Abstract View

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Subharmonic Destabilization off Vancouver Island

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ABSTRACT

The two-layer baroclinic instability model of the California undercurrent (CU) off Vancouver Island due to Mysak (1977) is modified to include the effects of nonlinearity. As a simple model to examine nonlinear effects, nonlinear interaction between two unstable baroclinic waves of frequencies $\omega_1 = k_1c_1$, $\omega_2 = k_2c_2$ ($k_1 = 2k_2$) is studied. The assumptions that $c_1 - c_2$, Im(c_1), Im(c_2) = O(ϵ) ($\epsilon \ll 1$) lead to the amplitude equations describing the resonant interaction of two modes within a limited time scale.

A linear dispersion tendency of these waves is weak in the parameter range appropriate to the CU regime. However, the coupling of the two modes vanishes if the mean potential vorticity gradient is constant. This difficulty can be removed, however, if the horizontal shear of the current and/or the curvature of the bottom slope are introduced. Here the coupling due to nonlinearity is modeled by invoking the latter effect. For the CU model off Vancouver Island, we found strong subharmonic instability owes its existence to horizontal Reynolds stress induced into the linearly unstable mode by the presence of bottom slope curvature. The instability has such a structure that the cross-stream mode function has a phase shift of π across the center of the channel. The present theory can explain well the discrepancy noted by Emery and Mysak (1980) between the waves observed in satellite images and those predicted by a linear theory.

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