Simulation of Tsunamigenic Earthquakes in the ASCETE Project

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Abstract

We show advanced numerical modeling of earthquakes capable to generate a tsunami. The dynamic earthquake rupture process, including frictional sliding and seismic wave propagation, serves as input for hydrodynamic tsunami models. We expect insights into the underlying physical processes and improved accuracy of tsunami hazard assessment.

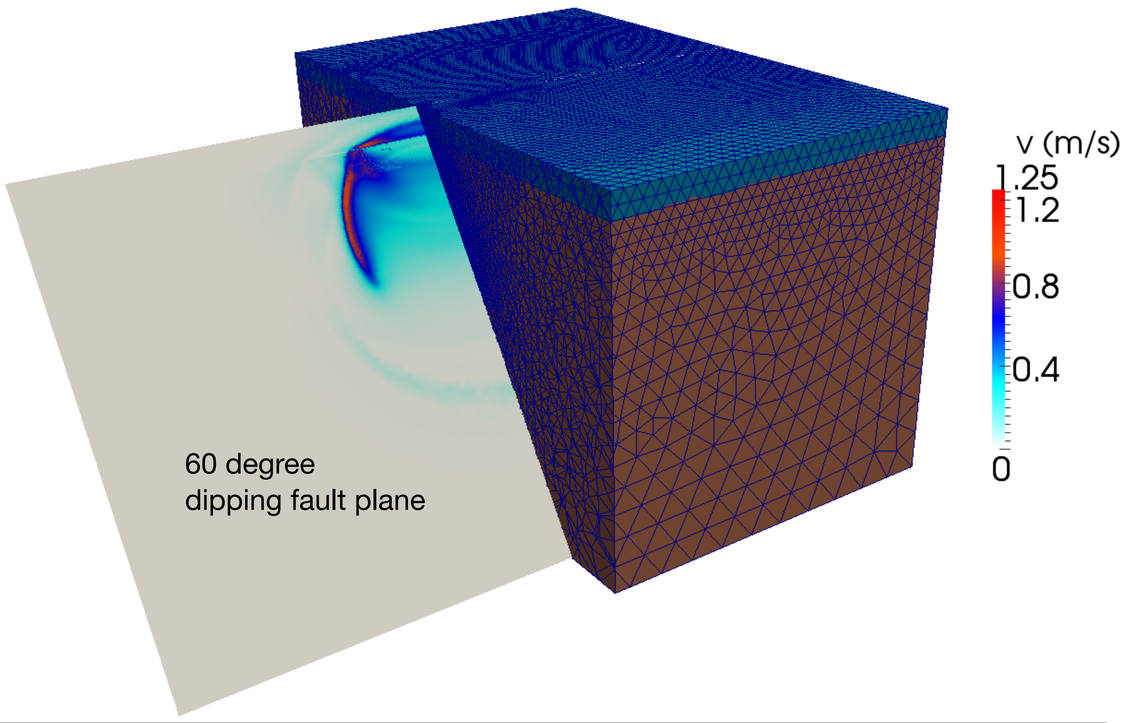
We apply the Arbitrary high-order DERivatives Discontinuous Galerkin (ADER-DG) method to solve the underlying seismic wave equations. To meet the requirements of modeling earthquake faulting on sub-kilometer scale and wave propagation over hundreds of kilometers is numerically and computationally challenging, and requires hardware-aware optimization on the latest supercomputing platforms.

SeisSol

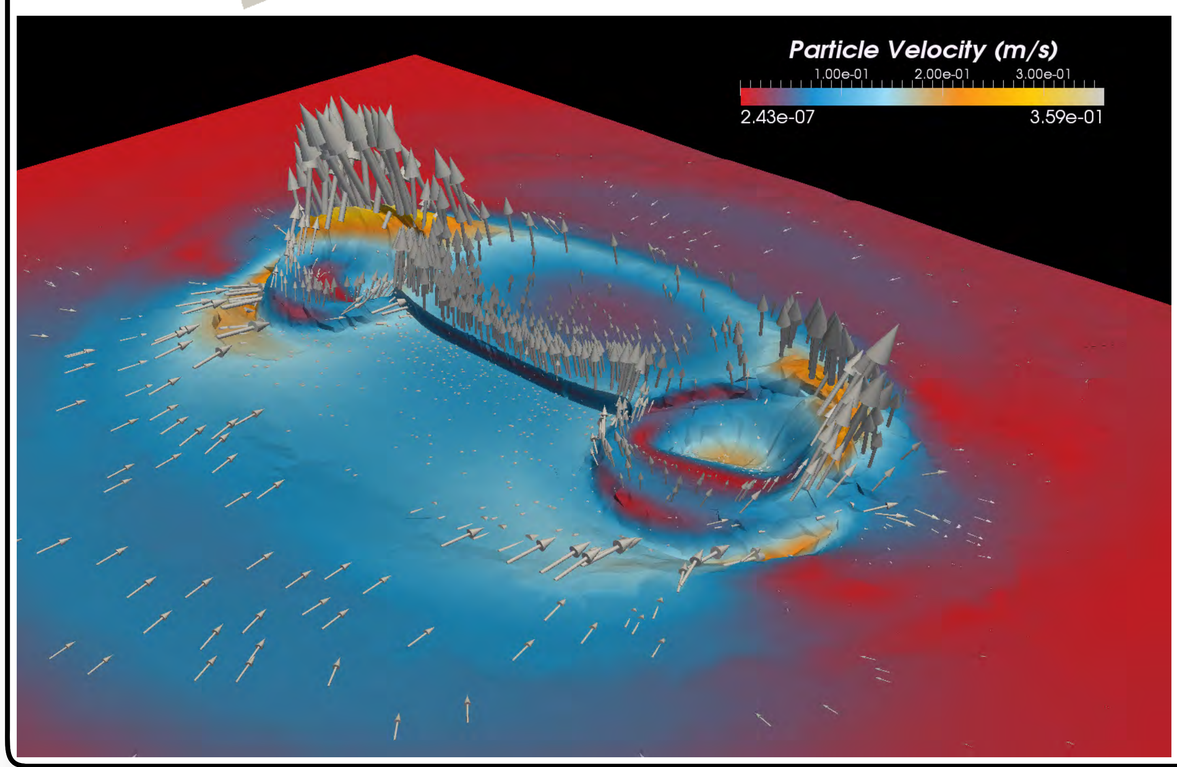
SeisSol is a software package including the solver, pre- and prostprocessing tools and a workflow of incorporating complex modeling geometries using unstructured tetrahedral element discretization techniques:

- → arbitrarily high approximation order in space and time using ADER-DG
- → tetrahedral element discretization to account for complex geometries including arbitrary fault shapes
- → interface to external mesh generators (such as Simmodeler) and large-scale partitioner
- → local time stepping approach to reduce computational costs
- → high accuracy of earthquake faulting solving the full frictional sliding

Tsunamigenic Earthquake Simulation



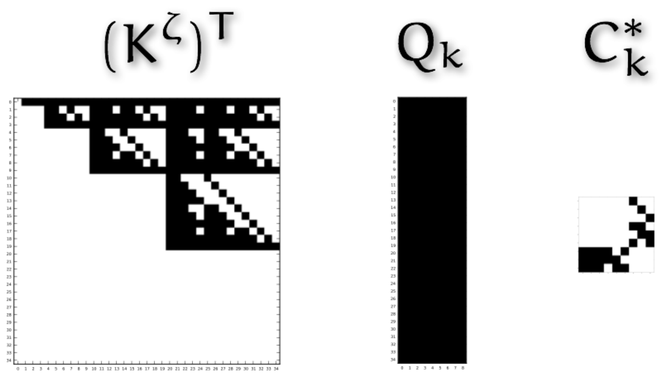
Earthquake rupture modelling: Dynamically propagating rupture front across the fault



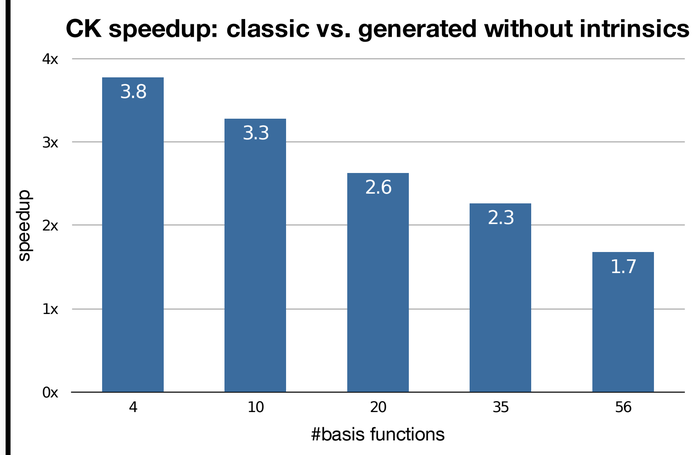
Postprocessing: Extraction of displacement at bathymetry to serve as Tsunami source

Optimization & Parallelization

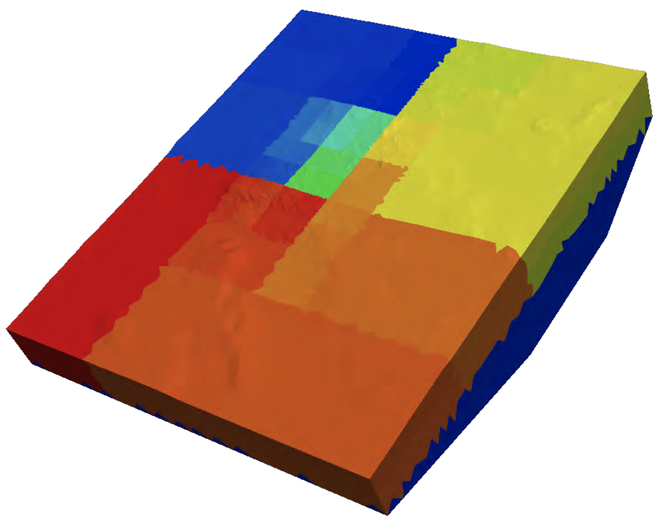
Core level: Code generation



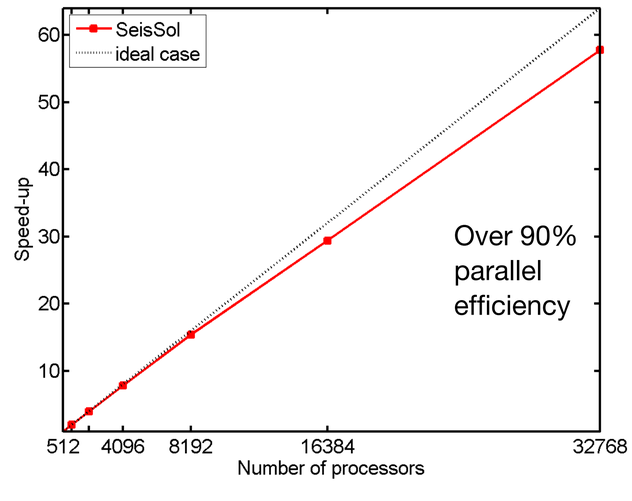
Intel Xeon CPU E5-2670 0 @ 2.60GHz (45) single node performance (16 cores, MPI)



Node level: Space-filling ordering



Inter-node level: MPI parallelization



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