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Robust Hazard and Loss Assessment Through Robust Simulation

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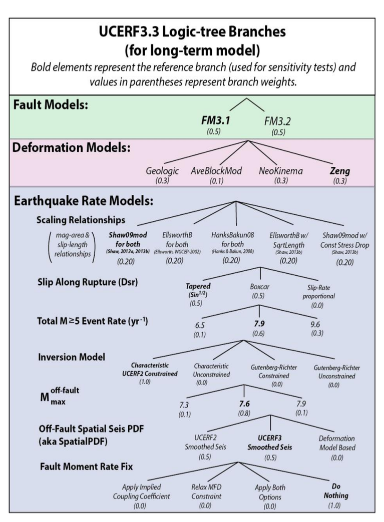
1. Abstract

Catastrophe modeling of natural disaster events is essential for hazard reduction, risk mitigation and insurance pricing. The typical approach utilizes multiple models with a logic tree to represent the scientific uncertainty in assessing future hazard or risk. The assessed outcome, however, is conventionally represented as a single solution (such as a mean hazard curve or single 'EP' curve), with a high level of precision. Although a single representation is certainly desired, hazard or risk may be misunderstood and underestimated without a proper understanding and characterization of the uncertainty embedded in the modeling approach. Presented with the illusion of precision, decision makers may be left with a false sense of security facing future catastrophe losses. In this study, we present the work by the authors (Lee et. al., 2014; Taylor, et. al., 2013) in which we utilize the USGS 2014 National Seismic Hazard Mapping (NSHM) models for robust seismic hazard analysis and loss assessment of spatially distributed building portfolios with the Robust Simulation technology. A more complete picture of the uncertainty is revealed through multiple scientifically credible models and characterized in hazard or risk outcome.

2. Complexity in Modeling the Epistemic (or Model) Uncertainty



- "Aleatory" uncertainty – Randomness, the odds of each outcome is known in advance
- "Epistemic" uncertainty – Lack of knowledge, the possible outcomes and/or their governing probability are unknown in advance
- **Epistemic uncertainty is more difficult to quantify and manage. The chance of failure is greatly increased when epistemic uncertainty is treated as known statistic variant.**

UCERF3 Compound Fault System Solutions -
Time-independent models: 1440 logic branches
Time-dependent models: 1440 x 4 probability models

3. Weaknesses with the conventional approach for Hazard and Loss Assessment

–Illusory precision: a single solution (mean Hazard or loss curve) is provided without a proper uncertainty characterization

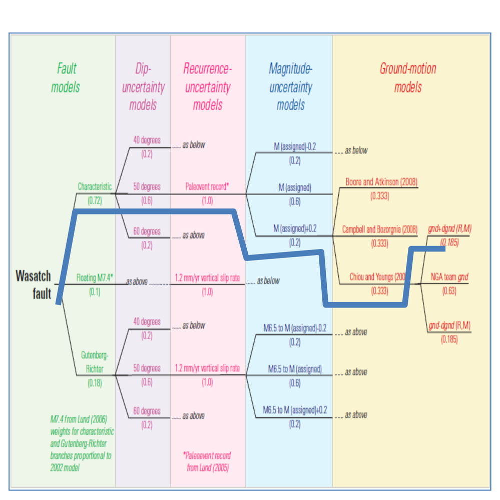
–'Blackbox': model implementation is hidden - difficult to check and verify

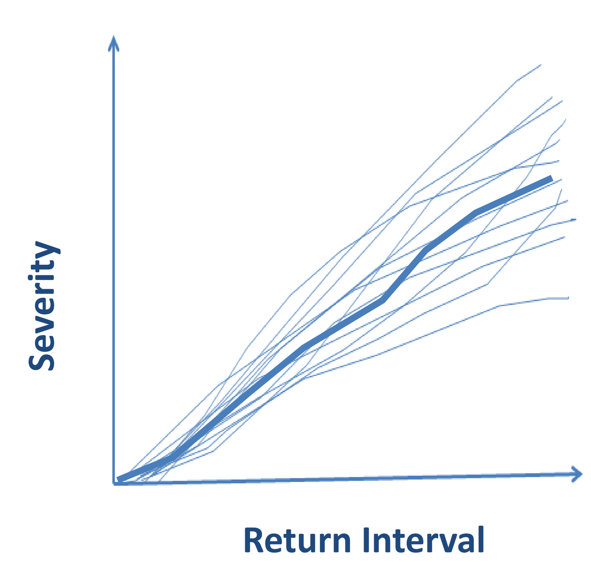
–Oversimplification: complex financial loss distributions are over-simplified with simple assumptions – Lognormal, Beta, Gamma, Pareto, etc. - potential gross inaccuracy

–Computational inefficiency: inefficient in (or even incapable of) handling complex statistical calculations

4. What is A Robust Simulation Approach?

Representation of future risk through simulation of an ensemble of views that integrates valid scientific disagreement and stochastic modeling of unknown variables.





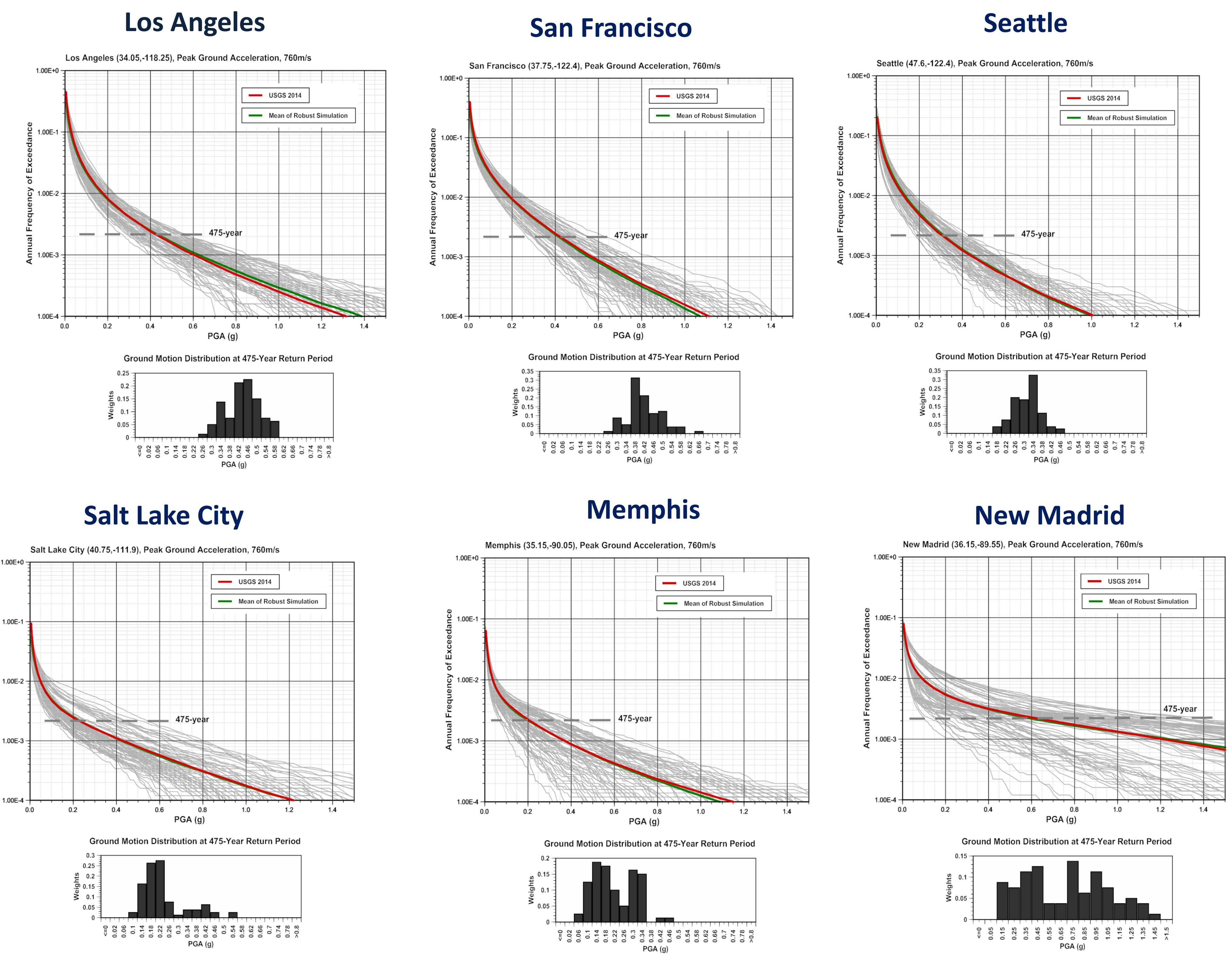
A Robust Event-set for Hazard and Loss Assessment

Event-sets are commonly used in catastrophe loss assessment. **A robust event-set** is defined as:

–A stochastic equiprobable event catalog and the associated random intensity fields that robustly characterize the scientific uncertainty in the hazard for a region

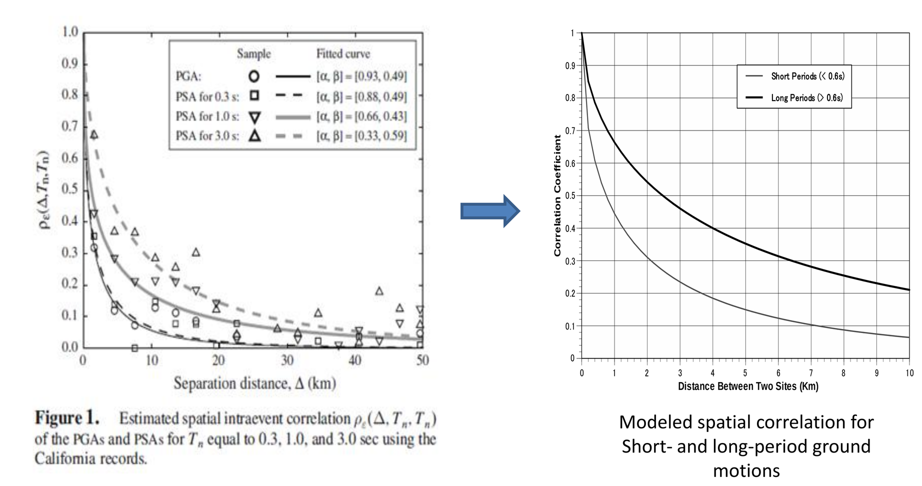
–Preserves model coherency, integrity and traceability

5. Robust Hazard Assessments



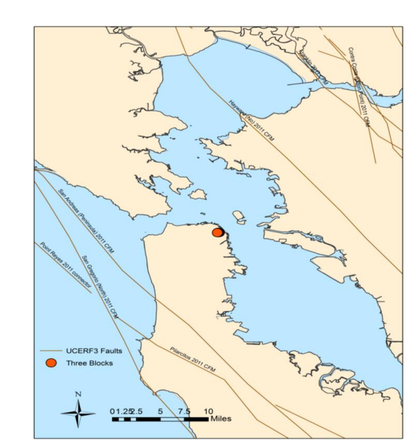
6. Robust Risk Assessments

Modeling Spatial Correlation of Shaking Intensity

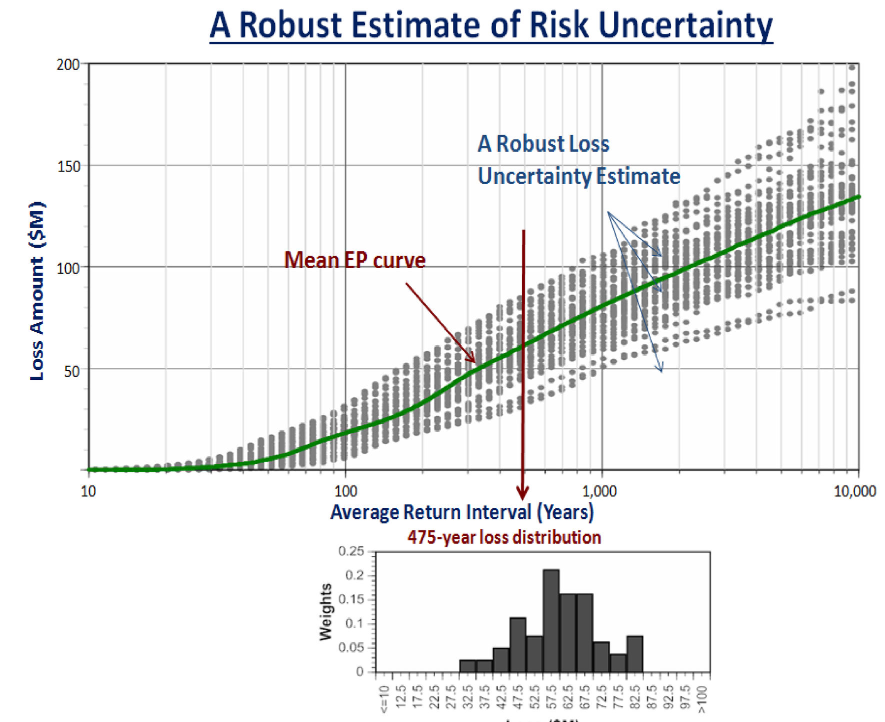


(Goda and Hong, 2008)

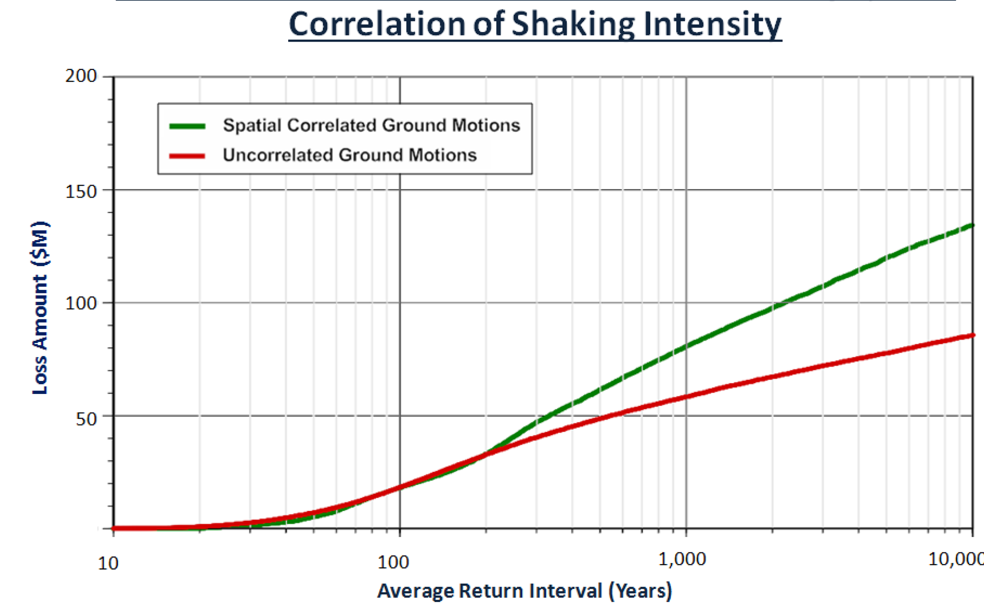
3-blocks of 18 Steel and Concrete Buildings in San Francisco, varying in height from 3 to 48 stories



A Robust Estimate of Risk Uncertainty



Portfolio Losses With and without Considering Spatial Correlation of Shaking Intensity



7. Advantages with Robust Simulation

–Robust uncertainty estimates: characterizes the uncertainty of future risks through simulation of an ensemble of views for more robust decision making

–Transparency: preserves model coherency, integrity and traceability

–Non-parametric statistics: minimizes need for complex classical statistical calculations

–Computational efficiency: propagates uncertainty through efficient statistical sampling

–Extreme risks: more useful in identifying the "black swan" cases that are typically hidden with the conventional approaches.