A Broad-Ranging Formulation of Lateral Mixing

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Abstract

A specification of lateral viscosity is developed, involving the combined application of biharmonic and Laplacian forms. Related to that of Chassignet andGarraffo (2001), our prescription is intended to be readily applicable across a wide range in model resolution.

Here, we apply this new approach in 0.1 degree simulations of Los Alamos’ POP ocean model. A regional North Atlantic simulation is considered first. Based on experience gained with the regional model, we then apply our formulation to a fully global model.

Developed as a viscous parameterization, as presented here, the prescription may also offer a useful method for the scaling of lateral tracer mixing coefficients as a function of grid resolution.

Introduction

More of the mixing processes that occur in the ocean are explicitly included in strongly eddying models, yet the parameterization of mixing remains of foremost importance. Beyond noise control and the path of Agulhas Rings are two notable points of improvement.

Our new prescription for combined use of Laplacian and biharmonic lateral mixing produces some additional improvement in the North Atlantic, as in the regional study. In particular, the somewhat excessive variability downstream of Cape Hatteras is lessened (see middle panel of Figure 5, case ghl).

Concluding remarks

We have developed a simple method of combining Laplacian and biharmonic forms of viscosity, as an extension of the work of CG01, and we have found this prescription to result in improvements in both regional and global versions of a high-resolution, strongly-eddying model. Variability in the Gulf Stream region and the path of Agulhas Rings are two notable points of improvement.

Our prescription is designed for use over a broad range of resolutions, with biharmonic viscosity providing noise control and Laplacian viscosity providing viscous balance over the western boundary current regions. The basic scheme can be extended readily to more sophisticated anisotropic schemes, where our prescription for the scaling of the coefficient of Laplacian viscosity with grid resolution would provide the cross-stream or zonal component in the western boundary regions. Use in non-eddying models may require such an extension.