S148-P005 Room: Poster Session Hall Time: May 20

High accuracy estimation of the spatial and temporal distribution of slip for the 2005 west off Fukuoka earthquake

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We determined the continuous spatio-temporal slip distribution for the 2005 West Off Fukuoka Earthquake (M_{JMA} 7.0) by kinematic inversion from near-field strong motion seismic records. Next, we used the obtained spatio-temporal slip velocity distribution as an input, and simulated strong ground motion, using 3-D finite-difference method targeting frequency band of 0.1-1.0 Hz. Then we compared the simulated waveforms with the observed waveforms and checked the reliability of the obtained results.

Although our inversion is based on the multi-time window technique, both time and space is discretized by the first order b-spline functions (Fujii and Takenaka, 2003) and we can determine continuous slip distribution based on grid model, at arbitrary spatio-temporal point.

We adopted the following devices in the inversion. At first, we made azimuthal corrections of the seismic records based on the actual orientation of seismometers (g.e., Takenaka et al., 2006). To use more realistic velocity structure models, we created a 3-D velocity structure model taking into consideration the geological information and geophysical data. Then we extracted 1-D velocity structure model beneath each station (i.e., adaptive 1-D velocity structure model) from the 3-D velocity structure model. By the study of Yamamoto and Takenaka (2006), where they used P-wave portion of seismic records, it was clarified that 2005 West Off Fukuoka earthquake has initial rupture phase of about 3 seconds and the fault plane on which the initial rupture phase brought about is different from the one on which the main rupture occurred. They also determined the rupture velocity from the hypocenter to the start point of the main rupture as 2.0 km/s. We set the rupture initiation point on the fault plane on which the main rupture occurred (the second hypocenter) as the input rupture initiation point used in the inversion. We also assumed the rupture velocity to be 2.0 km/s from the second hypocenter to the start point of the main rupture. Then we changed the rupture velocity after the rupture reached the start point of the main rupture. We also corrected the S wave arrival time to synchronize the observed and synthetic waveforms, with the data of aftershocks. By adopting such original devices, we managed to obtain high resolution and high accuracy slip distribution.

Our inversion results show that the maximum slip area on the fault plane exists Fukuoka city side of the second hypocenter, about the depth of 10-12 km. The position of the maximum slip area obtained in our inversion is a little deeper in comparison with the results by other researchers (g.e., Asano and Iwata, 2006; Kobayashi et al., 2006; Horikawa, 2006) and this features our results. In the study of other researchers, they did not do all of devices we executed in our study to get high resolution and accuracy results, and this maybe caused the difference. We adopted 2.6 km/s as the first-time-window propagation velocity because the value minimized the residual in the inversion. The seismic moment was determined to be $7.9*10^{18}$Nm and the moment magnitude was determined as 6.5. The maximum slip was 1.7 m and this is in harmony with the results by Kobayashi et al. (2006) and Horikawa (2006). The maximum slip velocity was determined to be 1.6 m/s.

By comparing the obtained slip distribution and the aftershock distribution (Uehira et al., 2006), we found a supplementary relation between them. Next, we input the slip velocity function into the strong ground motion simulation by finite-difference method (Takenaka and Fujii, 2002) using the 3-D velocity structure model we created beforehand. As a result, we successfully reproduced the observed seismic records in all around the study area. This successful results show the high accuracy of our results.