Effect of source process on seismic waveforms (2)

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1. Introduction

This study investigates the effect of complexity of the rupture process of earthquake on the seismic waveforms based on kinematic simulations. In the previous study (Kakehi, SSJ Fall Meeting 2003), numerical simulations targeting inland crustal earthquakes were made, and I found that the rupture process complexity is more clearly reflected on the waveform at the station located at the backward directivity side than at the forward station. This study treats deep slab earthquakes as the target of numerical simulations.

2. Setting of source model

This study targets the 2001 Geiyo earthquake (Mjma = 6.7), which is a slab earthquake occurring in the subducting Philippine Sea plate. The base source model for the numerical simulations is constructed by simplifying the rupture process obtained by Kakehi (2004) based on waveform inversion. The fault size is about 30 km x 18 km, and the fault plane lies with the depth range from about 40 km to 56 km. The base model has three rectangular areas with large slip, at the rupture starting point, at the southern shallow part (in the oceanic crust), and the southern deep part (in the oceanic mantle). The slip values are 0.8 m, 1.7 m, and 1.6m, respectively. Uniform slip of 0.2 m is given to the other area as background slip. The rupture is assumed to propagate radially with a rupture velocity of 3.47 km/s. The rise time is assumed to be 0.2 s, uniform over the fault.

Using this model as the base model, perturbation is given to each of the rupture parameters such as slip, rupture time, rise time, and rake angle. The perturbations are given to the 1 km x 1km meshes on the fault. The amounts of the perturbations are as follows.

slip: base slip +/- random perturbation within 50 %
rupture time: base rupture time +/- random perturbation within 0.2 s
rise time: rise time +/- random perturbation within 0.5 s
rake angle: rake angle +/- random perturbation within 45 degree

The theoretical waveforms are calculated at the forward station EHM006 and at the backward station HRSH12. Both of the epicentral distances of these two stations are about 60 km, which is roughly the same as the source depth.

3. Result

Though the source depth is deep, the kinematic simulation result shows that the source process complexity is more clearly reflected on the waveform at the station located at the backward directivity side than at the forward station. This is the same result as the case of shallow inland crustal earthquakes. Among the simulation cases tried in this study, the perturbations of rupture time, rise time, and rake angle have strong effects on the complexity of the theoretical waveforms at the ground surface. Particularly, the effect of the rise time perturbation is strong. On the other hand, slip perturbation has less effect on the complexity of the waveforms.