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Validation and Comparison of 2D and 3D Codes for Nearshore Motion of Long Waves Using Benchmark Problems

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Tsunamis are huge waves with long wave periods and wave lengths that can cause great devastation and loss of life when they strike a coast. The interest in experimental and numerical modeling of tsunami propagation and inundation increased considerably after the 2011 Great East Japan earthquake. In this study, two numerical codes, FLOW 3D and NAMI DANCE, that analyze tsunami propagation and inundation patterns are considered. Flow 3D simulates linear and nonlinear propagating surface waves as well as long waves by solving three-dimensional Navier-Stokes (3D-NS) equations. NAMI DANCE uses finite difference computational method to solve 2D depth-averaged linear and nonlinear forms of shallow water equations (NSWE) in long wave problems, specifically tsunamis. In order to validate these two codes and analyze the differences between 3D-NS and 2D depth-averaged NSWE equations, two benchmark problems are applied. One benchmark problem investigates the runup of long waves over a complex 3D beach. The experimental setup is a 1:400 scale model of Monai Valley located on the west coast of Okushiri Island, Japan. Other benchmark problem is discussed in 2015 National Tsunami Hazard Mitigation Program (NTHMP) Annual meeting in Portland, USA. It is a field dataset, recording the Japan 2011 tsunami in Hilo Harbor, Hawaii. The computed water surface elevation and velocity data are compared with the measured data. The comparisons showed that both codes are in fairly good agreement with each other and benchmark data. The differences between 3D-NS and 2D depth-averaged NSWE equations are highlighted. All results are presented with discussions and comparisons.

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