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A laboratory model of vertical ocean circulation driven by mixing

JOHN WHITEHEAD, Woods Hole Oceanographic Institution — A model of deep ocean circulation driven by turbulent mixing is produced in a rectangular laboratory tank. Salinity difference substitutes for thermal difference of surface forcing. Fresh water gently flows in at the top of one end, dense water enters at the other end, and an overflow in between removes the same amount of water. A mixing rod, extending from top to bottom of the tank, mixes near the fresh water source by traveling back and forth at constant speed (Reynolds number >500). A stratified upper layer deepens from the mixing and spreads across the entire tank. Simultaneously, a turbulent plume ("deep-ocean overflow") from the dense-water source descends through the layer and supplies bottom water, which spreads over the entire tank floor and rises into the upper layer to arrest the upper layer deepening. Recirculation from plume entrainment has a volume flux greater than the sources. Over a wide range of parameters there is approximate agreement with a scaling theory. Also, the rate of potential energy increase from mixing equals potential energy rate of decrease from the plume. Many of these features are found in our ocean.

John Whitehead
Woods Hole Oceanographic Institution

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