Improved fault model of the Tohoku intraslab earthquake on Dec. 2012 (Mw 7.2) and its implication for the post-2011 stress state

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We investigated the intraslab doublet earthquake occurred near the trench off Miyagi Pref. on December 7, 2012, based on near-field tsunami records by ocean bottom pressure gauges. Near the source area, the stress field before the 2011 Tohoku-Oki earthquake (Mw 9.0) was estimated to be tensile and compressional stresses in the upper and lower part of the subducting slab, respectively. The doublet was composed of the first deep (57.8 km) reverse faulting subevent (Mw 7.2, subevent 1) and the second shallow (19.5 km) normal faulting subevent (Mw 7.2. subevent 2) according to the GCMT solution, and the difference in focal mechanisms of the subevents is consistent with the stress state prior to the Tohoku-Oki earthquake. However, it is suggested that the intraslab stress state changed after the 2011 Tohoku-Oki earthquake (e.g., Obana et al., 2012, GRL), and the depth of the stress neutral zone, which exists between the upper tensile region and lower compressive stress region, may also changed. It is expected that the depth of the stress neutral zone after the Tohoku-Oki earthquake is constrained by the vertical extents of the fault ruptured during the two subfaults. The fault model estimated by our preliminary analysis (Kubota et al. (2015, JpGU; 2015, SSJ; 2015, AGU) consists of two planer subfaults, separated at around a depth of ~40 km from sea surface, which would be the depth to the stress neutral zone. However, the fault depths may not be constrained enough because we only used the tsunami waveforms, and we try to improve the fault model taking the other information (e.g., aftershock distribution) into account.
The aftershock distribution deduced from local OBS observation (Obana et al., 2014, EPS; 2015, AGU), the west-dipping aftershock lineation is clearly shown around the subevent 2, and little aftershocks were identified around the subevent 1. Therefore we compared between the tsunami source model derived from inversion analysis of pressure records and the sea surface vertical displacement expected only from the subevent 2 constraining the fault geomotry based on the aftershocks. In the calculation, we assumed a planar fault with uniform slip and constrained the location, strike and dip of the fault plane based on the aftershock distribution. The depth extent of fault plane was set between the slab surface (~7km) and the lower limit of aftershocks (~40km), and slip amount is given by scaling law and CMT solution. The sea surface displacement is obtained by applying depth filter (Saito and Furumura, 2009, GJI) to the seafloor displacement. As a result, the calculated extent and amount of the subsidence area is mostly comparable to the tsunami source model, suggesting that the subsidence area is created basically from the subevent 2. In the presentation, we will constrain the vertical depth extent of the subfault 2 in more detail considering the difference of the pattern of sea surface displacement associated with the vertical location of the fault slip. We will also constrain the hypocenter of the subevent 1 based on the local OBS network and improve the fault geometry of the subevent 1. Finally we will compare the previous studies of seismicity in this region and discuss the intraslab stress change associated with the Tohoku-Oki earthquake.

Keywords: Tsunami, Doublet earthquake, Intraslab stress state, 2011 Tohoku-Oki earthquake

