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Examination of source process for the 2011 off Miyagi earthquake of M 7.2 using strong-motion records

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The 7 April 2011 off Miyagi event of Mj 7.2 was a down-dip compression type earthquake in the Pacific slab, supported from the high dip angle in the moment tensor solution and the focal depth of 66 km. This is the largest event for the intra-slab earthquake occurring after the 2011 Tohoku great earthquake of Mw 9.0. The seismic intensity of 6 upper was recorded at Miyagi prefecture just above the source area, and the region of intensity 5 upper extended from southern Iwate to northern Fukushima prefecture. In this study detailed source rupture process is inferred by the inversion analysis using strong ground motion records in the source region. The source inversion algorithm adopted here is composed of the empirical Green's function method and the very fast simulated annealing developed by Shiba and Irikura (2005). In this inversion procedure we first estimate the spatial and temporal distributions of the slip and the rise time on the assumed fault plane from the relatively low-frequency ground motions. Then the effective stress and slip distributions are determined by using the result of the previous inversion analysis as a prior distribution of the new research with the waveforms in the higher frequency range. The fault plane model is assumed as the east-dipping plane with high dip angle based on the F-net moment tensor solution. For the empirical Green's function, the aftershock on 28 April of Mj 4.8 is employed and the sub-fault size is determined from the corner frequency of its source spectrum. Two horizontal velocity motions numerically integrated from the acceleration records at 21 KiK-net stations with one K-NET are provided for the inversion procedure. The source model derived from the slip and rise-time inversion shows rather simple slip distribution consist of one asperity located west of the hypocenter. The area of the asperity is 15 km long and 10 km wide, which is about 14 % of the whole rupture area. Rise time is relatively short of around 1 second, suggesting larger slip velocity and higher effective stress. Furthermore the source model obtained by the simultaneous inversion of the effective stress (peak slip velocity) and the slip indicates that the area of the high effective-stress is coincide well with the asperity, however the highest effective stress area is concentrated to the west end of the asperity, where the large slip ceases. The peak effective stress reaches about 120 MPa and the average on the asperity is 70 MPa, which is consistent with the stress drop on the strong motion generation area for the characterized source model of this event estimated with forward modeling analysis (Harada and Kamae, 2011; Somei et al., 2012).

Keywords: 2011 off Miyagi earthquake, intra-slab earthquake, source process, inversion analysis, strong motion record, effective stress