Elastic Green’s function library based on subduction zone models of high fidelity using the finite element method

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Green’s functions (GFs) for elastic deformation due to unit slip on the fault plane is an essential tool to estimate earthquake rupture processes and their preparation processes underground. Because these estimation results are often applied to creating socially important information such assessments of seismic and tsunami hazards, the dependence of these estimation results on the numerical models used for calculating GFs should be minimized to maintain the reproducibility of the estimations, which is essential to the reliability of the assessment. One solution is that the same GFs, which are calculated using numerical simulation models with high fidelity to a database of underground structures and the definitions of the coordinate systems to which many people agree, are used in various studies of estimating the underground processes. Here, we calculated an elastic Green’s function library based on subduction zone models of high fidelity using the finite element (FE) method, which is open to the public on a web server. We targeted two well-known subduction zones in Japan, the Nankai Trough and the Japan Trench subduction zones. The library was calculated based on the 3D heterogeneous elastic property of “Japan integrated velocity structure model version 1”, proposed for earthquake hazard assessments conducted by the Japanese government. In the FE meshes used for the calculation, the resolution of the layer boundaries in the underground structure is the same as that of the original database. The ellipsoidal shape of the earth, which is often approximated with a projected plane or a spherical shape, was also incorporated by faithfully following the definitions of the coordinate systems in Geodetic Reference System 1980 adopted by the International Union of Geodesy and Geophysics and the Japanese Geodetic Datum 2000. We expect the use of this library in estimating underground processes regarding earthquakes helps to minimize the variability of the estimation results depending on the settings of the numerical simulation model to calculate GFs, which should eventually contribute to the increase the reliability of seismic and tsunami hazard assessments. Furthermore, the library should also help researchers introduce a more realistic earth model in their analyses without laborious numerical model construction, numerical simulations and data processing.

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