A FULLY COUPLED UNSTRUCTURED-GRID MODEL FOR WIND WAVE-CURRENT INTERACTION IN LARGE-SCALE APPLICATIONS

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We have successfully coupled state-of-the-art wind wave and circulation models to study the wave-current interaction. The Wind Wave Model II (WWM-II, Roland et al. 2008) solves the Wave Action Equation (WAE) using Residual Distribution Schemes on unstructured meshes (Hubbard & Roe, 2010) and incorporates up to date physical source terms describing growth and decay of wind generated waves (e.g. Ardhuin et al. 2010). The circulation model (hydrodynamic) is the 3D Semi-implicit Eulerian-Lagrangian Finite-Element (SELFE) model that combines accuracy, efficiency and robustness for large-scale applications (Zhang and Baptista 2008; Burla et al. 2010).
The coupling between WWM-II and SELFE was accomplished through recasting WWM-II as a subroutine of SELFE so that they share the same domain decomposition under MPI in order to avoid interpolation and to maximize efficiency. Physically the models have been coupled based on the wave induced radiation stresses following Longuet-Higgins and Stewart (1964), and the wave induced surface and bottom stresses.
We have successfully applied the coupled model to several large-scale applications for recent storms including tropical cyclone and extra-tropical storms in the Gulf of Mexico and US East Coast. The coupled model is shown to accurately simulate the water level, wave heights as well as the changes in the dominant wave frequency (e.g. between swells and rough seas) from deep ocean to shallow water with reasonable cost.