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A Benchmarking Setup for Coupled Earthquake Cycle - Dynamic Rupture - Tsunami Simulations

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We present advances in a benchmark setup for a subduction zone seismic cycle model coupled to a dynamic rupture model of a single earthquake, then coupled to tsunami propagation and inundation model. Thus, we achieve realistic initial stress and strength conditions for a megathrust earthquake and physically consistent seafloor displacements for the resulting tsunami. First, a single earthquake is selected from the 2D seismo-thermo-mechanical model representing long term deformation. Slip instabilities that approximate earthquakes arise spontaneously along the subduction zone interface in this model. The absolute stress field and material properties for a single slip event, as well as the fault geometry, are used as initial conditions for the dynamic earthquake rupture model. This second model uses SeisSol (www.seissol.org), which employs an ADER discontinuous Galerkin discretization scheme with an unstructured tetrahedral mesh. Initial conditions for the SeisSol model are mapped from the seismo-thermo-mechanical model using ASAGIan open-source library with a simple interface to access Cartesian material and geographic datasets in massively parallel simulations with dynamically adaptive mesh refinement. The time-dependent seafloor displacements are then transferred to the tsunami model. An accurate and efficient representation of the evolution of the tsunami and the following coastal inundation are achieved with an adaptive mesh discretizing the shallow water equations with a Runge-Kutta discontinuous Galerkin (RKDG) scheme. This workflow allows for evaluation of how the rupture behavior and fault geometry affect the hydrodynamic wave propagation and coastal inundation. It is part of the project "Advanced Simulation of Coupled Earthquake and Tsunami Events" (ASCETE), funded by the Volkswagen Foundation.