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Probabilistic Tsunami Hazard Analysis: High Performance Computing for Massive Scale Monte Carlo type Inundation Simulations

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Probabilistic Tsunami Hazard Analysis (PTHA) is an approach to quantifying the likelihood of exceeding a specified metric of tsunami inundation at a given location within a given time interval. It provides scientific guidance for decision making regarding coastal engineering and evacuation planning. PTHA requires a discretization of many potential tsunami source scenarios and an evaluation of the probability of each scenario. The classical approach of PTHA has been the quantification of the tsunami hazard offshore, while estimates of the inundation at a given coastal site have been limited to a few scenarios. PTHA, with an adequate discretization of source scenarios, combined with high-resolution inundation modelling, has been out of reach with existing models and computing capabilities with tens to hundreds of thousands of moderately intensive numerical simulations being required. In recent years, more efficient GPU-based High Performance Computing (HPC) facilities, together with efficient GPU-optimized shallow water type models for simulating tsunami inundation, have made a regional and local long-term hazard assessment feasible. PTHA is one of the so-called Pilot Demonstrators of the EC-funded ChEESE project (Center of Excellence for Exascale Computing in the Solid Earth) where a workflow has been developed with three main stages: source specification and discretization, efficient numerical inundation simulation for each scenario using the HySEA numerical tsunami propagation model, and hazard aggregation. HySEA calculates tsunami offshore propagation and inundation using a system of telescopic topo-bathymetric grids. In this presentation, we illustrate the workflows of the PTHA as implemented for HPC applications, including preliminary simulations carried out on intermediate scale GPU clusters. Finally, we delineate how planned upscaling to exascale applications can significantly increase the accuracy of local tsunami hazard analysis.

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