Abstract View

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Generation of Fronts by Mixing and Mutual Intrusion

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ABSTRACT

In this paper a mechanism is proposed which could be responsible for the formation of sharp horizontal density gradients such as those observed in shallow seas, from fluid which initially has weak horizontal density gradients. The sharp density gradients result from the mutual intrusion of several stratified bodies of water which were exposed to various degrees of vertical mixing for a limited amount of time. The dynamics of the intrusion are examined by a simplified nonrotating, frictionless multilayer model. The results are compared quantitatively to laboratory experiments and qualitatively to field observations.

The theoretical model contains an upper and lower portion, each of which consists of several bodies of fluids with different densities corresponding to various degrees of mixing. It predicts that in both the upper and the lower portions, fluids which were exposed to intermediate mixing sink rapidly from the surface, rise from the bottom, and after a finite amount of time concentrate in mid-depth. This results in a formation of density discontinuities (fronts) near the surface, bottom, and in the boundary between the upper and the lower portions.

Rotation is excluded from the simplified model, but it is expected that mutual intrusion will take place even if rotation is included, provided that the flow is not in an exact geostrophic balance. The theoretical predictions were tested in the laboratory in a tank which contained several bodies of water with different densities separated initially by a number of gates. The experimental results compare favorably with the theoretical predictions. Observations which suggest the existence of mutual intrusion in frontal zones are discussed.