KAREN CLARK & COMPANY

Using Open Source and Open Platforms to Build Your Company's Own View of Catastrophe Risk

CAS Annual Meeting

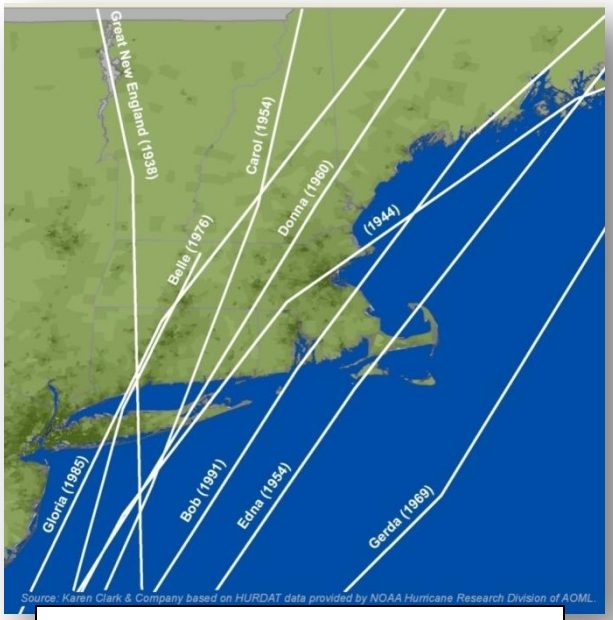
New York, NY

November 2014

Why as an Insurer or Reinsurer You Must Own Your View of Catastrophe Risk

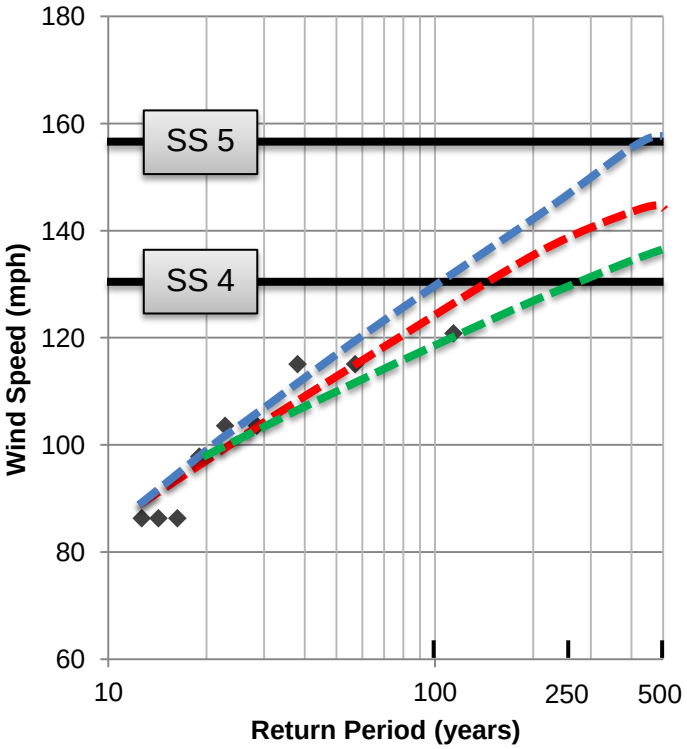
- Because there is so little data and so many unknowns the models will never be accurate—there is no “right” model
- The models do not provide “answers”—they provide loss estimates based on sets of assumptions
- A lot of the model volatility is driven by changing assumptions (and mistakes!) and not new scientific facts
- External stakeholders, such as investors, rating agencies, and regulators are increasing their demands with respect to your understanding of and ownership of the risk

There is no Right Model: Model Volatility Driven by Changing Model Assumptions



Tracks of Landfalling Hurricanes Since 1900

Year	Maximum Wind Speed* (mph)
1938	121
1944	104
1954	115
1954	115
1960	98
1969	86
1976	75
1985	86
1991	104



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 …

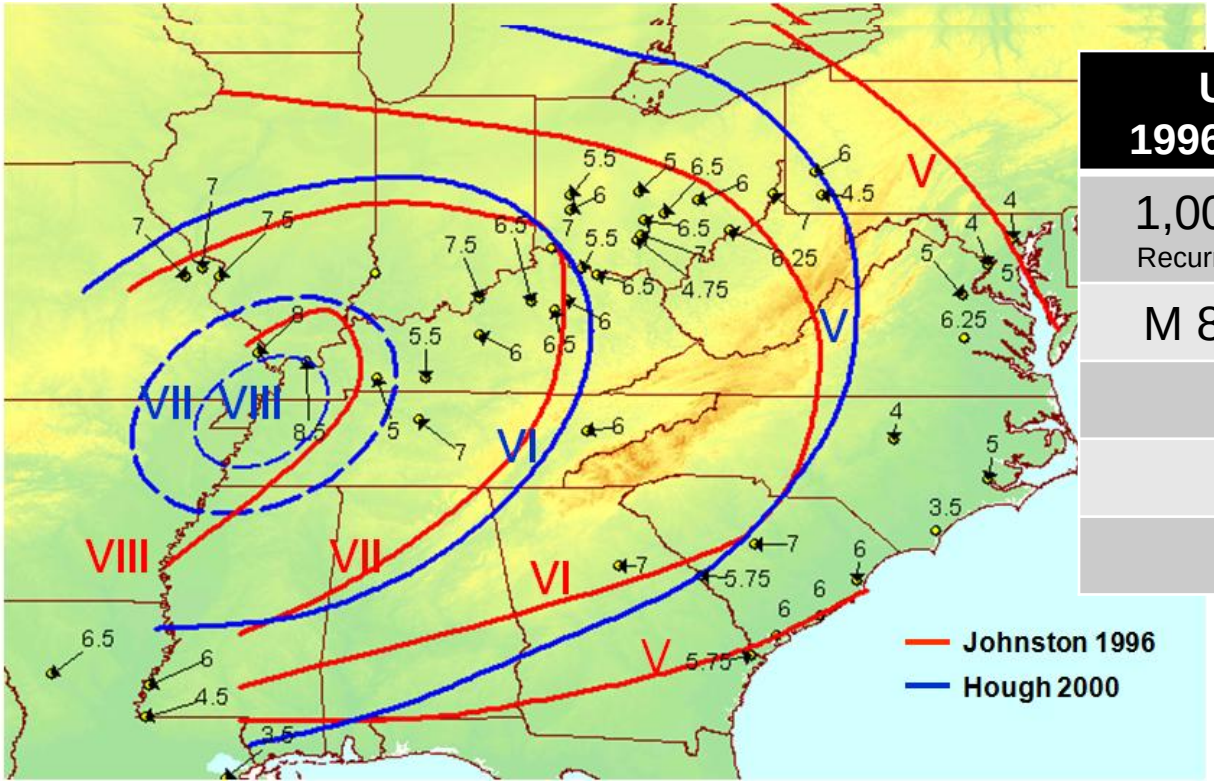
From Eliza Bryan's personal account in *Lorenzo Dow's Journal*, published by Joshua Martin in 1849.

What We Know About the Damage is Largely 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

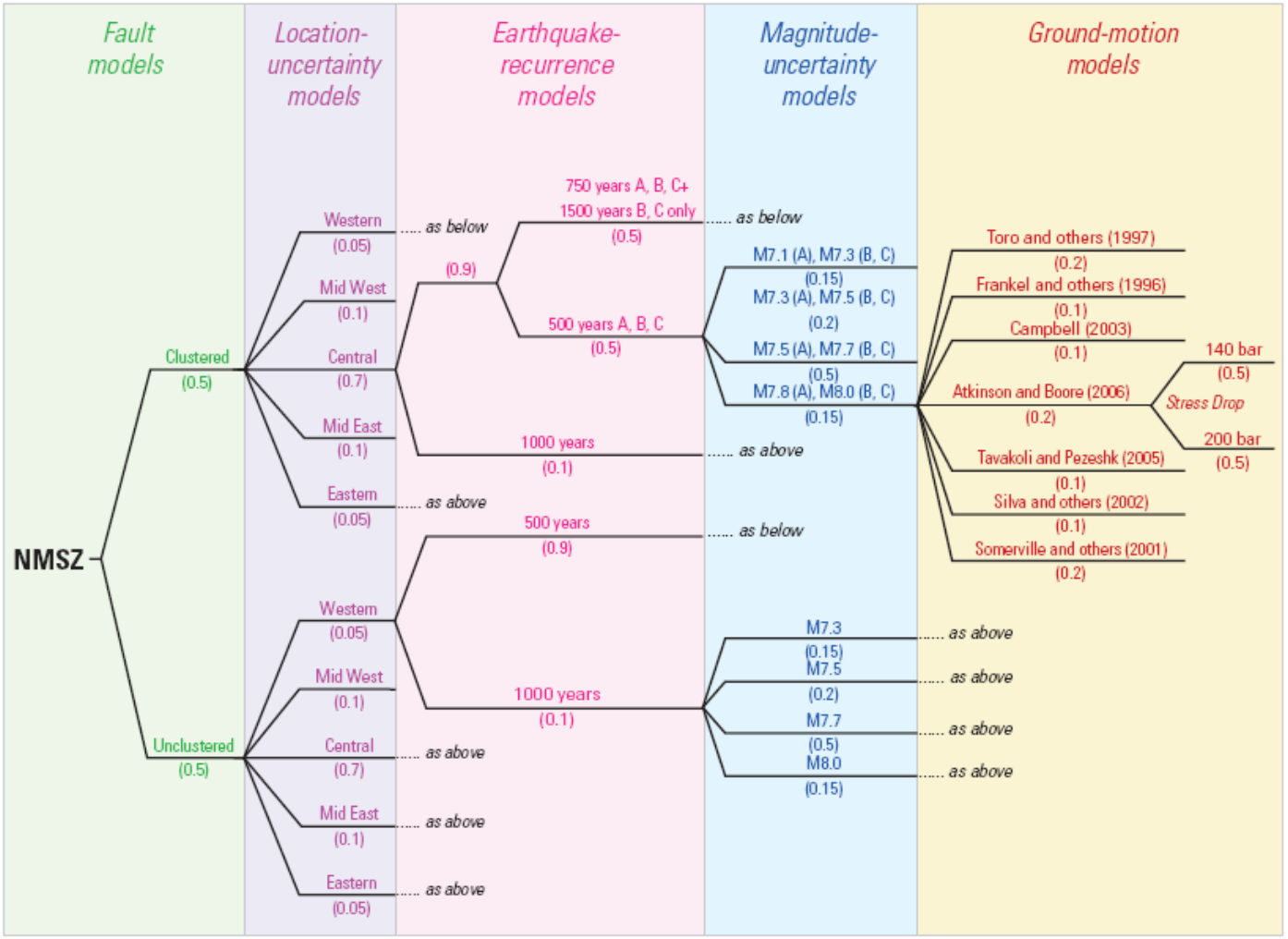
There is Scientific Disagreement on the Magnitudes of the NM Earthquakes and the Return Periods



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



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

What the Experts Have to Say About What They Know and Don't Know

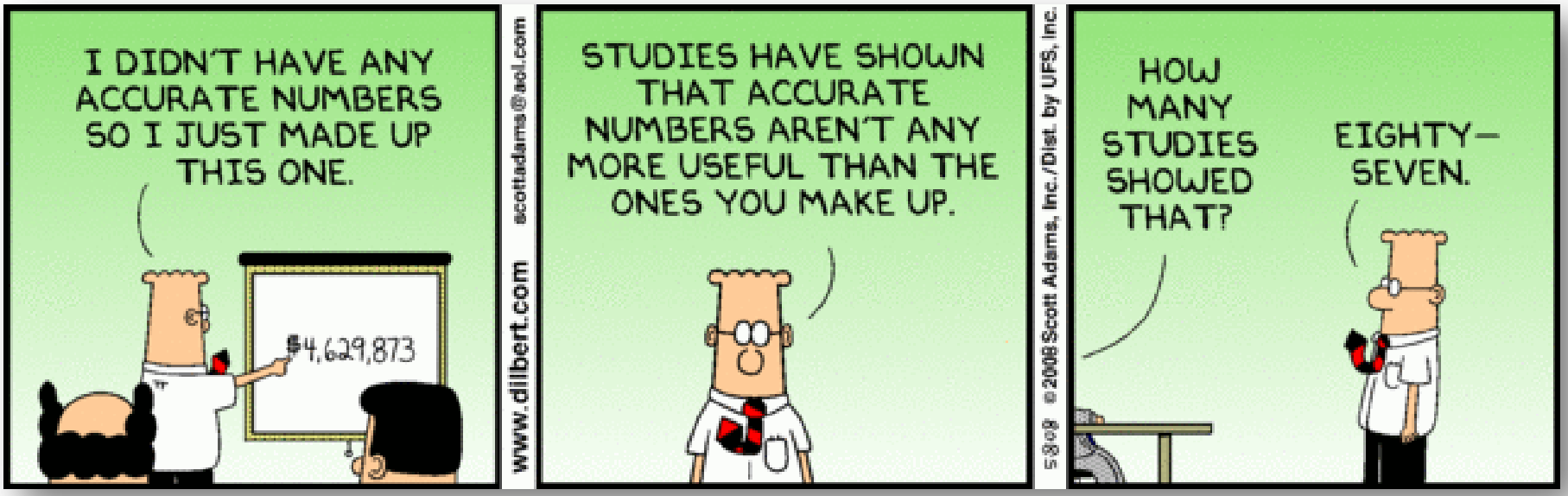
- Kerry Emmanuel, MIT: "While there has been some advance in the theory of tropical cyclone intensity, the question of frequency is more vexing … a good theoretical understanding of the environmental control of storm frequency is lacking."

- Researchers from Georgia Tech: "The challenge to scientists is to assess the future risk in the face of incomplete data, imperfect models, and incomplete understanding."

- SSA Bulletin "When I asked George Housner, the father of modern earthquake engineering, about the design philosophy used when he advised the Caltech Administration about campus buildings from 1950s [when there was much less knowledge of seismic hazards] he told me 'I kind of knew what I didn't know'".

- Dr. Thomas Heaton, Caltech "a high-rise building's integrity depends more on what we don't yet know about large earthquakes."

Given All of the Unknowns Why Do We Expect the Models to Give an Accurate Number?



How Can the Models Improve—What's the Next Generation?

- Model components are fully transparent—no more "black boxes"
- Model assumptions can be accessed and customized—scientists give you their opinions (not answers) and you make the decisions
  - ✓ Event frequency and severity
  - ✓ Peak wind speeds and footprints
  - ✓ Damage functions
- Advantages
  - ✓ You see the drivers of your loss estimates and can test different sets of credible assumptions
  - ✓ You control the set of assumptions reflecting your company's view of risk
  - ✓ You can test new scientific research as soon as it becomes available

Open Source and Open Loss Modeling Platforms

- Open source means software for which the original source code (computer program) is made freely available and may be redistributed and modified—works best when there are thousands of software developers who understand the code and can work on it (Linex)

- There is no standard definition of open platform but in the context of catastrophe models it means the model components can be accessed and modified

- In Oasis, this will be done by third model vendors who will create components that can “plug and play” into the platform so the user can then choose which vendor components to use

- In RiskInsight this is done through built-in modules that enable the users to modify and customize the model components directly
  - ✓ Event catalogs
  - ✓ Intensity footprints
  - ✓ Damage functions

The RiskInsight® Open Platform

- A robust, fully transparent, and customizable catastrophe loss modeling platform that has all of the components of the traditional cat models
  - ✓ Hazard
  - ✓ Vulnerability
  - ✓ Financial loss
- Built-in reference models by peril region
  - ✓ Hurricane
  - ✓ Earthquake
  - ✓ Storm surge flooding
  - ✓ Etc.
- Built-in modules—WindfieldBuilder®, HazardMapper, and DamageRatesManager make it possible for you to test and customize the model assumptions

US Hurricane Reference Model

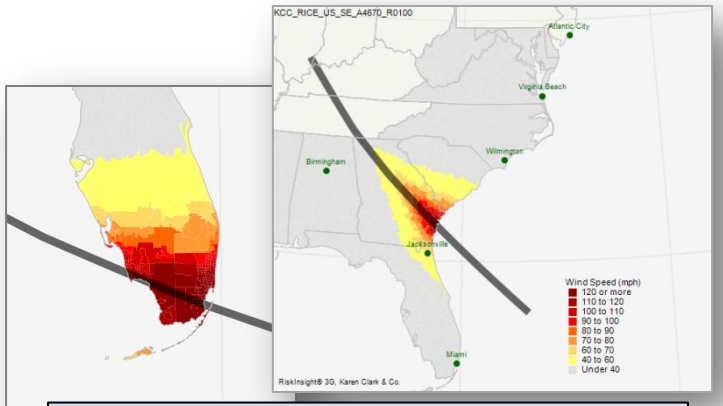
- Grounded in the best available data from multiple sources
  - ✓ HURDAT database
  - ✓ Tropical cyclone reports
  - ✓ Scientific literature

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

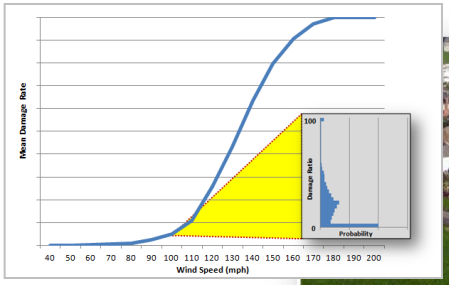
- Robust set of 21,000+ damage functions accounts for construction and occupancy types, local building practices, and year built

- Damage functions consider mean damage rates as well as “secondary uncertainty” or variability around the mean

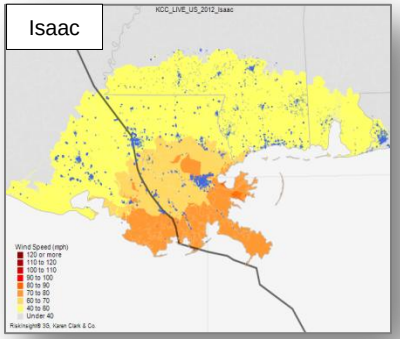
Hurricane Research Division
Atlantic Oceanographic & Meteorological Laboratory
National Oceanic & Atmospheric Administration

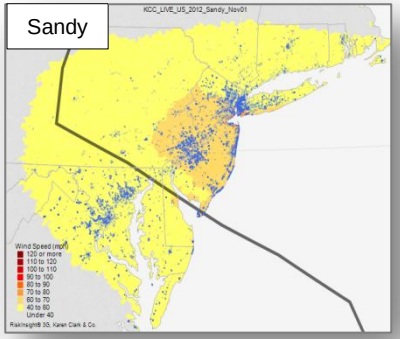


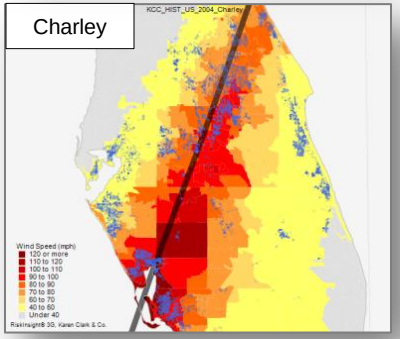
$$V_{1\min,10m}(r > R) = \left\{ gf\left(c_1 \left[\sqrt{\frac{1}{\rho e}(P_w - P_0)} - \frac{Rf}{2} \right] \left[c_2 + c_3 \ln(c_4 R) + (c_5 + c_6 \ln(c_4 R)) \ln(c_4 r) \right] \right) + 1.5 T^{c_7} T_0^{c_8} \cos(\beta) \right\}$$

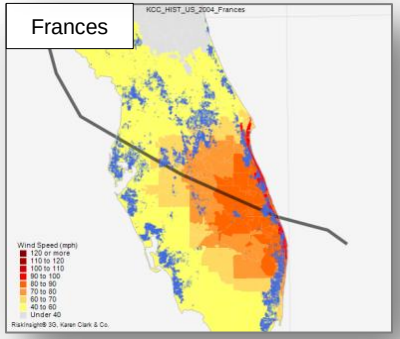


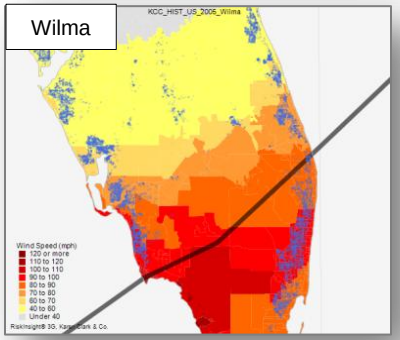
What's Different—Fully Transparent High Resolution Footprints and Customizable Damage Functions

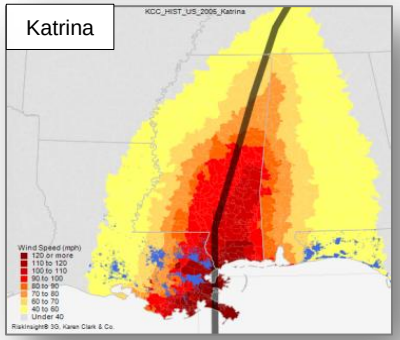






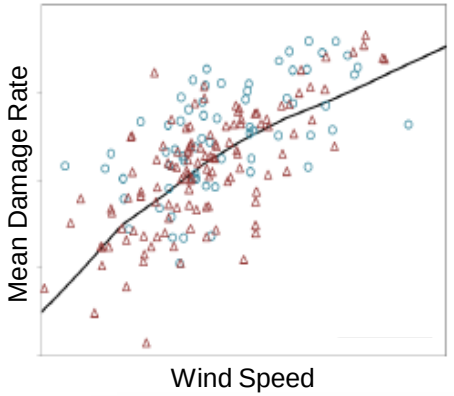


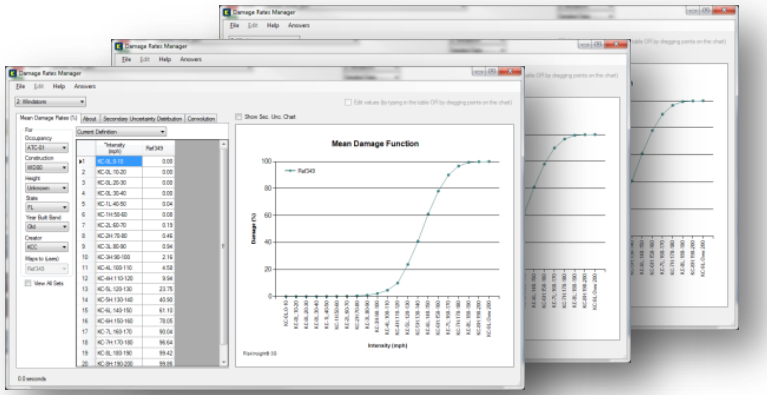




Powerful tools enable you to refine the reference functions

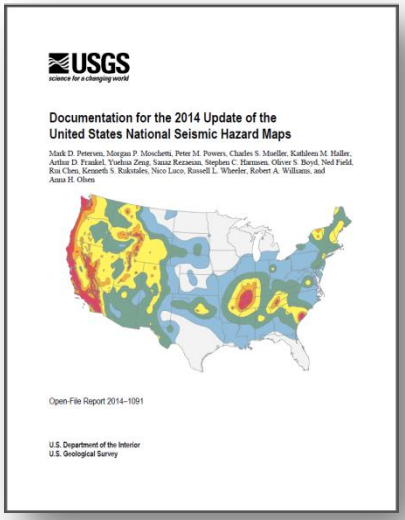
- Losses estimated using the built-in historical event footprints can be compared to claims information
- DamageRatesManager allows you to refine reference damage rates and to test custom damage functions

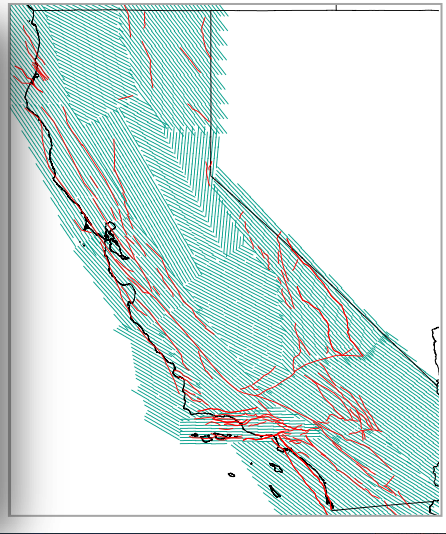


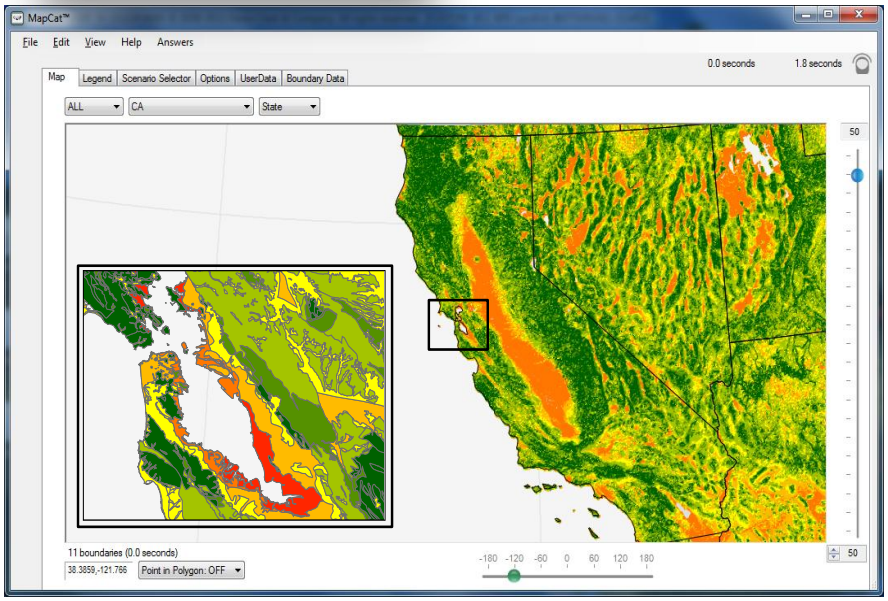


US Earthquake Reference Model

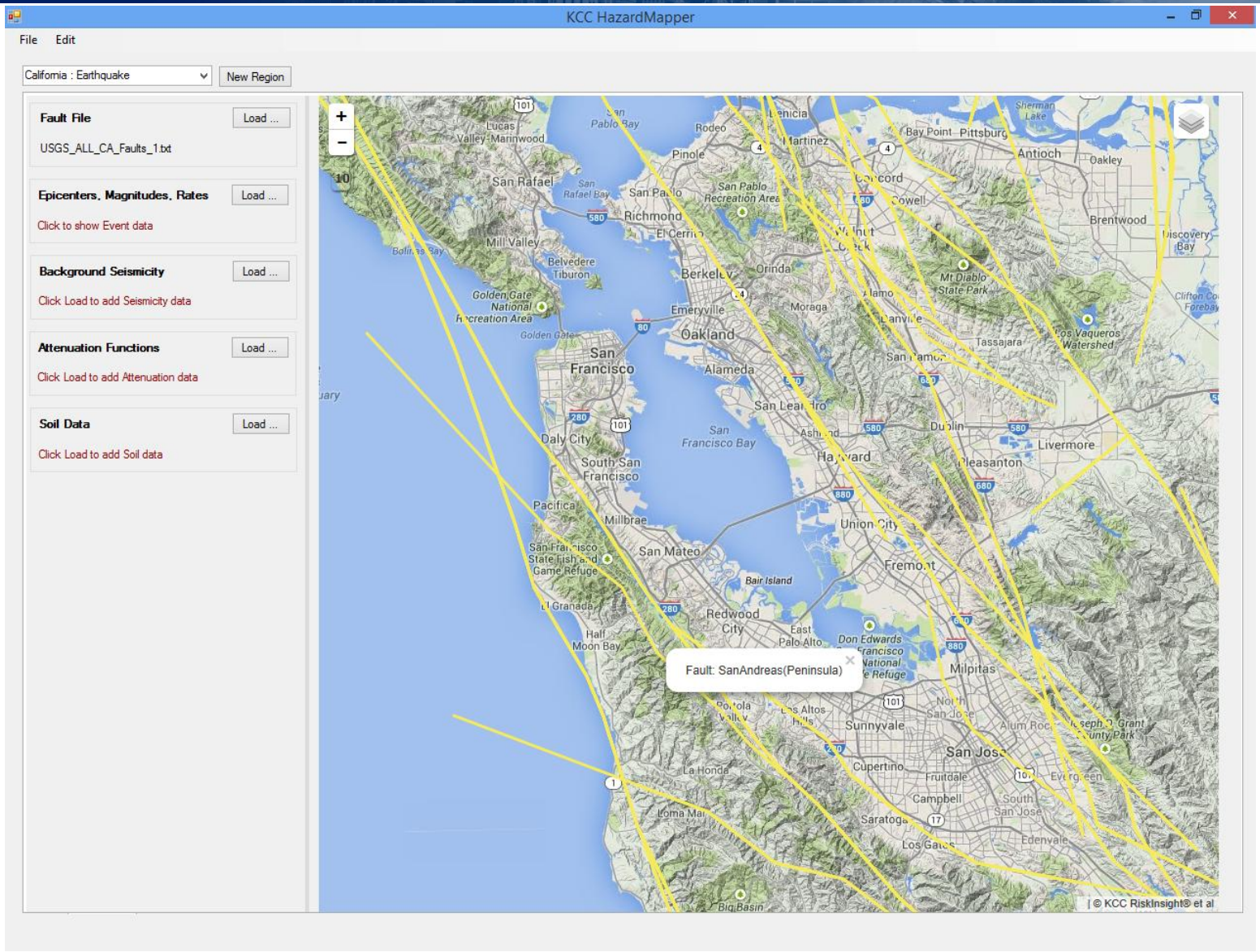
- Consistent with the latest research from the USGS
- High resolution soils database (≈ 100 m)
- Damage functions by construction, occupancy, age, height based on
  - ✓ Post disaster surveys
  - ✓ Observations of damage
  - ✓ HAZUS, ATC reports
  - ✓ Other engineering research
  - ✓ Expert analysis and opinion



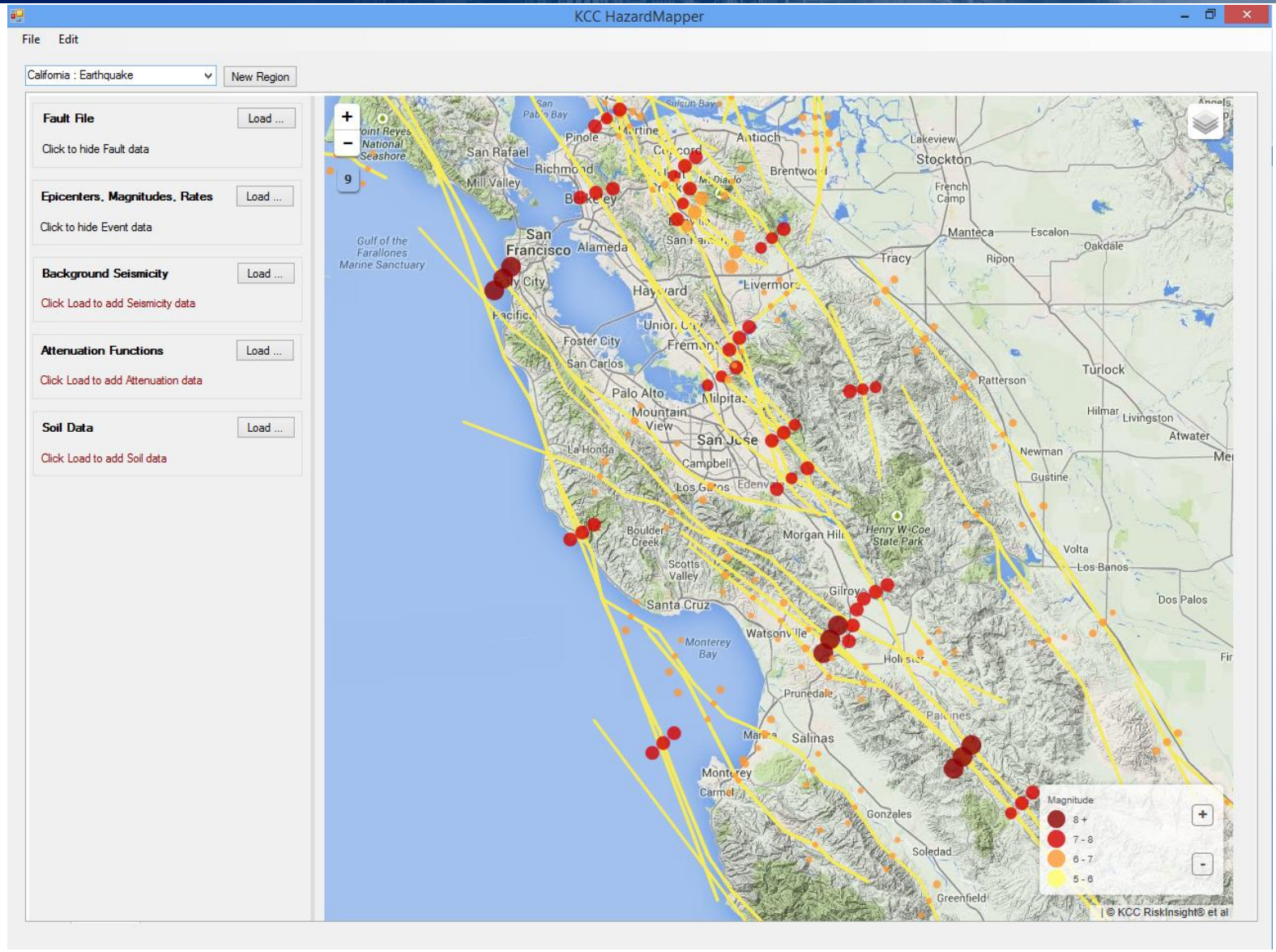




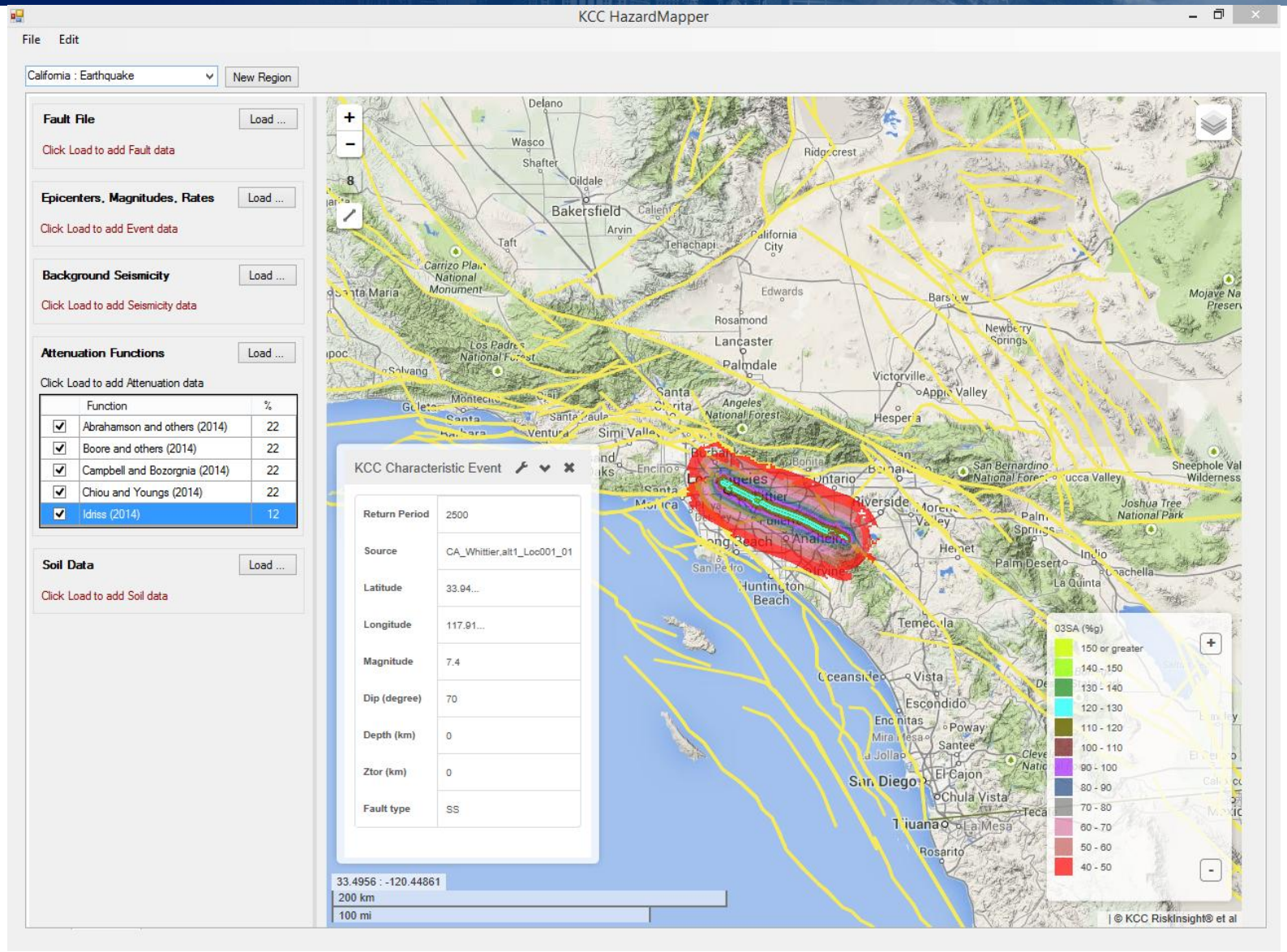
In RiskInsight You See All the Underlying Components Including Detailed Hazard Data and Vulnerability



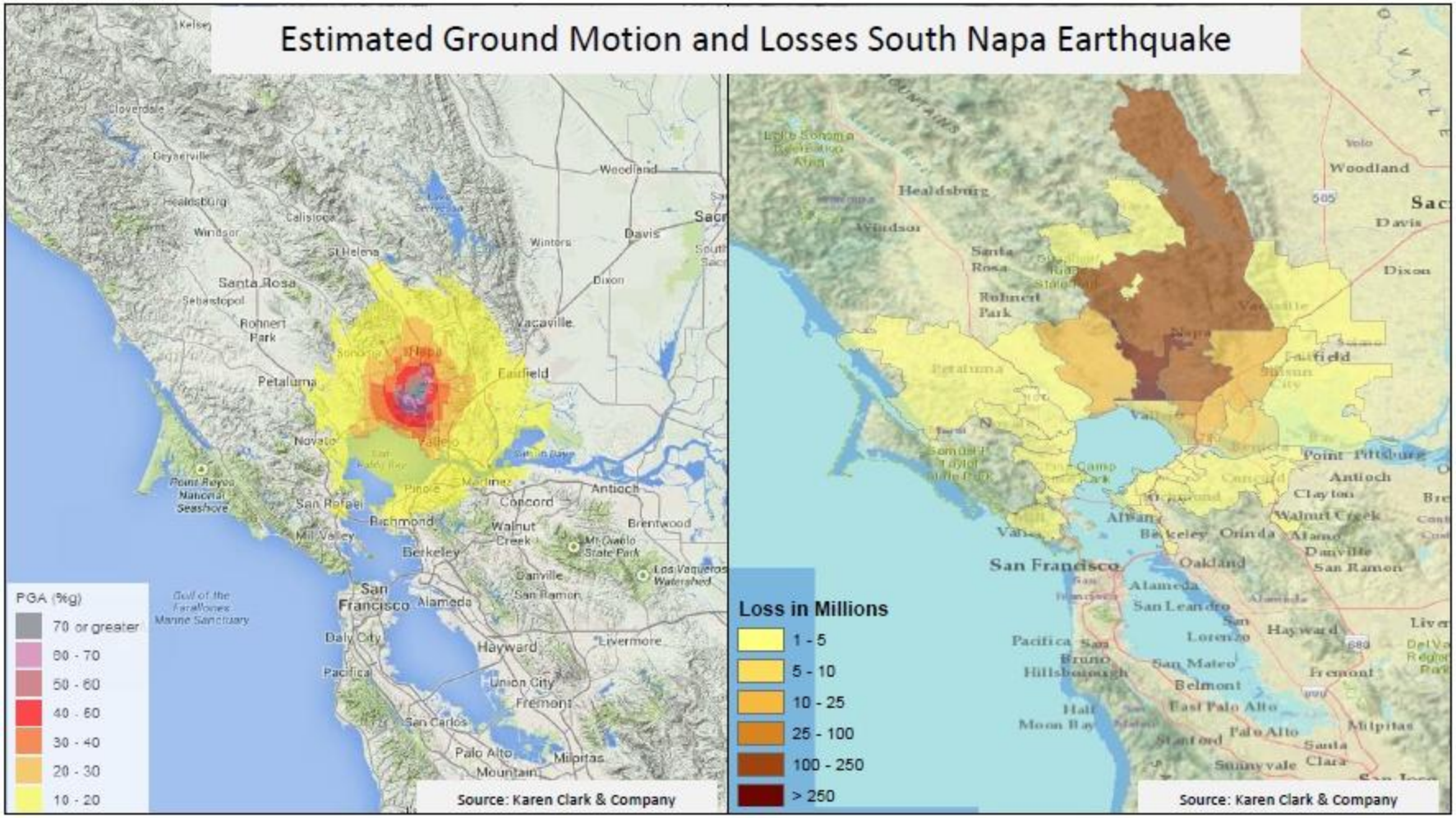
You Can See the USGS Estimated Return Period Magnitudes by Fault Segment



You Can Generate the Ground Motion Using Different Attenuation Functions and Weights



You Can Produce Real-time Loss Estimates for Actual Events



How Does RiskInsight Compare to Oasis?

- RiskInsight is a complete end-to-end solution for underwriting, pricing, and portfolio management—including interactive graphical user interfaces, exposure analytics and loss analysis modules

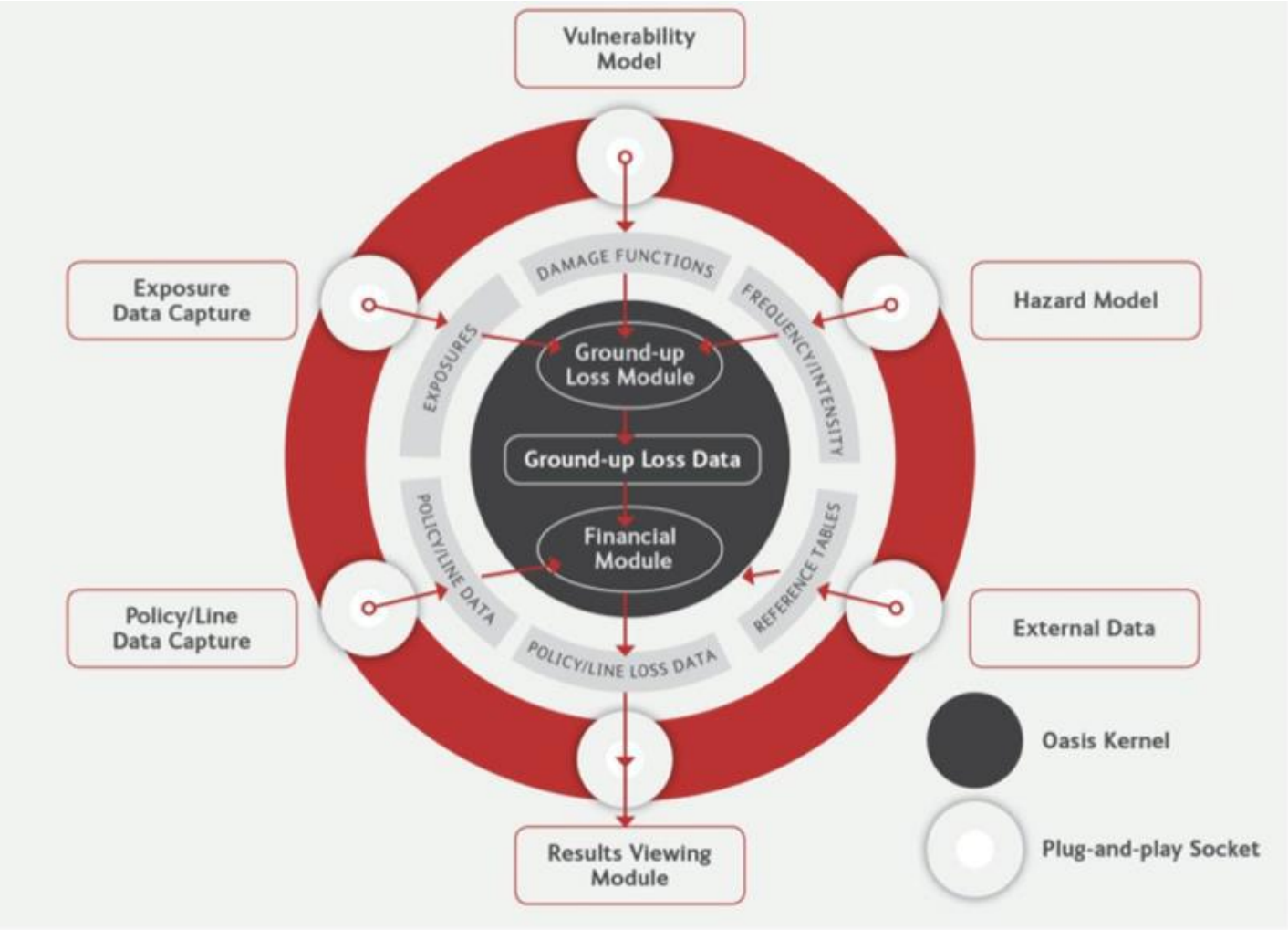
- Oasis “isn’t a model or a front end for users or an output analysis tool—it’s a ‘kernel’ that sits agnostically behind ‘plug and play sockets’” that others will populate

- Oasis is not building any models rather it’s a platform for running third party models (ARA, JBA, etc.)

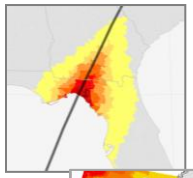
- RiskInsight is a platform that comes with Reference Models that can be scientifically and efficiently customized using built-in tools to create bespoke models

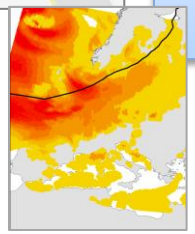
- Not really substitutes, but could be complementary

Oasis Overview



RiskInsight Overview

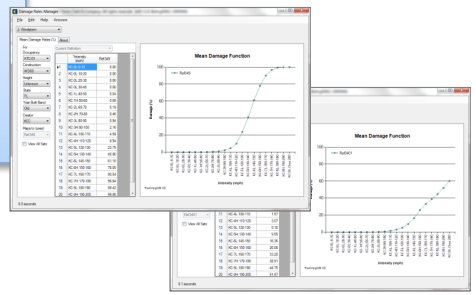




WindfieldBuilder®

HazardMapper

Damage Rates Manager



Reads Detailed Exposures

Exposure

Superimposes Intensity Footprints on Detailed Exposures

Hazard

Applies Damage Functions and Secondary Uncertainty

Vulnerability

Accounts for Detailed Policy Conditions and Reinsurance Terms

Financial Loss

Losses by event by location

RiskInsight Open Loss Analysis Platform

Summary and Conclusions

- Catastrophe models are important tools that have been around for decades but have not changed fundamentally
- The first generation “black box” models are not well suited to the expanding uses of the models
- Today we need open models that are
  - ✓ Transparent
  - ✓ Flexible and customizable
  - ✓ Efficient
- This means exciting new opportunities for actuaries
  - ✓ You build models versus just running models
  - ✓ You more deeply understand catastrophe risk
  - ✓ You control the model assumptions and make more informed risk management decisions