Broadband ground-motion simulations considering aleatory variability in source parameters

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Introducing physics-based ground-motion simulations to probabilistic seismic hazard assessment (PSHA) is a challenging task in seismic hazard issues. Compared to empirical-based approaches using ground-motion prediction equations (GMPEs), physics-based simulations can provide more spatially-dense ground motion distributions that directly reflect the source rupture and wave propagating models. For PSHA it is essential to evaluate the variability of the simulated ground motions due to the epistemic and aleatory uncertainties in model parameters.

This study investigates the ground-motion variability considering aleatory variability in various source parameters. We conduct broadband (0.1–10 s) ground-motion simulations for a past strike-slip event (2000 M_W6.6 Tottori earthquake) using the characterized source models (e.g. Irikura and Miyake, 2011). Broadband ground motion is computed by a hybrid approach that combines a 3D finite-difference method at long periods (> 1s), and the stochastic Green's function method at short periods (< 1 s), using the 3D velocity model J-SHIS v2. We consider various locations of the asperities, which are defined as the regions with large slip and stress drop within the fault, and the rupture nucleation point (hypocenter). Ground motion records at 29 K-NET and KiK-net stations are used to validate the performance of our simulations. We also set 318 virtual receivers with the spatial intervals of 10 km for statistical analysis of the simulated ground motion. Standard deviation (SD) for the simulated PGA, PGV, and acceleration response spectra (Sa, 5% damped) is investigated at each receiver. SD due to variation in asperity locations is generally smaller than 0.15 in terms of log10 (0.34 in natural log). It shows dependence on distance at periods shorter than 1 s; SD decreases as the distance increases. On the other hand, SD due to hypocenter variation showed azimuthal dependence at long periods; it increases as the rupture directivity parameter (e.g. Somerville et al. 1997) increases at periods longer than 1 s.

The characteristics of ground-motion variability inferred from simulations can provide information on variability in simulation-based seismic hazard assessment for future earthquakes. We will further investigate the ground-motion variability due to other source parameters; seismic moment, rupture velocity and stress parameters.

References

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