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Initial waves from submarine landslides

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Modeling tsunamis generated by submarine mass failure is not as well understood as waves generated by seismic displacements. Co-seismic deformation occurs very rapidly even in comparison with the shallow-water wave speed, allowing for a specification of the displacement of the sea surface to be set as identical to the deformation of the ocean floor, as initial conditions for computer modeling. Submarine mass failure exhibits slower speeds and water gravitationally adjusts to a new potential field while the submarine mass is failing.

Empirical formulae and computer models exist to calculate the one or two-dimensional surface waveform generated by underwater mass movements. For different empirical formulae, estimates vary over orders of magnitude for the same slide. We present the scatter from ten different empirical formulations for the leading wave amplitude for 19 different underwater landslides. Some of these formulations are based on modeling, some on analytical solutions, and some are based on experimental data. The scatter highlights that it is important to use higher order approximations of the Navier-Stokes equations to reliably and robustly compute the interaction between water surface and the deforming mass. We carry out modeling with iSALE, a hydrocode that numerically solves the compressible Navier-Stokes equations in a multi- material and multi-rheology framework, and present preliminary results for the leading wave height with varying rheologies to account for different slide materials. It appears that multi-material modeling is important in for understanding the hydrodynamics of tsunamis generated by submarine mass failures under geophysically realistic conditions.