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Faster Than Real Time tsunami simulations – challenges and solutions towards High Performance Exascale Computing

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Tsunami simulation in the framework of Tsunami Early Warning Systems (TEWS) is a quite recent achievement, but still limited regarding the size of the problem and restricted to tsunami wave propagation. Faster Than Real Time (FTRT) tsunami simulations require greatly improved and highly efficient computational methods to achieve extremely fast and effective calculations. HPC facilities have the role to bring this efficiency to a maximum possible and drastically reducing computational times. Putting these two ingredients together is the aim of Pilot Demonstrator 2 (PD2) in ChEESE project. This PD will comprise both earthquake and landslide sources. Earthquake tsunami generation is to an extent simpler than landslide tsunami generation, as landslide generated tsunamis depend on the landslide dynamics which necessitate coupling dynamic landslide simulation models to the tsunami propagation. In both cases, FTRT simulations in several contexts and configurations will be the final aim of this pilot.

Among the objectives of our work in ChEESE project are achieving unprecedented FTRT tsunami computations with existing models and investigate the scalability limits of such models; increasing the size of the problems by increasing spatial resolution and/or producing longer simulations while still computing FTRT, dealing with problems and resolutions never done before; developing a TEWS including inundation for a particular target coastal zone, or numerous scenarios allowing PTHA (PD7) and PTF (PD8), an aim unattainable at present or including more physics in shallow water models for taking into account dispersive effects.

Up to now, the two European tsunami flagship codes selected by ChESEE project (Tsunami-HySEA and Landslide-HySEA) have been audit and efficiency further improved. The improved code versions have been tested in three European 0-Tier HPC facilities: BSC (Spain), CINECA (Italy) and Piz Daint (Switzerland) using up to 32 NVIDIA Graphic Cards (P100 and V100) for scaling purposes. Computing times have been drastically reduced and a PTF study composed by around 10,000 scenarios (4 nested grids, 12 M cells, 8 hours simulations) have been computed in 6 days of wall-clock computations in the 64 GPUs available for us at the BSC.

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