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How entraining density currents influence the stratification in a one-dimensional ocean basin

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The sensitivity of ocean stratification to the vertical distribution of plume entrainment is analyzed. A large ocean basin supplied by dense water from an adjoining marginal sea is considered. The dense water flows into the ocean basin as an entraining density current and interleaves at the bottom, or at the level of neutral density, where it deposits a mixture of marginal sea- and basin water. As the basin water, i.e. 'old' plume water, is entrained and re-circulated in the plume, a stratification develops in the basin. The mixture deposited at the bottom hence contains an increasing fraction of marginal sea water, and the basin density increases with depth as well as with time. A stationary solution in which diffusion of buoyancy from above balances the upward advection from below is approached asymptotically in time. Non-diffusive solutions to the initial transient adjustment, as well as the diffusive asymptotic state, have been studied for different parameterizations of plume entrainment. It is shown that in the transient regime the basin stratification and plume density are highly sensitive to how mixing is parameterized. The stationary diffusive solution that is approached asymptotically in time is less sensitive to parameterization, but depends strongly on basin topography, source water density, and buoyancy flux at the surface.