Modelization of highly nonlinear waves in coastal regions

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The proposed work deals with the development of a highly non-linear model for water wave propagation in coastal regions.

The accurate modelization of surface gravity waves is of major interest in ocean engineering, especially in the field of marine renewable energy. These marine structures are intended to be settled in coastal regions where the effect of variable bathymetry may be significant on local wave conditions.

This study presents a numerical model for the wave propagation with complex bathymetry. It is based on High-Order Spectral (HOS) method, initially limited to the propagation of non-linear wave fields over flat bottom. Such a model has been developed and validated at the LHEEA Lab. (Ecole Centrale Nantes) over the past few years and the current developments will enlarge its application range.

This new numerical model will keep the interesting numerical properties of the original pseudo-spectral approach (convergence, efficiency with the use of FFTs, . . .) and enable the possibility to propagate highly non-linear wave fields over long time and large distance.

Different validations will be provided in addition to the presentation of the method. At first, Bragg reflection will be studied with the proposed approach. If the Bragg condition is satisfied, the reflected wave generated by a sinusoidal bottom patch should be amplified as a result of resonant quadratic interactions between incident wave and bottom. Comparisons will be provided with experiments and reference solutions.

Then, the method will be used to consider the transformation of a non-linear monochromatic wave as it propagates up and over a submerged bar. As the waves travel up the front slope of the bar, it steepens and high harmonics are generated due to non-linear interactions. Comparisons with experimental data will be provided.

The different test cases will assess the accuracy and efficiency of the method proposed.