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A GPU-Accelerated, Ensemble-Based High-Order Spectral Solver for Surface Gravity Waves ALEXANDER HRABSKI, GUANGYAO WANG, YULIN PAN, University of Michigan — Many applications in the physical study and forecasting of nonlinear waves require the efficient computation of ensemble wave fields. In physical studies, e.g. wave turbulence, considerable effort is required to compute statistics from large ensembles of simulations. In marine engineering, ensemble-based forecasting tools are ideally integrated with remote sensing technology, to be deployed on compact devices in offshore environments. For these purposes, we develop an ensemble-based solver of the gravity wave equations for a CPU-GPU heterogeneous architecture that allows for the fast and efficient computation of wave field evolution and statistics via the High-Order Spectral method (HOS). This is achieved by simultaneously computing the evolution of ensemble wave fields, leveraging GPU-acceleration for highly-parallel array operations and fast Fourier transforms. Performance metrics are provided for comparison to serial and MPI-based HOS codes, and the solver's accuracy is validated. We conclude with applications in wave forecasting via the ensemble Kalman filter and a study of the long-term evolution of wave field statistics.

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