Abstract View

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Interface Migration in Thermohaline Staircases

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ABSTRACT

A theory for the vertical migration speed (e) of interfaces within thermohaline staircases is developed and illustrated with several oceanic examples. It expresses e in terms of layer-to-layer variations in the vertical buoyancy flux (J). We discuss three mechanisms which can induce migration: 1) the nonlinearity of the equation of state; 2) layer-merging (the coalescence of adjacent layers); and 3) interface-splitting (the creation of new layers at the interfaces between existing layers), The theory predicts that migration will be much slower for nonlinearity than for layer-merging and inteface-splitting, because layer-merging and interface-splitting should lead to large O(1) variations in J, while nonlinearity leads to much smaller $O(10^{-2})$ variations. Even so, the net effect of migration associated with layer-merging and interface-splitting should be small, since the interfaces will not have time to migrate very far before the staircase readjusts to a new, migration-free, equilibrium state.

The large-scale effects of interface migration are predicted to be small, with migration-induced heat and salt fluxes being less than 20% of the double-diffusive fluxes. The migration itself will be difficult to observe: for example, we calculate $e \sim 10^{-1}$ m s^{-1} for Arctic halocline staircases. This is much too small to explain the *apparent* migration speed, $e \sim 10^{-4}$ m s^{-1}, derived by tracking interfaces in CTD Arctic profiles. Therefore, the apparent migration is probably a sampling artifact associated with advection of staircase anomalies having vertical scales of O(1) m (i.e., the layer thickness) and horizontal scales of O(100) m.

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