Abstract View

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Mixed Instabilities in the Gulf Stream over the Continental Slope

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ABSTRACT

A numerical model study is presented of the unstable normal modes of oscillation of a boundary current. The model background current approximates the Gulf Stream south of Cape Hatteras, North Carolina. Both vertical and horizontal shear in current velocity and a sloping bottom topography are included. The study seeks small amplitude, alongshore propagating perturbations with real frequency and complex alongshore wavenumber. A nonzero imaginary part of the wavenumber ensures that the wave amplitude either grows or decays in the alongshore direction. The first four eigenmodes are identified and their dispersion relations are investigated. Higher order modes are not resolved by the model. The dispersion surfaces (eigenvalues of frequency as a function of complex wavenumber) appear to bifurcate with increasing values of real wave number.

Observations in the Gulf Stream south of Cape Hatters have revealed a persistent wave-like meander pattern in the Stream with a period of 7–8 days. This wave form propagates in the downstream direction with a phase speed of about 40 km day^{-1} and is uncorrelated with local wind forcing. An 8-day wave also appears as an eigenmode in the model, and the perturbation velocity and buoyancy fields are consistent with observations. The instability mechanism of the model wave is of the mixed barotropic-baroclinic type, with the majority (about 80%) of the perturbation energy derived from the potential energy of the background flow. The model 8-day wave consists of a side-to-side meandering of the core of the current with filament-like structures of warm water (positive perturbation buoyancy) trailing the shoreward-most excursion of the core of the current. These filaments are separated from the core of the current by a cold dome of upwelled water.

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