Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)
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SSS39-11 Room:IC Time:May 25 14:30-14:45

Seismic Source Process of the 2011 Tohoku-oki Earthquake retrieved from tele-seismic body waveform

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Many researchers have performed source inversion using seismic waveforms observed at near-source or/and global seismic networks. As pointed out by some researchers, however, seismic source models for the 2011 Tohoku-oki earthquake are different from one another. The discrepancy has prevented us to understand the nature of mega-thrust earthquake in Tohoku-oki region. In this study, we compared seismic radiation area estimated by new back-projection method and fault slip distribution obtained by the new waveform inversion (Yagi and Fukahata, 2011), and then discussed the rupture process of the 2011 Tohoku-oki earthquake.

In general, back-projection images of shallow and thrust faulting earthquakes are contaminated by the reflected phase (e.g. pP and sP phase). In this study, we developed the back-projection method so as to use information of the reflected phases, and then applied it to tele-seismic body waveforms recorded on station of GSN and FDSN. Concretely, we project coross-correlating function between theoretical Green's function and observed waveform to seismic source region. The result obtained by the new method revealed that the result with the conventional back-projection is contaminated by the depth phases (Nakao and Yagi, 2012).

The estimated back-projection image is consistent with the rupture pattern by Yagi and Fukahata (2011) especially early episode, when projected wave sources slowly move both eastward and westward from the hypocenter. We also find high seismic energy released narrow area near trench after 35 - 50 sec from origin time where maximum slip is obtained by Yagi and Fukahata (2011). The high-energy event in huge slip area implied the continuous and large stress drop event occurred near trench, which may be explained by significant weakening of frictional strength on the fault plane.

Keywords: the 2011 Tohoku-oki Earthquake, Seismic Source Process, back-projection