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Exploring viscosity space in a 1/4° global NEMO: is viscosity a useful control for numerical mixing?

Alex Megann

National Oceanography Centre, Marine Systems Modelling, Southampton, United Kingdom (apm@noc.ac.uk)

The standard ORCA025 NEMO configurations use a biharmonic viscosity scheme for lateral momentum diffusion, with a default value for rn_ahm_0_blp of -1.5 x 10-11 m4/s. This is widely suspected to be too small to provide an ideal closure for the momentum equation discretisation, and in practice leads to grid-scale noise in regions where mesoscale features are poorly resolved. Megann (2017) diagnosed the effective diapycnal diffusivity in the GO5.0 configuration, and showed that this was up to an order of magnitude larger than the explicit diffusivity, interpreting the excess as numerical mixing, and ascribing at least part of this to the grid-scale noise.

A suite of simulations is described, all using an identical NEMO configuration, but with different viscosity parametrisations. Two have values of the bilaplacian viscosity increased relative to that in the control experiment, and a further three use instead the biharmonic Smagorinsky viscosity scheme, which enhances the momentum diffusion in eddy-rich regimes, while decreasing it for more laminar flows. We use the method described in Megann (2017) to analyse the numerical mixing in these experiments, and show that increasing the viscosity tends to reduce diapycnal mixing by suppressing vertical velocity noise at the grid-scale, and we also discuss the relative advantages of the various viscosity schemes in the context of the mean circulation and drifts of the model fields.