

Spatio-temporal distribution of interplate coupling in southwest Japan

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1. Introduction

It is well known that great interplate earthquakes have occurred repeatedly along the Nankai trough, with recurrence intervals of about 90 to 150 years. From the viewpoint of short-term forecasts of great earthquakes, it is the most important to catch the formation process of the earthquake nucleus in real time. However, for long-term forecasts of great earthquakes, clarifying the accumulation process is more important. In order to clarify the accumulation process of tectonic stress, one strategy is to perform an inversion analysis using the available crustal deformation field. In this study, we try to obtain the spatio-temporal distribution of the strength of interplate coupling from geodetic data such as levelings, triangulations and trilaterations, and GPS surveys during recent 100 years in SW Japan.

2. Method of Analysis

The crustal deformation data contain useful information about the spatio-temporal distribution of slip on the plate interface. To extract hidden information from the data effectively, we develop a new inversion method to reconstruct the spatio-temporal slip distribution from surface displacement data. In our inversion method, the spatio-temporal slip rate distribution is expressed by the superposition of basis functions (B-spline functions of one degree in time domain and bi-cubic B-spline functions in space). Therefore, we can deduce the amount of slip rate, its direction and its temporal change by determining the coefficients of each basis function. We used the dislocation theory in viscoelastic body to calculate displacement rates at each observation points from slip rates on the plate interface. We also have prior information about the smoothness of spatio-temporal distribution of slip rates. We construct a highly flexible model that is controlled by hyperparameters. To determine the most optimal hyperparameters, we used ABIC. Therefore, we can uniquely determine the spatio-temporal distribution of slip rates.

3. Result

By using the new inversion method we analyzed surface displacement data (leveling, triangulation and trilateration surveys and GPS for about 100 years in southwest Japan), and obtained to spatio-temporal slip distribution on the plate interface. The inverted spatio-temporal distribution of slip rates has some features.

(1) There are afterslips in the deeper part following the 1946 Nankaido earthquake at postseismic stage (about 30 years after earthquake). The location of maximum afterslip is beneath central Shikoku, and the total afterslip is about 1.0m.

(2) The slip deficit distribution at interseismic stage (from 40 year to 70 year after earthquake) is 5-6 cm/year in the N45W-N70W direction, which is almost consistent with the relative plate motion between the Philippine Sea and the Amurian plates. The strongly coupled region is shallower than the depth of about 30 km, and the slip deficit rate takes its maximum at the depth of about 20 km. The interplate coupling is very weak on the plate interface deeper than about 30 km.

(3) If we assume recurrence time of interplate earthquake to 92 years, the predicted amount of slip distribution at coseismic may reach about 6m off Shikoku and about 3m off Kii peninsula. It suggests rapid fault healing and full interplate coupling.