Geophysical Research Abstracts
Vol. 18, EGU2016-15153, 2016
EGU General Assembly 2016

Surface roughness modulations by submesoscale currents

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At times, high resolution images of sea surface roughness can provide stunning details of submesoscale upper ocean dynamics. As interpreted, transformations of short scale wind waves by horizontal current gradients are responsible for those spectacular observations. Here we present two major advances towards the quantitative interpretation of those observations.

First, we show that surface roughness variations mainly trace two particular characteristics of the current gradient tensor, the divergence and the strain in the wind direction. Local vorticity and shear in the wind direction should not affect short scale roughness distribution and would not be detectable.

Second, we discuss the effect of the viewing direction using sets of quasi-simultaneous sun glitter images, taken from different satellites to provide different viewing configurations. We show that upwind and crosswind viewing observations can be markedly different. As further confirmed with idealized numerical simulations, this anisotropy well traces surface current strain area, while more isotropic contrasts likely trace areas dominated by surface divergence conditions.

These findings suggest the potential to directly observe surface currents at submesoscale by using surface roughness observations at multiple azimuth viewing angles. They also pave the way towards a better understanding of the coupling between ocean, waves and atmosphere at high resolution.