Simple estimation of interplate coupling in the Kushiro-oki and the Nemuro-oki regions, eastern Hokkaido in Japan from onshore GNSS data

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It is important to understand interplate coupling conditions on plate interface to upcoming earthquake occurrence. The interplate coupling along the Kurile trench in the Kushiro–Nemuro-oki region eastern Hokkaido in Japan, have been discussed by many previous studies using onshore geodetic data (e.g., Hashimoto et al., 2009), and most of them estimated high coupling ratio in around the region during the interseismic period. A study of tsunami analysis points out the possibility of a great earthquake occurrence along the shallow part of this area in 17th century(Ioki and Tanioka 2016). Therefore, there is a possibility that a great earthquake will occur in the future. Under those background in this area, there is a plan to install two GNSS-Acoustic (GNSS-A) observation sites on the seafloor to understand the interplate coupling more precisely, especially for near the trench. As the preliminary research, we estimate interplate coupling ratio and its distribution around this region from onshore GNSS data (GEONET), and confirm the constrain limit of the result for sea area. We construct simple backslip model(Sanvage, 1983) in an elastic half-space(Okada, 1992), we calculated several synthetic profiles of the displacement rate due to the plate coupling assuming various coupling ratios and various ranges of the coupling zone, and we explored an optimal condition to explain the profile of the observed displacement rates. As a result, using the horizontal component data, coupling ratio, depth of the up-dip limit and of the down-dip limit of the coupling zone was calculated to be 1.0–1.1, 0–5 km and 50–55 km, respectively. In this result, coupling ratio was over 1.0. The reason of this high coupling ratio is probably caused by small plate convergence velocity (8.4 cm/yr)(Altami et al., 2016) we assumed in this study, and/or ignorance of viscoelastic effect in the asthenosphere. The estimated coupling zone is deeper than that of the previous studies(e.g., Hashimoto et al., 2009). This might be caused by our simple assumption of a uniform dip-angle of the plate interface fixed to 15 degrees. As for the actual geometry of the plate interface, the dip angle is increased with depth; thus, we should consider it for the next modeling. As previous studies(e.g., Hashimoto et al., 2009) suggested, it is difficult to constraint the interplate coupling condition of shallow part around the trench only from onshore geodetic data. Meanwhile, in order to find the appropriate GNSS-A installation areas, we explored locations sensitive to the fault parameters for the shallow coupling by comparing the above synthetic profiles of the placement rates. As a result,, we determined two points as candidates at 25 km and 40 km from the trench axis considering the detection limits of the observations, which correspond to the following the conditions: (1) a point demonstrating clear differences among the velocity profiles depending on special extent of the coupling area, and (2) a point demonstrating a large inclination of each profile. Since our estimation is simple due to the ignorance of the underground rheological structure and of the distilled plate geometry, it is necessary to update the modeling results by considering the above matters and other additional geophysical information, such as seismic activities in this region.

Keywords: Earthquake, Crustal deformation, Interplate coupling

