PG&E Remarks on Importance of SCEC Research

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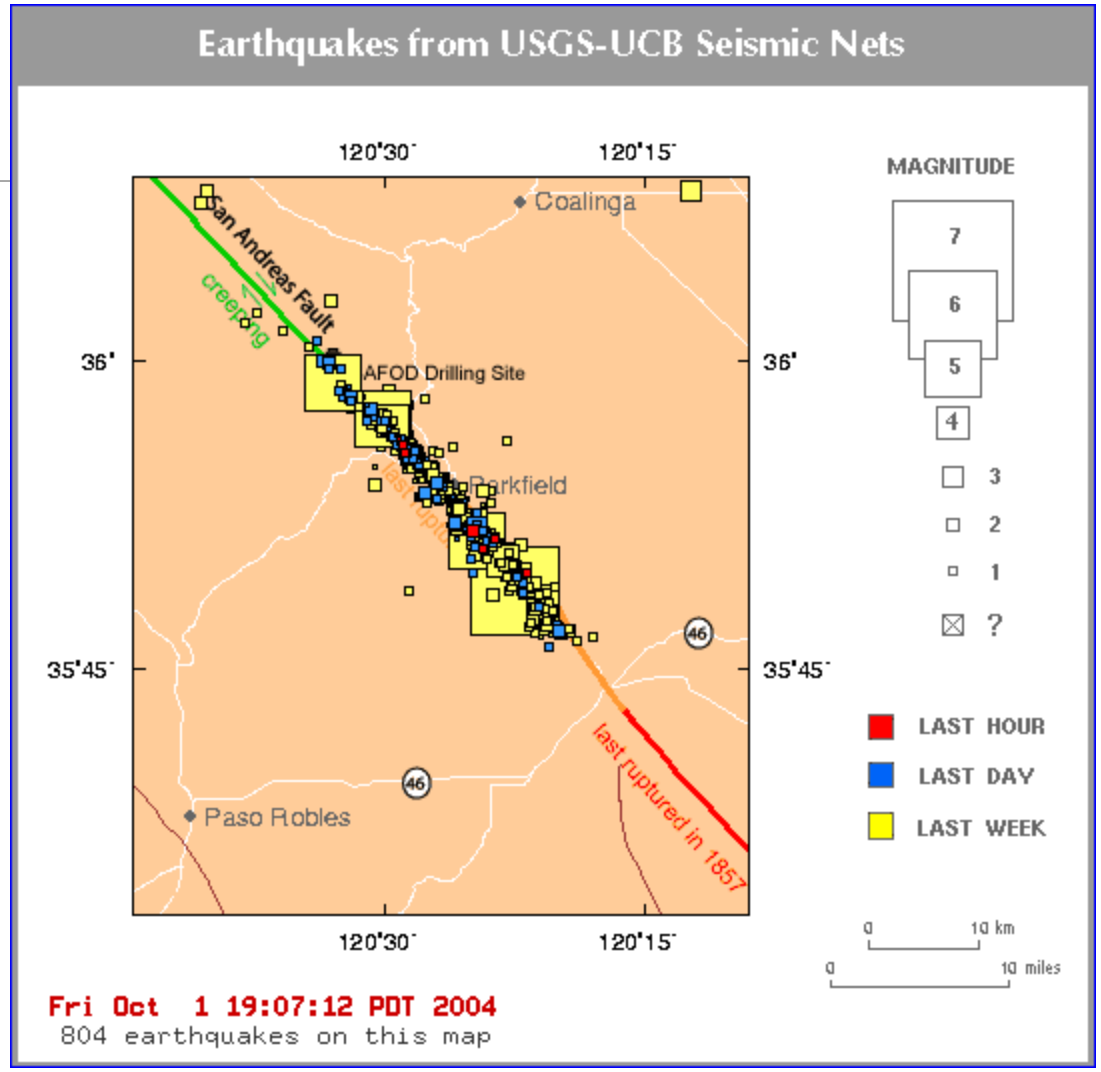
PG&E GEOSCIENCES

Parkfield

2004 + 22 = 2026



Importance of SCEC Community

Geoscience's Long-Term Seismic Program:

- Licensing commitment for Diablo Canyon
- Improve seismic hazard characterization through support of long-term research and **implementation**

- Achieving our goal requires working with geologists, seismologists, engineers, etc. to better understand earthquakes and their associated ground shaking and faulting
- SCEC:
  - Brings together this diverse group
  - Focuses them to working towards specific goals
  - Excellent long-term performance
- Benefit comes when we implement the understanding developed through SCEC studies; participation is key
- First funded SCEC through the 1995 Research On Site Response issues for the Northridge Earthquake (ROSRINE)

Wide range of important research

- Identification and characterization of earthquakes and faults
- Geologic frameworks
- Spatial and temporal variations in physical properties
- Numerical model of earthquakes and earthquake cycles
- Methods for constraining magnitude and ground shaking hazard

Risk Attitude

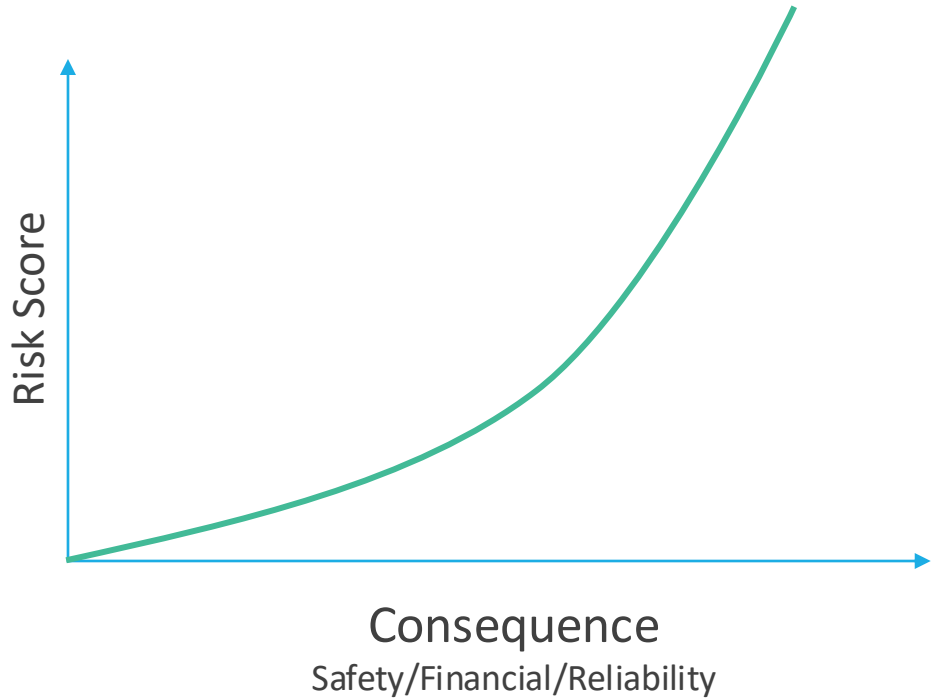
Risk is how we measure the impact of earthquakes to our infrastructure

Not all losses are the same; depends on risk attitude

Risk at PG&E:

- Quantified using a multi-attribute risk score that considers safety, financial, and reliability
- Risk adverse scaling – large consequences have inflated risk scores

Risk adverse scaling changes the impact of earthquakes

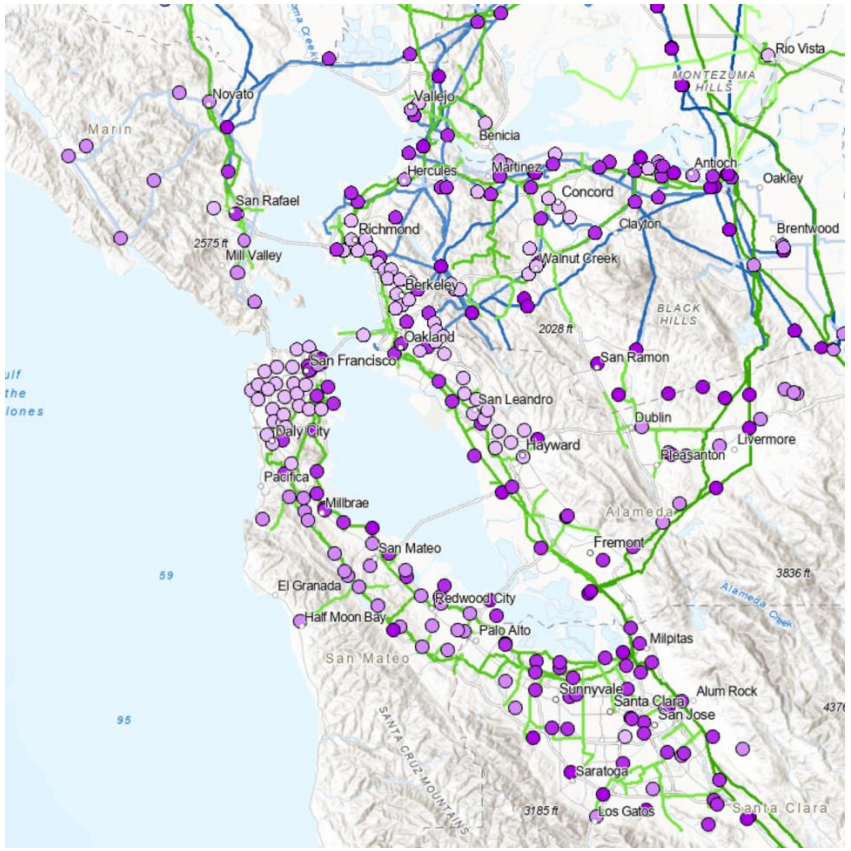


PG&E Assets

PG&E maintains a range of assets:

- Nuclear power plant
- Hydro-electric dams (166) and power houses (106)
- Electric transmission (19k mi) and distribution lines (107k mi)
- Electric substations (170 T & 770 D)
- Gas transmission (6k mi) and distribution lines
- Gas transmission and storage facilities
- Service centers and offices (760)

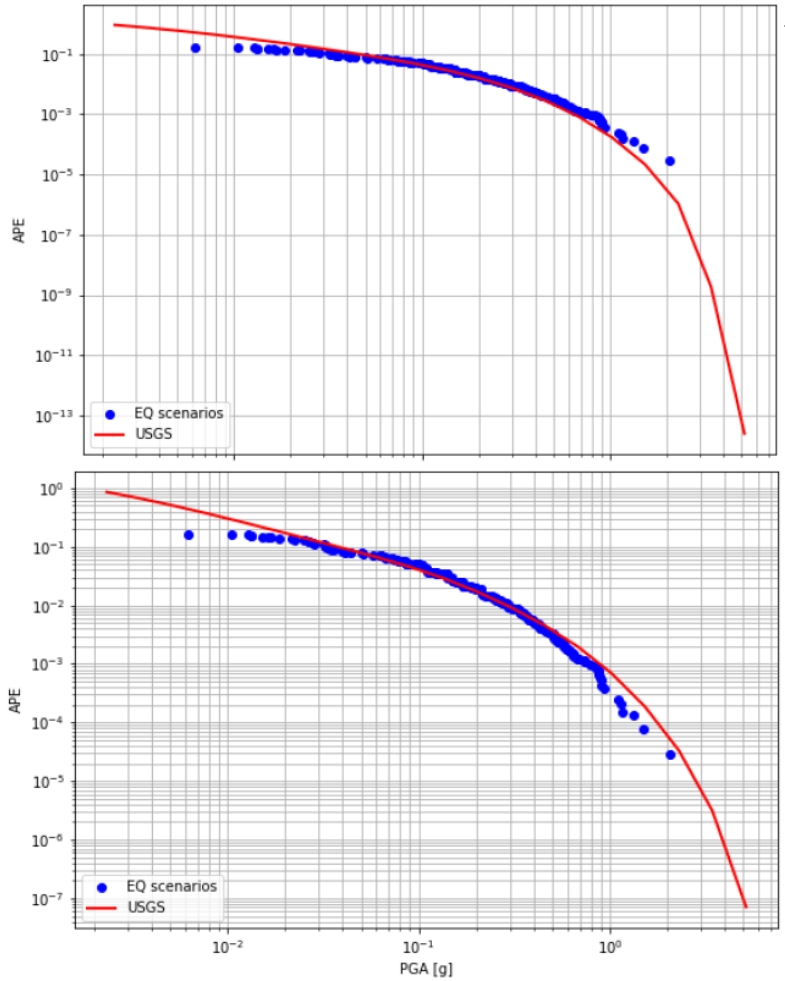
Density of customers and assets in the SF Bay Area makes this an important area for quantifying risk and requires consideration of spatial correlation

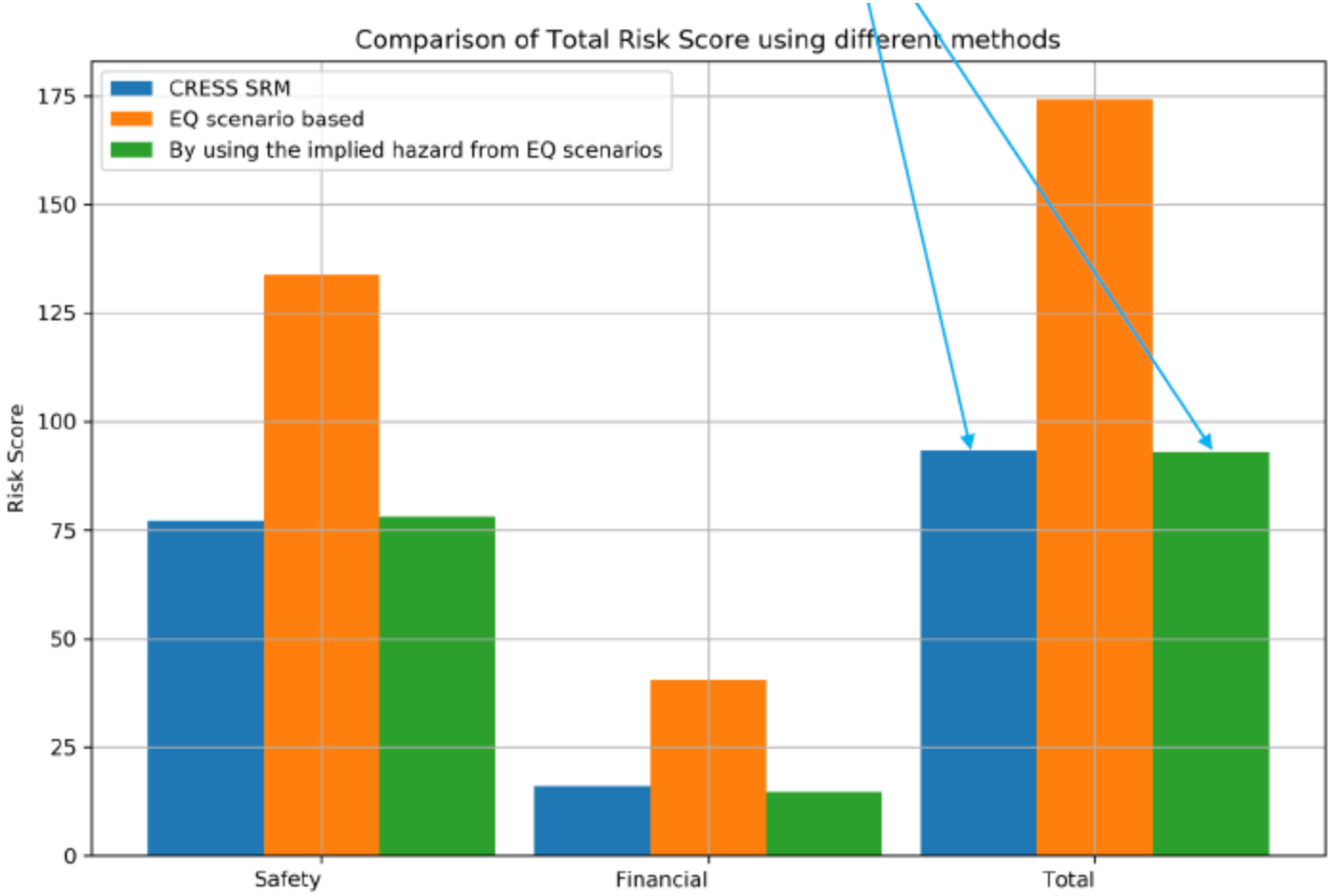


Approach to characterizing seismic risk

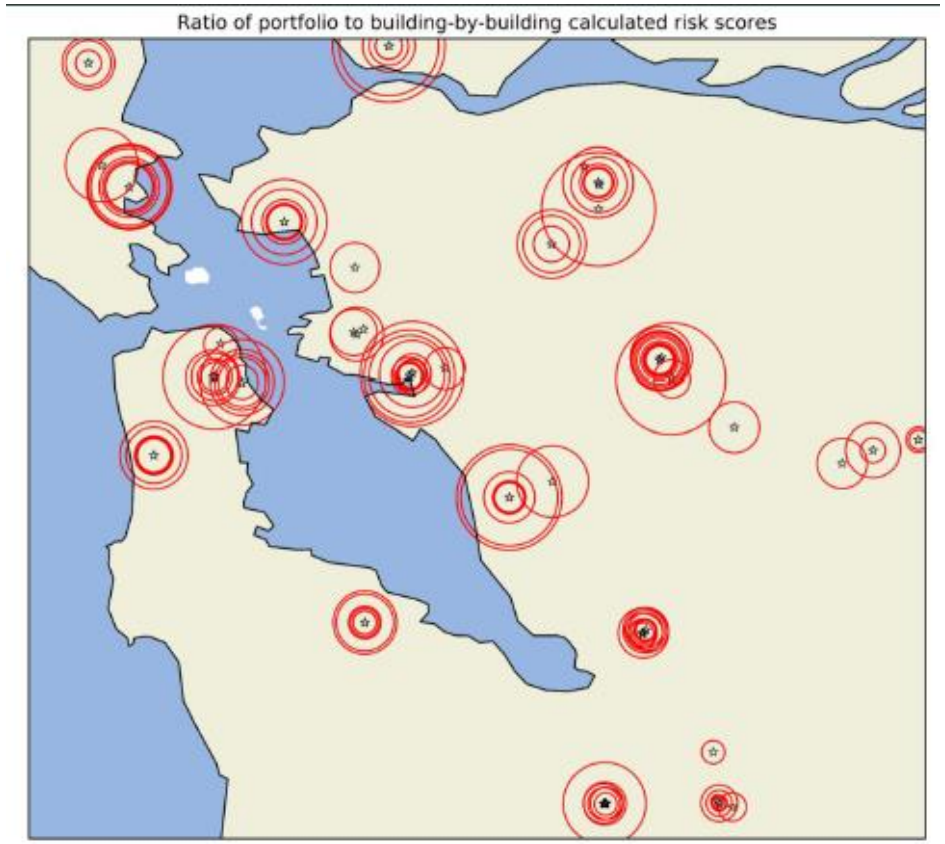
1. Develop regional probabilistic hazard seismic assessment to quantify seismic hazard on a grid of points
2. Select representative sources that are hazard significant
3. Develop a suite ~300 maps of ground shaking and rates of occurrence:
   - Captures spatial and intensity measure correlation
   - At any point within the region the maps and the rates approximate the hazard curve
   - Adjusted for site-specific conditions using V_{S30} maps
4. Combine ground shaking with asset performance models
5. Combine rates of occurrence and performance to compute annualized loss and risk score

Risk score doubles with scenarios





Ratio of portfolio to building-by-building calculated risk scores



Earthquake scenario effects are more pronounced for building clusters because of stronger correlation between ground motions

Including of more assets will increase the relative importance of portfolio-based evaluation

If the population is risk adverse, then this scaling extends beyond PG&E:

- Larger events are going to be more impactful (i.e., higher risk score) because of spatial correlation
- Will increase as impacts are quantified better

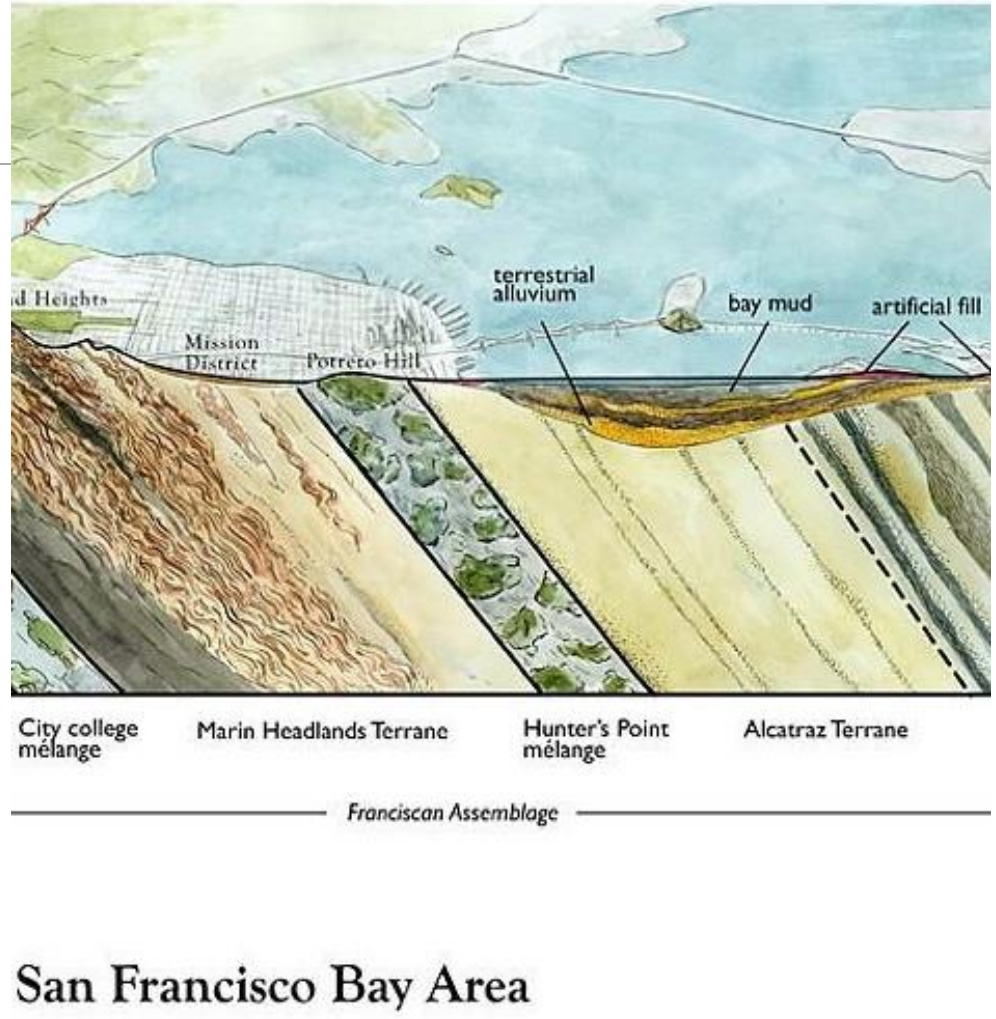
Implications

With a risk adverse attitude, capturing accurate spatial variation and correlation in ground shaking is key to improving risk assessments

Existing models rely on correlation functions that only consider distance – not location

Simulations offer an opportunity provide this valuable information

Plan to test and use **spatial information** in on-going ground motion development effort



San Francisco Bay Area

Gaining trust in simulations

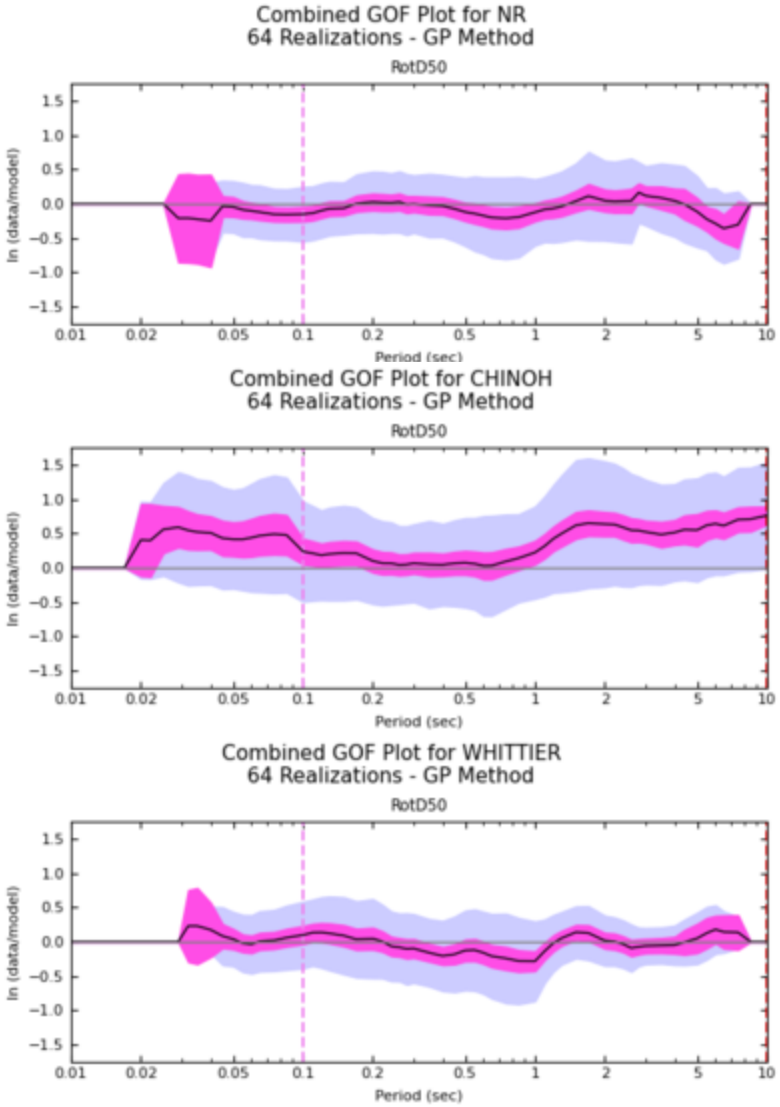
Engineers are cautious; a structure is designed once.

Current validation effort considered only fit of average metric for a limited number of events (~30)

Need to much more granular in the validation efforts:

- Consider a wide range of events sampling a range of travel paths (100s-1000s)
- Look at station-specific agreement for engineering metrics
- Do the simulations outperform spatially varying ground motion models at each station?
- How to confirm large magnitude effects?

For hazard analysis, need to evaluate variability and rigorously assess uncertainty



A few concluding thoughts

The SCEC community has been invaluable for advancing understanding and modeling of earthquakes

That community could be extended closer to the engineering to include ground-motion modeling, seismic hazard, and engineering site response communities

The need for validation of simulations grows with the increasing scope and complexity of the models

Thanks to the organizers and attendees that makes the annual meeting a rewarding experience