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Geometrical and dynamical properties of breaking wind waves

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Wind wave breaking plays a crucial role in momentum, heat and gas exchanges across the ocean-atmosphere interface. Despite many efforts in modelling experimentally, numerically or theoretically this phenomenon, the key features of natural wind wave breakers and the processes leading to wave breakdown are far from being entirely described and understood. This work aims at better characterizing short wind wave breaking by using high-resolution space-time wave slope observations.

Experiments were conducted in the large [40 x 2.6 x 1 m3] wind-wave facility of Marseille-Luminy at fetches ranging from 6 to 26 m and at wind speed up to 10 m/s. A specially made Color Imaging Slope Gauge (CISG) was designed for measuring both components of water surface slope over a 65 $\times$ 45 cm2 area. This technique, first described by Ja¨hne & Riemer (1990), is based on visualization of the water surface illuminated by a two-color underwater light pattern deformed by refraction at the wavy interface. Observations of the water surface slopes were made by a video camera mounted on the ceiling of the air tunnel.

This study first investigates geometrical properties of wind waves just before and during breaking events, in particular the spatio-temporal evolution of the front-back crest asymmetry, the wavefront steepening, the three-dimensional wave shape as well as the wave crest displacement speed. The universality of the shape of wave breakers of various scales and the existence of a slope threshold beyond which wave breaking becomes irreversible have been examined in detail. On the basis of these findings, the average length of breaking wave fronts per unit area of water surface has been quantified as function of wind speed and wave field development.