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Directional spreading of surface waves by wind-wave interaction
SANG SOO LEE, DAVID WUNDROW, Naval Surface Warfare Center, Carderock Division — A transition process from long-crested to short-crested wind- driven surface waves was analyzed using a first-principles- based asymptotic method. It is shown that a nonlinear interaction between wind and a surface wave, that initially grows linearly, can generate higher spanwise harmonics whose spanwise wave numbers are integer multiples of the primary wave. The amplitudes of the nonlinearly generated spanwise harmonics are of the same order as the primary fluctuation in the air and can be as large as the primary wave in the water. The mean wind is two-dimensional and there is no mean current. The primary wave can start as a single wave that propagates obliquely to the wind direction. The spanwise harmonics are generated by the nonlinear interaction in the air critical layer. They then induce corresponding perturbations in the water. Even though the magnitude of the primary surface wave is small, it generates spanwise harmonics of equal amplitude which lead to multi-directional water wave field.

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