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Modelling of shelf water cascades on the continental slope

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The sinking of dense shelf waters down the continental slope “cascading” contributes to oceanic water mass formation and the off-shelf transport of carbon. Using a process-based approach we study cascading over idealised bottom topography in numerical experiments using POLCOMS, a 3-D ocean circulation model employing a terrain-following s-coordinate system. The model setup is based on a laboratory experiment of a continuous dense water flow from a central source on a steep conical slope (39°) in a rotating tank. The vertical resolution and bottom boundary condition are configured specifically to resolve the physics of Ekman veering in the bottom and interfacial boundary layers. The descent of the dense flow as characterised by the length of the plume as a function of time is studied for a range of experimental parameters, mainly the density difference between plume and ambient water, the flow rate and the speed of rotation. The model is successfully validated in a series of runs accurately reproducing the laboratory experiments. Our results demonstrate that a hydrostatic model is capable of reproducing the essential physics of cascading on a very steep slope if the model correctly resolves velocity veering in the bottom boundary layer. On the other hand, numerical simulations utilising the standard parametrisation of the bottom boundary layer (instead of resolving it) fail to reproduce the lab experiments. Our 3-D modelling confirms findings previously obtained by reduced physics models for a 2-layer flow.

We further explore the dynamics of cascading outside of the controlled laboratory conditions in model runs where viscosity and/or diffusivity are modified. The limits of the reduced physics theory are identified in simulations with increased diffusivity where the cascade has a blurred interface between plume and ambient water and can no longer be considered a 2-layer flow. We show that downslope transport is reduced when the plume interface is strongly diffused, but enhanced in a regime that simulates cascades with increased turbulence where diffusivity and viscosity are both increased.

References

Shapiro, G. I., Hill, A. E., 1997. Dynamics of dense water cascades at the shelf edge. *Journal of Physical Oceanography* 27 (11), 2381–2394.

Shapiro, G. I., Zatsepin, A. G., 1997. Gravity current down a steeply inclined slope in a rotating fluid. *Annales Geophysicae* 15 (3), 366–374.