Enhanced wave breaking modelling in a High-Order Spectral model

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The efficient solution of the deterministic nonlinear wave propagation has drawn attention of several research groups in the past decades. Different numerical models have been developped, and the High-Order Spectral (HOS) method appears as a good candidate when targeting a fast and accurate solution that allows the study of domains of significant spatial size. This is at the expense of constraints in terms of geometry (rectangular domain and constant depth) in the original HOS framework. Such nonlinear models, based on the potential flow theory, cannot simulate the wave breaking events that exhibit strong viscous effects, vorticity, etc. Then, different strategies have been proposed to take into account the main effects associated to breaking (dissipation, redistribution of energy along frequencies) in such models. For instance, the open-source HOS models HOS-ocean and HOS-NWT Ducrozet et al. (2012, 2016) have been enhanced with a dedicated strategy described and validated experimentally in Seiffert and Ducrozet (2018), Seiffert et al. (2017). Those previous works are based on the use of the breaking onset parameter B_x established by (Barthelemy et al., 2018) and the breaking dissipation using an eddy viscosity ν_{eddy} proposed by (Tian et al., 2010).

In the present work, a novel eddy viscosity parameterization is proposed. This relies on the recent work of (Derakhti et al., 2018) that demonstrated, thanks to high-fidelity CFD simulations of the wave breaking phenomena, a link between the wave breaking dissipation strength b and the rate of change of the breaking onset parameter B_x through the parameter $\Gamma = T_b dB_x/dt$. In the present study, this breaking strength allows the parameterization of a new eddy viscosity ν_{eddy} that will ensures a relevant dissipation of energy. The comparison between current new model and Tian's original one (Seiffert et al., 2017) is performed and the energy dissipated by this novel parameterization is evaluated on different cases. Further, the comparison of the present results with CFD results is also conducted. Finally, the study is complemented by comparisons to experiments at model scale.

References

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