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Run-up of long solitary waves of different polarities on a plane beach

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We study the run-up of long solitary waves of different polarities on a beach in the case of composite bottom topography: a plane sloping beach transforms into a region of constant depth. We confirm that nonlinear wave deformation of positive polarity (wave crest) resulting in an increase in the wave steepness leads to a significant increase in the run-up height. It is shown that nonlinear effects are most strongly pronounced for the run-up of a wave with negative polarity (wave trough). In the latter case, the run-up height of such waves increases with their steepness and can exceed the amplitude of the incident wave.
This study is extended to the case of long breaking solitary waves, simulated numerically in the nonlinear shallow-water theory framework using CLAWPACK-software. For small-amplitude incident waves regardless their polarity, the results of numerical computations usually coincide with predictions of the nonlinear shallow water theory for non-breaking waves. Nonlinear effects start to be important when incident wave is located far from the shoreline even for initially small-amplitude waves. With further increase in incident wave amplitude, the wave transforms into the shock wave (bore) before approaching the beach. Run-up characteristics of waves of different polarities are compared. Nonlinear effects and induced energy dissipation caused by wave breaking during its run-up on a beach are more prominent for negative pulses rather than for positive ones.