Spatiotemporal distributions of interplate coupling for 15 years prior to the 2011 Tohoku-Oki earthquake inverted from GNSS data

*Daiki Abe[1], Shoichi Yoshioka[2]

1. Department of Planetology, Graduate School of Science, Kobe University, 2. Research Center for Urban Safety and Security Kobe University

Tectonic horizontal and vertical crustal deformations due to plate motion were obtained, using data observed at the GEONET stations in the Tohoku district, and the spatiotemporal interplate coupling between the Pacific and the North American plates were estimated by an inversion analysis. In this study, plate motion of the Amurian plate with respect to the North American plate was taken into account, using the reference station Fukue in Nagasaki prefecture. The analyzed period was 15 years just prior to the 2011 Tohoku-Oki earthquake (Mw 9.0). In this study, the high accurate tectonic crustal deformations were estimated, using Chebyshev polynomials, and the optimal order of the polynomial was determined so as to minimize the value of AIC. After removing steps caused by antenna exchange and coseismic steps associated with large earthquakes, we removed the effects of postseismic horizontal deformations associated with large earthquakes, by approximating them using a logarithmic function. Furthermore, tectonic crustal deformations were estimated, by removing annual and semi-annual components, and common-mode errors obtained from the time series data of all the observation stations. Dividing thus obtained time series into every one year, spatiotemporal changes of tectonic crustal deformations were investigated in detail. As a result, westward horizontal displacement of 2 cm/yr was identified at the stations on the Pacific side of Iwate and Miyagi prefectures throughout the analyzed period. Until the year of 2003, northward component of about 0.5 cm/yr was observed, which disappeared after the year of 2004. The vertical displacements tended to subside on the Pacific side and uplift on the Sea of Japan side. In addition, we found that the westward horizontal displacements were larger at all stations between January, 2008 and December, 2010. Inversion analysis was performed at a time step of one year based on thus obtained tectonic crustal deformations, and spatiotemporal distribution of interplate coupling and aseismic slips off Tohoku was estimated. Geometry model of Nakajima and Hasegawa (2006) was used for the upper surface of the Pacific plate. Our inversion analysis is based on the inversion method that gives three a priori information that 1) spatial distribution of slips is smooth to some extent, 2) slips are mainly directed to the plate convergence direction, and 3) temporal change of slips is smooth to some extent (Yoshioka et al., 2015). The values of the three optimal hyperparameters were determined uniquely and objectively based on ABIC minimization principle (Akaike, 1980). As a result, we found that interplate coupling was dominant throughout the analyzed period; Interplate coupling of about 8 cm/yr was identified in the surrounding area of the hypocenter. We also confirmed that interplate coupling increased at a rate of about 3 cm/yr on the land side of the hypocenter during the period from 2009 to 2010.

Keywords: GNSS, interplate coupling

