Effects of heterogeneous structures on source parameter estimations of small offshore earthquakes and shallow low frequency tremors

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Developments of offshore seismic networks allow us to investigate small earthquakes or slow earthquakes occurred on offshore regions (e.g., Nakano et al., 2015, 2018; Nishikawa et al., 2019; Tanaka et al., 2019; Yabe et al., 2019). In almost of previous studies, conventional methods using 1D velocity models were used. Due to 3D offshore heterogeneities, 1D methods could cause incorrect estimations of earthquake source parameters, such as duration and radiated energy. In this study, by using numerical simulations of seismic wave propagation, we evaluate the effects of offshore heterogeneities, such as oceanic sediments, seawater, and small-scale velocity heterogeneity, on source parameter estimations.

We synthesized velocity seismograms at DONET ocean bottom seismometers via numerical simulation code of OpenSWPC (Maeda et al., 2017) using the realistic velocity structure model. The simulation model covered the region southeast off the Kii Peninsula, which was discretized by a uniform grid of 0.015 km. The 3D model below bedrock depths was the JIVSM (Koketsu et al. 2012). The 3D model of the accretionary prism was constructed by interpolating and extrapolating 1D local *S*-wave velocity structures beneath DONET stations estimated by Tonegawa et al. (2017). The source model of shallow low-frequency tremor (LFT) was a double-couple component of the shallow very low-frequency earthquake (Takemura et al., 2019) with a 0.2-s triangle function. According to the minimum *S*-wave velocity (0.5 km/s) and grid interval, our simulation can evaluate seismic wave propagation for frequencies less than 5 Hz.

Simulated RMS envelopes for frequencies of 1-5 Hz at stations with epicentral distances greater than approximately 10 km show long-duration (> 10 s) *S* waves. This elongation is mainly caused by the low-velocity accretionary prism, where seismic energy is effectively trapped. The duration of *S* waves increased with increasing distance. The half duration of RMS envelopes is generally considered as event duration for small events (e.g., Yabe et al., 2019). Thus, if half durations of envelopes were used in duration estimation for shallow LFTs, results would be overestimated. To achieve precise source parameter estimations, the method incorporating effects of 3D heterogeneities or sophisticated station selection should be required.

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