東北沖の陸海統合３次元構造モデルに基づくアジョイントカーネルの計算と波形インバージョンによる構造モデル改良の考察

Preliminary study of the waveform inversion of the structure model using the adjoint kernels computed based on a land-ocean unified 3D structure model at Tohoku-Oki, Japan

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At the subduction zones, the heterogeneous structure strongly affects the propagation of the seismic waves. Such structural effect can cause significant distortions in the waveforms and biases in the estimation of the earthquake source parameters, including the earthquake locations. Thus it is important to construct precise three-dimensional (3D) structure models with which we are able to reproduce the seismic waveforms from the subduction zone earthquakes. In this paper, we study the sensitivity kernels to improve the parameters of the structure model at the Tohoku-oki area of the Japan trench. We generate the sensitivity kernels based on the method presented by Tanimoto and Okamoto (2014). The forward and adjoint wavefields are computed based on a land-ocean unified 3D structure model (Okamoto et al. submitted). Thus the “starting model” of the inversion is a 3D model, not a standard, one-dimensional model. The numerical simulations are performed using the scheme of HOT-FDM (Nakamura 2012) with multi-GPU acceleration (Okamoto et al. 2013) on the TSUBAME supercomputer at Tokyo Institute of Technology. As a preliminary analysis, we selected a single component from a station (TYS from F-net of NIED) for a shallow interplate earthquake on 2003/11/1 (Mw5.8). In order to reduce the biases in the earthquake parameters used in generating the synthetic waveforms, they are estimated by FAMT method (Okamoto et al. 2017) based on the 3D model. We construct the sensitivity kernels of rigidity for frequency components from 0.024 to 0.53 Hz (210 components in total). The size of the target region is 300 km x 350 km in horizontal and 15 km in vertical, and the region is divided into sub-blocks of 50 km x 50 km x 5 km. Then we invert the residuals between the observed and synthetic spectral components (Fourier coefficients) for the rigidity perturbations of the blocks. This preliminary result shows perturbations with amplitudes of about 1 to a few percent at each of the layers. We will presents further inversion analysis and discuss the improvements in the spectral components and waveforms. (We are grateful to NIED for providing the waveform data. This research is partially supported by KAKENHI (16K05535), HPCI System Research Project (Project ID: hp130118) and JHPCN (Project ID: jh170022-NAJ).)

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