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An extension of the kinematic slip inversion method to include unknown fault geometry by using strong motion data

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Near-source strong ground motions during large earthquakes are governed by spatio-temporal slip progression on the fault plane. Many previous studies succeeded to obtain precise slip distributions of large earthquakes from strong motion and other seismic and geodetic data set. The geometry of source fault is also known to be important to quantitatively explain near-source strong ground motions as seen in the previous studies (e.g., Iwata et al., 2000; Gallovic et al., 2010). However, most of kinematic source inversion studies except special cases assumed one or plural planar fault planes in their analyses. In order to include effects of fault geometry on near-source ground motions, we are trying to develop a method to invert slip distribution simultaneously with its fault geometry. The developed method is applied to the dataset of the 2008 Iwate-Miyagi Nairiku earthquake.

The source inversion is done in two steps as following. In the first step, a linear source inversion (e.g., Hartzell and Heaton, 1983) is carried out assuming a planar fault model, which follows the focal mechanism solution determined by the F-net, NIED. That is, all the subfaults have same strike and dip angles same as in conventional source inversions. In the second step, the fault geometry is represented by strike and dip angles at some control points distributed on the fault model. The strike and dip angles at each subfault is calculated by bilinear interpolation. Then, strike and dip angles at control points and slip amounts at each subfaults are iteratively solved from the same data set using the Levenberg-Marquardt method starting from the solution of the first step as the initial model. The velocity structure model is constructed through waveform modeling for a moderate aftershock following the procedure proposed by Asano and Iwata (2009).

The preliminary result shows that the strike angle in the asperity is almost similar to the F-net MT solution (N209E), but dip angle at shallower part of the fault tend to be smaller than the MT solution (51 deg.). In the northern part of the fault, the strike angle is obtained to be rotated northwestward. These features are consistent with aftershock distribution.

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Keywords: source rupture process, source fault geometry, kinematic waveform inversion, strong motion data, the 2008 Iwate-Miyagi Nairiku earthquake