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Meteotsunami-HySEA: A GPU accelerated code for simulating atmospherically-driven tsunamis on real bathymetries. Benchmark tests.

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Atmospherically-driven tsunamis or meteotsunamis are generated by atmospheric disturbances with steep gradients of pressure and/or wind. In recent years, meteotsunamis have received more attention from the tsunami modelling community. Although their destructive potential might be less severe than for earthquake or landslide triggered tsunamis, their frequency is much higher. The two main processes driving the most extreme meteotsunami events are the offshore amplification of the ocean long-waves due to Proudman or Greenspan resonances (i.e., when the atmospheric disturbance travels at the same speed than the long-waves) and, nearshore, the amplification factor of the shelfs, bays or inlets (i.e., resonance frequency associated to the nearshore geometry). As meteotsunamis have a high-dependence on the nearshore geometric characteristics, they often occur at known hotspot locations such as along the coastlines of Croatia, the Balearic Islands, Sicily, Malta, the Nagasaki Bay or the Baltic Sea. One of the most devastating meteotsunami events took place in Menorca (Balearic Islands) in 2006, where tsunami-like oscillations caused an economic loss of several tens millions of euros.

The EDANYA group from the university of Málaga is widely known for its GPU-accelerated tsunami simulation codes, such as Tsunami-HySEA (earthquake source) or Landslide-HySEA (landslide source). Here, we present our brand-new code for simulating meteotsunamis following the same philosophy as the previous codes. Meteotsunami-HySEA incorporates the atmospheric forcing together with additional terms such as Coriolis and the wind drag. The PDE system is written in spherical coordinates and implemented in CUDA. An additional feature related to preserving a linear version of the quasi-geostrophic equilibrium is added to the numerical scheme in order to preserve the structure of geostrophic flows, as large scale geophysical flow are often perturbations of this steady state.

To demonstrate the Meteotsunami-HySEA reliability, we first applied the code to some carefully-crafted benchmark tests, where Proudman resonance is exhibited and precisely capture, enabling accurate measures of the amplification gain due to the coupling of the propagation velocities. Then we followed the NTHMP's guidelines for simulating a pilot study in the region of the Gulf of Mexico with a real topobathymetry. Further work will be focused on testing real scenarios, incorporating real atmospheric data and bathymetry for reliable forecast.

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