Broad-band source image for the 2011 Tohoku earthquake constructed by strong-motion data

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From the comparison between slip model using long-period (10s\(^{-}\)) seismic waves and excitation zones of short-period (0.1-10s) seismic waves, it has been suggested that the 2011 Tohoku earthquake (Mw9.1) has the period-dependent spatial variation on the seismic-wave radiation and this variation would be caused by the spatial difference of slip behavior on the plate boundary (e.g., Koper \textit{et al.}, 2011; Lay \textit{et al.}, 2012). However, their studies were based on the qualitative comparison of the results obtained by different methods, and the quantitative comparison between source models having different period-bands has not been made. Therefore, the construction of the source models at different period-bands by a common method is important to further understand the source characteristics of the 2011 Tohoku earthquake. Kubo \textit{et al.} (2013, Fall Meeting of SSJ) estimated the spatiotemporal slip models for the 2011 Tohoku earthquake on three different period bands (10-25s, 25-50s, and 50-100s). In this study, we estimate the source models for the 2011 Tohoku earthquake on five continuously-different period bands (10-25s, 17-33s, 25-50s, 33-67s, and 50-100s) using strong-motion data, and construct broad-band source image for the 2011 Tohoku earthquake.

The spatiotemporal rupture history is estimated by the kinematic linear waveform inversion using multiple time windows (Hartzell \& Heaton, 1983). The Green’s functions are calculated by the 3D FDM (GMS; Aoi \& Fujiwara, 1999) using a 3D velocity structure model, Japan Integrated Velocity Structure Model Version 1 (Koketsu \textit{et al.}, 2012). Three components of velocity waveforms at 25 stations of K-NET, KiK-net, and F-net of NIED are used in this analysis. Using waveform records at the stations for the middle-size events which occurred in the source area of the 2011 Tohoku earthquake, we confirmed the adequacy 3D velocity structure model at the analyzed period-band.

The source image for the 2011 Tohoku earthquake on the period band of 10-100s is summarized as follows: (1) (1st) Deep rupture off Miyagi rupture at 0-60s toward down-dip mostly radiating relative short period (10-25s) seismic waves. (2) Shallow rupture off Miyagi at 45-90s toward up-dip with long duration radiating long period seismic wave. (3) (2nd) Deep rupture off Miyagi at 45-90s toward down-dip radiating long period (25-100s) seismic waves. The dominant-period difference in the seismic-wave radiation between twice deep ruptures off Miyagi may result from the mechanism that the second rupture is smoother than the first one because small-scale heterogeneities on the fault are removed by the first one. (4) Deep rupture off Fukushima at 90-135s.

The broad-band source model on the period band from 5-100s is under construction and we will report this.

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Keywords: The 2011 Tohoku earthquake, Broad-band source image, Source models on different period bands, Source inversion, Strong-motion data