



HAL
open science

Enhanced wave breaking modelling in a High-Order Spectral model

Guillaume Ducrozet, Ying Wang, Morteza Derakhti

► **To cite this version:**

Guillaume Ducrozet, Ying Wang, Morteza Derakhti. Enhanced wave breaking modelling in a High-Order Spectral model. B'Waves 2023, May 2023, Bordeaux, France. <hal-04491055>

HAL Id: hal-04491055

<https://hal.science/hal-04491055v1>

Submitted on 5 Mar 2024

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire HAL, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



HAL Authorization

Enhanced wave breaking modelling in a High-Order Spectral model

Guillaume Ducrozet¹, Ying Wang¹, and Morteza Derakhti¹

¹Nantes Université, École Centrale Nantes, CNRS, LHEEA, UMR 6598,
F-44000 Nantes, France

²Applied Physics Laboratory University of Washington, Seattle, WA, United
States

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 developed, 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 ensure 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

- Barthelemy, X., Banner, M., Peirson, W., Fedele, F., Allis, M., Dias, F., 2018. On a unified breaking onset threshold for gravity waves in deep and intermediate depth water. *Journal of Fluid Mechanics* 841, 463–488.
- Derakhti, M., Banner, M.L., Kirby, J.T., 2018. Predicting the breaking strength of gravity water waves in deep and intermediate depth. *Journal of Fluid Mechanics* 848, R2.

- Ducrozet, G., Bingham, H.B., Engsig-Karup, A.P., Bonnefoy, F., Ferrant, P., 2012. A comparative study of two fast nonlinear free-surface water wave models. *International Journal for Numerical Methods in Fluids* 69, 1818–1834.
- Ducrozet, G., Bonnefoy, F., Le Touzé, D., Ferrant, P., 2016. Hos-ocean: Open-source solver for nonlinear waves in open ocean based on high-order spectral method. *Computer Physics Communications* 203, 245–254.
- Seiffert, B.R., Ducrozet, G., 2018. Simulation of breaking waves using the high-order spectral method with laboratory experiments: wave-breaking energy dissipation. *Ocean Dynamics* 68, 65–89.
- Seiffert, B.R., Ducrozet, G., Bonnefoy, F., 2017. Simulation of breaking waves using the high-order spectral method with laboratory experiments: Wave-breaking onset. *Ocean Modelling* 119, 94–104.
- Tian, Z., Perlin, M., Choi, W., 2010. Energy dissipation in two-dimensional unsteady plunging breakers and an eddy viscosity model. *Journal of fluid mechanics* 655, 217–257.