Geophysical Research Abstracts
Vol. 18, EGU2016-5890, 2016
EGU General Assembly 2016

Finite volume methods for submarine debris flows and generated waves

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Submarine landslides can impose great danger to the underwater structures and generate destructive tsunamis. Submarine debris flows often behave like visco-plastic materials, and the Herschel-Bulkley rheological model is known to be appropriate for describing the motion. In this work, we develop numerical schemes for the visco-plastic debris flows using finite volume methods in Eulerian coordinates with two horizontal dimensions. We provide parameter sensitivity analysis and demonstrate how common ad-hoc assumptions such as including a minimum shear layer depth influence the modeling of the landslide dynamics. Hydrodynamic resistance forces, hydroplaning, and remolding are all crucial terms for underwater landslides, and are hence added into the numerical formulation. The landslide deformation is coupled to the water column and simulated in the Clawpack framework. For the propagation of the tsunamis, the shallow water equations and the Boussinesq-type equations are employed to observe how important the wave dispersion is. Finally, two cases in central Norway, i.e. the subaerial quick clay landslide at Byneset in 2012, and the submerged tsunamigenic Statland landslide in 2014, are both presented for validation. The research leading to these results has received funding from the Research Council of Norway under grant number 231252 (Project TsunamiLand) and the European Union's Seventh Framework Programme (FP7/2007-2013) under grant agreement 603839 (Project ASTARTE).