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Statistical characterization of short wind-waves from stereo images of the sea surface

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Today, direct in situ measurement of the topography of the sea surface is still a challenging issue. Spatial properties of the sea surface are routinely characterized by indirect measurements such as radar or optical remote sensing, time series at a fixed location (gauge, buoys, laser) or controlled tank experiments. These techniques, however, suffer from known shortcomings and limitations.

With the ever increasing accuracy of satellite microwave radar sensors for geophysical purpose and the progress of the electromagnetic wave interaction models, there is a need for direct measurements of short waves in natural conditions. In this respect, the technique of stereo image reconstruction is very promising. It has been recently employed in the context of ocean waves for the reconstruction of the topography and estimation of the elevation spectrum. However, the processing of these data raises technical issues when it comes to the estimation of their key statistical parameters.

In this work we propose a methodology to extract spatial statistical characteristics of the sea surface topography by means of stereo image reconstruction. We discuss the possibilities and limitations of this technique and validate the results of data set acquired from an oceanographic platform at the Black Sea with simultaneous in situ measurements as well as results from the literature. In spite of the limited resolution and restricted field of view of the images, we show that the following quantities can be well estimated: the probability distribution and spectrum of small-scale elevations, the variance and kurtosis of total and filtered slopes and the so-called skewness function of small-scale elevations. This last quantity is less conventional but is of primary importance in analytical scattering models from the sea surface.