Abstract View

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The Influence of Sloping Mean Density Surfaces on Low-Frequency Shelf Water Flow

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ABSTRACT

A model is derived to explore the influence of sloping mean density surfaces on low-frequency wind-driven, frictional shelf water flow. The model coastline, isobaths and mean density field do not vary alongshore and a simple wave-like form is assumed for the wind stress forcing. A perturbation solution near the barotropic limit shows that sloping mean density fields can fundamentally influence the low-frequency flow. For example, it is quite possible for low-frequency wind-driven flow on a shelf with mean density field sloping upwards toward the coast (corresponding to an upwelling situation) to be barotropic even though the low-frequency flow is baroclinic for the corresponding horizontally uniform stratification.

The solution for the alongshore velocity field was calculated for some idealized cases using simple models of bottom topography and mean density field. In addition to the expected influence of the sloping mean density surfaces, the structure of the alongshore velocity response was significantly affected by the direction of wind stress propagation. Wind stress forcing which propagates in the opposite direction to free coastally-trapped waves produces a significantly more baroclinic and weaker alongshore velocity than forcing propagating in the same direction.

These results may qualitatively explain the strong seasonal difference in low-frequency wind-driven response over the Oregon shelf. In the summer upwelling season the upward tilting isopycnals and forcing by mainly poleward propagating wind stress suggest a barotropic low-frequency response as observed. In winter the horizontal or slightly downward tilting isopycnals and mainly equatorward propagating weather systems are consistent with the observed baroclinic response.

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