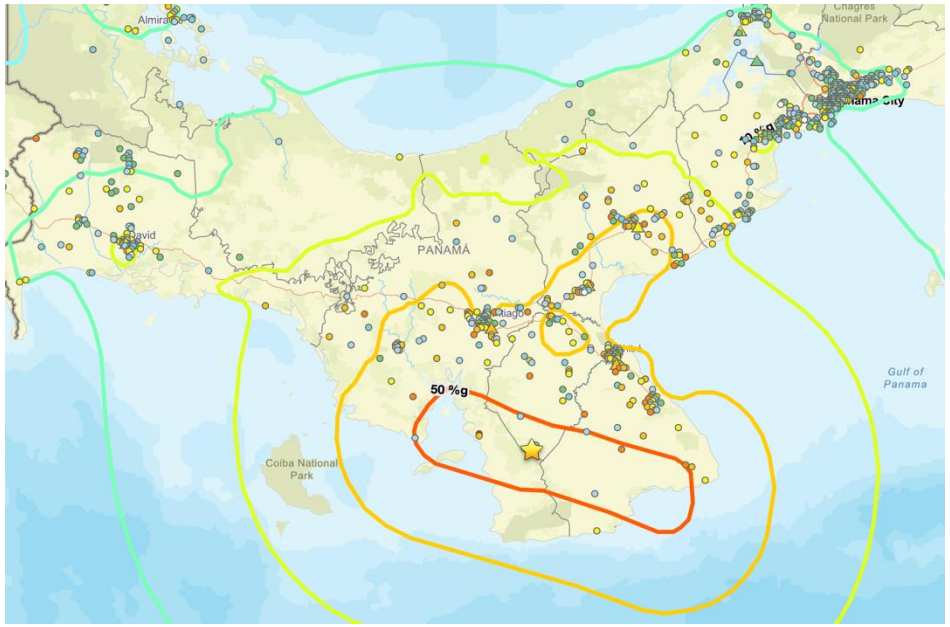
Ground Motion Intensity

Prevalent intensity observations enable:

- More accurate post-event ShakeMaps
- Characterization of repeatable, non-ergodic effects



ShakeMap 2026 M7.7 Panama Earthquake
212 DYFI, 3 Stations within 100km radius

Current State of GMICE

Inverse:

$$\log(PSA) = c_0' MMI + c_1' M + c_2' R$$

Forward:

$$\underbrace{MMI}_{\text{Intensity}} = c_0 \underbrace{\log(PSA)}_{\text{Shaking Information}} + \underbrace{c_1 M + c_2 R}_{\text{Scenario Information}}$$

Suggest a physically inconsistent behavior

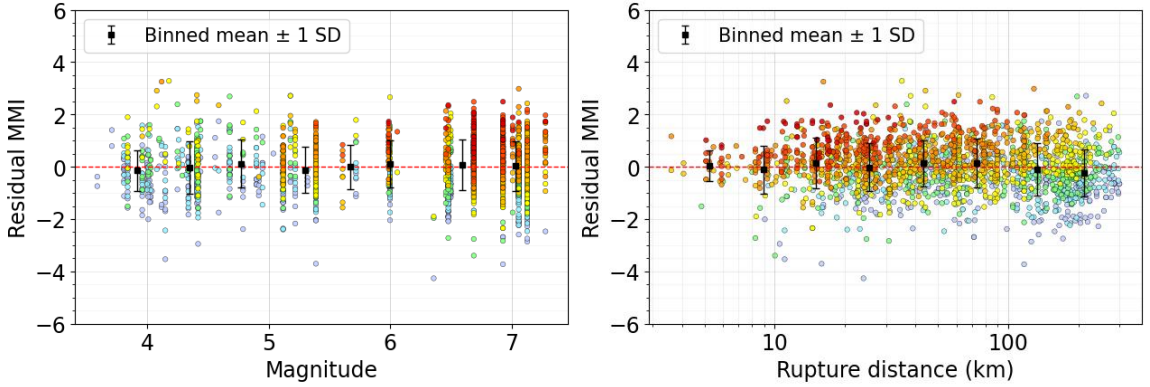


Structural and human responses are governed by shaking characteristics, not scenario characteristics

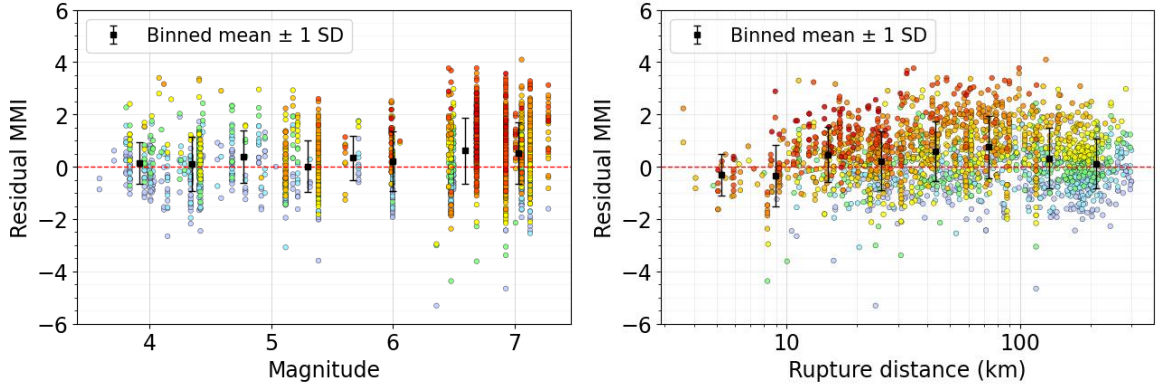
New MMI-PSA Model

$$MMI|\overrightarrow{PSA} = N(\mu, \kappa)$$

- Improved MMI prediction given PSA



Proposed model: RMSE (test): 0.92

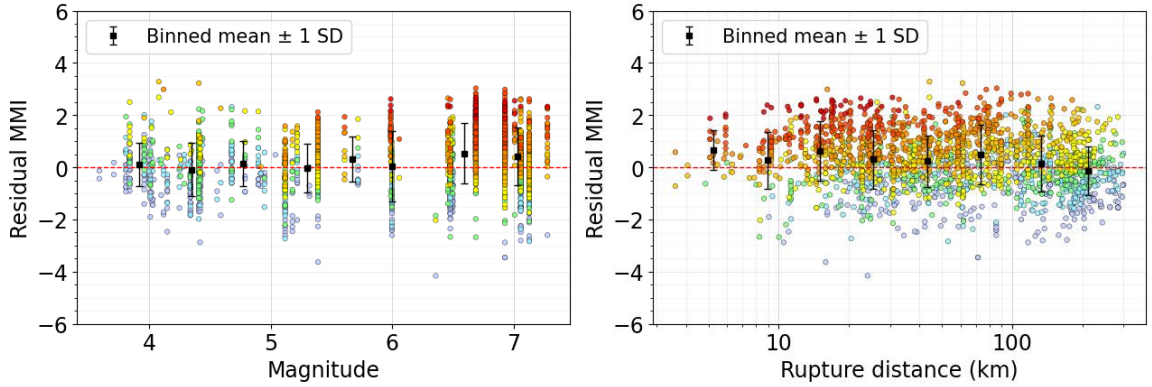


Worden et al., 2012 : RMSE (test): 1.21

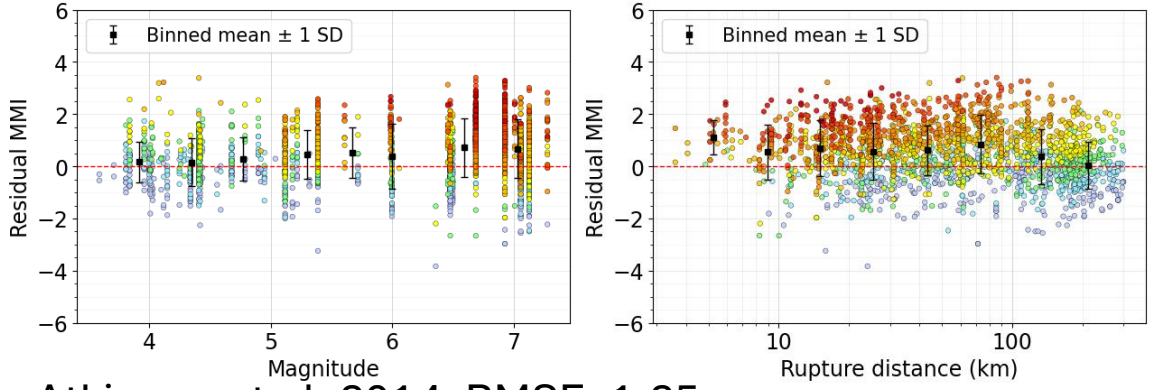
40% variance reduction

MMI-EQ Scenario Scaling

$$\mathbb{P}\left(MMI|M, R, V_{S30}\right) = \int \underbrace{\mathbb{P}\left(MMI|\overrightarrow{PSA}\right)}_{\text{MMI-PSA Model}} \underbrace{\mathbb{P}\left(\overrightarrow{PSA}|M, R, \ldots\right)}_{\text{Any PSA GMM}} d\overrightarrow{PSA}$$



Proposed model + ASK14: RMSE: 1.12



Atkinson et al. 2014: RMSE: 1.25

PSA-MMI Inversion

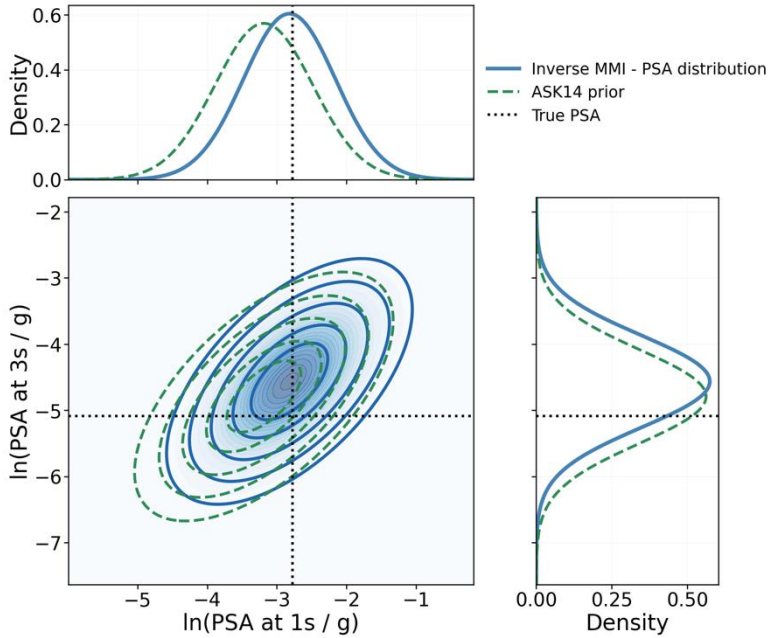
Bayes' Rule:

Proposed MMI-PSA Model

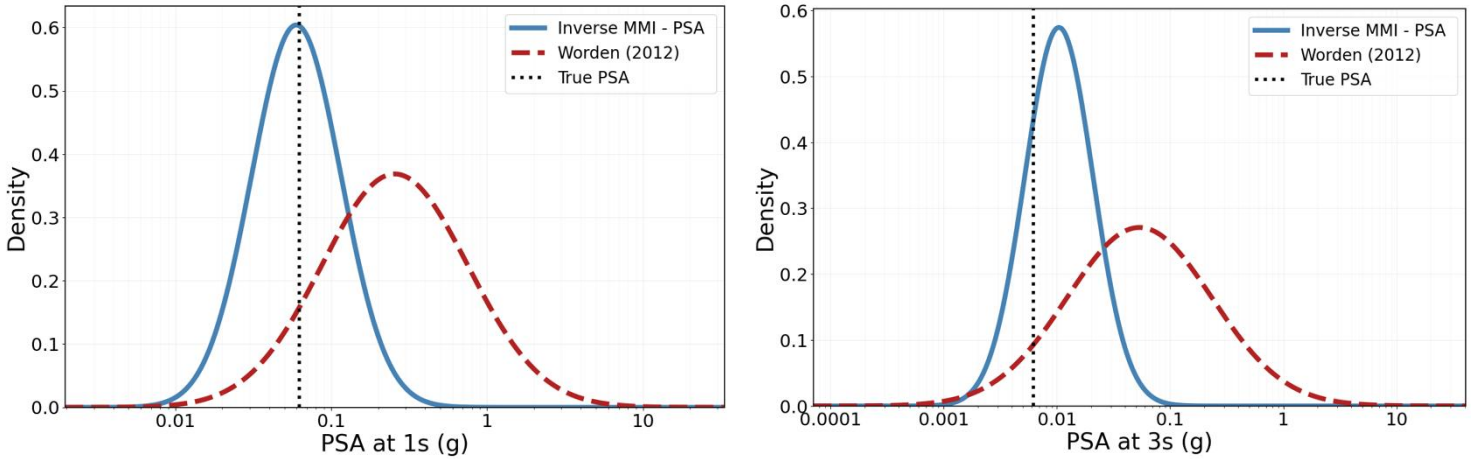
Prior PSA distribution - PSA GMM

$$\underbrace{\mathbb{P}\left(\overrightarrow{PSA}\middle|MMI, M, R, \ldots\right)}_{\text{Posterior PSA distribution given intensity \& earthquake scenario}} = \frac{\mathbb{P}\left(MMI\middle|\overrightarrow{PSA}\right)\mathbb{P}\left(\overrightarrow{PSA}\middle|M, R, \ldots\right)}{\mathbb{P}(MMI|M, R, \ldots)}$$

MMI-EQ Scenario Model (Previous slide)



Prior and posterior PSA distribution given MMI observation



Comparison of prior distributions with Worden et al., 2012
(a) PSA(T=1sec), (b) PSA(T=3sec)