O-13

Ground-Motion Modeling of Hayward Fault Scenario Earthquakes

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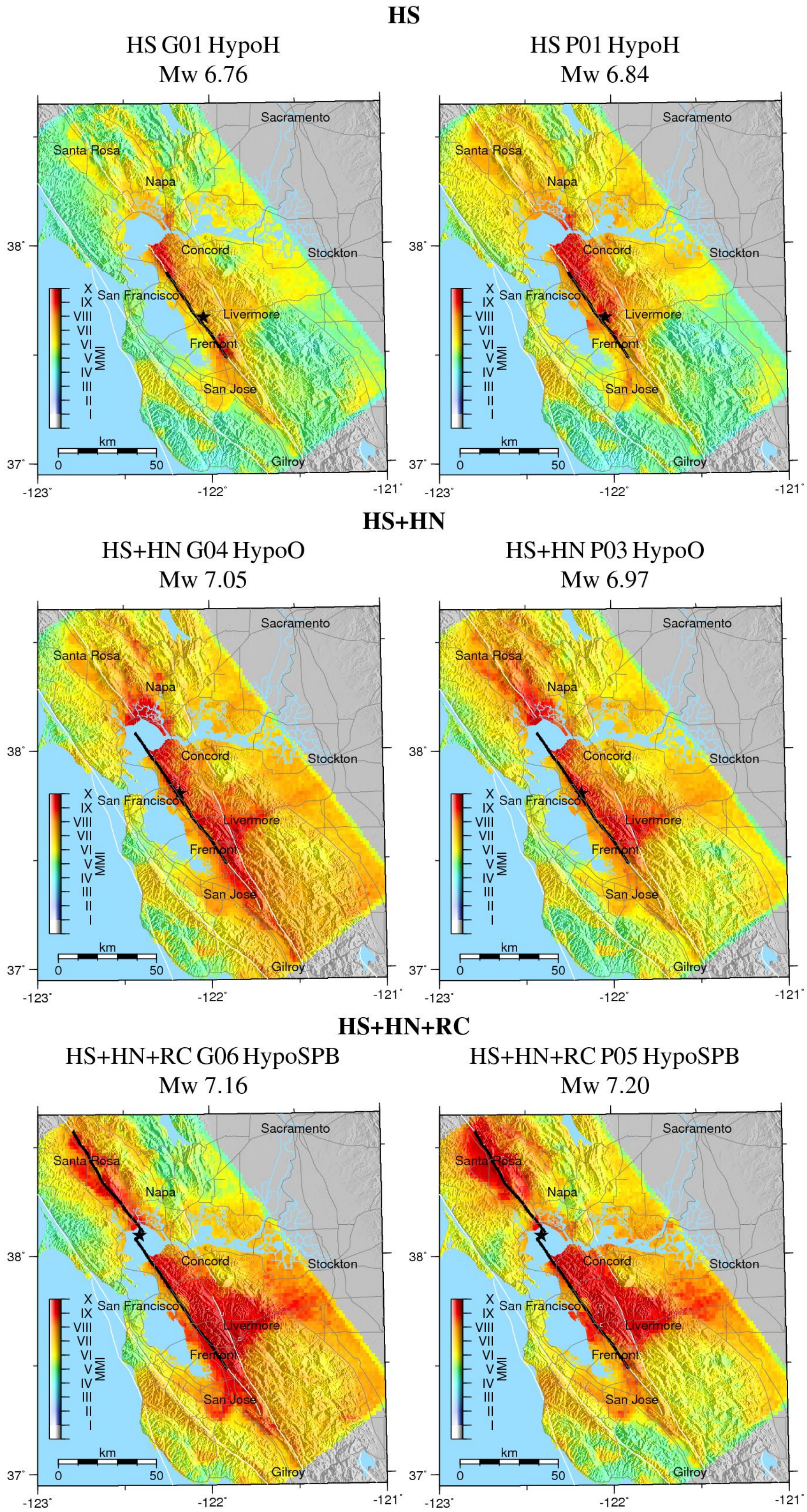
We simulate long-period (T > 1.0-2.0 s) and broadband (T > 0.1 s) ground motions for 39 scenarios earthquakes (Mw 6.7-7.2) involving the Hayward, Calaveras, and Rodgers Creek faults. For rupture on the Hayward fault we consider the effects of creep on coseismic slip using two different approaches, both of which reduce the ground motions compared with neglecting the influence of creep. Nevertheless, the scenario earthquakes generate strong shaking throughout the San Francisco Bay area with about 50% of the urban area experiencing MMI VII or greater for the magnitude 7.0 scenario events. Long-period simulations of the 2007 Mw 4.18 Oakland and 2007 Mw 5.45 Alum Rock earthquakes show that the USGS Bay Area Velocity Model version 08.3.0 permits simulation of the amplitude and duration of shaking throughout the San Francisco Bay area for Hayward fault earthquakes, with the greatest accuracy in the Santa Clara Valley (San Jose area). The ground motions exhibit a strong sensitivity to the rupture length (or magnitude), hypocenter (or rupture directivity), and slip distribution. The ground motions display a much weaker sensitivity to the rise time and rupture speed. Peak velocities, peak accelerations, and spectral accelerations from the synthetic broadband ground motions are, on average, slightly higher than the Next Generation Attenuation (NGA) ground-motion prediction equations. We attribute much of this difference to the seismic velocity structure in the San Francisco Bay area and how the NGA models account for basin amplification; the NGA relations may under-predict amplification in shallow sedimentary basins. The simulations also suggest that the Spudich and Chiou (2008) directivity corrections to the NGA relations could be improved by increasing the areal extent of rupture directivity with period.



Modified Mercalli Intensities from long-period (T > 2.0 s) simulations of six scenario earthquakes with different rupture lengths (HS: Hayward South; HS+HN: Hayward South + Hayward North; HS+HN+RC: Hayward South + Hayward North + Rodgers Cree) and slip distributions. The top row uses the slip-gradient approach for accounting for the effects of creep on the slip distribution, and the bottom row uses the slip-predictable approach. The black line indicates the rupture and the black star identifies the epicenter.