Simulation of Strong Ground Motion from the 2004 Parkfield Earthquake

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Two different studies have been conducted to simulate the near-field strong ground motion generated by the 2004, Mw=6.0 Parkfield earthquake. This earthquake took place in a very well instrumented area producing a substantial amount of high-quality near-field recordings. The first study is based on the hybrid Green's function method (HGF). HGF method starts with calculating the synthetic Green's function which is a combination of deterministically calculated, low frequency motion and stochastically simulated, high frequency motion. Summation of Green's functions using the numerical framework of the Empirical Green's Function method gives the large earthquake synthetics. Simulations with this method were carried out for the frequency range 0.1-25 Hz at eight rock and four soil site stations. The results compare favorably with the empirical data. Frequency dependent site amplification values are calculated using empirical data, and considered for the soil site simulations. The comparisons of simulated motion in time and frequency domain proved the efficiency of the HGF method in such broadband simulations. The second study is based on an explicit finite-difference algorithm developed by Frisenda and Madariaga for the computation of radiation from complex ruptures on extended faults. Taking advantage of the rare luxury of having a large number of near field ground motion recordings distributed around the fault zone, we used recordings from 40 stations covering a rectangular area of about 55 km by 33 km in fault parallel and fault normal directions, respectively. Using a grid spacing of 100 m in our 4th order explicit finite difference code, we could properly resolve frequencies of up to 1 Hz at a minimum of 8 grids per wavelength. A one dimensional averaged velocity structure was used in the simulations of wave propagation. The effect of the strong velocity contrast between the NE and SW sides of the San Andreas fault in Parkfield region at 5-12 km's depth has been investigated by using different velocity models for the two sides. The effects of different slip distributions and source-time functions have also been studied. We first used a simplified version of the preliminary source model by Ji (2004). A more recent slip distribution model by Ji et al. (2005) obtained by the inversion of waveforms from both strong motion and GPS stations has also been considered. The latest slip model that was implemented was the one obtained by Liu et al. (2006) using kinematic inversion. Several different kinematic rupture scenarios were considered with variable rupture speeds and several source-time functions of different shapes (decreasing exponential and trapezoidal) and durations.