# Interplate coupling distribution along the Nankai trough in southwest Japan estimated by the block motion model on the basis of onshore and seafloor geodetic observation data

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In southwest Japan, the Philippine Sea Plate (PHS) is subducting under the overriding plate such as Amurian Plate (AM), and mega interplate earthquake has occurred at about 100 years interval. There is no occurrence of mega interplate earthquakes in southwest Japan, although it has passed about 70 years since the last mega interplate earthquake, 1944 and 1946 along the Nankai trough, meaning that the strain has been accumulated at plate interface. It is essential to reveal the interplate coupling more precisely for predicting or understanding the mechanism of mega interplate earthquakes which is possible to occur in the future. Some previous studies have estimated the interplate coupling distribution in southwest Japan, such as, based on the seafloor geodetic observation using GNSS acoustic (GNSS/A) combination technique (Yokota et al., 2016), or by considering the block motion model based on onshore GNSS observation data (Loveless and Meade, 2010). However, these studies have several problems to be solved. In this study, we estimate the interplate coupling distribution along the Nankai Trough, by using the seafloor geodetic observation data as well as onshore GNSS observation data, applying the block motion model, and optimizing the estimation error of coupling.

In the block motion model, observed crustal deformation $\boldsymbol{d}_k^{Obs}$ is assumed that the sum of rigid block motion $\boldsymbol{v}_{ik}^{Rigid}$ and elastic deformation due to coupling at block boundaries $\boldsymbol{v}_{ijk}^{Elastic}$ as follows:

$$\boldsymbol{d}_k^{Obs}=\boldsymbol{v}_{ik}^{Rigid}+\boldsymbol{v}_{ijk}^{Elastic}=\boldsymbol{\omega}_i\times\boldsymbol{r}_k+G_{kl}C_l(\boldsymbol{\omega}_i-\boldsymbol{\omega}_j)\times\boldsymbol{r}_l$$

($\boldsymbol{\omega}$, Euler pole; $\boldsymbol{r}$, position; $G$, Green function of elastic half-space; $C$, Coupling ratio (0-1); $i, j, k$, site; $l$, subfault).

This is a non-linear equation; thus, we estimate the probability density function (PDF) of $\boldsymbol{\omega}$ and $C$ simultaneously to minimize the sum of squared residuals between observed and calculated crustal deformation vectors, using the Markov Chain Monte Carlo (MCMC) method. The estimation error is optimized to be homogeneously in space, using the method of Kimura et al. (2016, 126th meeting of the Geodetic Society of Japan). The input data are onshore GNSS (GEONET, 2006-2009; ZENISU, 2005-2010) and seafloor GNSS/A observation conducted by Nagoya University and Japan Coast Guard (2004-2016); the total number of data is 887. The tectonic models are made based on the active fault trace and spatial epicenter distribution. We select the best tectonic model, which consists of 12 blocks, based on the Akaike's Information Criterion.

We show the estimated coupling distribution and some examples of PDF of coupling ratio obtained by MCMC in the Figure. Variances of PDFs are nearly equal in all the subfaults, meaning that the coupling is estimated with homogeneously in space for almost all the subfaults by optimization of estimation error. We find that the spatial distribution of interplate coupling along the Nankai Trough is heterogeneous along the strike of the trough axis, although plate interface shallower than 25 km is strongly coupled overall. This spatial heterogeneity of shallow interplate coupling is an important feature obtained by using the seafloor GNSS/A observation data.

 

Although Yokota et al. (2016) has estimated the strong coupling on the plate interface deeper than 40 km, we estimate that the down-dip limit of strong coupling is about 30 km in depth, by applying the block motion model. Our estimation coincides with the down-dip limit of locking area estimated from the thermal and deformation model (e.g., Hyndman et al., 1995).

Keywords: Interplate coupling, Onshore and seafloor geodetic observation data, Block motion model, Optimization of estimation error

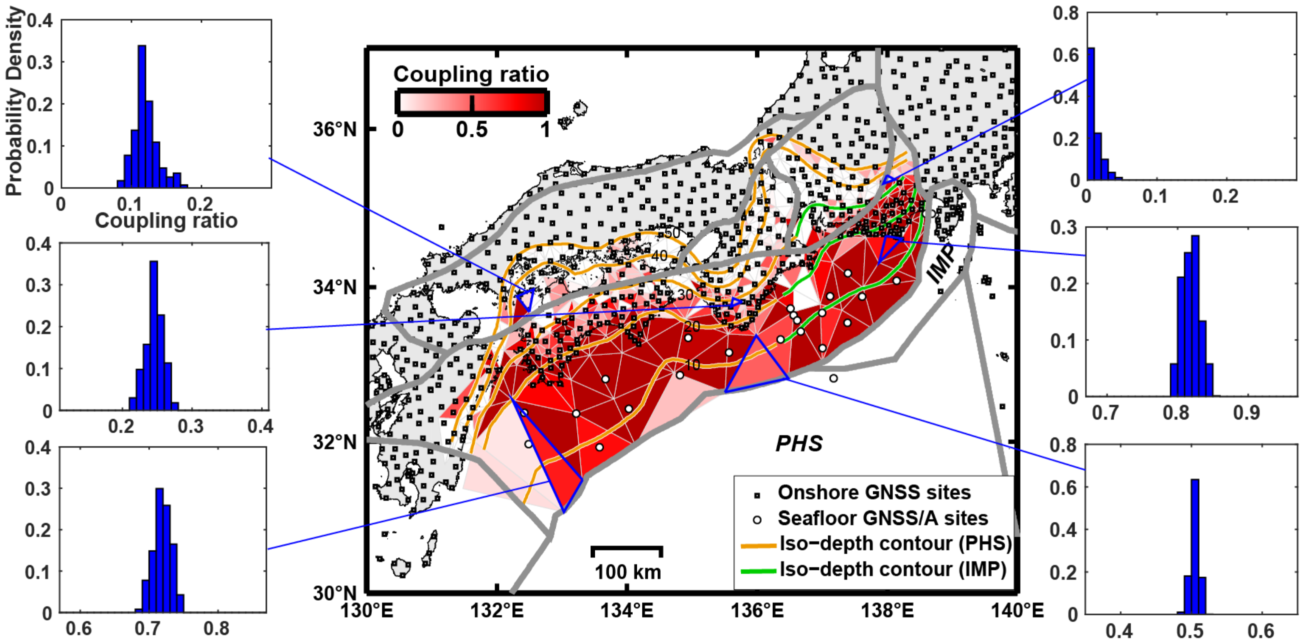


Figure. Spatial distribution of estimated coupling ratio along the Nankai Trough and example of PDF sampled by MCMC of some subfaults.

 