Numerical Shake Prediction incorporating heterogeneous structure: a case for the 2016 Kumamoto Earthquake

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Generally, ground motion prediction depends on three factors: source characteristics, path effects and site amplification. In the new concept of real time ground motion prediction scheme, called “Numerical Shake Prediction” proposed by Hoshiba and Aoki (2015), these three components are taken into consideration as follows: (a) Site amplification can be corrected using time domain filters (e.g. Ogiso et al., 2016). (b) Effects of source and path term are included in observed waveforms. Observed waveforms are used to estimate initial wavefield for prediction using data assimilation technique.
Incorporating heterogeneous structure in the real time ground motion prediction such as earthquake early warning should be one of the key issues to improve the precision of ground motion prediction. Homogeneous structure is used for the prediction of future wavefield in the current numerical shake prediction scheme. In this study, we took the heterogeneous structure into consideration in the prediction scheme so as to evaluate the effects of heterogeneous structure for the real time ground motion prediction.
First, we estimated heterogeneous intrinsic and scattering attenuation structure in the western part of Japan using Multiple Lapse Time Window Analysis (MLTWA: Hoshiba, 1993; Carcole and Sato, 2010). Derived structure shows strong intrinsic and scattering attenuation around active faults and volcanoes in the Kyushu area.
Then, we conducted ground motion prediction simulation based on the numerical shake prediction scheme with the heterogeneous structure estimated before. The target earthquake was the largest one of the 2016 Kumamoto earthquake sequence. In the case of 10 s ahead prediction, root-mean-square of seismic intensity prediction residuals became lower by 15 % in the case of heterogeneous structure than the case of homogeneous structure. The rate of improvement became higher in the case of longer lead time prediction.
Although there is still room for improvement in estimating structure, intrinsic and scattering attenuation structure derived by the MLTWA is useful for real time ground motion prediction as well as the discussion of tectonics of the region.

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