"Abyssal Recipes and Spatially Varying Diapycnal Mixing"

Abstract: The concept of uniform diapycnal mixing balancing uniform upwelling in the abyssal ocean is now slowly being abandoned. Observations indicate weak mixing in the ocean interior away from topography and mixing enhanced by orders of magnitude over rough topography. Numerical studies using Ocean General Circulation Models (OGCMs) with mixing parameterizations mimicking observations have dispelled the idea of a simple link between diapycnal mixing and the Meridional Overturning Circulation (MOC). In contrast, a number of other important aspects of the ocean circulation (e.g., the Antarctic Circumpolar Current, marine biogeochemistry) are now known to be sensitive to the spatial distribution of diapycnal mixing.

We here review some of these recent findings and then compare and contrast two rudimentary, spatially-varying mixing schemes to each other and observations. The parameterizations considered are the widely implemented tidal mixing parameterization by St. Laurent and co-authors and the empirical Roughness Diffusivity Model (RDM) by Decloedt and Luther. It is found that the parameterizations yield similar basin-averaged diffusivities but have spatial distributions of diffusivity that are dramatically different, which would lead to quite different circulations in OGCMs. A comparison to microstructure-based diffusivity estimates reveals that the vertical structure in the tidal mixing parameterization compares poorly to observations, an issue of concern since it is the vertical gradient of the diapycnal diffusivity that is of dynamical importance. Both parameterizations are conservative compared to hydrographic inverse estimates in the Atlantic and Pacific mid-latitude basins and significantly underestimate diffusivities in the Indian and Southern Oceans. This suggests that abyssal mixing processes other than the breaking of bottom-generated internal waves may be important in setting the global spatial distribution of diapycnal mixing in the abyssal ocean.

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