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Properties of the wave breaking onset

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The breaking of deep-water surface water waves represents one of the most interesting and challenging problems of fluid mechanics. Breaking is a strongly nonlinear shock-like intermittent random process, the distribution of which on the water surface is not continuous. The role breaking plays in maintaining the energy balance in continuous air-sea interaction field is, however, critical. Despite decades of research in the field, a basic physical understanding and mathematical description remain elusive.

Results will be presented on predicting the wave breaking onset and a detailed investigation of the properties and the causes of breaking of two-dimensional waves in deep water. The progression of initially monochromatic steep waves to the point of breaking is first investigated by means of the fully nonlinear Chalikov-Sheinin model. Particular attention is paid to the evolution of nonlinear wave properties, such as steepness, skewness and asymmetry, in the physical space, and to their interplay leading to breaking onset. The addition of wind forcing can play multiple roles in changing the wave-breaking dependences. Instantaneously, wind has only a marginal affect on breaking onset, unless the wind forcing is very strong. Wind action is, however, important on longer scales in altering breaking statistics and breaking severity. These roles are investigated.

The results are then verified and expanded in a laboratory experiment. The experiment demonstrated good qualitative agreement with the numerical simulations and consequently the breaking dependence was quantified. These experiments also revealed a number of new features of the nonlinear wave development near breaking, i.e. reduc-

tion of the wave period prior to breaking.

The location of breaking onset, which occurs as a result of the natural evolution of nonlinear wave trains, can be controlled in such laboratory experiments. Therefore, the properties of the incipient breakers, as well as those of waves preceding and following the breaker, were measured and investigated in detail. In particular, it is demonstrated that the breaking will occur once the wave reaches the Stokes limiting steepness. Potential applications of the approach to field conditions are also discussed.