2012 SCEC Annual Report

Ground Motion (0 – 5 Hz) Validation of Dynamic Heterogeneous Rupture Models on a Strike-Slip Fault

Shuo Ma[1], Dudley J. Andrews[2], and Ruth Harris[2]

[1]Department of Geological Sciences
San Diego State University
San Diego, CA 92182

[2]United States Geological Survey
Menlo Park, CA 94025

We validate the heterogeneous stress models of Andrews and Barall (2011) by comparing the simulated ground motions (0 – 5 Hz) using a 1D velocity structure proposed by Boore and Joyner (1997) for a generic rock site with the GMPEs from the NGA project. The advantage of Andrews and Barall's (2011) approach is that the rupture length is determined by the long-wavelength stress variation that is part of the same spectrum as the shorter wavelength heterogeneity. The short-wavelength stress variations are fixed once the rupture length is determined (from the empirical relationship between magnitude and rupture area). There are no hard barriers. The rupture stops naturally due to the long-wavelength stress variation specified in the model. Therefore there is no arbitrariness to specify different scales of stress variations. The ratio of initial stress and normal stress is self-similar, thus allowing the use of a depth-dependent normal stress.

We generated 10 random realizations for the ratio of initial shear stress to the normal stress on the fault. The target event is an M 7 on a vertical strike-slip fault. We simulate dynamic rupture on the fault using the generated random stresses with a time-weakening friction law. We computed ground motions at 61 stations at 10 km off the fault and the psudo-acceleration values at periods 1s, 3s, and 10s. The results are shown in Figure 1. A preliminary inspection of the results shows that the mean and variability of the simulated ground motion are consistent with the GMPE of Boore and Joyner (2008). We are trying to understand all the parameters in the GMPEs in order to make more quantitative comparisons. Once successful, this approach will be a significant contribution to the ground motion prediction. We extend the project for an additional year. We will report our final results in the next year.

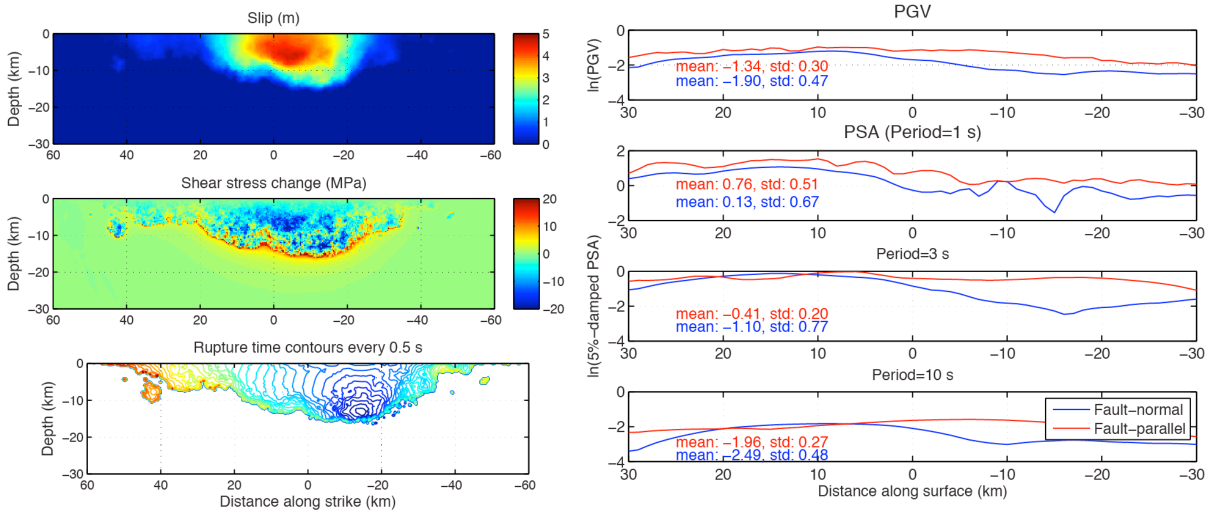
References

Andrew, D. J., and Barall, M. (2011). Specifying initial stress for dynamic heterogeneous earthquake source models, Bull. Seismol. Soc. Am. 101, 2048 – 2417, doi: 10.1785/0120110012.

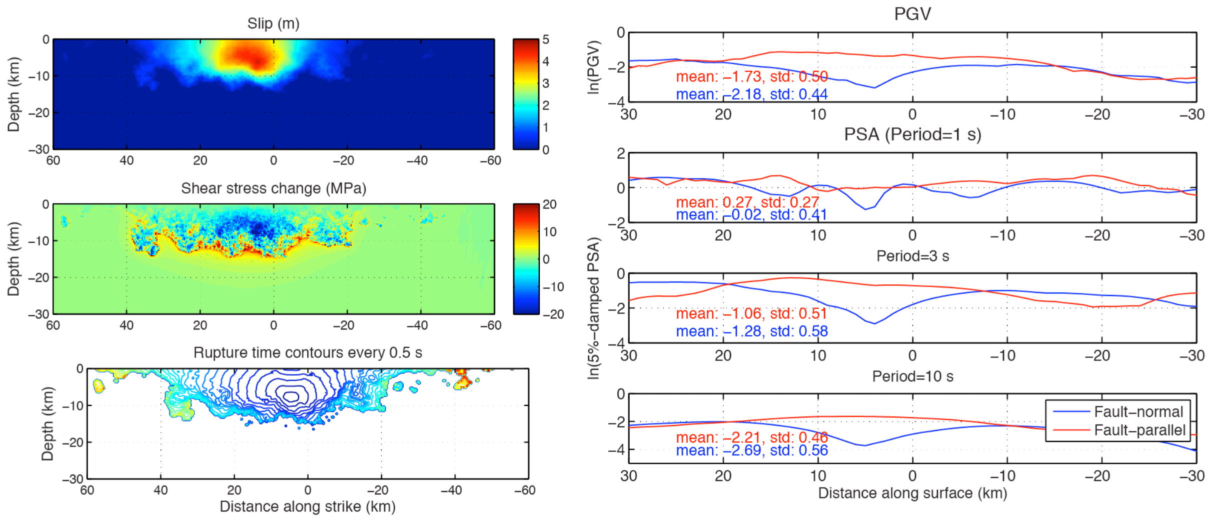
Boore, D. M., and W. B. Joyner (1997). Site amplifications for generic rock sites, Bull. Seismol. Soc. Am. 87, 327 – 341.

Boore, D. M., and G. M. Atkinson (2008). Ground-motion prediction equations for the average horizontal component of PGA, PGV, and 5%-damped PSA at spectral periods between 0.01 s and 10.0 s, Earthquake Spectra 24, 99 – 138.

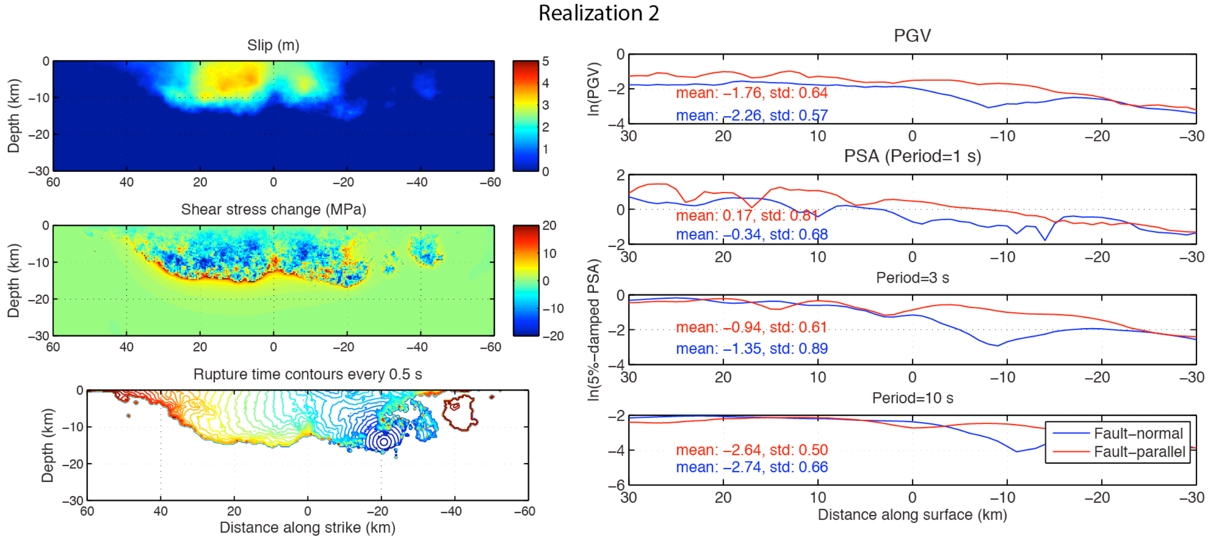
Realization 0



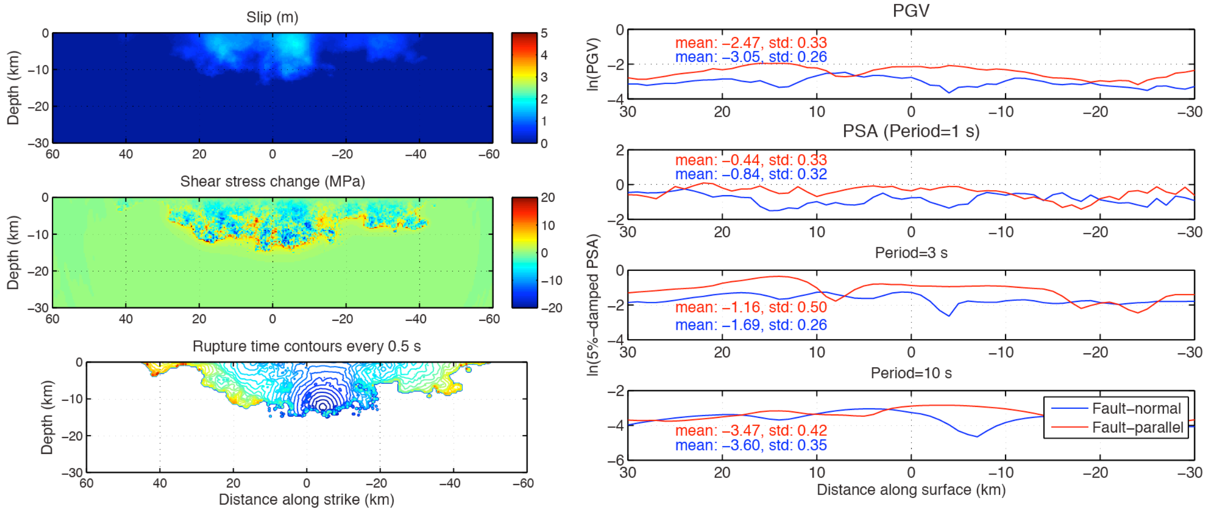
Realization 1



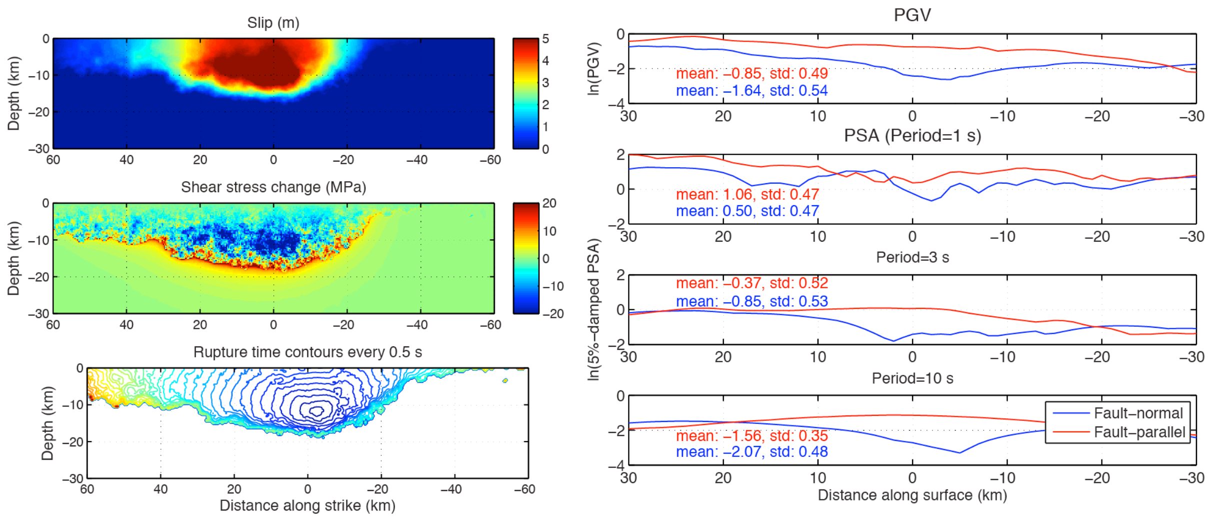
Realization 2



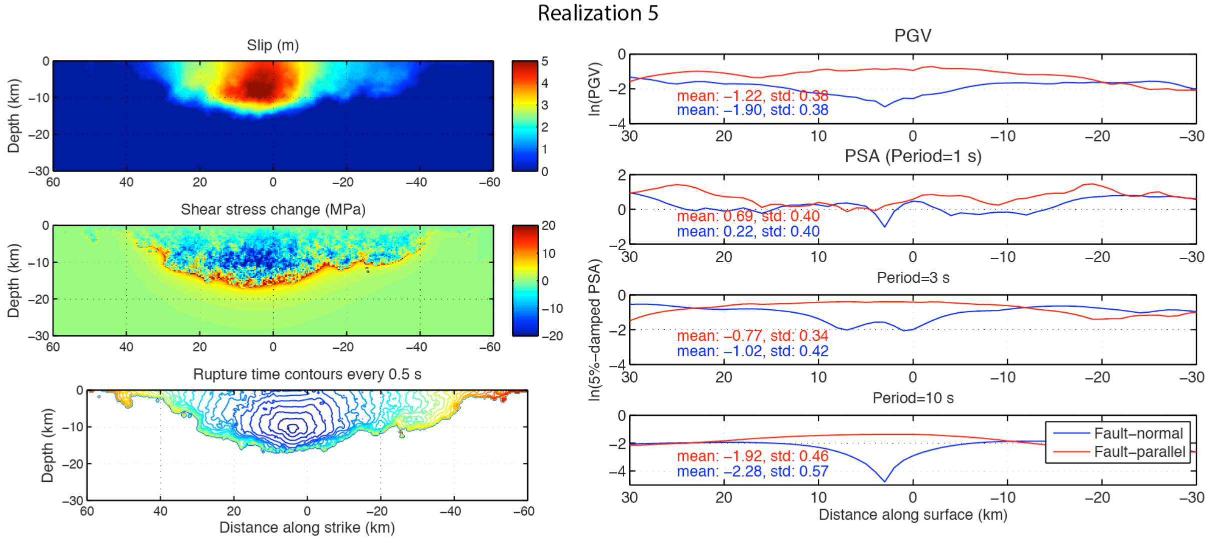
Realization 3



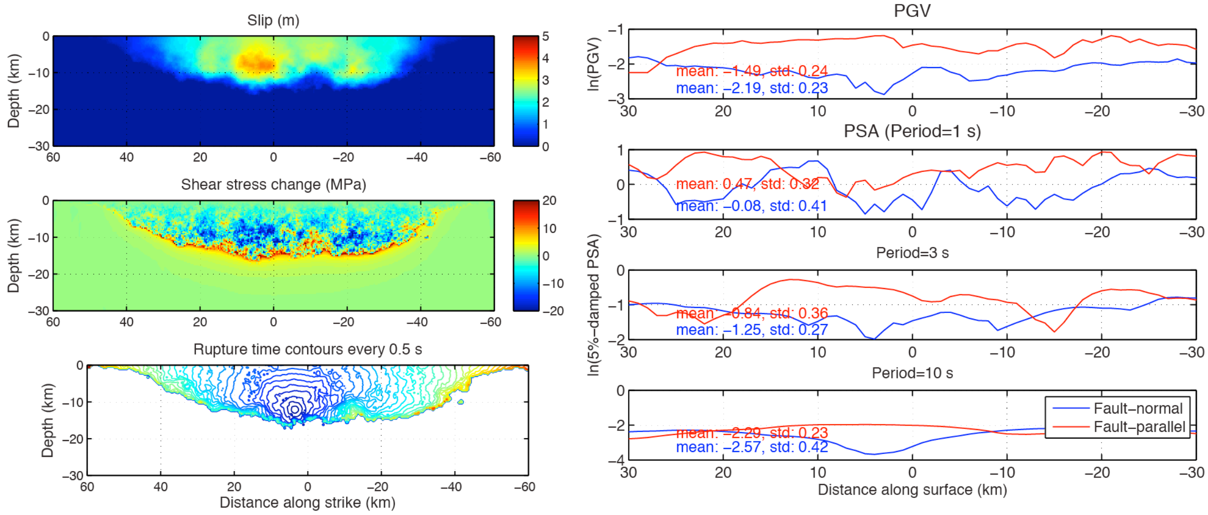
Realization 4



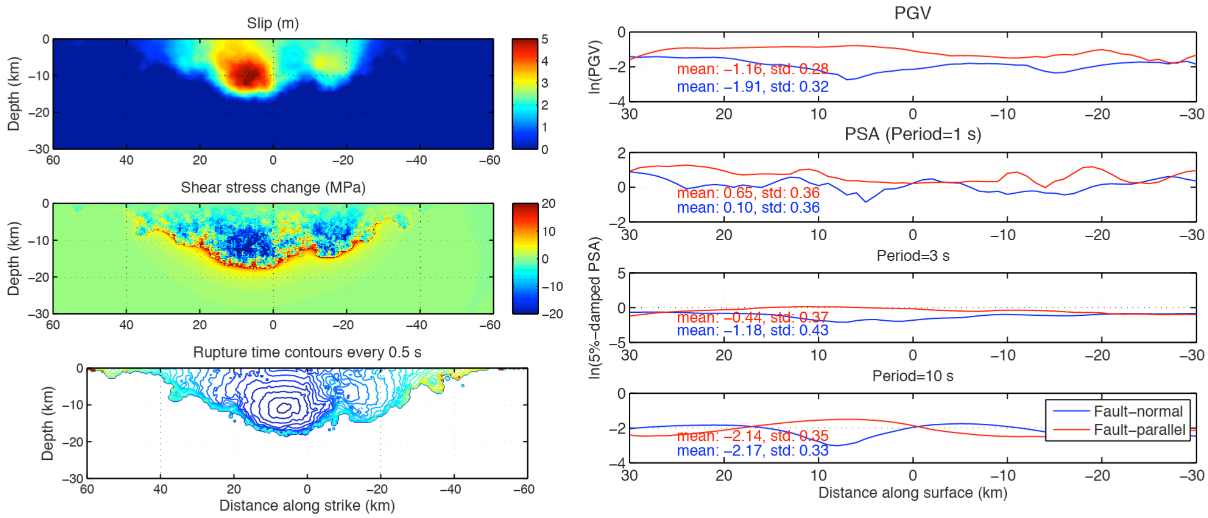
Realization 5



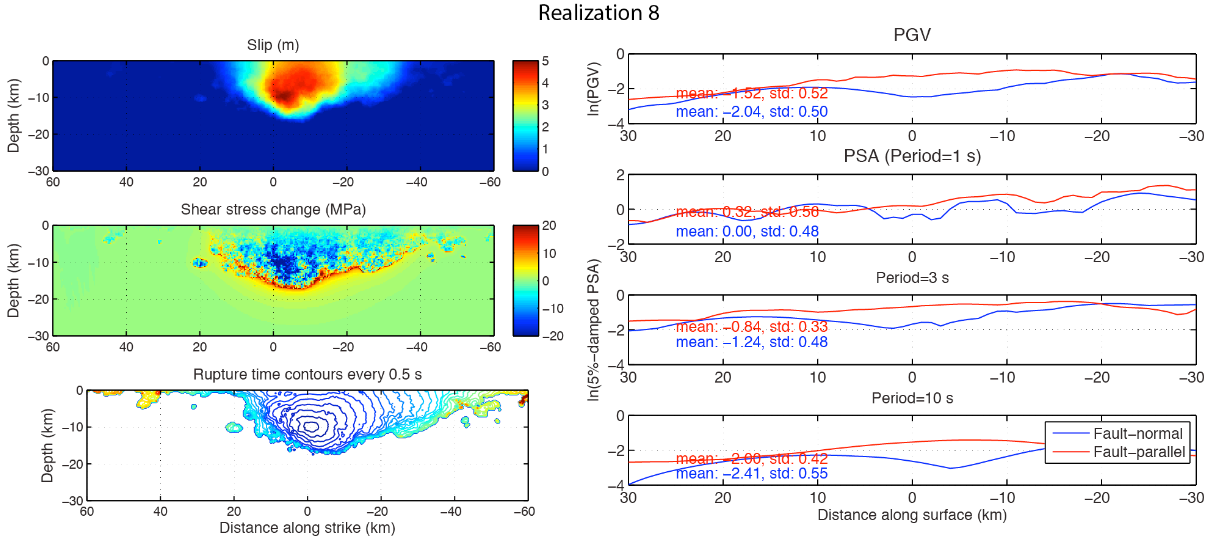
Realization 6



Realization 7



Realization 8



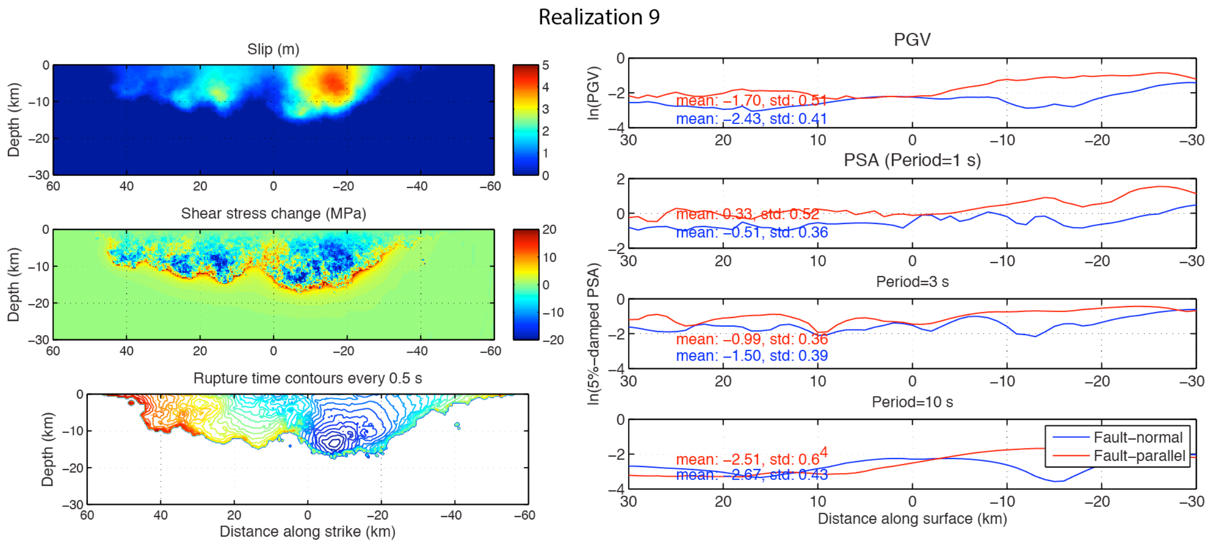


Figure 1. Results for 10 random realizations, in which we show the distributions of slip, stress drop, rupture time on the fault, and peak ground velocity (in m/s) and pseudo-acceleration values (in m/s^2)at periods 1 s, 3s and 10s at 61 surface stations 10 km off the fault. Also indicated are the mean and standard deviations of ground motions, which we can compare with the values from the GMPEs.