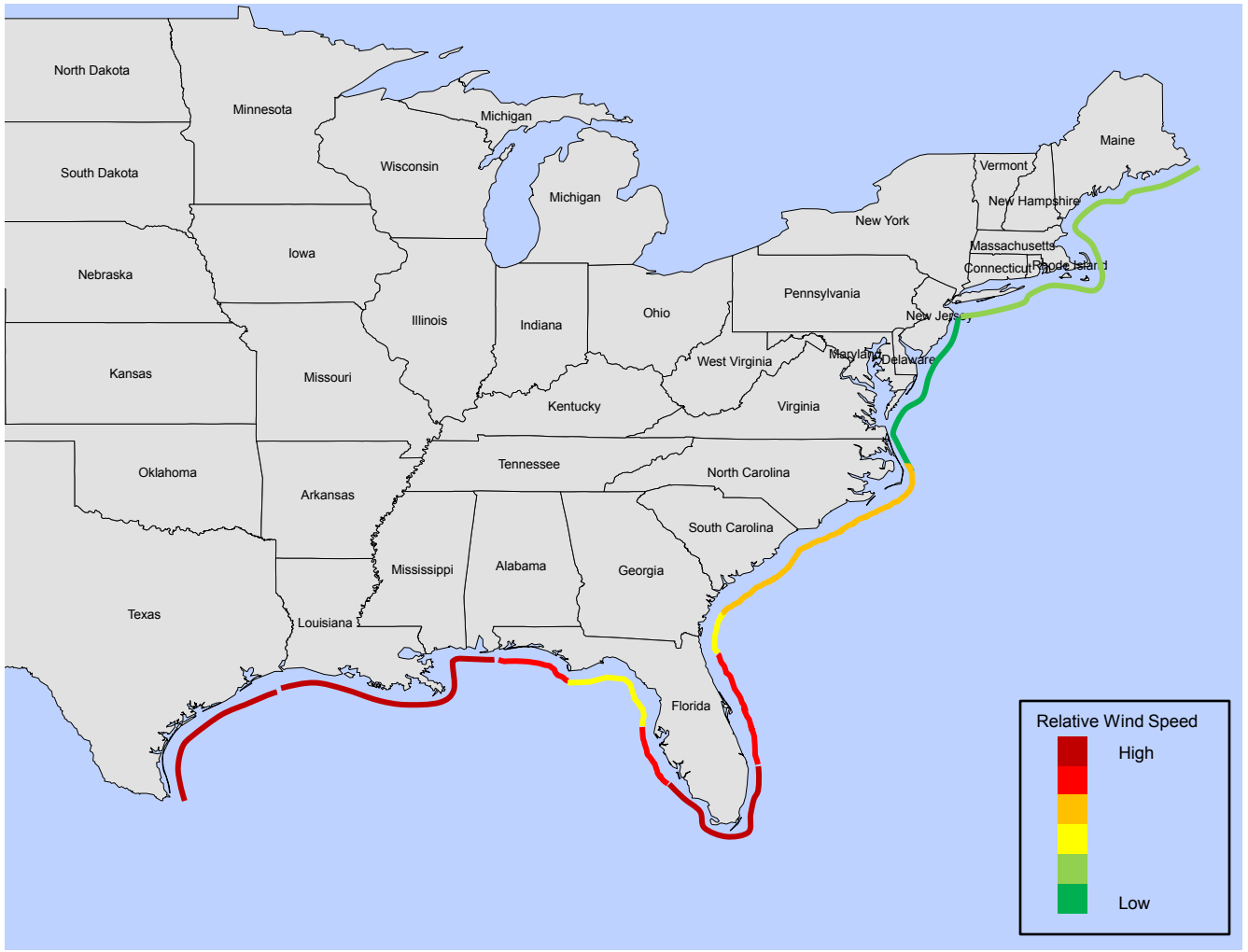
- Over reliance on vendor models due to
  - ✓ Scientific seduction
  - ✓ False model precision
  - ✓ Convenience
- Highly volatile loss estimates due to noise and over specification
  - ✓ Pressure on modelers to incorporate more and more variables
  - ✓ Little or no data supporting most model variables
  - ✓ Loss estimates highly sensitive to changes in model assumptions
  - ✓ Added complexity means higher propensity for mistakes and “bugs”
- No 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
- Other than “knobs” no flexibility to customize approach or build proprietary view of risk

How Can We Address These Issues?

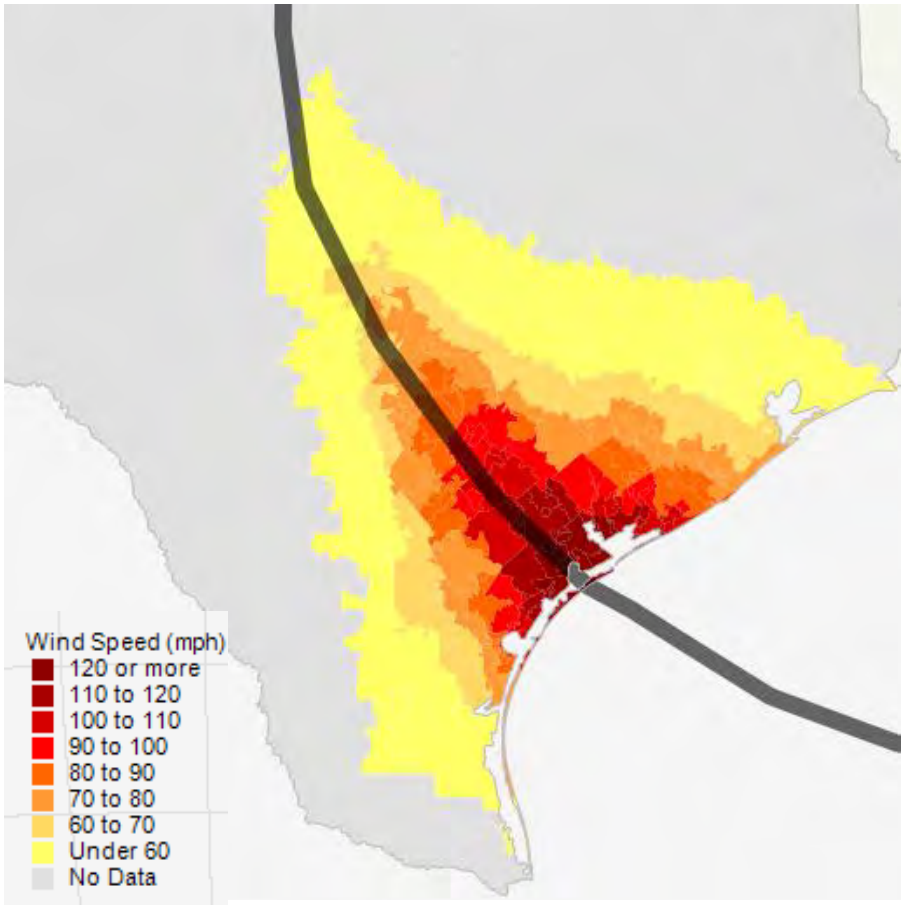


"We can't solve problems by using the same kind of thinking we used when we created them."

Characteristic Events (CEs) Provide These Benefits and a New Perspective on Risk



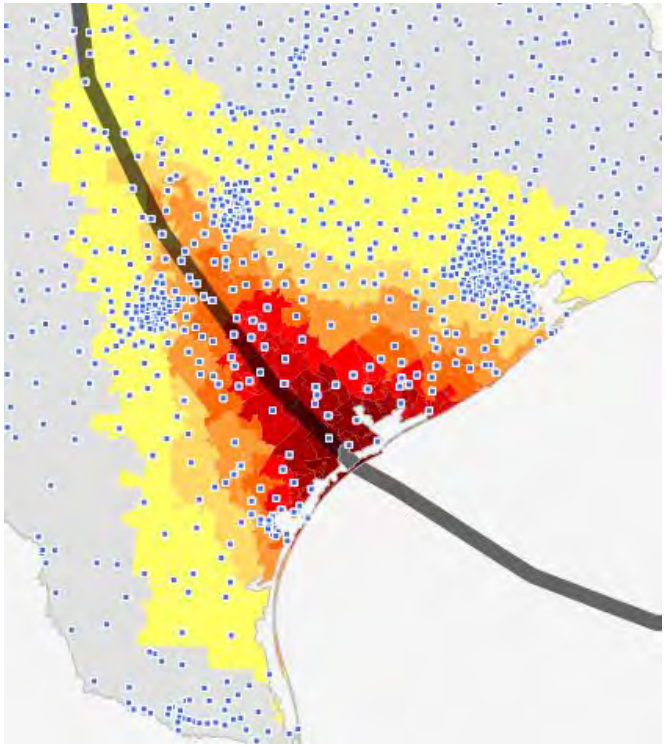
100 Year Texas CE



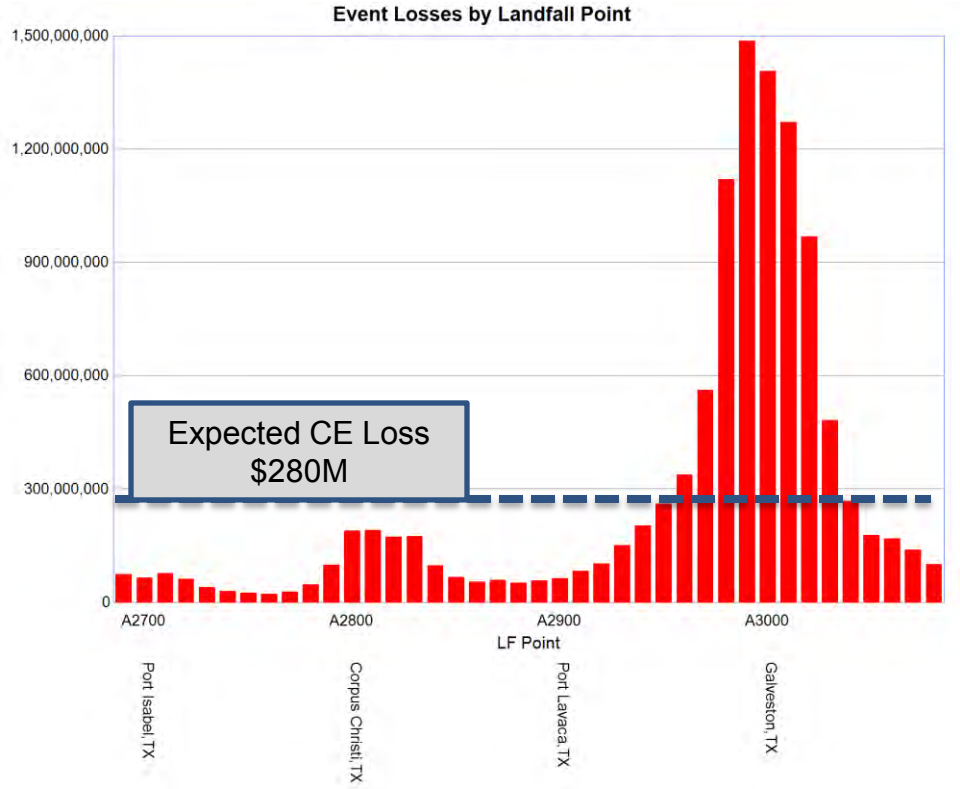
- Footprint is similar to 1900 Galveston event
- Maximum over land wind speed is 167 mph (Category 5 hurricane)
- Typical track for region

Sample Company 100 Year CE Results for Texas

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

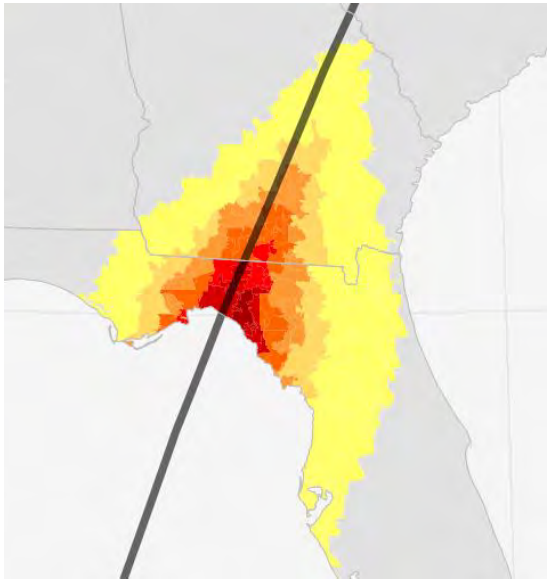


2. CE losses are estimated at ten mile landfall points and summarized for each event. The resulting regional loss summary identifies the range of potential losses and identifies peak loss scenarios. The expected losses for the region can be compared to model PMLs.



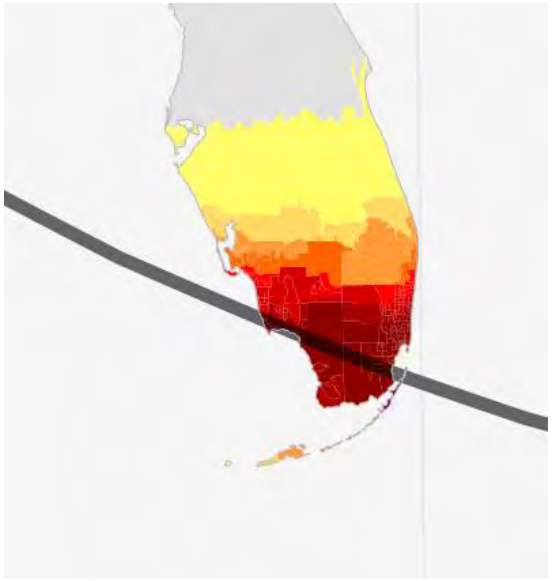
100 Year Florida CEs

Florida NW



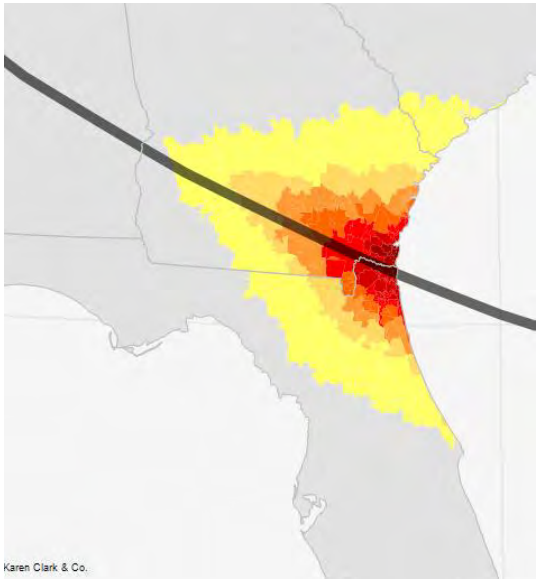
- Max over land wind speed varies from 135 mph to 164 mph

Florida SO



- Max over land wind speed is 167 mph

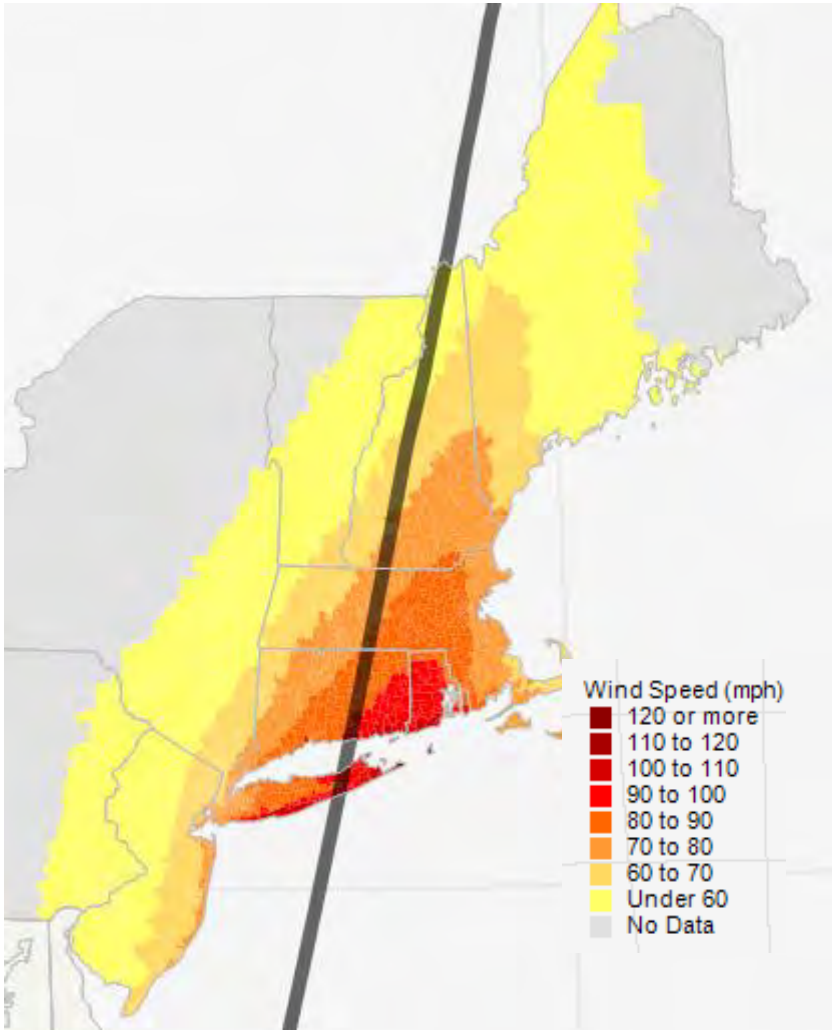
Florida NE



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

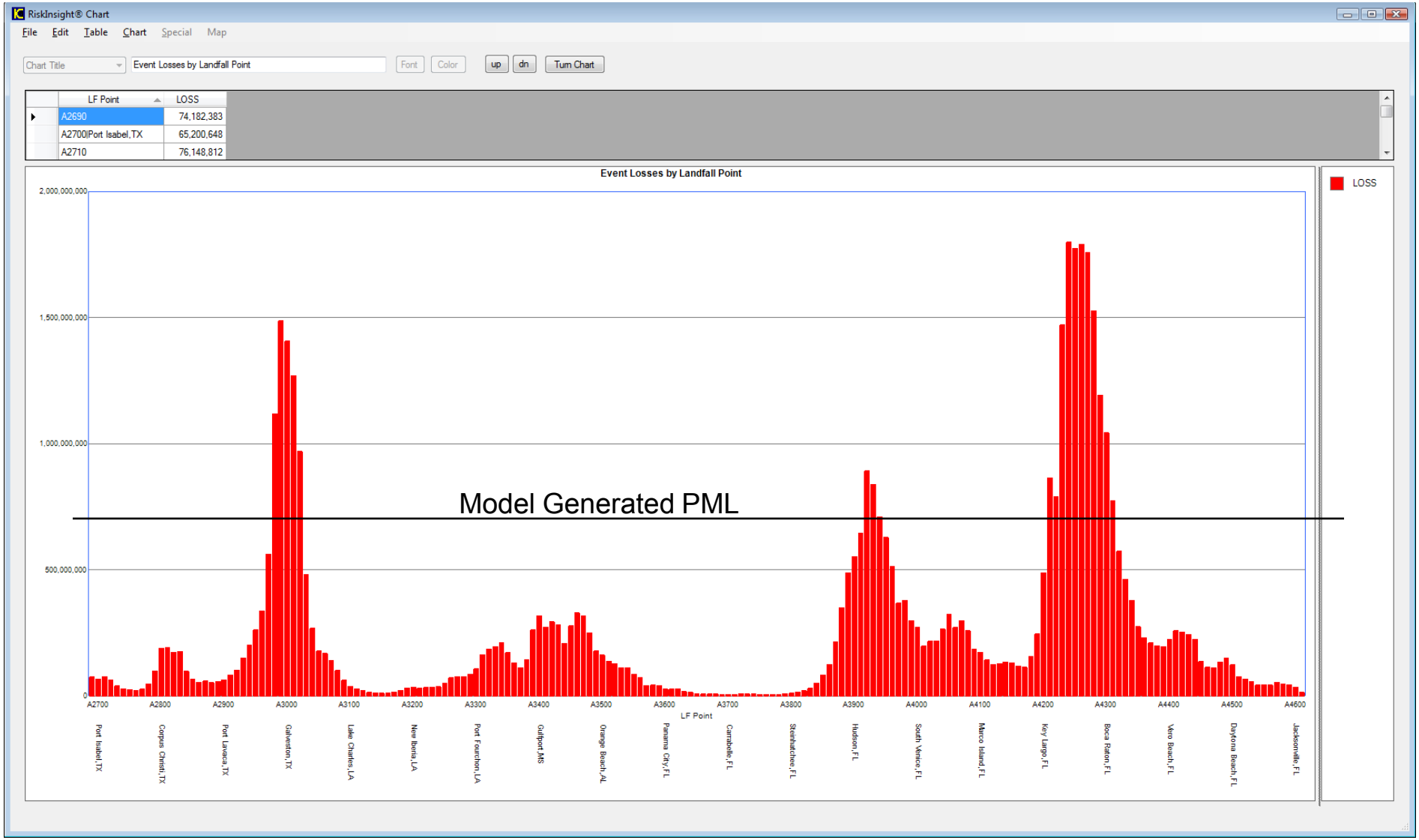
- Storm track varies within each region

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

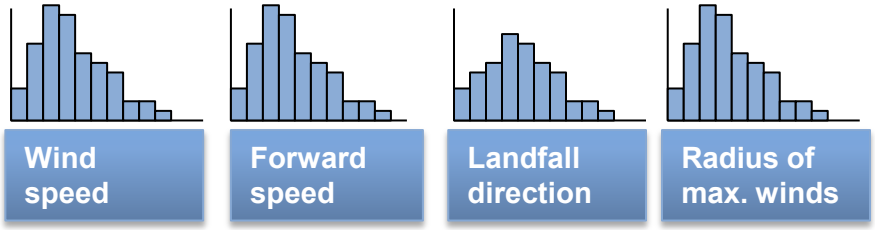
Model-generated PMLs Mask Exposure Concentrations of Ceding Companies



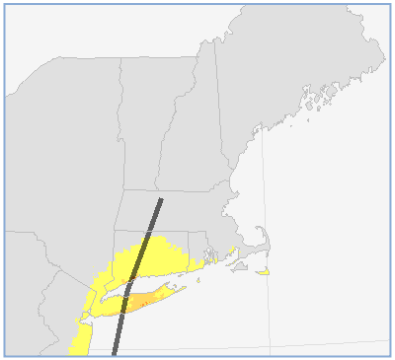
One Fundamental Difference from the Models – Defined Probability versus Randomly Generated Events

Historical hurricane data from National Hurricane Center…

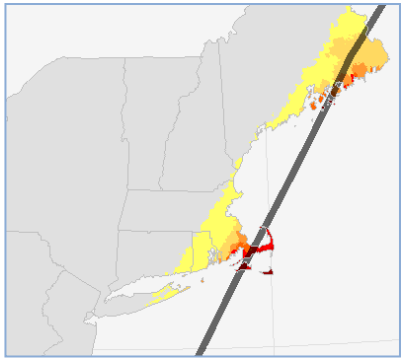
Catastrophe Models – Random Events



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

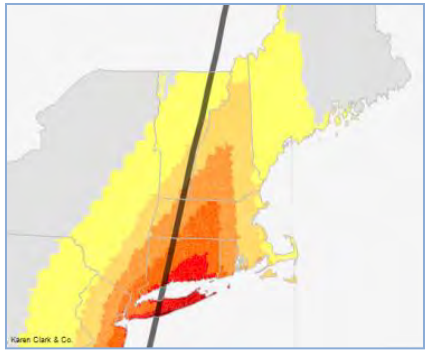


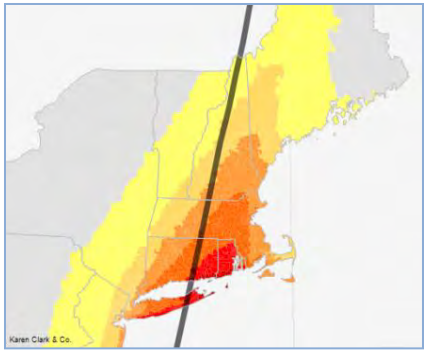
Random Event 2
Wind speed = 152 (SS4)
Rmax = 13
…..

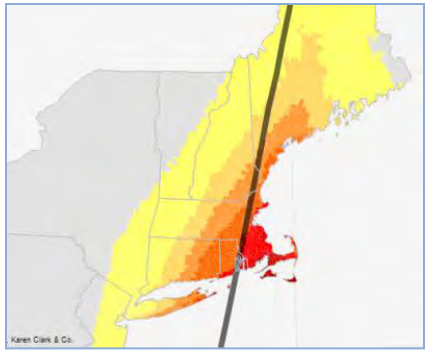


Events are generated by sampling from parametric distributions.

CEs – Defined Probability Events



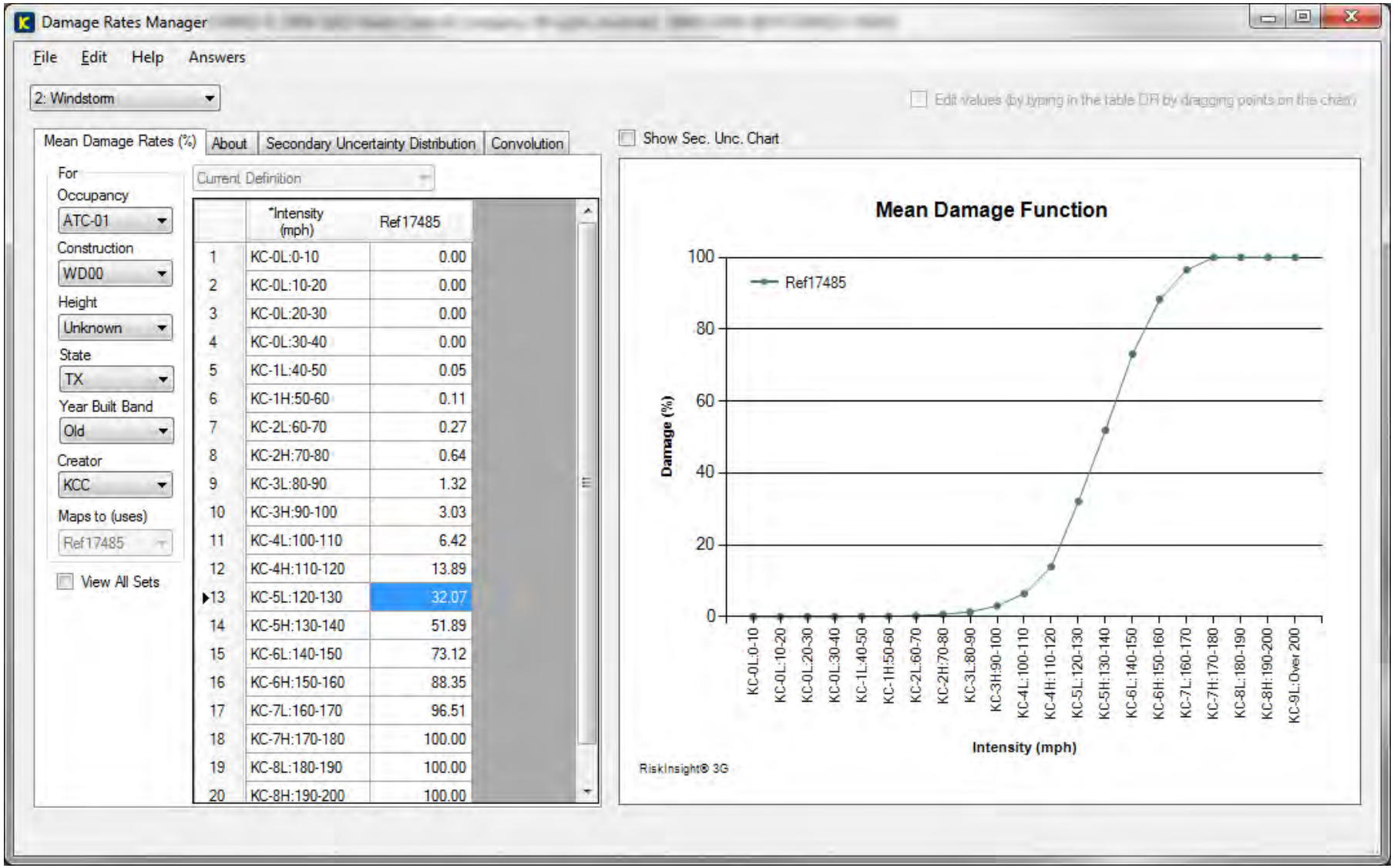




Characteristic Event 1, 2, ….
Wind speed = 122 (SS3)
Rmax = 40
…..

Events are defined based on meteorological characteristics representative of specific return periods.

In New Approach Damage Functions Are Visible and Customizable for US and Other Peril Regions



How Companies Are Using RiskInsight for Direct Business

- 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”
- Ratemaking and pricing with more robust policy-level loss results
- Fine-tune damage functions using detailed claims data and other information
- Create customized and proprietary view of risk

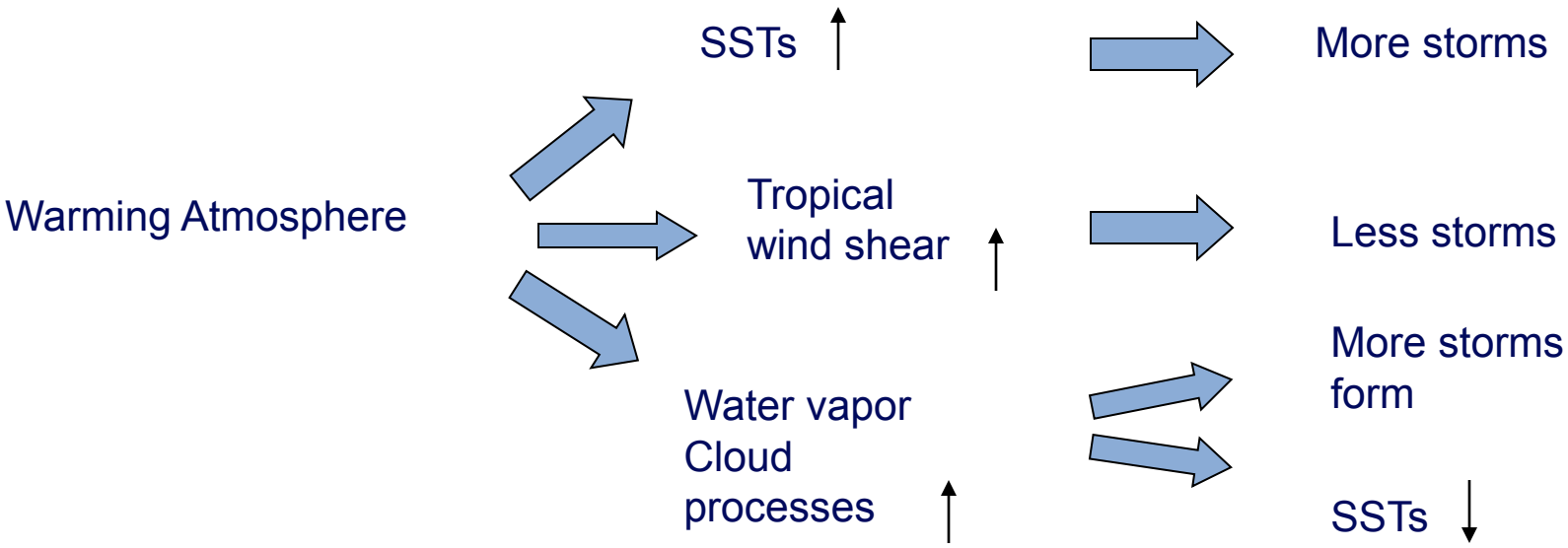
How Companies Are Using RiskInsight for Treaty Books

- Quickly analyze and score the submission data
- Create customized reports and maps for underwriters
- Perform ad hoc data analysis and reporting to answer questions
- Calculate ceding company losses from 100 year and other return period events (to identify cedants who are vulnerable to large losses)
- Calculate market shares of losses for individual cedants and total treaty book
- Identify correlations between ceding companies and conduct marginal impact analyses to improve portfolio metrics
- Build proprietary view of risk scientifically and efficiently

What Insurers Want to Know About Climate Change

- Will there be an increase in the frequency?
- Will there be an increase in intensity?
- Why is it difficult to figure out the impacts of climate change?

Atmosphere is very complex and has many feedback mechanisms



Even the most sophisticated climate models cannot capture precisely every variable and physical process in the atmosphere

Some Scientists Have Argued that North Atlantic Tropical Cyclone Activity is Increasing

Trends in Atlantic Basin Tropical Cyclone Storm Counts

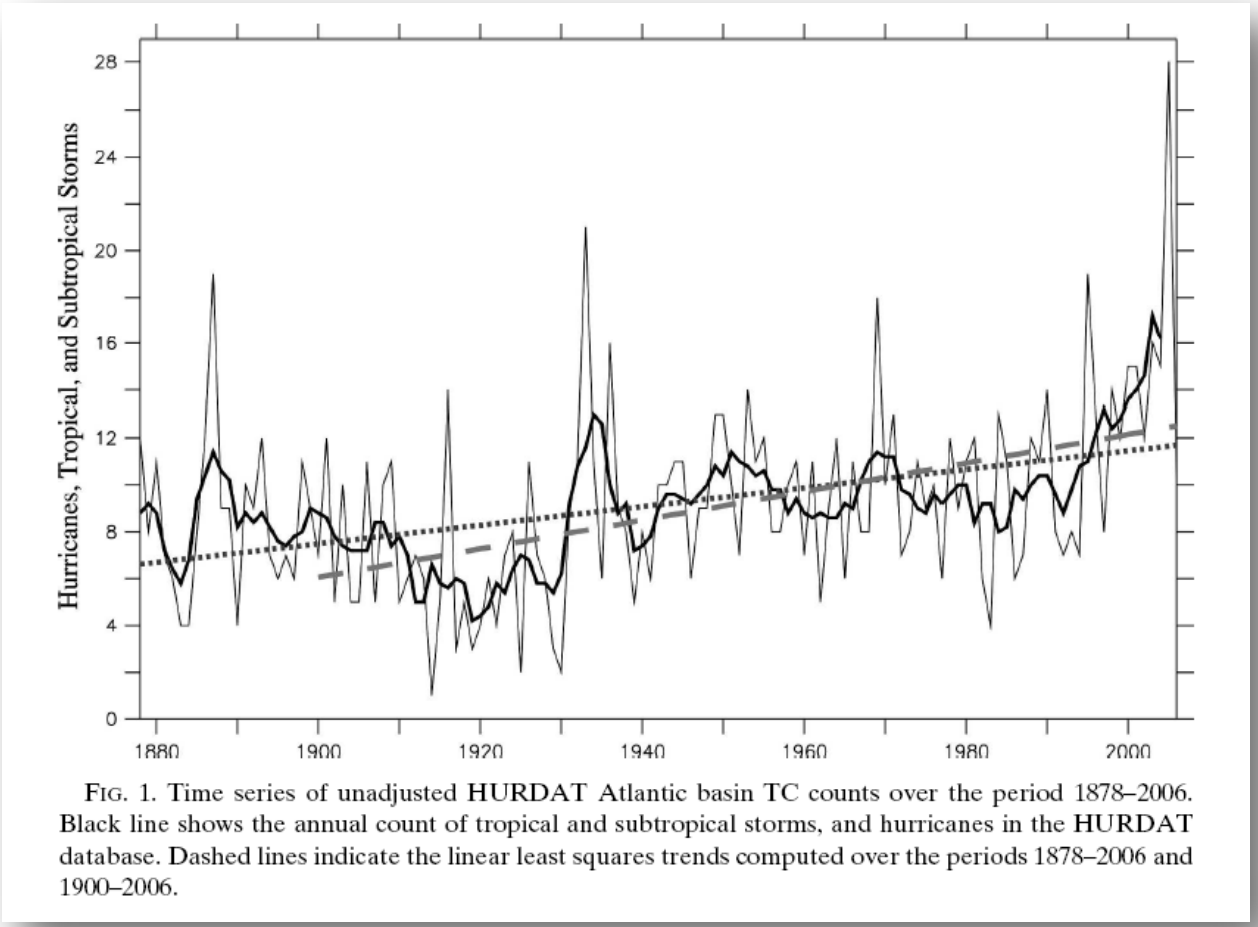
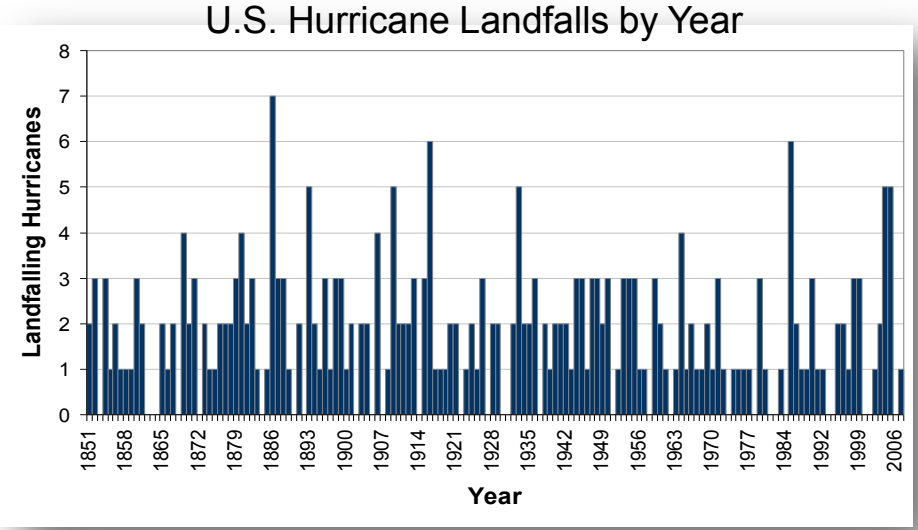


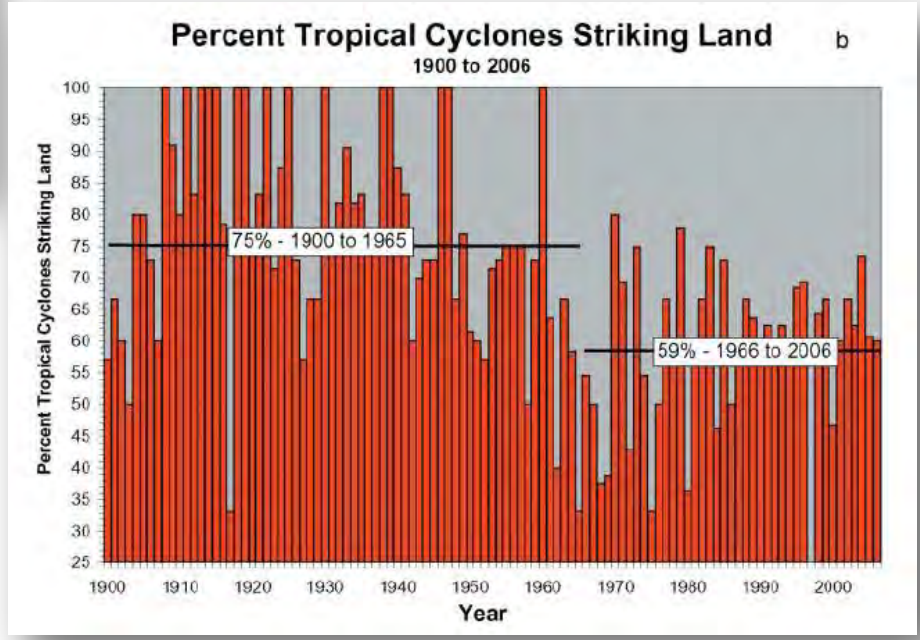
FIG. 1. Time series of unadjusted HURDAT Atlantic basin TC counts over the period 1878–2006. Black line shows the annual count of tropical and subtropical storms, and hurricanes in the HURDAT database. Dashed lines indicate the linear least squares trends computed over the periods 1878–2006 and 1900–2006.

Source: Vecchi, G. A. and T. R. Knutson, 2007: On Estimates of Historical North Atlantic Cyclone Activity. J. Climate, 21, 3580 - 3600

The Landfall Paradox: Increase in Basin Storm Observations Has Not Resulted in Increase in U.S. Hurricane Landfalls

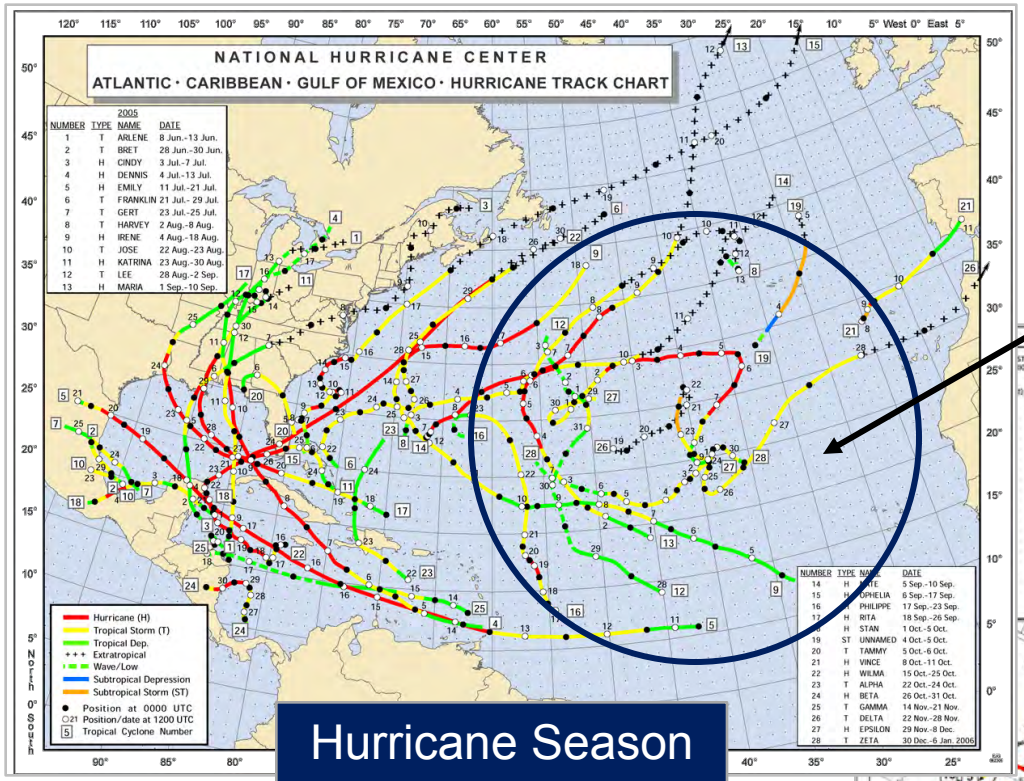


Source: Blake, E.S., E.N. Rappaport, C.W. Landsea, 2007: The Deadliest, Costliest and Most Intense United States Tropical Cyclones from 1851 to 2006 (and Other Frequently Requested Hurricane Facts). NOAA, Technical Memorandum NWS-TPC-5, 43 pp, and National Hurricane Center Tropical Cyclone Reports. Updated to 2007 by Karen Clark & Company.



Source: Landsea, C.W., 2007: Counting Atlantic Tropical Cyclones Back to 1900. EOS, Vol. 88, No. 18, pp. 197-208.

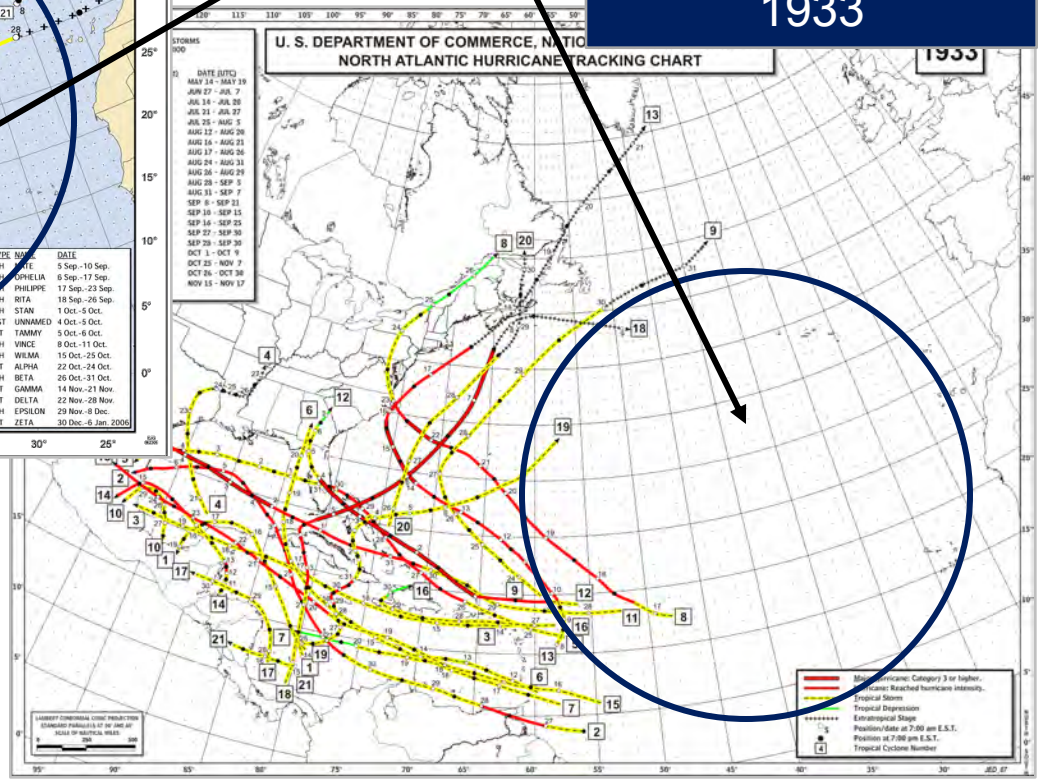
Other Scientists Have Argued Apparent Increases in Activity Are Due to Advances in Detection Technology



Hurricane Season 2005

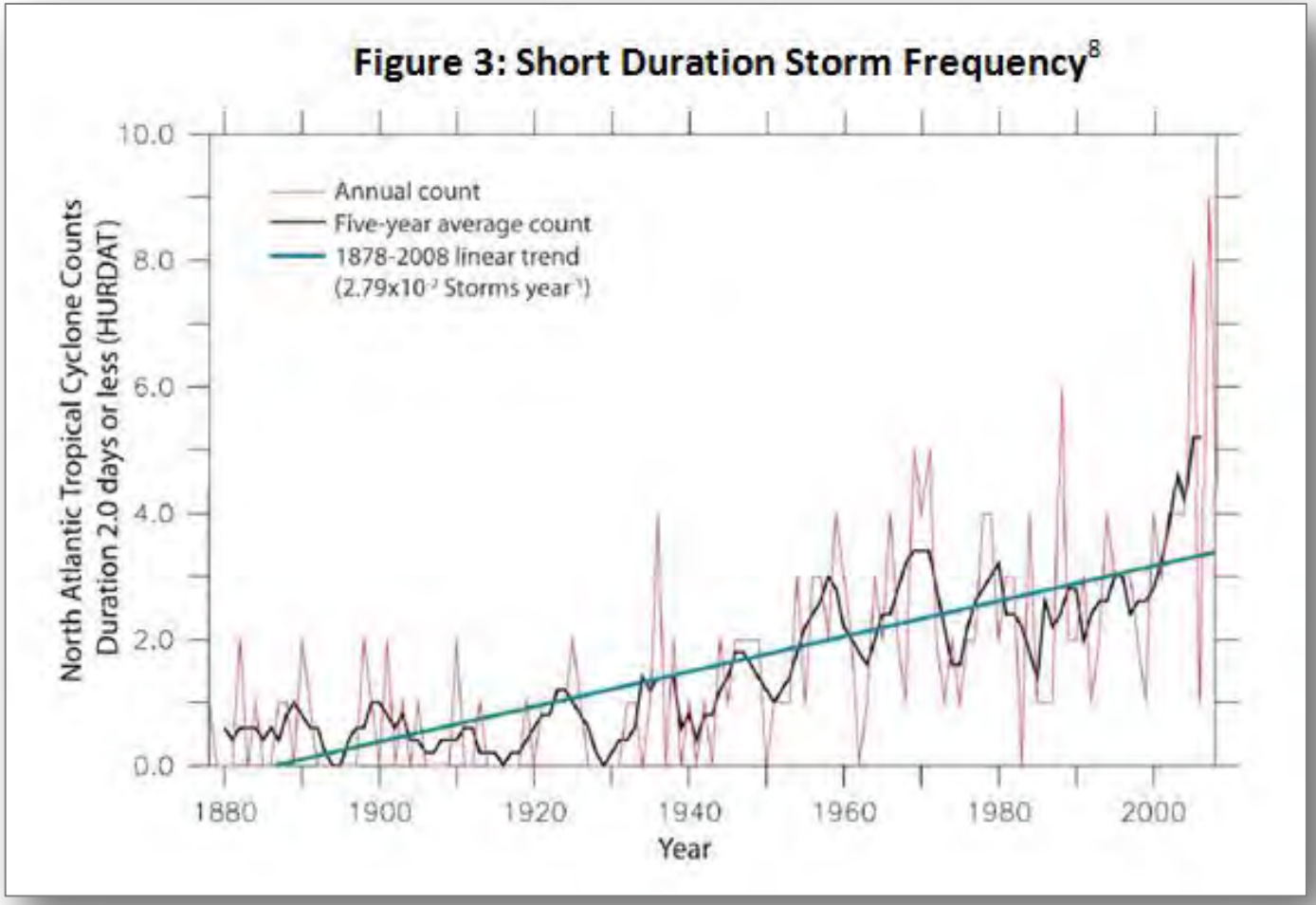
Open Atlantic Ocean Differences

Hurricane Season 1933



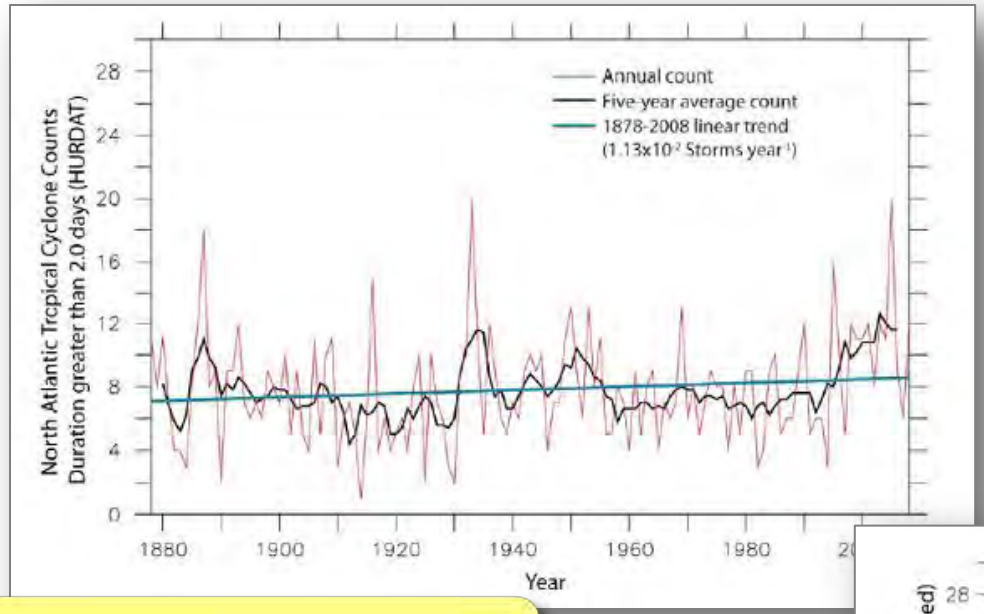
Source: NOAA

Advances in Detection Technology Have A Dramatic Impact on Increasing Frequency of Short Duration Storms



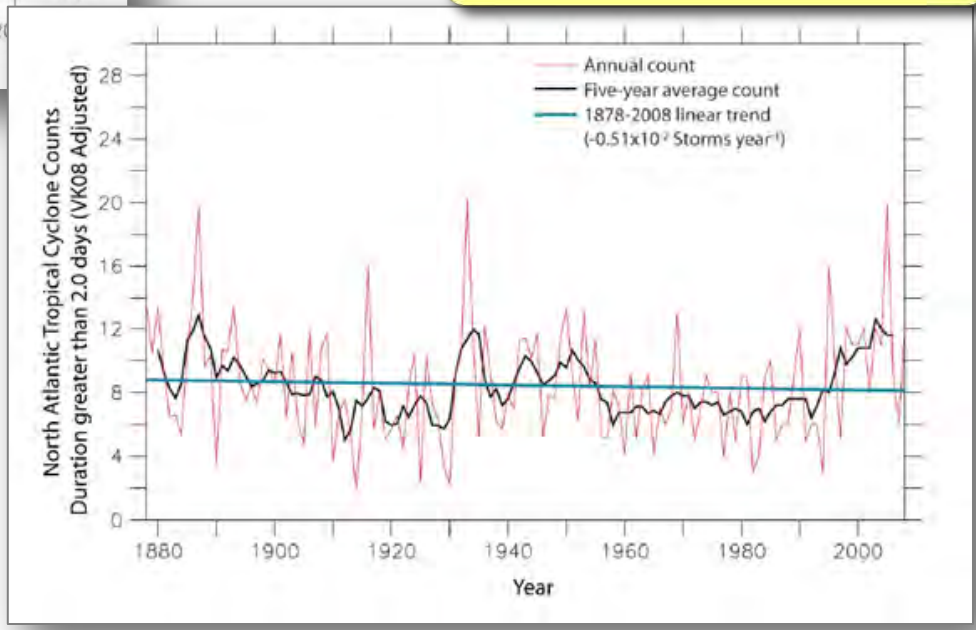
Source: Landsea, Christopher W., Gabriel A. Vecchi, Lennart Bengtsson, Thomas R. Knutson, "Impact of Duration Thresholds on Atlantic Tropical Cyclone Counts," *Journal of Climate,* http://ftp.nhc.noaa.gov/users/landsea/landsea-etal-final-jclimate.pdf

Correcting for The Detection Anomaly Removes the Perceived Trend in Storm Counts



Moderate to Long Lived Storm Frequency

Adjusted Long Duration Storm Frequency



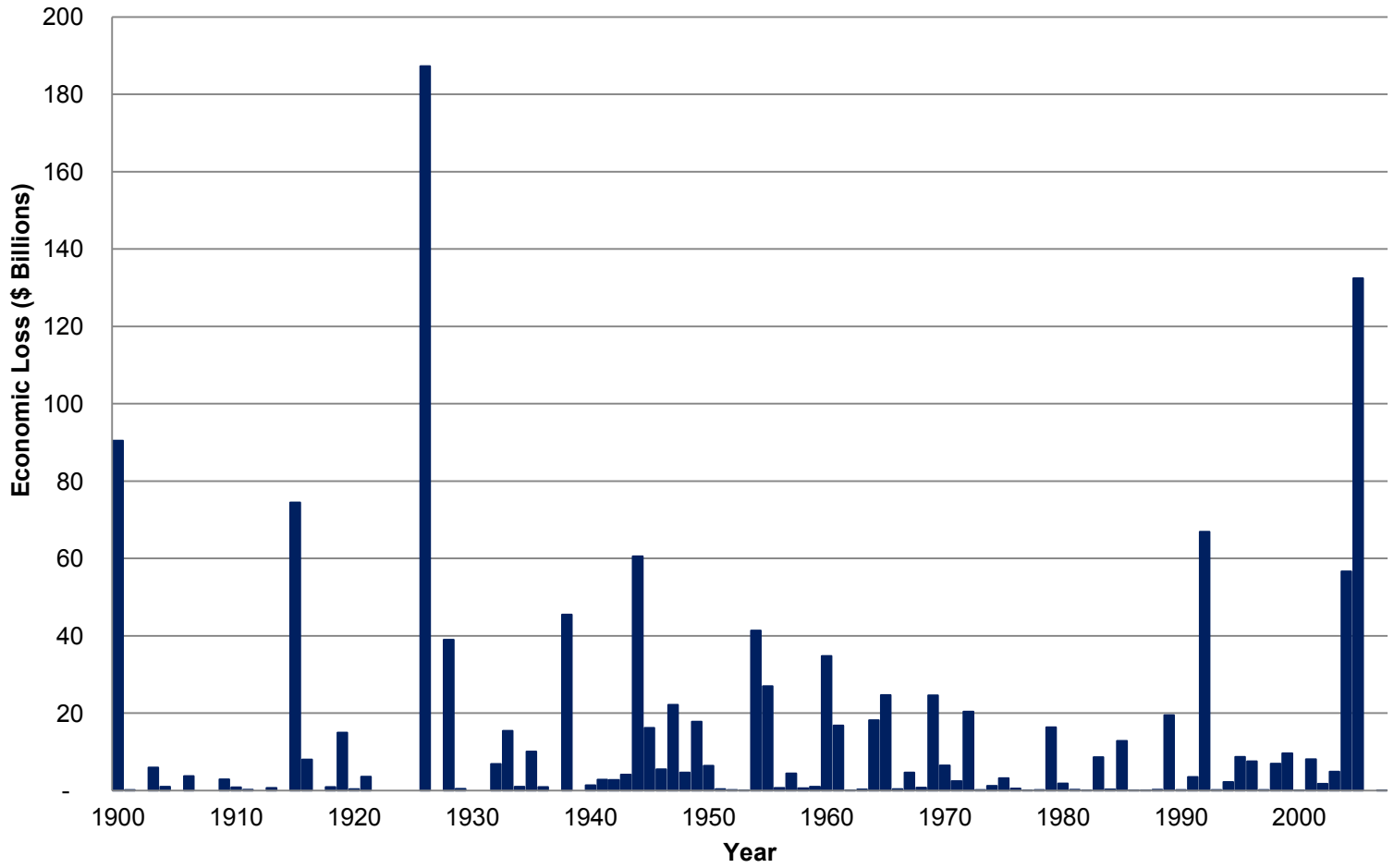
Most Recent IPCC Findings and Projections

- 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, a time period spanning ~ 2007 to 2027)

- Most climate models project global *decrease* in tropical cyclone frequency

No Trend In Hurricane Losses When Normalized to Current Exposure Values



Source: Methodology based on Pielke, Jr., R.A., J. Gratz, C.W. Landsea, D. Collins, M. Saunders, and R. Musulin, 2007: Normalized Hurricane Damages in the United States: 1900-2005. *Natural Hazards Review*, Vol. 9, No. 1, February 1, 2008, 29-42. Karen Clark & Company updated economic loss estimates through 2007.

Summary

- Newer technology makes the hazard and engineering components transparent to insurance companies rather than a “black box”

- Open, flexible platforms enable insurers to build their own proprietary views of risk more efficiently and scientifically
  - ✓ Internal experts
  - ✓ External experts
  - ✓ Detailed claims and other data

- How risk managers will benefit
  - ✓ Company specific factors and loss mitigation activities more directly feed the loss estimation process
  - ✓ Prices that better reflect the true risk
  - ✓ More transparency and consistency from year to year