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Postseismic deformation associated with the 2011 Tohoku Earthquake deduced by means of GPS/Acoustic surveys

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Postseismic deformation of the 2011 Tohoku Earthquake has been measured by on- and off-shore geodetic studies (e.g., Ozawa et al., 2012, JGR; Watanabe et al., 2014, GRL), which generally showed trenchward movement in the on-shore area and landward movement in the off-shore, above the coseismic primary rupture area (PRA). These features were roughly modeled as viscoelastic relaxation and local afterslip (e.g., Sun et al., 2014, Nature). However, the previous observations are insufficient to describe whole spatial pattern of the postseismic deformation, especially in the off-shore areas along the Japan Trench. In this study, we show observation results using a wide GPS/acoustic (GPS/A) observation network (Kido et al., 2015, IAG) deployed for spatially constraining the postseismic deformation pattern along the trench.

We had conducted repeated campaign surveys from Sep. 2012 to Sep. 2016 at 20 GPS/A sites. GPS/A positioning was performed by means of Kido et al. (2006, EPS). Then, a horizontal postseismic displacement rate at each site is calculated by a weighted robust linear fitting technique.

The obtained displacement rates demonstrate clear spatial variation of the postseismic deformation; slight trenchward movement (<∼5 cm/yr) in the north region of PRA, significant trenchward movement (5-15 cm/yr) in the south region of PRA, and significant landward movement (10-15 cm/yr) above PRA were shown. To investigate contributed postseismic deformation processes, we compared our results with the displacement rates predicted from an existing viscoelastic relaxation model (VR model, Sun et al., 2014). The observed landward movement can be roughly explained by the VR model, but it cannot be fully accounted, which suggests a contribution of interplate locking causing further landward movement. We expect that the pattern of the observed landward movement has potential for demonstrating the spatial variation of the interpolate locking and for revising the VR model. In the north region of PRA, both of the observed and the VR modeled movement are small; contribution of other processes (e.g., afterslip and interplate locking) might be suggested to be trivial. In the south region of PRA, the observed trenchward movements are clearly larger than ones predicted from the VR model, which would be accounted by afterslip. Meanwhile, the results in the south region of PRA may show temporal decay of afterslip; such a temporal decay has not been detected in the region where viscoelastic relaxation is a dominant deformation process.