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Prospects of real time tsunami inundation estimates with TsunAWI - Studies in the LEXIS project

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Based on the shallow water equations,the tsunami wave propagation in the deep ocean and an assessment of the wave height at the coast can easily be simulated online during an event. To simulate the estimated inundation, however, poses higher demands on model physics and mesh resolution. Whereas in the deep ocean, a simple balance between pressure gradient force and acceleration is sufficient for first estimates of the wave propagation, additional nonlinear factors like bottom friction and momentum advection gain importance close to the coast. For a seamless simulation of the transition from wave propagation to inundation, the finite element model TsunAWI has been developed as part of the efforts within the GITEWS project (German Indonesian Tsunami Early Warning System) and in the meantime, the code has evolved considerably with applications in several projects. The triangular mesh approach allows for large freedom in the resolution of coastline and bathymetric features, however is also numerically demanding. In the ongoing EU-project LEXIS (Large-scale Execution for Industry & Society), the simulation of earthquake and tsunami events is one of the pilot study cases and on the tsunami side puts focus on the optimization of TsunAWI on modern HPC architectures. Targeting FPGAs, an accelerator for TsunAWI is being designed. It relies on a software-distributed shared memory (S-DSM) allowing sharing of the memory between distributed nodes and the accelerator(s), and is showing that TsunAWI optimisations, namely single precision and unstructured mesh traversal, are key elements to reach high performance and efficiency. For HPC systems, an MPI parallelization was implemented, based on domain decomposition. The MPI parallel code shows good scaling, making high resolution simulations feasible during an event. The developments are evaluated in simulations of tsunami inundation in hypothetical and real events in Indonesia and Chile. It turns out that the optimized approach allows for improved fast estimates of the tsunami impact in the application cases.