Development of a Phase-resolving Computer Model for Operational Coastal Wave Processes

Volker Roeber, Univ. Pau & Pays de l’Adour, E2S-UPPA; Chaire HPC-Waves, volker.roeber@univ-pau.fr

Fatima-Zahra Mihami, Univ. Pau & Pays de l’Adour, E2S-UPPA; Chaire HPC-Waves, fzmihami@univ-pau.fr

Quantitative assessments of wave-driven run-up and inundation scenarios have been of high interest to coastal residents, engineers, emergency managers, and scientists. Though it is possible to obtain general estimates of wave run-up based on empirical formulae, such approximations are often of limited applicability, especially in areas with complex shorelines and bathymetries. Due to the substantial increase in computing power, numerical models have emerged as reliable and cost-effective tools for nearshore wave assessment. Accurate computation of wave run-up requires the numerical models to account for phase-dependent processes that can pose challenges to the quality and computational complexity of the numerical solution.

We present the strategic development of a new Boussinesq-type model with the objective of building a reliable tool for operational run-up forecasting systems. The effort has led to a computer code where multiple fundamental features are optimized for both computational efficiency and accuracy to achieve fast and reliable solutions of nearshore waves. This requires the model to answer to several challenges including wave breaking, numerical diffusion, moving boundaries, and computational complexity. To solve for these contradicting requirements, the model relies on a lean numerical structure that supports mass and momentum conservation across discontinuities and long-distance propagation of irregular waves. An eddy viscosity closure approach based on temporally and spatially varying turbulent kinetic energy alleviates the chronic limitation of depth-integrated dispersive solutions to wave breaking. In an attempt to achieve real-time run-up computations over large domains, the new model efficiently uses commodity graphics cards hardware, and targeted grid refinement through locally nested domains.