Toward short-period (< 10 s) full waveform tomography in and around the 2011 Tohoku-Oki source area using land-ocean unified 3D initial model

*Taro Okamoto[1], Hiroshi Takenaka[2], Takeshi Nakamura[3]

1. Department of Earth and Planetary Sciences, Tokyo Institute of Technology, 2. Graduate School of Natural Science and Technology, Okayama University, 3. Earthquake Engineering Sector, Civil Engineering Research Laboratory, Central Research Institute of Electric Power Industry

We need accurate 3D structure model to study the correlation between the physical properties of the materials and the seismicity as well as the rupture processes of earthquakes. Currently available 3D structure model in and around the 2011 Tohoku-Oki source area is not sufficient in terms of the accuracy of the synthetic waveforms generated based on the model: we found that short period (< 10 s) synthetics for land stations in northeastern Japan do not reproduce the characteristics in the observed full waveforms from shallow earthquakes occurred there (Okamoto et al. *Earth Planets Space (EPS)* 2018). This research suggests the short wavelength features in the current model are not sufficient. Thus we attempt to improve the 3D model using the waveform tomography. We select shallow earthquakes (Mw˜6) in and around the source area. In this study, we re-analyze six events that we have previously reported (SSJ Fall Meeting 2019) and newly add five more shallow events. The observed full waveforms recorded by land seismic network (F-net, KiK-net) in northeastern Japan are used. A land-ocean unified 3D structure model including oceanic water layer is used as the initial model. First, we re-determine the source parameters (the moment tensor, source time function, source location, and origin time) based on the initial model using First-motion Augmented Moment Tensor analysis method (Okamoto et al. *EPS* 2017, 2018) to minimize the biases due to one-sided (i.e., only on land) station distribution. Then we simulate the forward (using the earthquake source) and the adjoint (using a single force at the station location) wave propagations based on the initial model. The simulations are performed on TSUBAME super computer of GSIC, Tokyo Institute of Technology using a multi-GPU version (Okamoto et al. in *GPU Solutions to Multi-scale Problems in Science and Engineering* 2013) of HOT-FDM (Nakamura et al. *BSSA* 2012). The simulated waveforms are Fourier transformed and multiplied to generate waveform sensitivity kernels of relaxed modulus for P- and S-waves, density, Qp and Qs in frequency domain. For example, the kernels for a pair of a F-net station (TYS) and an outer-rise event (2017/10/06 Mw 6.2) show an asymmetric pattern with respect to the straight path even at a period of 9.8 s. At a period of 7.1 s, large amplitude pattern is observed along the oceanic trench, suggesting scatterings due to strong heterogeneity there. We will discuss the kernel features in other examples, and the results of the attempts of tomographic inversion.

Acknowledgements: The authors are grateful to Japan Meteorological Agency, National Research Institute for Earth Science and Disaster Resilience (NIED), and Global Centroid-Moment-Tensor (CMT) Project for providing the earthquake parameters, to K Kisimoto for providing the topography models, to Headquarters for Earthquake Research Promotion and NIED for providing the structure models, and to NIED for providing the waveform records of KiK-net, and F-net. This study is supported by the Japan Society for the Promotion of Science (KAKENHI grant no.16K05535 and 20K04101), and Joint Usage/Research Center for Interdisciplinary Large-scale Information Infrastructures in Japan (JHPCN) (Project ID: jh200059-NAH).