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Test Problems for Coupled Earthquake-Tsunami Simulations

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For the project "Advanced Simulation of Coupled Earthquake and Tsunami Events" (ASCETE, funded by the Volkswagen Foundation), a simulation framework for coupled physics-based earthquake rupture generation with tsunami propagation and inundation has been developed. The rupture simulation is performed using an ADER discontinuous Galerkin discretization on an unstructured tetrahedral mesh. It is able to accurately represent complex geometries, is highly parallelized, and works efficiently in high-performance computing environments. An adaptive mesh discretizing the shallow water equations with a Runge-Kutta discontinuous Galerkin (RKDG) scheme subsequently allows for an accurate and efficient representation of the tsunami evolution and inundation at the coast.

We aim to validate and understand this new coupled framework between the dynamic earthquake within the earth's crust and the resulting tsunami wave within the ocean using a simplified model setup. The earthquake setup includes a planar, shallowly dipping subduction fault with linear depth-dependent initial stress and strength in a homogeneous elastic medium. Resulting sea floor displacements along an initially planar (and later realistic) bathymetry profile are transferred to the tsunami setup with an initially simple coastal run-up profile. We present preliminary evaluations of the rupture behavior and its interaction with the hydrodynamic wave propagation and coastal inundation. Once validated in this simplified setup, we will constrain the earthquake initial stress and strength conditions from realistic and physically consistent seismo-thermo-mechanical modeling on long timescales.