Abstract View

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On the Response of Short Ocean Wave Components at a Fixed Wavenumber to Ocean Current Variations

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ABSTRACT

This paper is concerned with the patterns in the degree of saturation of short wind-generated waves (at scales much smaller than those of the spectral peak but large compared with the capillary scales) that are produced by current variations in the presence of wind energy input and loss by breaking or by the formation of parasitic capillaries. It has two aims: the first is to provide a base for interpretation of patterns observed in synthetic aperture radar imagery in terms of current features. The second is to give analytical expressions for the magnitude of the variations in degree of saturation produced by given current fields so that, when appropriate quantitative measurements become available, better parametric representations of the energy loss rates can be developed.

Particular care is taken to provide physically based representations of wind input and loss by wave breaking and a relatively convenient equation (4.2) is derived that specifies the distribution of the degree of saturation in a current field, relative to its ambient (undisturbed) background in the absence of currents. The magnitude of the variations in *b* depends on two parameters, U_0/c, where U_0 is the velocity scale of the current and *c* the phase speed of the surface waves at the (fixed) wavenumber considered or sampled by SAR, and $S = (L/\lambda)(u_*/c)^2$, where *L* is the length scale of the current distribution, λ the wavelength of the surface waves and u_* the friction velocity of the wind. When *S* is large (of order 10 or more) the distribution of *b* is insensitive to currents for which $U_0/c \sim 1$, but when *S* is of order unity or less, significant variations in *b* are produced. A convergence zone is associated with a maximum in *b* relative to its ambient levels of where $m \approx 0.04$ and $n \sim 3$. This appears as a bright line in the SAR imagery against the ambient background. In general, changes of order unity in *b* (and the return SAR signal) should be observed if the local current strain-rate scale A local divergence or upwelling reduces the relative degree of saturation; when *S* is small the reduction is by the factor $(1 + 2U/c)^{-9/2}$ and continues until the waves grow back to the equilibrium level under the influence of the wind. A divergence line would be imaged as a line across which the return decreases relatively abruptly from the ambient level upwind, to a lower level downwind, gradually recovering to the ambient.

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