

Energetically consistent, resolution aware, parameterization of mesoscale eddies in the ocean

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This presentation discusses a framework for the parameterization of subgrid-scale eddies, which makes use of a subgrid eddy kinetic energy (EKE) budget and can be applied at both "non-eddy" and "eddy-permitting" resolutions. The subgrid-scale eddies exchange energy with the resolved flow via a GM-based parameterization of baroclinic instability, as well as bi-harmonic and negative Laplacian viscosity terms. This formulation allows us to represent the turbulent cascades of energy and enstrophy in a way that is consistent with our current understanding of the turbulent eddy energy cycle. At the same time, the approach is simple and general enough to be readily implemented in ocean climate models, without adding significant computational cost.

The closure has been implemented in GFDL's Modular Ocean Model (MOM6) and tested in the "Neverland" configuration, which employs an idealized analytically defined topography and has been designed as a testbed for mesoscale eddy parameterizations. The parameterization allows us to adequately reproduce high-resolution simulation results over a range of coarser resolutions, seamlessly connecting the traditional "non-eddy" and "eddy permitting" regimes.

The results also point towards limitations in our theoretical understanding of eddy energetics that need to be addressed in order to further improve the formulation of eddy parameterizations, highlighting in particular the need to better understand the routes to dissipation of mesoscale eddy energy.