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Diapycnal diffusivity in Drake Passage

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Enhanced mixing over regions of rough topography is believed to be important in driving the upward transport of water required to close the meridional overturning circulation of the oceans. Drake Passage in the Southern Ocean is thought to be a region where strongly enhanced mixing takes place, and quantifying this is one of the aims of the UK-US DIMES (Diapycnal and Isopycnal Mixing Experiment in the Southern Ocean) project. The DIMES programme involves a tracer release at 107°W in the SE Pacific sector of the Southern Ocean with a number of subsequent cruises tracking the spreading and mixing of the tracer as it progresses through Drake Passage into the Scotia Sea. We present here a simple 2D advection-diffusion model that has been combined with results from the 2010 and 2011 DIMES tracer surveys to derive a preliminary estimate for the diapycnal diffusivity in the region.

The area occupied by the tracer has been divided into two zones: west of 67°W, designated as the Pacific, and east of 67°W, where the rough topography of Drake Passage begins. The tracer evolution relative to an isopycnal surface is then modelled with mean advection and Fickian diffusion in the along-stream direction, and Fickian diffusion only in the vertical. The isopycnal diffusivity κ_h, diapycnal diffusivity κ_z, and the zonal velocity u for each zone are optimised to fit the model output to the experimental tracer data for the two cruises by minimising a cost function which compares the modelled profile widths and peak concentrations with their experimental values. κ_z is found to be strongly enhanced in Drake Passage: approximately 30 times higher than in the Pacific.

Further work is currently in progress using an offline version of MITgcm to model the evolution of the tracer in three dimensions. The velocity field from the SatGEM product is used to provide realistic advection, in order that a better constrained estimate of the diapycnal diffusivity field may be made. A similar investigation with the SOSE (Southern Ocean State Estimate) fields will be carried out for comparison. Ultimately a three dimensional diapycnal diffusivity field will be derived which best fits the DIMES tracer observations.