Breaking Statistics of Wind Forced Waves in Sea and Laboratory conditions.

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The hydrodynamical process of waves breaking is still a source not fully understood. An extensive research work has been carried out during the last decades to quantify and define the associated energy redistribution, which directly influences a wide range of climate processes, maritime applications, and oceanic phenomena.

Naturally, waves become steeper toward the inception of breaking; however, there is still a lack of unanimity regarding the relationship between breaking probability statistics and wave steepness. Here we present a detailed analysis of different sea states from the Black Sea measurements and from a closed wind-wave flume experiment. Together with the wind-derived parameters, the water wave statistics were gathered using an innovative breaking wave detection algorithm. The algorithm was recently developed to allow accurate detection of breaking waves based on the phase-time approach and wavelet analysis to identify breaking-associated patterns in the instantaneous frequency variations of surface elevation fluctuations. The in-depth analysis of breaking and non-breaking wave statistics included wave-by-wave calculations resulting in steepness and celerities of the local wave, derived from the local wave frequency and wavenumber.

Finally, the findings, after investigation and validation, presented a skewed Gaussian-like steepness histogram, revealing that both non-breaking and breaking waves can reach steep profiles, above the Stokes limit.