大規模シミュレーションとアジョイントカーネルに基づく沈み込み帯での地震波伝播の考察

Property of the seismic-wave propagation in subduction zone studied by large-scale simulation and adjoint kernels

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At the subduction zones, such as the Japan trench, the Nankai trough and the Ryukyu Islands, the propagation of the seismic-waves are affected by the strong lateral heterogeneities [1]. Such effects must be considered in generating the synthetic waveforms for the analyses of earthquake sources and structural heterogeneities. In the previous presentation [2], by using a 3D structure model for the northeastern Japan (including Japan trench) and by using finite-difference simulations, we showed that the observed surface-waves with a period band of 12-40 s were well reproduced by the synthetics while for periods shorter than around 10 s the misfit between the observed and synthetic waveforms were large. In order to improve the structure model for the short-period waves we need to understand the properties of the wave propagation through the heterogeneous media. Thus, in this paper, as a continuation of the project [2], we study the property of the wave propagation in term of the adjoint kernels [3-6] which represent how the waves sample the different part of the structure. As an example, we use the same 3D structure model (Japan trench) and the same shallow suboceanic earthquake whose epicenter is only about 50 km landward from the trench (2003/11/1, Mw5.8) as those of [2]. We apply a GPU-accelerated finite-difference program developed by ourselves [7,8] and use the TSUBAME-2.5 supercomputer in Tokyo Institute of Technology. As in [6] the adjoint kernels are computed by using two wave-fields: one propagates from the source point and the other from the station point. We selected a KiK-net station, Yamada (IWTH21 in Iwate) as the preliminary example. The horizontal slice of the resultant rigidity kernel at near the source depth (11 km) and at period of 12.80 s shows nearly symmetric pattern with respect to the straight line (i.e., great circle path) connecting the source and the receiver positions projected onto the plane of the slice. Thus, for this period, the distortion of the wave propagation path is weak: the required perturbations in material parameters would be applied mainly to those along and near the great circle path to improve the structure. The rigidity kernel at period of 7.31 s, however, shows distorted pattern that represents complicated wave propagation such as bending and scattering. This result indicates that perturbations just along the great circle path would not be enough to improve the structure for short period waves. We will consider more kernels computed for the Japan trench and the Ryukyu Islands. This project is partially supported by HPCI System Research Project (hp130118), JHPCN (15-NA12) and KAKENHI (26282105).

References: [1] Nakamura, T. et al. *Scientific Reports*, doi: 10.1038/srep16648, 2015. [2] Okamoto, T. et al. *JPGU Meeting*, SSS25-P02, 2015. [3] Tarantola, A. *Geophysics*, 49, 1259-1266, 1984. [4] Tanimoto, T. *Geophys. J. Int.*, 102, 89-100, 1990. [5] Tromp, J. et al. *Geophys. J. Int.*, 160, 195-216, 2005. [6] Tanimoto, T. and Okamoto, T. *Geophys. J. Int.*, 198, 1081-1095, 2014. [7] Okamoto, T. et al., *Earth Planets Space*, 62, 939-942, 2010. [8] Okamoto, T. et al., *GPU Solutions* *to Multi-scale Problems in Science and Engineering*, 375-389, Springer-Verlag, 2013.

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