## Abstract View

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# Air-Sea Momentum Transfer by Means of Short-Crested Wavelets

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ABSTRACT

Recent laboratory studies of Okuda and others revealed shear stress “spikes” over wavelet crests as the principal instruments of air-sea momentum transfer. Examination of other laboratory evidence shows that sharp local intensifications of skin friction is a characteristic of reattaching flow in *three-dimensional* separation only.

Flow reattachment over a downwind wavelet crest ensures the coincidence of high shear stress and downwind orbital velocity, resulting in energy input to the fluctuating motion, i.e., a coupling of the wavelets to the wind. Such coupling is shown to occur over short-crested wavelets at a specific waveheight-to-wavelength ratio.

Under the shear stress spikes a thin vertical layer develops on the water surface, which rides over the essentially irrotational motion of the wavelets. Thickening of the vortical layer over the windward face of a wavelet causes a positive pressure perturbation in quadrature with downward vertical velocity, which tends to transfer energy to the wavelet. A counter-effect occurs, however, because the surface velocity exceeds the phase velocity: vortical fluid accumulates ahead of the wave crest and exerts pressure where the vertical velocity is upward, extracting energy from the wavelet. When the two effects balance, on the average, the wavelets are in statistical equilibrium with the energy supply and their average amplitude remains unchanged.

Such equilibrium conditions can be maintained only for wavelets of a specific wavelength. This is shown by an argument relating to energy dissipation: with the wavelets in statistical equilibrium, the energy supply to the surface must be dissipated by the eddies of the turbulent surface shear layer. Standard hypotheses on turbulence lead to the result that the celerity of the wavelets coupled to the wind must be a function of the friction velocity.

Certain implications of the wind-wavelet coupling mechanism (inferred from laboratory evidence) for the aerodynamic roughness of the sea surface, and for the near-surface properties of the turbulent shear layer in water, are in satisfactory agreement with field evidence, suggesting that the same coupling mechanism also operates on a natural windblown surface.

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