A unified framework for predicting the breaking onset, type, and strength of surface gravity waves from deep to shallow water

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Abstract

We present a unified framework to predict the onset, type, and strength (or energy dissipation) of breaking surface waves in arbitrary depth, including shallow water breaking over varying bathymetry. The framework is motivated by and builds on recent results obtained using high-resolution numerical simulations [Derakhti et al., 2018, 2020], which establish that the onset and strength of breaking of an individual wave crest can be determined solely from local properties of the evolving crest as it approaches breaking. The proposed parameterization framework is entirely local and can handle multiple breaking events in time and space. Notably, the framework can be efficiently implemented in phase-resolving, energy-conserving surface wave models such as High-order Spectral (HOS, commonly used in deep water) and Boussinesq (commonly used in shallow water) models. Our new wave breaking closure model will enhance understanding and prediction of surface wave breaking in various oceanic and coastal environments.

References

M. Derakhti, M. L. Banner, and J. T. Kirby. Predicting the breaking strength of gravity water waves in deep and intermediate depth. *J. Fluid Mech.*, 848, 2018. doi: 10.1017/jfm.2018.352.

M. Derakhti, J. T. Kirby, M. L. Banner, Stephan T. Grilli, and Jim Thomson. A unified breaking-onset criterion for surface gravity water waves in arbitrary depth. *J. Geophys. Res.:Ocean*, 125, 2020. doi: 10.1029/2019JC015886.