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Simulations of the Peregrine Breather with a Multi-Layer Non-Hydrostatic Model

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In ocean engineering, wave focusing techniques are routinely adopted to deterministically reproduce rogue waves in numerical and physical wave experiments. The nonlinear Schrödinger Equation (NLSE), that accounts for the nonlinear dynamical evolution of a wave envelope, accurately describes the physical mechanism leading to the formation of rogue waves in the ocean. Here, we use the Peregrine breather solution of the NLSE to generate a doubly-localised rogue wave, i.e. one single extreme event at a specific time and position. A comparison is performed to validate numerical simulations with physical experiments. The physical experiments have been conducted in the Extreme Air-Sea Interaction (EASI) facility at The University of Melbourne, while numerical simulations have been performed in a nonlinear multi-layer numerical wave tank (NWT), designed using the non-hydrostatic model SWASH. We discuss the performance of SWASH with respect to number of layers, initial boundary conditions, time-stepping technique and numerical propagation schemes via a thorough convergence study. We show that the propagation of steep non-breaking wave in a high-resolution NWT in SWASH is in good agreement with the surface elevation, measured in the physical experiments. Satisfactory agreement is achieved for computational time, that is considerably lower than the one required by traditional Navier-Stokes simulations. This opens the possibility to investigate the propagation of extreme waves over complicated bathymetries as well as their interaction with marine structures