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Long-period ground-motion observations and simulations in the Nankai Trough, southwest Japan

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We deployed a dense-array seafloor seismic observatory in the source area of great subduction earthquakes in southwest Japan in 2010. We observed the development of long-period motions in the seafloor strong-motion data at a moderate inland event (Mw 5.8) occurred in April 2013. The observed seismic waveforms are significantly prolonged and amplified, which does not agree with an empirical relation of amplifications for epicentral distances. We reproduce these features of waveforms at the seafloor stations in the period range of 10-20 s with FDM simulations and demonstrate the significant effects of seawater and sediment structures in ocean area on seismic wavefields. The long-period motions are predominantly caused by the propagation of surface waves developed within sediment layers in the subduction area. For the motions of the vertical component, the presence of a seawater layer also contributes to the developments. The snapshots in the cross section in depth show more trapped seismic energies and slower seismic-wave propagation in the subduction area than those in the land area, which produces the amplified and prolonged long-period motions at the seafloor stations. The snapshots in the horizontal plane show the distortion of concentric wave trains propagating from the source, indicating significant lateral variations of seismic velocity structures between land and ocean areas. The long-period range we analyzed is very important for magnitude estimations and moment tensor and finite-source analyses at great subduction earthquakes. Our observation and simulation results highlight the importance of ocean-specific structures for the seismic wave propagation and would contribute to advancing the seismic source studies and the strong-motion prediction by using seafloor station data.

Keywords: Long-period ground motion, strong motion, Nankai Trough, seafloor observation, DONET