The 2008 National Seismic Hazard Maps, UCERF-2, and Earthquake Cat Models

a backdrop for the EQ panel discussion

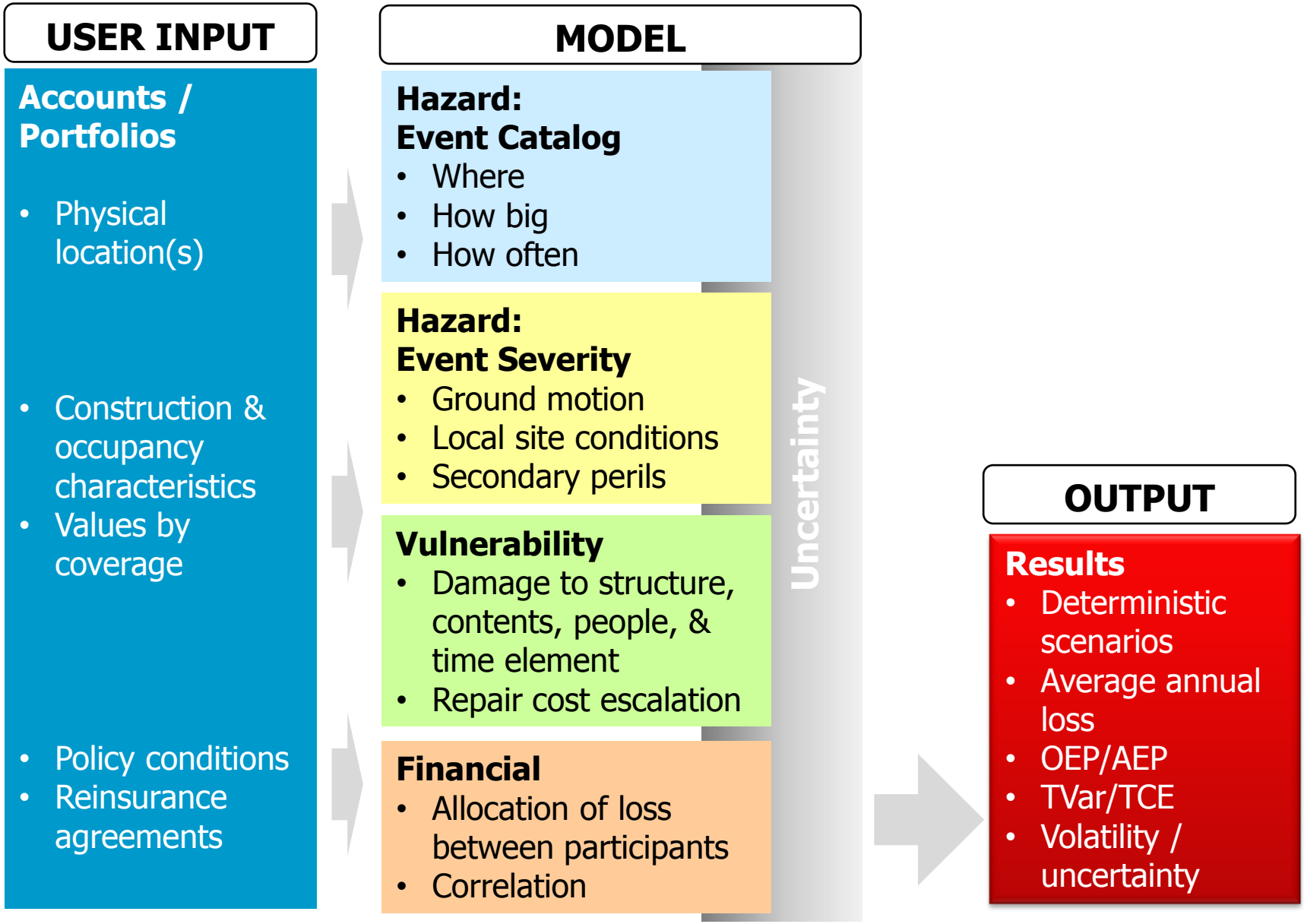
Don Windeler
Director, Nat Cat & Portfolio Solutions
Risk Management Solutions

2010 CAS Spring Meeting, San Diego, May 23-26

Topics

- Basics of an earthquake catastrophe model
- What happened in 2008?
  - Next Generation Attenuations (NGA)
  - USGS National Seismic Hazard Mapping Project (NSHMP)
  - Uniform California Earthquake Rupture Forecast 2 (UCERF 2)
- Why are the USGS changes different in each model?

Earthquake Risk Modeling Framework



Where Do the USGS Studies Fit In?

USER INPUT

Accounts / Portfolios

- Physical location(s)
- Construction & occupancy characteristics
- Values by coverage
- Policy conditions
- Reinsurance agreements

MODEL

Hazard: Event Catalog
- Where
- How big
- How often

Hazard: Event Severity
- Ground motion
- Local site conditions
- Secondary perils

Vulnerability
- Damage to structure, contents, people, & time element
- Repair cost escalation

Financial
- Allocation of loss between participants
- Correlation

Uncertainty

USGS 2008 NSHMP

Best estimate compilation of
- Active faults & background seismicity
- Ground motion attenuations
- Time-independent rates

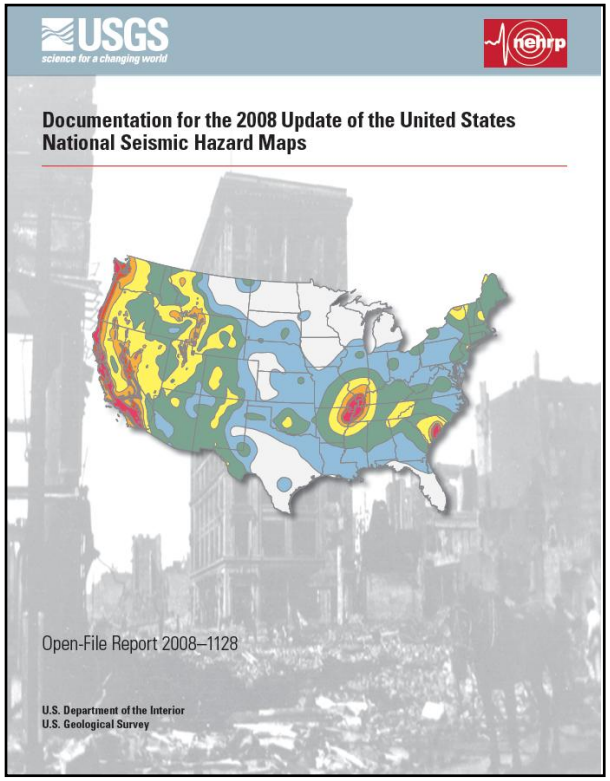
2008 UCERF-2
- Time-dependent probabilities for California

Local amplification not considered

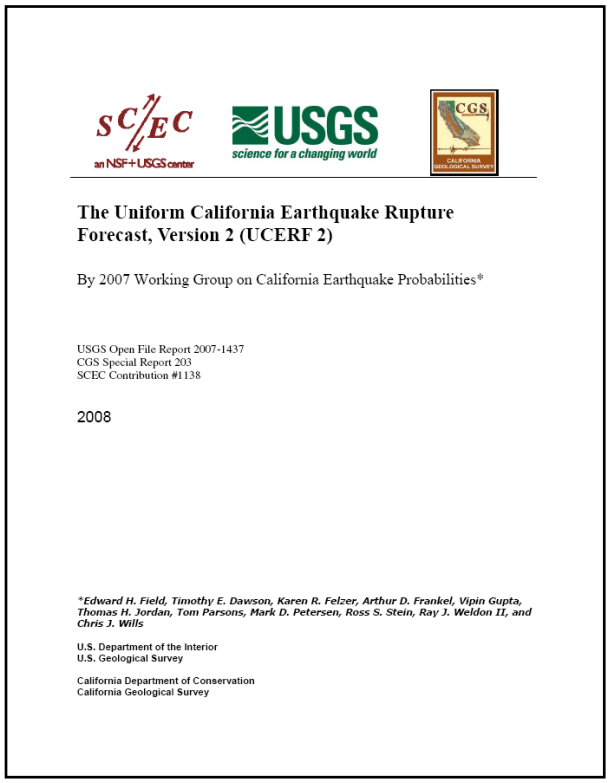
OUTPUT

Results
- Deterministic scenarios
- Average annual loss
- OEP/AEP
- TVar/TCE
- Volatility / uncertainty

U.S. Earthquake Hazard: The New Benchmarks



- Lower 48 states, time-independent
- New faults and recurrence parameters
- Updated catalog and rates of background earthquakes
- Attenuations by EQ type, including NGA

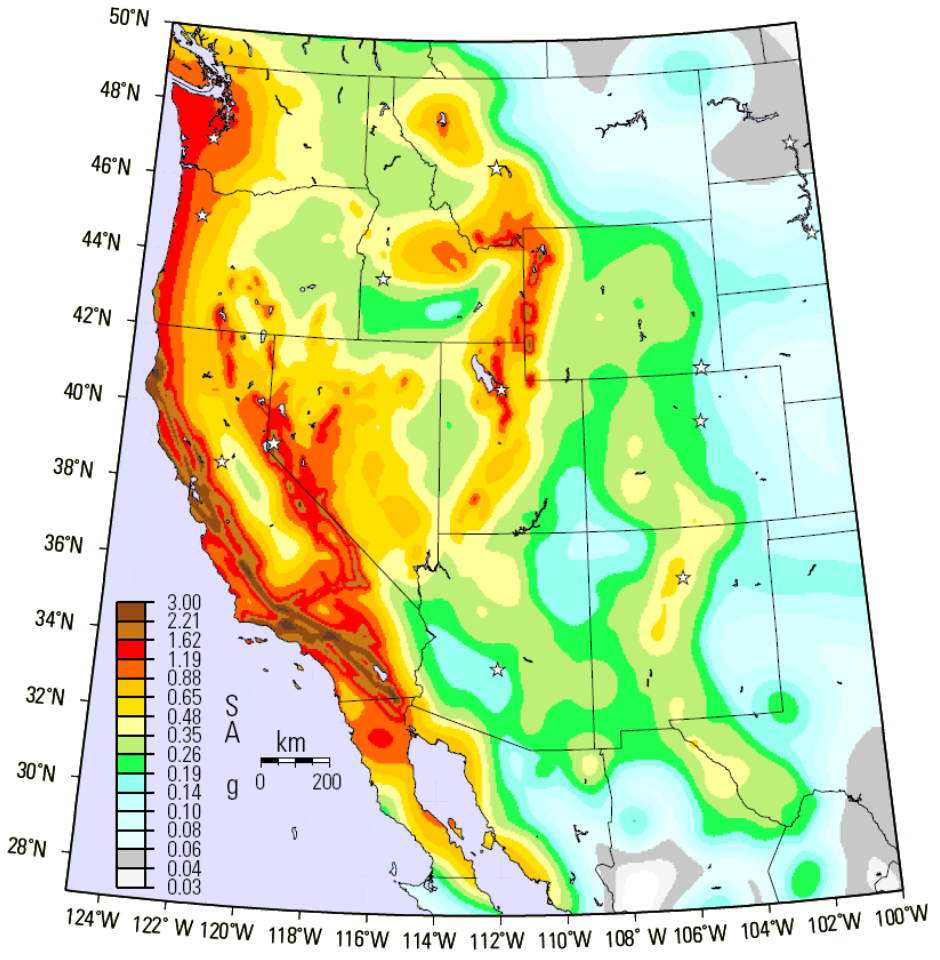


- California only, considers time-dependent probability models
- Time-independent results used for NSHMP

Western U.S. Ground Motion & Hazard

- Next Generation Attenuations (NGA)
  - Applies to shallow crustal events
  - Multi-year research project to address observed shortcomings of previous relationships
  - Significant changes, mostly **decreasing** ground motions
- Subduction
  - One new attenuation published
  - Deep intraslab events modeled at constant depth
  - Overall impact is to **increase** ground motion

From USGS OFR 2008-1128



1-Hertz (1 sec) SA
10% probability of exceedance in 50 years

Next-Generation Attenuation (NGA): What is It and Why Does It Matter?

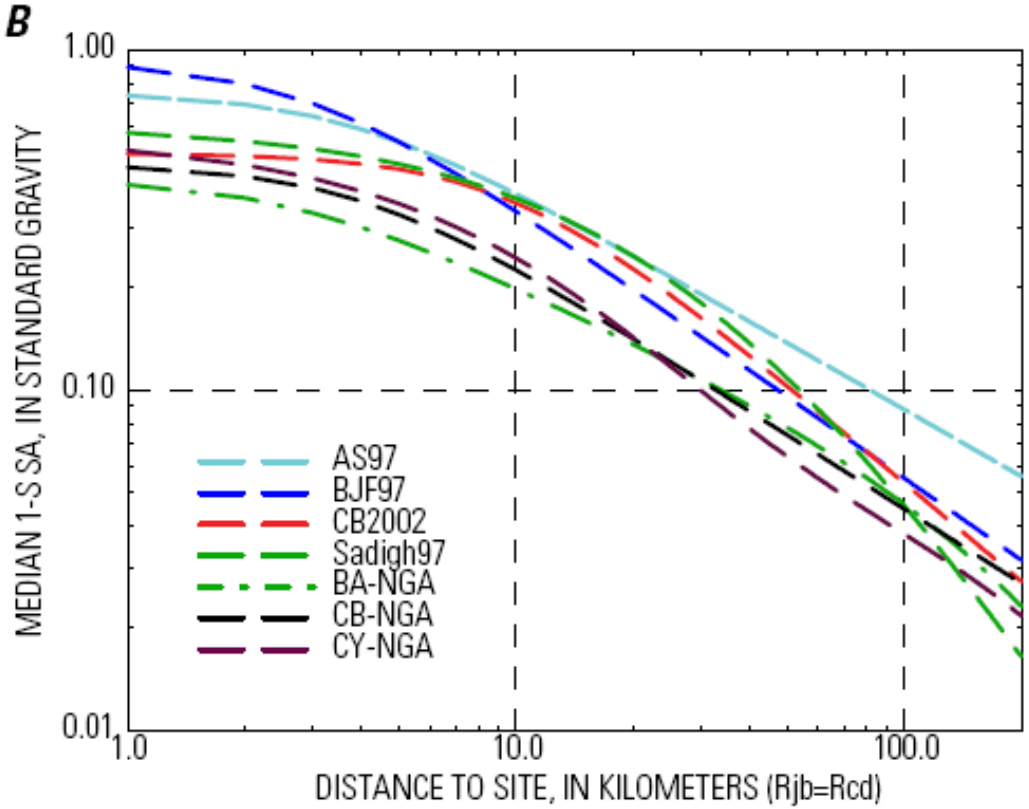
The new NGA relationships are the largest single driver of changes to modeled losses for California and the western U.S.

These relationships represent a major step forward in the understanding of ground motion modeling and were carefully reviewed given the implications of their adoption

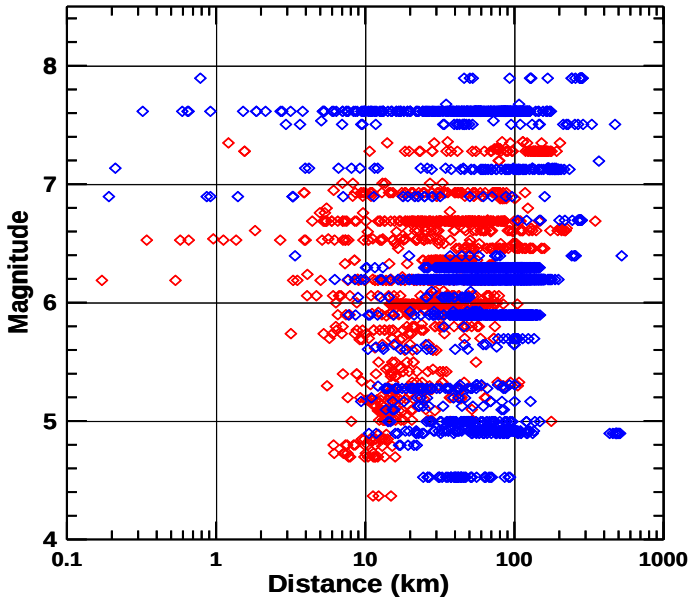
- Next Generation Attenuation Models
- Multi-year research project (2004-2008) organized by the Pacific Earthquake Engineering Research (PEER) Center to address a fundamental source of uncertainty in seismic hazard modeling
- Engaged well-known ground motion experts to define the next level of modeling technology
  - Abrahamson & Silva
  - Boore & Atkinson
  - Idriss
  - Campbell & Bozorgnia
  - Chiou & Youngs

(underlined used in USGS 2008)

What is an Attenuation Relationship?



Attenuation describes the surface ground motion (e.g. acceleration) resulting from a given earthquake, and how shaking diminishes over distance.



Previous Data New Data

- 3 times the number of acceleration records
- 173 earthquakes
- 1400 recording stations
- 10,000 data points

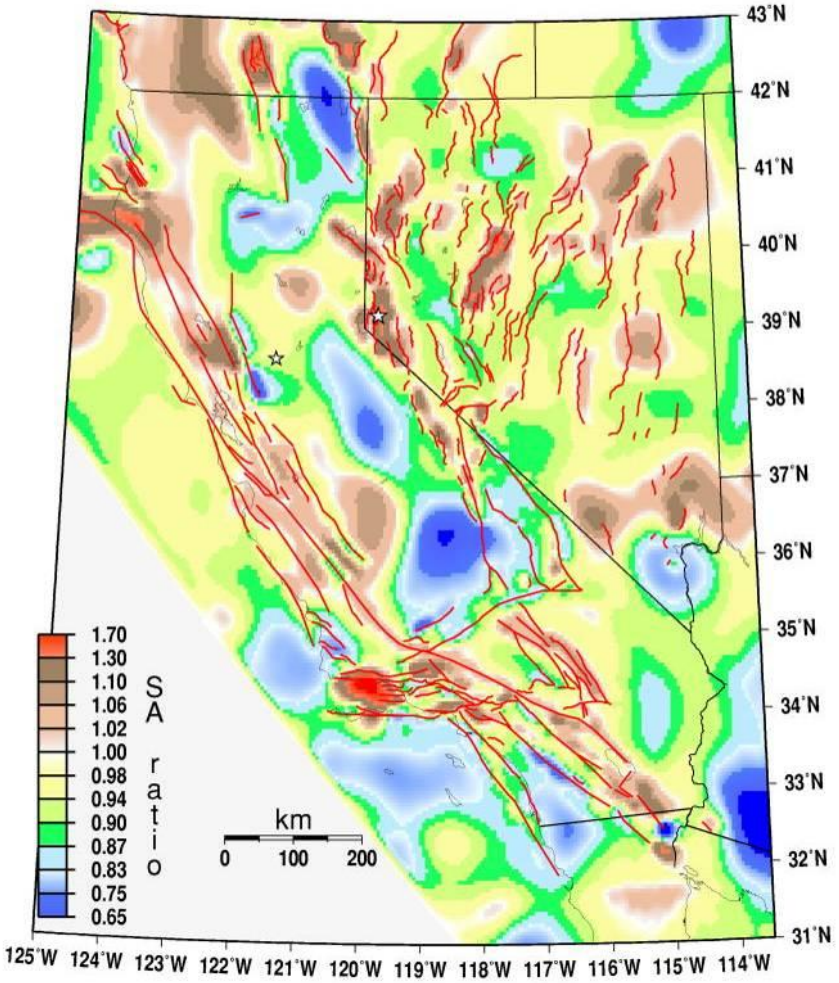
Impacts of NGA

Characteristic	Variations
Site class	▪ Rock generally decreases, soil similar to previous ▪ Implies greater spread between rock and soil
Fault Type	▪ Strike-slip & surface-rupturing thrust decreasing ▪ "Blind" thrust similar to previous
Magnitude	▪ Large magnitudes (>7.5) decrease more than moderate

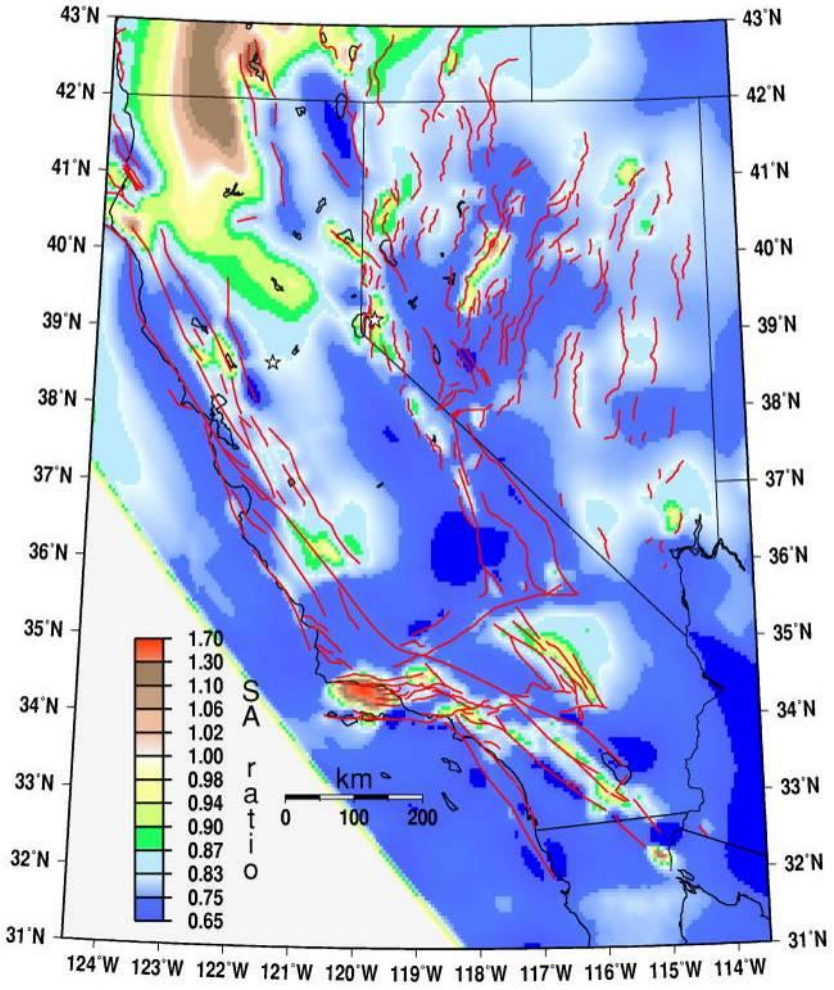
Distance	▪ Decreases for the near field (<20km) in general, but special cases exist
	  ▪ Hanging wall term increases
	  ▪ Very near field (<5km) for strike-slip events increases for short periods

Spectral Period	▪ Long periods show much greater reduction than short periods ▪ Spectral peak shifts to shorter periods as a result

Hazard Map Ratios: California & Nevada



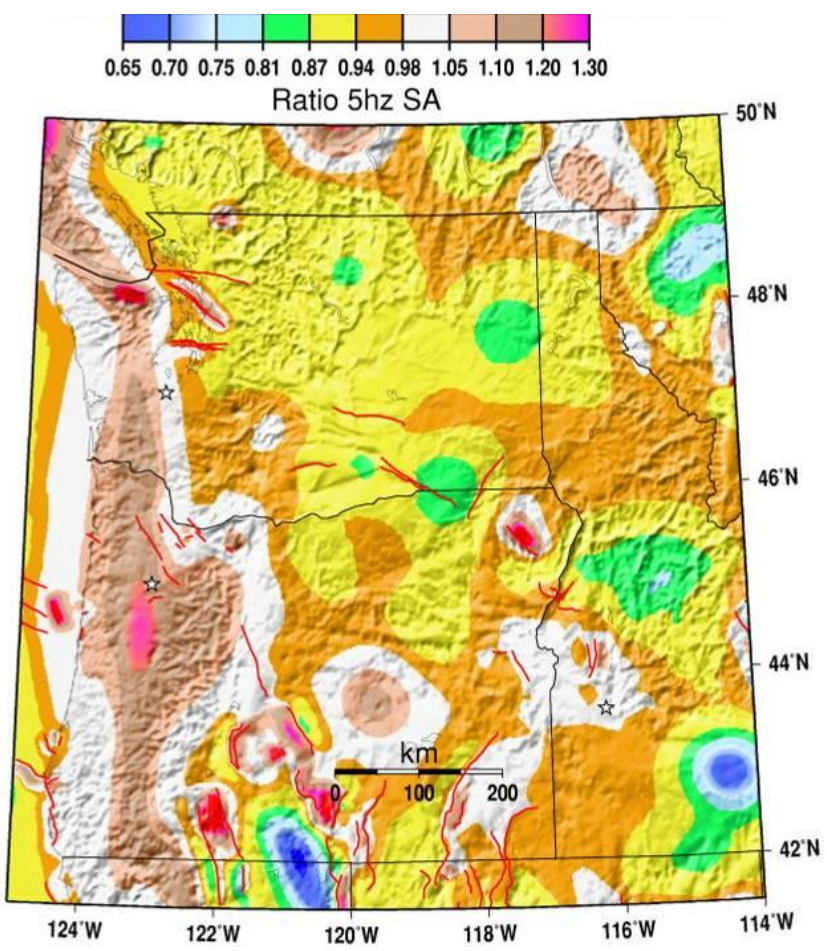
0.2 sec (short, stiff structures)



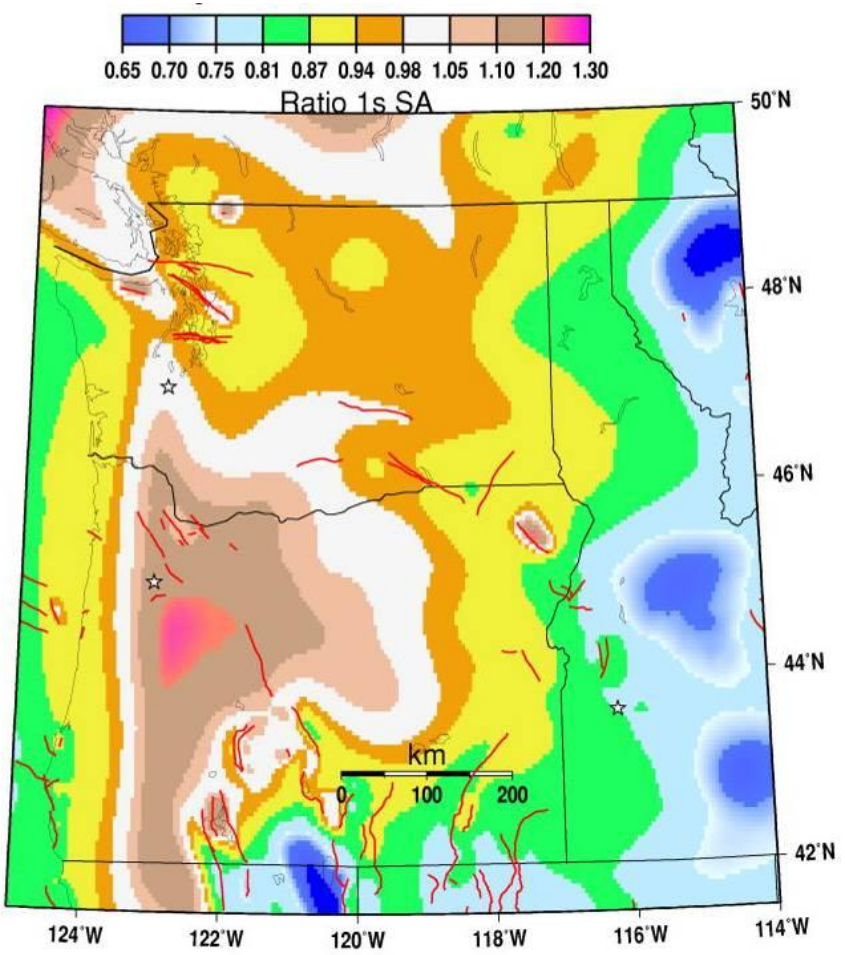
1.0 sec (mid-rise structures)

Sa Ratio for 2008/2002 Maps (2% in 50yrs) **From USGS OFR 2008-1128**

Hazard Map Ratios: Pacific Northwest



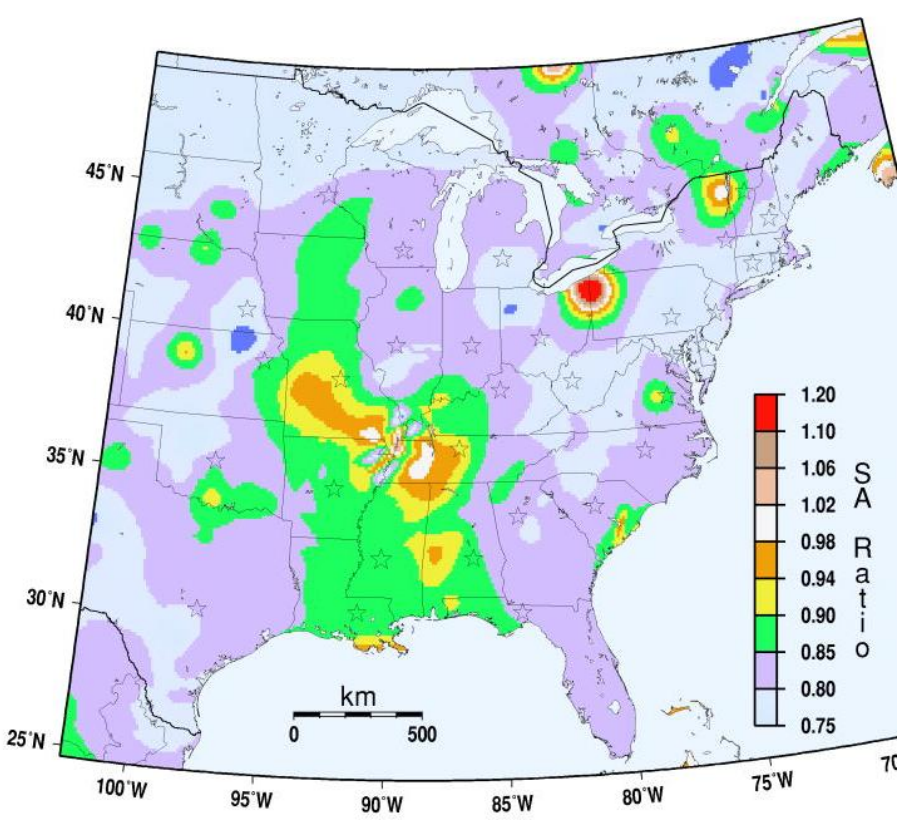
0.2 sec (short, stiff structures)



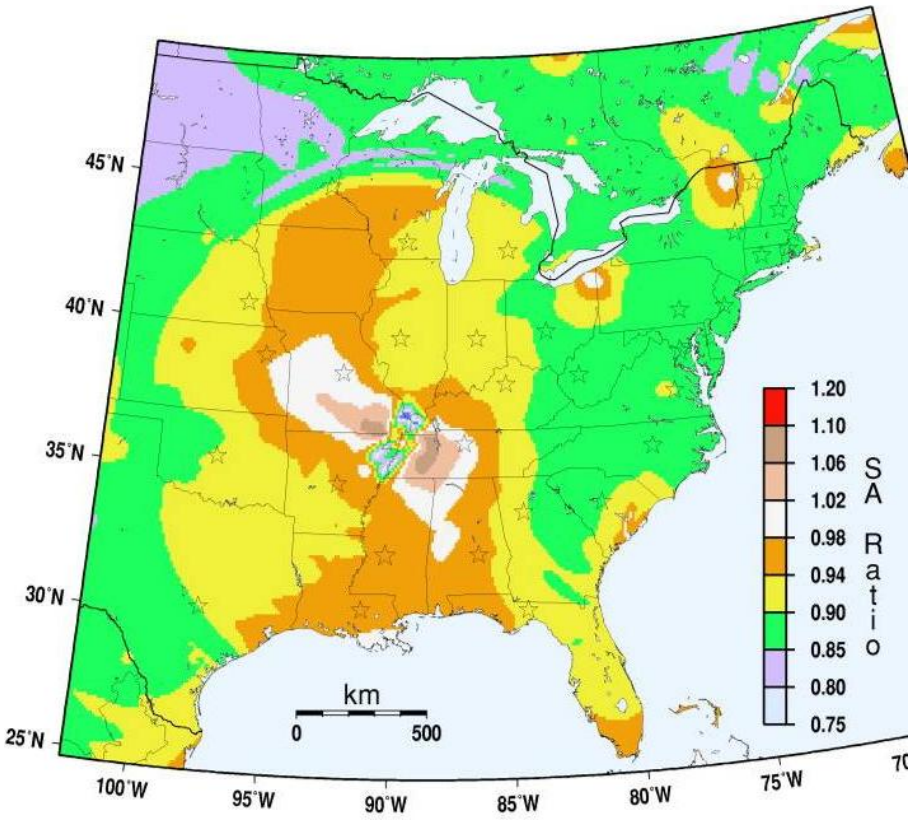
1.0 sec (mid-rise structures)

Sa Ratio for 2008/2002 Maps (2% in 50yrs) **From USGS OFR 2008-1128**

USGS CEUS Hazard Map Ratios: 2008/2002



0.2 sec (short, stiff structures)

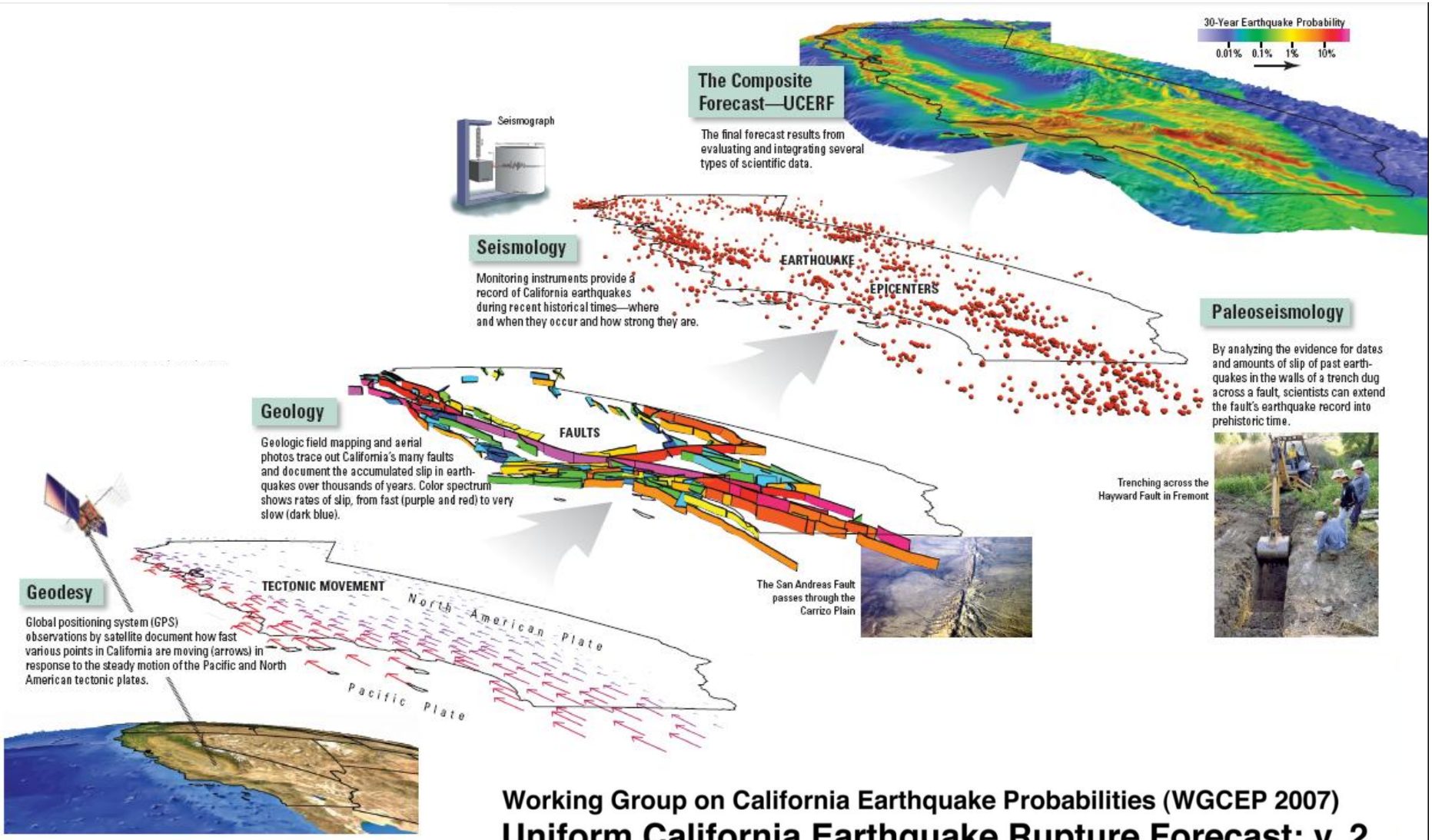


1.0 sec (mid-rise structures)

Sa Ratio for 2008/2002 Maps (2% in 50yrs)

From USGS OFR 2008-1128

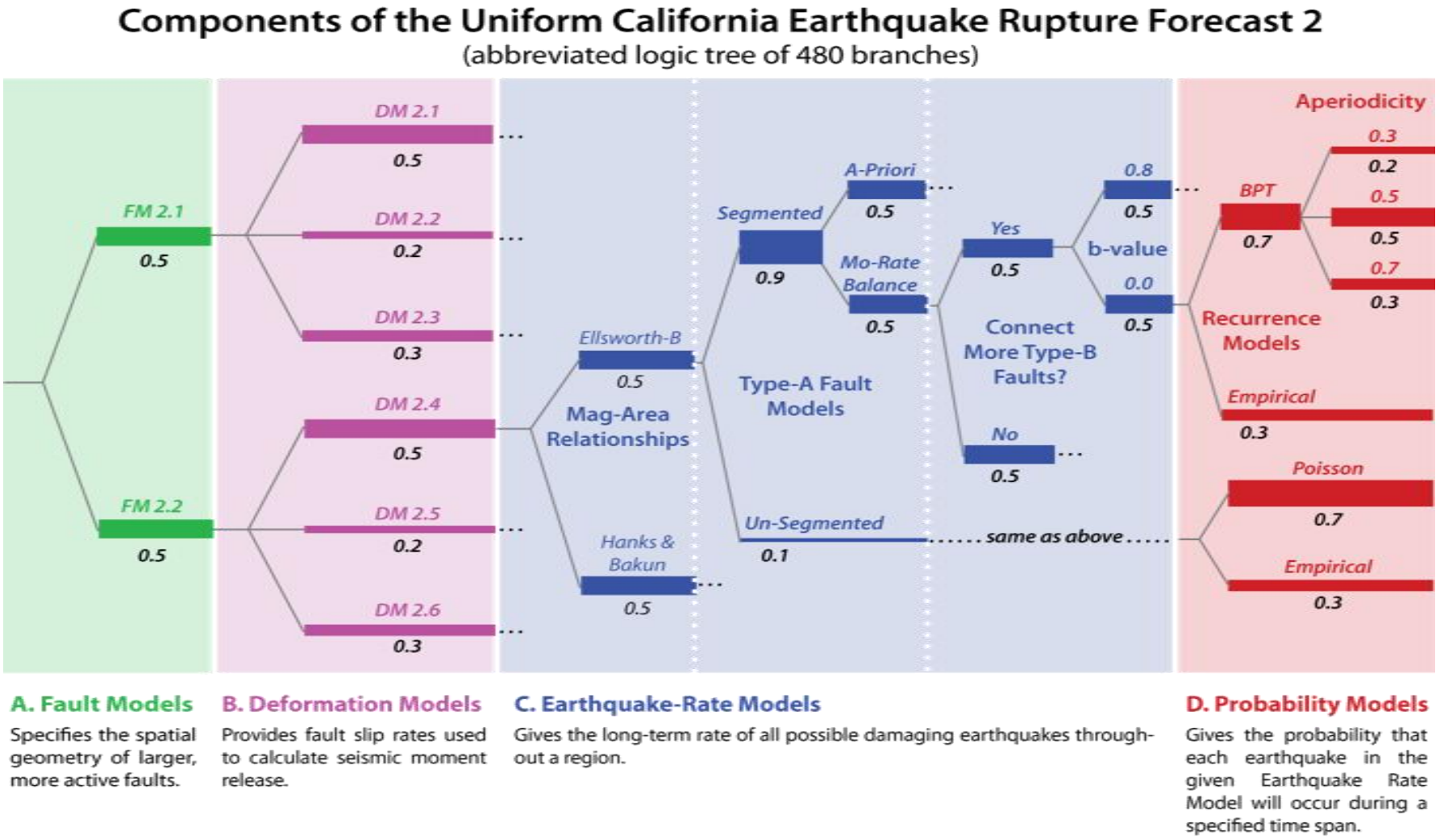
UCERF-2 Ingredients for a Seismic Source Model



Working Group on California Earthquake Probabilities (WGCEP 2007)

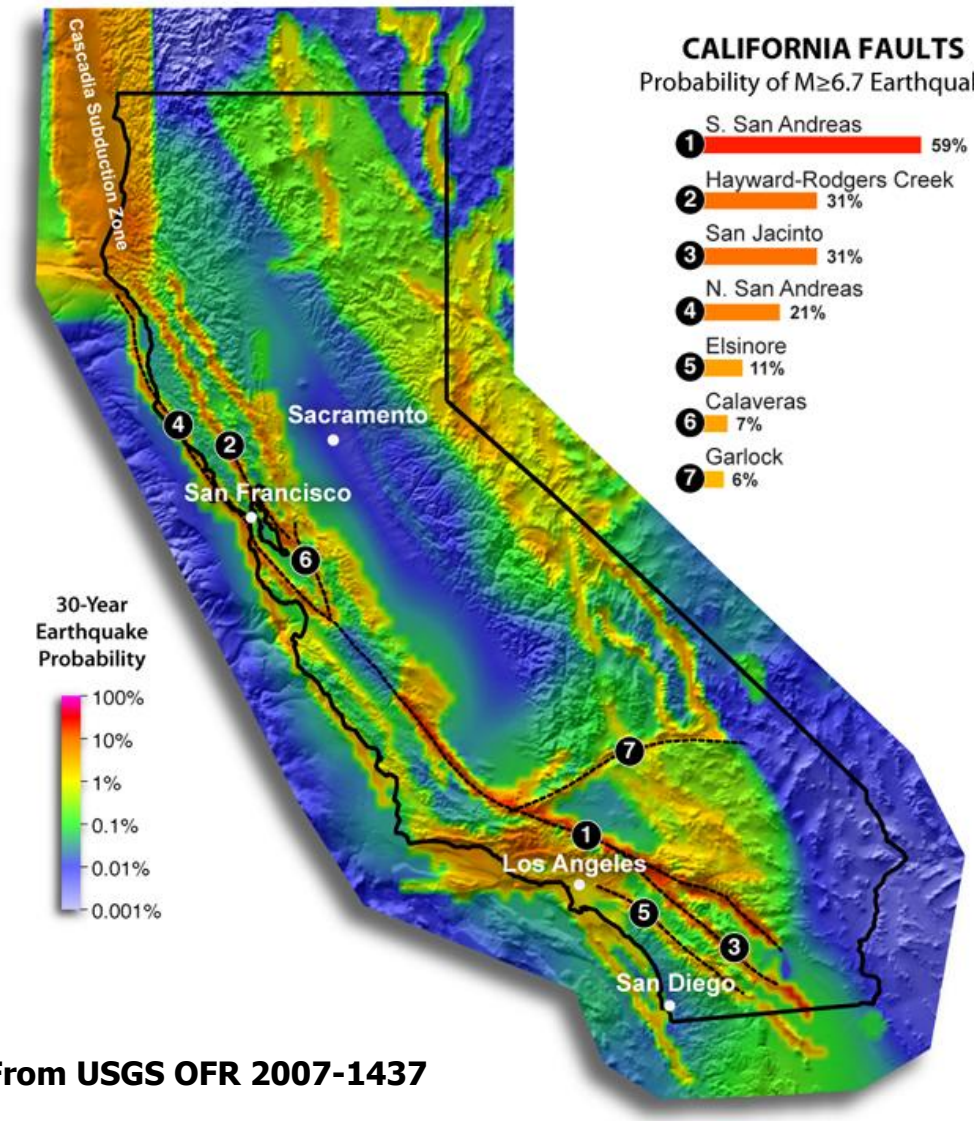
Uniform California Earthquake Rupture Forecast: v. 2

UCERF-2 Logic Tree Approach



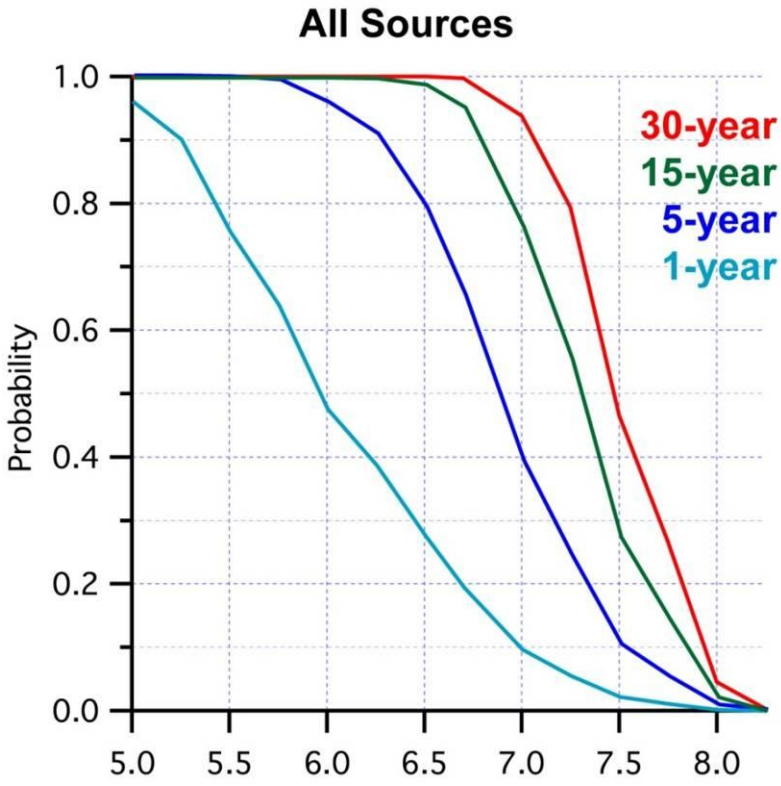
UCERF output: 4m pairs of data: (earthquake, probability of occurrence)

UCERF v2 30-Year Probabilities



30-yr probability

M ≥ 6.7: p= 99.7%
M ≥ 7.0: p= 94%
M ≥ 7.5: p= 46%
M ≥ 8.0: p= 4.5%



From USGS OFR 2007-1437

"So… why are the changes different for each modeler?"

- What was implemented in the previous version of the model?
- How were the new USGS data implemented and adapted into the modeler's product?
- How does the rest of the product interact with the USGS hazard data?
- What changes were made to other model components?