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Numerical Modeling of Submarine Landslide Tsunami Assuming a Source on the Continental Slope in the Nankai Trough, Japan

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Tsunami is generated by not only an earthquake but also a submarine landslide. Submarine landslides generally do not radiate clear seismic signals, resulting in silent attacks of tsunami to the coast. Because the nature of submarine landslides and generation process of tsunami are not understood, risk assessments of the submarine landslide tsunami are still insufficient. In this study, we carried out numerical simulations of tsunami that is caused by a submarine landslide. The submarine landslide was modelled based on a detailed bathymetric map of the Nankai trough which shows clear evidences of submarine landslides. Four series of sliding cliffs with a width of 3 to 7 km on the continental slope at the water depth of about 700 m. Seafloor slope angles of the cliffs are about 6 degrees in the area. It was also found the collapse of the slopes had happened multiple times. The sliding volume in a single collapse was estimated 1.9 km^3 from the bathymetric features.

Mass movement in this tsunami simulations was estimated using a two-layered model that consists of sea water and turbidity currents (Imamura and Imteaz, 1995). The estimated mass movement was used as seafloor boundary conditions for tsunami generation. Because the submarine landslide-induced tsunami contained short wavelength components in comparison with tsunami from subduction zone earthquakes, the dispersive tsunami equations were adopted. However, sudden seafloor displacements due to the mass movement caused numerical instability in the dispersive tsunami simulation. For the short wavelength source of tsunami, a hydraulic filter needs to be adopted based on the theory of water waves (Kajiura, 1963). With the filter on the tsunami generation, the dispersive tsunami simulations provided reasonable solutions. Dispersive effects were clearly seen in the dispersive calculation (see the comparison between non-dispersive and dispersive calculations in Figure 1). The maximum tsunami height was estimated about 7 m along the coast from the dispersive calculations.

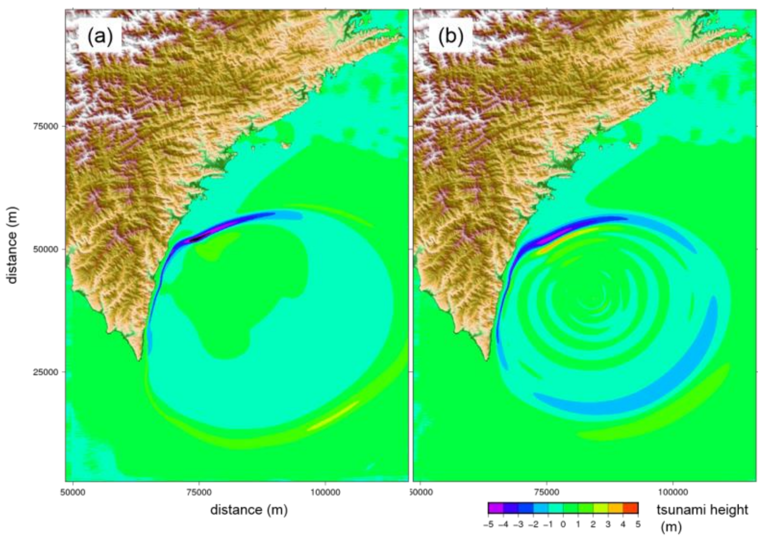

Figure 1. Sea-surface fluctuation at 300 seconds after initiation obtained by (a) non-dispersive and (b) dispersive tsunami simulations.