Prototype of Green’s function library for geodetic slip inversion based on an integrated velocity structure model of Japan

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Displacements and displacement rates on the earth’s surface obtained by means of geodetic observations such as Global Navigation Satellite System (GNSS), GNSS-Acoustic ranging technique, and ocean bottom pressure measurement help us understand how co-, post- and inter-seismic slip and/or slip deficit occur through inversion analyses. Recent researches revealed that it is important to incorporate heterogeneity of the elastic material properties and topography in such slip estimations, as geodetic stations used in the estimation are spatially widespread nowadays (e.g. Ichimura et al. 2013, Kyriakopoulos et al. 2013). In spite of these findings, the homogeneous half-space model (e.g., Okada 1992) is still usually applied to model the crustal deformation associated with the earthquakes in both academic studies and the national working groups of hazard estimations, because in part of the slightly complex procedures to introduce the features in the modeling. Furthermore, choice of the model settings associated with using the half-space model, such as plate geometry, consistency of the plate and the trench axis, and the coordinate projection method possibly degrades both transparency and efficiency of the studies. In this study, we propose a Green’s function library based on an integrated velocity structure model to account for these problems. In our framework, we convert the digital elevation model (DEM) data of the Japan Integrated Velocity Structure Model (Koketsu et al. 2008), which is currently one of the best-compiled velocity structure models in Japan, into a Cartesian coordinate system based on the reference ellipsoid of Geodetic Reference System 1980 (GRS80). In the Cartesian coordinate, we construct a finite element (FE) mesh of high fidelity to the converted DEM data using a structured-grid-based unstructured tetrahedral mesher (Ichimura et al. 2016). Based on the constructed FE mesh, Green’s functions for geodetic slip inversion are calculated using fast and scalable FE solver (Ichimura et al. 2014, 2016). Our final goal is to develop a Green’s function library of three focal regions of the subduction zones in Japan, namely, the Tohoku, Boso, and Nankai regions following the above manner. This hopefully will enable many studies to consider heterogeneous elastic material properties and topography in their geodetic inversion without being involved in complex modeling procedures, while maintaining transparency of the studies. We have calculated Green’s functions in the Tohoku region and applied to geodetic inversion of the 2011 Tohoku-Oki Earthquake (Iinuma et al., this meeting). The details of the framework and the prototype of the library will be presented in the poster.

Keywords: Geodetic slip inversion, Crustal deformation, Green's function, Finite element method

