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Seismic wave simulation for terrestrial and submarine landslide sources in and around the Kii peninsula, southwest Japan

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We deployed permanent seafloor stations in water depths of 1,900-4,400 m near the Nankai trough of southwest Japan in 2010. We observed seismic signals in the broadband seismometer of the seafloor station at a terrestrial landslide event caused by a typhoon passing over the Kii peninsula on September 4, 2011 (Nakamura et al., 2014). We simulated seismic waveforms for the event with the finite-difference method by using a three-dimensional structure model in and around the Nankai trough. From our simulations, we reproduced the features of the observed waveforms in terms of the arrival times of the main phases and the waveform as a whole.

We also simulated seismic waveforms at the seafloor stations for a submarine landslide event assuming the epicenter to be located in the middle of the large slump between the source area of the Tonankai and Nankai earthquakes. We assumed the source time function with a duration time of more than 50 s referring to the analysis results of the 2011 terrestrial landslide event presented by Yamada et al. (2013). Our simulation results show the prominent propagation of Rayleigh waves in the vertical component because of the shallow source location of the submarine landslide near the seafloor and the effective development of the waves. We also find the significant variations of the Rayleigh wave propagation depending on the presence of a seawater layer. This is because the phase and group velocities and the dispersion of Rayleigh waves can be affected by the thickness of a seawater layer. In our simulation, the maximum amplitude of the vertical component for the structure model with a seawater layer is four times greater than that for the non-seawater case at the seafloor stations. Our results indicate that a seawater layer should be correctly incorporated into source analyses such as the size of the submarine landslide and the mechanism analysis when we use waveform data observed at seafloor stations.

Keywords: submarine landslide, wave propagation, seafloor observation, Tonankai area, DONET