Abstract View

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An Integral Hydrodynamic Model of Upper Ocean Frontal Dynamics: Part I. Development and Analysis

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ABSTRACT

The paper develops and analyzes a model of frontal-scale dynamics applicable to established, persistent upper ocean density fronts. The effects of interfacial friction and mass entrainment arising from turbulent dissipative processes are incorporated as well as the effects of earth rotation and wind stress. The model is of hydrodynamic character in that the circulation is not permitted to do its own mixing. The equations of motion are solved after their integration over the vertical from the pycnocline bottom to the sea surface. Two independent frontal length scales are found. one is L_t, the dissipative length scale, defined as the ratio of the asymptotic pycnocline depth to the magnitude of the interfacial entrainment coefficient; the other is the baroclinic Rossby radius, the internal wave phase speed divided by the Coriolis parameter. The ratio of these length scales forms the fundamental parameter of the model dynamics, P_r, called the rotation parameter. For large values of P_r the frontal length scale is the Rossby radius alone and the model dynamics show features in common with the inertial, inviscid Gulf Stream theories. For small values of P_r the frontal zone can have a double structure with the inner region corresponding to the nonrotational dynamics explored in a previous paper. For values of order one both dissipative and rotational effects enter the dynamics.

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