Accelerating dense-water flow down a slope

J. M. Huthnance

NERC Proudman Oceanographic Laboratory, Liverpool, United Kingdom (jmh@pol.ac.uk, +44-(0)151-7954801)

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 -Rx∞ and bottom slope (angle to horizontal):

$b \equiv |Rx\infty|\, g \sin / (f^{**}2\, R0) < 1.$

Here g is acceleration due to gravity, $R0$ 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

$0.5\, f\, b^{**}2\, (1+b)^{**}(-1/2)$

and slower-growing flow higher up. For stronger stratification $b^{**}2 > 2$, 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 $[|Rx\infty|\, g \sin / R0]^{**}(1/2)$ if f is negligible.