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Strong ground motion simulation of West off Fukuoka earthquake by asperity-incorporated stochastic finite fault modeling

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Fukuoka earthquake (Mw6.6) occurred on March 20, 2005 under the sea off Fukuoka city at 10:53 a.m.(JST). The rupture propagated toward Fukuoka city from NW direction and strong ground motion with JMA seismic intensity 6 lower was observed in Fukuoka city. We apply stochastic finite-fault simulation to simulate the acceleration records of the earthquake recorded at 27 strong motion stations of K-NET and K-net (NIED), whose epicentral distances range from 21km to 92km. We set target frequency band from 1 to 10Hz because we can not find out any sign of f_{max} effects in that frequency band. We do simulation by using method of Motazedian and Atkinson (2005) with a little modification. Motazedian and Atkinson (2005) introduced some new concepts into stochastic finite-fault simulation method while the fundamental portion of the method to calculate synthetic waveforms is based on Beresnev and Atkinson (1997). One of the new concept introduced by them is dynamic corner frequency, where the corner frequency is a function of time, and the rupture history controls the frequency content of the simulated time series of each subfault. We apply this concept with the modification that enables us to treat variable stress parameter value on the fault plane while stress parameter takes constant value on the whole fault plane in conventional stochastic finite-fault simulation. We assign higher stress parameter value to asperity than that of background region. We use the concept of 'pulsing area' by Motazedian and Atkinson (2005) above this to simulate earthquake in more realistic way. To incorporate accurate site amplification effects, we employ site amplification data extracted from other event records by Kawase and Matsuo (2004) where they got site amplification by using the spectral separation technique. The dimensions of the fault length, width and the depth to the top of the fault are chosen to be 24 km, 16 km and 1 km, respectively, based on the spatial distribution of aftershocks. Simulations are done for two different source models: One is characterized by its constant stress parameter on the whole fault plane with slip weight randomly distributed, the other is characterized by an asperity where stress parameter and slip weight have higher values than the surrounding background region. We determine unknown parameters such as rupture velocity, stressparameter, and pulsing area by grid search. The evaluation function we use in grid search is misfit between synthetic waveform and observed waveform. The misfit is calculated by the code of Kristekova et al. (2006) in which dissimilarity of two waveforms is calculated both in time and frequency domain with using wavelet analysis. Rupture velocity is kept constant on the fault plane for both models. The obtained synthetic Fourier amplitude spectra and time series show overall agreement with the observed. In particular, the fitting of the Fourier amplitude spectra are pretty well, mainly owing to Kawase and Matsuo's work, except 9 stations. In those exceptional stations where rather large discrepancy between observed and synthetic spectra is found, the observed site amplifications differ from those we used in the simulation. These facts show the importance of accurate evaluation of site amplification. We could not get good results at stations where observed PGA exceeded 200gal. It's desirable to take non linear site response effects into account when we simulate at stations located very close to causal fault. We could not find out any significant difference between the time series and Fourier amplitude spectra of two models. Our results show that stochastic finite-fault modeling is a useful tool to simulate middle to high frequency strong ground motion, in spite of its low cost.