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Directional short wind wave spectra derived from the sea surface photography

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New field measurements of 2-D wave number short wind wave spectra in the wavelength range from few millimeters to few decimeters are reported and discussed. The measurement method proposed by [Kosnik and Dulov, 2011] is based on stereophotography and image brightness contrast processing. The method strongly builds on the brightness cross-spectral analysis to reduce the noise within this short wave gravity and capillary range. Field measurements of wind wave spectra are still rare, and the reported data thus provide valuable information to bring new evidences on the 2-D spectral distribution of short wind waves in the wavelength range from decimeters to millimeters.

As found, the folded spectra of decimeter waves are very weakly dependent on the wind speed and its direction. Wind speed and direction sensitivity only starts to appear in the short wavelength range, more precisely in the vicinity of the wave number 100 rad/m, where the wind exponent grows from 0.5 to 1.5–2.5 at 800 rad/m, and angular anisotropy parameter introduced by [Elfouhaily et al., 1997] amounts the value of 0.5. These aspects are consistent with other previously reported optical and radar data. For the latter, we solely extracted the polarization sensitivity to best isolate the contribution associated to the wave saturation spectrum around the Bragg resonant wave number. For the former, mean-squared slope statistics were used to assess the integrated shortscale directional spectral properties.

As revealed, observed direction spectral distributions are significantly different from those previously suggested [Elfouhaily et al., 1997; Kudryavtsev et al., 2003, 2005]. On the basis of these new in situ measurements, we then propose to revise the semiempirical analytical model of short wind wave spectra developed by [Kudryavtsev et al., 2003, 2005]. In this model the key parameter is exponent n governing the nonlinear dissipation rate as $D \sim B^{n+1}$, where B is saturation spectrum. Accordingly, new additional constraints are used to refine the dependence of the n on dimensionless wave number to match the inferred wind exponent data. As appeared, such a constraint is a key to refine the directional spectrum. The mean saturation spectrum is further adjusted to be consistent with the robust Cox and Munk [1954] dependence of mean-square slope on wind speed. As developed, the proposed two-dimensional wave number spectrum is valid over the ultragravity and capillary large wave numbers, and is analytically amenable to different usage. This revised model can readily be implemented in other studies (radar scattering, air-sea interaction issues, etc.), where detailed knowledge of short wind wave spectra is crucial.

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