Investigation to estimate high-frequency Empirical Green’s tensor derivatives (EGTD) using aftershocks for the 2016 Kumamoto earthquake

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1) Introduction
Green’s tensor derivatives play a key role for evaluation and prediction of strong ground motions and for surveys of the velocity and damping structures. However, it is difficult to generate high-frequency (above 1Hz) Green’s tensor derivatives using numerical approaches for want of fine geological structure models. Plicka and Zahradnik (1998) proposed a method for estimation of Empirical Green’s tensor derivatives (EGTDs) using multiple small earthquakes. EGTDs does not require the structural model along propagation paths for their estimation and is possible to calculate high-frequency ground motions for any focal mechanism. In this study, we investigate the conditions required (focal mechanism, grouping radius, applicable frequency) to obtain high-frequency EGTDs, using aftershocks of the 2016 Kumamoto earthquake.
2) Data and method
The size of the aftershocks ranges between the magnitudes 2 and 4. The focal mechanism, such as the strike, the dip angle, and the rake angle, and the source parameters of radiated spectra, such as the seismic moment and the corner frequency, are required for the estimation of EGTDs. The focal mechanism was obtained from the sign of P-wave first motions and the source parameters were obtained from the Fourier spectra of S-wave motions, assuming the model.
We first set the grouped aftershocks located within a sphere with a certain radius. Then, we estimated 3 EGTDs for 3-component ground motions from the grouped aftershocks by the approach developed by Plicka and Zahradnik (1998). Finally, we evaluated the accuracy of the estimated EGTDs by the correlation coefficients between observed seismic recordings of the grouped aftershocks and those calculated using the estimated EGTD for the 3- component ground motions. We furthermore evaluate the accuracy of EGTDs by investigating whether they can reproduce seismic waveforms of the aftershocks which are not contained in the group.
3) Results
Accurate EGTDs up to 2 Hz can be stably estimated from most groups with the radius of 1km, having the correlation coefficients over 0.8. Also, these EGTDs can reproduce the seismic motions of the aftershock that is not contained in the group. In the meantime, the correlation coefficients calculated from the estimated EGTDs up to 4Hz are not always not high values over 0.8 even for the groups with the radius 0.5 km. These results suggest that estimation of EGTDs up to the frequency higher than 2Hz requires accurate focal mechanism and source parameters of the radiated spectra. Thus, we will improve them, for example, using the Genetic algorithm.
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Keywords: Empirical Green’s tensor, 2016 Kumamoto earthquake, high-frequency

