Resonant generation and energetics of wind-forced near-inertial motions in a geostrophic flow.

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Abstract

A slab mixed layer model and two-dimensional numerical simulations are used to study the generation and energetics of near-inertial oscillations in a unidirectional, laterally sheared geostrophic current forced by oscillatory winds. The vertical vorticity of the current modifies the effective Coriolis frequency, which is equivalent to the local resonant forcing frequency. In addition, the resonant oscillatory velocity response is elliptical, not circular, because the oscillation periodically exchanges energy with the geostrophic flow via shear production. With damping, this energy exchange becomes permanent, but its magnitude and sign depend strongly on the angle of the oscillatory wind vector relative to the geostrophic flow. However, for a current forced by an isotropic distribution of wind directions, the response averaged over all wind angles results in a net extraction of energy from the geostrophic flow that scales as the wind work on the inertial motions times the square of the Rossby number of the geostrophic flow for small Rossby number. For O(1) Rossby number, this sink of geostrophic kinetic energy preferentially damps flows with anticyclonic vorticity and thus could contribute toward shaping the positively skewed vorticity distribution observed in the upper ocean.

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