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# Accelerating dense-water flow down a slope

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Where water is denser on a shallow shelf than in the adjacent deep ocean, it tends to flow down the slope from shelf to ocean. The flow can be in a steady bottom boundary layer for moderate combinations of up-slope density gradient -$\rho_{x\infty}$ and bottom slope (angle $\theta$ to horizontal):

$b \equiv |\rho_{x\infty}| \; g \sin\theta / (f^2 \rho_0) < 1.$

Here $g$ is acceleration due to gravity, $\rho_0$ is a mean density and $f$ is twice the component of earth's rotation normal to the sloping bottom. For stronger combinations of horizontal density gradient and bottom slope, the flow accelerates. Analysis of an idealised initial-value problem shows that when $b \geq 1$ there is a bottom boundary layer with down-slope flow, intensifying exponentially at a rate $fb^2(1+b)^{-1/2}/2$, and slower-growing flow higher up. For stronger stratification $b > 2^{1/2}$, i.e. relatively weak Coriolis constraint, the idealised problem posed here may not be the most apposite but suggests that the whole water column accelerates, at a rate $[g\rho_0^{-1}|\rho_{x\infty}|\sin\theta]^{1/2}$ if $f$ is negligible.