Geophysical Research Abstracts
Vol. 13, EGU2011-7116, 2011
EGU General Assembly 2011

Statistical properties of short wind waves : a high resolution laboratory study

Charles-Antoine Guérin (1) and Guillemette Caulliez (2)

(1) LSEET, Université de Toulon, France (guerin@univ-tln.fr), (2) IRPHE, CNRS, Marseille (caulliez@irphe.univ-mrs.fr)

Statistical properties of short wind waves: a high resolution laboratory study

Charles-Antoine Guérin, Université de Toulon, Laboratoire LSEET, France
Guillemette Caulliez, Laboratoire des Interactions Océan-Atmosphère, Institut de Recherche sur les Phénomènes Hors Equilibre (IRPHE, CNRS), Marseille, France

The characterization of the sea surface from microwave remote sensing techniques relies on a detailed description of the surface roughness at the centimeter and millimeter scales. The geometrical and kinematics properties of surface waves are described by a number of statistical quantities which are key parameters in the modeling of the back-scattered radar cross-section. In particular, it is well-known that the non-Gaussian features of wave motions have a dramatic impact on the scattered field. However, there is very little experimental knowledge of the higher-order statistics of the sea surface besides the classically employed cumulants (skewness and kurtosis).

We take advantage of a novel experimental technique of wave profile imaging to study the statistical properties of short wind waves in the large wind-wave facility of IRPHE-Luminy (Marseille). We study four typical regimes with increasing wind (from 3 to 10 m/s) and fetch (2 to 26 m), corresponding to different dominant wave dissipation mechanisms: capillary-gravity waves, gravity-capillary waves with parasitic capillary ripples riding over the wavefront, gravity-capillary waves with apparition of steep wavefronts and microscale breaking, short gravity waves with occurrence of crest overturning and plunging microjet. Wave profile snapshots of 21 cm length and a resolution of about 0.1 mm were derived from images by using a contour detection method. We have elaborated and validated a method to obtain the one- and two-points statistical functions of surface heights, slopes and curvatures for the different regimes, as well as the first four cumulants. We discuss the accuracy and reliability of the methodology and assess the results when possible with the earlier ones in the literature. In particular, special attention is paid for estimating the effect of the unidirectionality of the method, which provides presently only the longitudinal component of the surface topography.

We show that the higher-order statistical parameters provide significant information about the shape and the intermittency of the surface wave disturbances and so, can be used in a certain extent to characterize the various wave dissipation regimes. Deviations from Gaussian distributions are found very important, especially for the slopes and curvatures, and their evolution is described empirically. Some heuristic justifications are given on the basis of the underlying physical mechanisms at the origin of the different regimes.