Modeling Waves in the Nearshore with GPUSPH: a Graphics Card Accelerated Smoothed Particle Hydrodynamics Code

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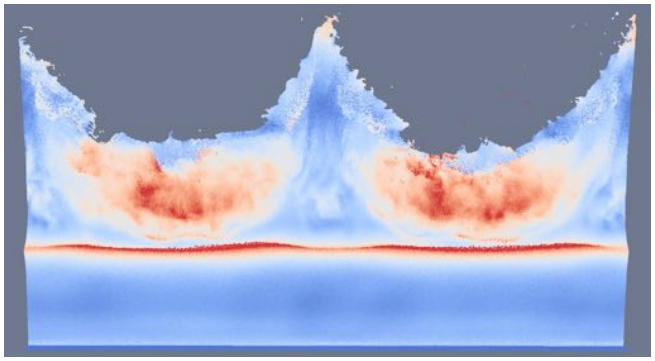
ABSTRACT

Smoothed Particle Hydrodynamics (SPH) has been shown to be an effective model for free surface flows (Monaghan, 1994), including water waves in the surf zone (also, Dalrymple and Rogers, 2006). For the accurate modelling of all facets of wave propagation, the SPH model has to correctly model refraction, shoaling, diffraction, and wave breaking. In addition, for the study of nearshore flows, the model has to simulate mean wave properties, such as wave setup and momentum and energy fluxes, as well.

GPUSPH (Hérault et al. 2010) is an open source SPH code that is run on Nvidia graphics cards using the CUDA language to take advantage of the highly parallel nature and the computation ability of present day video cards (with thousands of compute cores): www.gpusph.org.

One example of the ability of GPUSPH to model the nearshore includes the nonlinear problem of subharmonic generation of edge waves at a steep beach, which involves a three-wave resonance (here a normally incident wave train and two edge waves travelling in the opposite direction along the beach). The velocity magnitudes of the resulting large amplitude standing edge waves on the beach face are shown in the figure with the red line denoting the large velocity magnitudes in the \breaking wave, incident from the bottom of the figure (beach face is gray).



The remaining examples involve the modelling of solitary waves (tsunami surrogates) and their interaction with complicated coastal shorelines and structures. Comparisons to laboratory studies of solitary waves impinging on a coastal barrier (2D) and a coastal headland (3D) are shown. In addition the solitary wave attack on a coastal island is shown. Finally the solitary wave attack on a vertical rectangular structure and a bridge are provided. Forces on the structures are compared to experiment.

REFERENCES

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