Statistical characterisation of breaking waves in short-crested seas

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Abstract:
Understanding and predicting wave breaking remains a fundamental challenge in ocean and coastal engineering, particularly in short-crested wave fields over finite water depths. This study introduces a novel methodology to identify breaking wave events using a unique dataset that combines laboratory experiments with numerically simulated wave fields. The dataset captures realistic sea states used in engineering design, covering a broad range of conditions from mild to extreme. The proposed approach enables the detection and statistical analysis of breaking waves, allowing for quantification of both the probability of breaking and the associated energy dissipation. In addition, the method identifies waves that exhibit strong nonlinear amplifications, which are analysed in parallel. This facilitates the decomposition of standard wave statistics into separate distributions for breaking and non-breaking waves, offering a more nuanced understanding of wave dynamics. Finally, these are incorporated into a predictive statistical model.