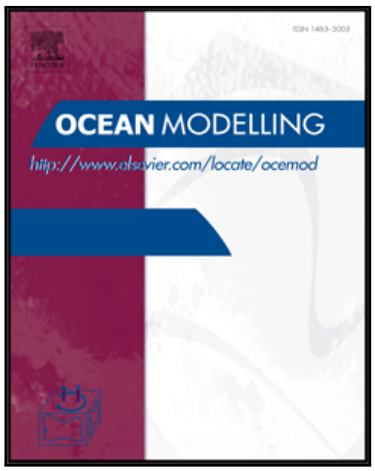

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Impacts of wave-induced circulation in the surf zone on wave setup

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Abstract

Wave setup corresponds to the increase in mean water level along the coast associated with the breaking of short-waves and is of key importance for coastal dynamics, as it contributes to storm surges and the generation of undertows. Although overall well explained by the divergence of the momentum flux associated with short waves in the surf zone, several studies reported substantial underestimations along the coastline. This paper investigates the impacts of the wave-induced circulation that takes place in the surf zone on wave setup, based on the analysis of 3D modelling results. A 3D phase-averaged modelling system using a vortex force formalism is applied to hindcast an unpublished field experiment, carried out at a dissipative beach under moderate to very energetic wave conditions (H_{m0} = 6 m at breaking and T_p = 22 s). When using an adaptive wave breaking parameterisation based on the beach slope, model predictions for water levels, short waves and undertows improved by about 30%, with errors reducing to 0.10 m, 0.10 m and 0.09 m/s, respectively. The analysis of model results suggests a very limited impact of the vertical circulation on wave setup at this dissipative beach. When extending this analysis to idealized simulations for different beach slopes ranging from 0.01 to 0.05, it shows that the contribution of the vertical circulation (horizontal and vertical advection and vertical viscosity terms) becomes more and more relevant as the beach slope increases.

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