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Effect of higher order nonlinearity, directionality and finite water depth on wave statistics: Comparison of field data and numerical simulations

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This research is focused on the study of nonlinear evolution of irregular wave fields in water of arbitrary depth by comparing field measurements and numerical simulations.It is now well accepted that modulational instability, known as one of the main mechanisms for the formation of rogue waves, induces strong departures from Gaussian statistics. However, whereas non-Gaussian properties are remarkable when wave fields follow one direction of propagation over an infinite water depth, wave statistics only weakly deviate from Gaussianity when waves spread over a range of different directions. Over finite water depth, furthermore, wave instability attenuates overall and eventually vanishes for relative water depths as low as kh=1.36 (where k is the wavenumber of the dominant waves and h the water depth). Recent experimental results, nonetheless, seem to indicate that oblique perturbations are capable of triggering and sustaining modulational instability even if kh<1.36. In this regard, the aim of this research is to understand whether the combined effect of directionality and finite water depth has a significant effect on wave statistics and particularly on the occurrence of extremes. For this purpose, numerical experiments have been performed solving the Euler equation of motion with the Higher Order Spectral Method (HOSM) and compared with data of short crested wave fields for different sea states observed at the Lake George (Australia). A comparative analysis of the statistical properties (i.e. density function of the surface elevation and its statistical moments skewness and kurtosis) between simulations and in-situ data provides a confrontation between the numerical developments and real observations in field conditions.