



HySEA: An operational GPU-based model for Tsunami Early Warning Systems

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HySEA numerical model for the simulation of earthquake generated tsunamis is presented. The initial sea surface deformation is computed using Okada model. Wave propagation is computed using nonlinear shallow water equations in spherical coordinates, where coastal inundation and run-up are suitably treated in the numerical algorithm. Generation, propagation and inundation phases are all integrated in a single code and computed coupled and synchronously when they occur at the same time. Inundation is modelled by allowing cells to dynamically change from dry to wet and reciprocally when water retreats from wetted areas. Special effort is made in preserving model well-balanced (i.e. capturing small perturbations to the steady state of the ocean at rest). The GPU model implementation allows faster than real time (FTRT) simulation for real large-scale problems. The large speed-ups obtained make HySEA code suitable for its use in Tsunami Early Warning Systems. The Italian TEWS at INGV (Rome) has adopted HySEA GPU code for its National System. The model is verified by hindcasting the wave behaviour in several benchmark problems. Numerical results for an earthquake-generated tsunami in the Mediterranean Sea is presented and computing time analysed. The interest of using higher order methods, analysing numerical schemes from first order up to order five, in the context of TEWS, is also addressed. Tsunami codes do not usually use higher than second order methods. It is demonstrated that this should be revised.