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Tsunami simulation with inequi-spaced grids, using Pearson approximation

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Tsunami is generated by a sudden deformation of the seafloor, such as uplift and subsidence, caused by fault motion of an earthquake below the seafloor. Tsunami propagation simulation is frequently used to predict the arrival time and the order of magnitude of the inundation for disaster mitigation purposes. In the generation process, acoustic waves, the coupling between solid and fluid through the seafloor, and the reflected waves caused by change in water depths are well known phenomena associated with the tsunami generation. In the simulation, it is necessary to simulate both the generation and propagation processes of tsunamis to estimate precisely these parameters. When the tsunami propagates, the change in water depths influences the tsunami height estimation. In this study, we try to simulate tsunami propagation to accommodate the change in water depth.In our simulation code, we assume water as a non-viscous fluid. A finite difference method (FDM) is employed using 3 equations; the equations of continuity, motion, and barotropy. We use the inequi-spaced grids with the Pearson approximation to accommodate the spatially varying water depth. In this study, we examine the validity of our numerical simulations using the other two different models, i.e. step-wise seafloor models of two different steps of depths to see both the travel time and the amplitudes of reflected tsunamis. The results demonstrate that the travel time of tsunamis satisfies what is expected from the linear long wave theory and that the amplitude of tsunamis is augmented as water depth becomes shallower. Finally, in case of step-wise seafloor models, artificial large amplitude of reflected tsunamis is observed in contrast to more piled energy generated for the model with naturally varying water depths. These results show that our numerical model can express the behavior of tsunami with a slope structure.

Keywords: tsunami, Pearson approximation, inequi-spaced grids, the change in water depth