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3 次元強震動・2.5 次元遠地理論波形により地震波波形データから推定される東北地方太平洋沖地震の破壊過程

Seismically inferred rupture process of the 2011 Tohoku-Oki earthquake by using 3D and 2.5D Green's tensor waveforms

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The March 11, 2011 Tohoku-Oki earthquake (GCMT Mw9.1) generated strong ground motions and large tsunamis, and caused devastating damages in the northeastern Japan. The rupture process of this event provides important clues for understanding the geophysical condition of the generation of mega-thrust earthquakes and the mechanism of the excitation of the large tsunamis.

We analyze "seismic" rupture process of this event by using a non-linear full-waveform inversion method. We incorporate the effect of the near-source laterally heterogeneous structure on the synthetic Green's tensor waveforms because the analysis can result in erroneous solutions if the effect is not considered [1]. Also, in order to increase the resolution we use the teleseismic and the strong-motion seismograms jointly: the distribution of strong-motion station is one-sided and analysis with only the strong-motion records may result in reduced resolution near the trench axis [2]. For the teleseismic P-wave synthetics we use a 2.5-dimensional finite-difference method [3]. For the strong-motion synthetics we use a full three-dimensional finite-difference method that incorporates topography, oceanic water layer, three-dimensional heterogeneity and attenuation. Our simulation is accelerated by GPUs used in parallel [4]: we use the TSUBAME GPU supercomputer in Tokyo Institute of Technology.

In the previous study [5] we used only a single structure model (i.e., a single vertical slice of the 3D heterogeneous structure) to generate all the 2.5D Green's functions. In this paper we have updated the 2.5D structure models. That is, we extracted twenty-three vertical slices from the 3D structure model: each slice was (nearly) perpendicular to the trench axis and was taken along the nodes of the grid that formed the fault plane. By using these new models the 2.5D Green's functions and 3D Green's functions are now "consistent" with each other.

We computed Green's tensor synthetic waveforms for 31 teleseismic and 32 strong-motion components. We used 640 GPUs of the TSUBAME supercomputer for the calculation of each strong-motion synthetics. The inferred slip distribution has large slips near the JMA epicenter with the maximum slip of about 32 m. The amount of slips at the areas close to the trench axis is smaller than that of the land-ward area (i.e., near the JMA epicenter). Inversion results similar to these features have been obtained by previous study [2] but it is remarkable that our joint "seismic" inversion using 2.5D-teleseismic and 3D-strong-motion Green's tensor waveforms resulted in the solution with these features (i.e., land-ward large slips and trench-ward small slips). These features have important implications for tsunami studies because large slips near the trench axis are expected for large tsunamis. In order to verify the solution we will inspect the resolution by using simulations of inversion and the effect of the choice of the Green's tensor waveforms on the solutions.

[1] Okamoto and Takenaka, Earth Planets Space, 61, e17-e20, 2009.
[2] Yokota et al., Geophys. Res. Lett., 38, doi:10.1029/2011GL050098, 2011.
[3] Takenaka and Okamoto, in Seismic Waves, Research and Analysis, ed. K. Masaki, Intech, 2012.
[4] Okamoto et al, in GPU Solutions to Multi-scale Problems in Science and Engineering, ed. D.A. Yuen et al., Chapter 24, 375-389, Springer, 2013.
[5] Okamoto et al., Seismological Society of Japan, 2013 Fall Meeting, P1-62, Yokohama, Japan, October 7, 2013.

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