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Modelling diapycnal diffusivity in Drake Passage with MITgcm and the DIMES tracer

Neill Mackay (1), Andrew Watson (1), Marie-Jose Messias (1), Alberto Naveira-Garabato (2), and Katy Sheen (2)
(1) University of East Anglia, School of Environmental Sciences, Norwich, United Kingdom (n.mackay@uea.ac.uk), (2) National Oceanography Centre, Southampton, United Kingdom

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. We present here a 3D model of the tracer evolution which is combined with measurements from the 2010 and 2011 DIMES cruises to quantify the diapycnal mixing in the region and characterise its distribution.

The model used is an offline version of the MITgcm, forced with spatially and time varying velocities from the SatGEM product. Velocity fields are mapped onto isopycnals centred on the γ_n=27.9 neutral density surface, onto which the tracer was released. The tracer is initialised at release in February 2009 and advected and diffused until April 2011 using the 'Prather' advection scheme. The observations were made along 3 north-south transects at 79°W and 58°W - sampled in December 2010 and April 2011 - and at 68°W - sampled only in December 2011. A 3-dimensionally varying diapycnal diffusivity field κ_z is applied to the model and optimised to give the best fit to the tracer observations by minimising a cost function.

The diapycnal diffusivity field which best fits the observed tracer distribution is a simple 2 zone field, with κ_z = 1.8x10^{-5}m^{2}s^{-1} in all locations west of 67°W, designated the SE Pacific, and κ_z = 3.4x10^{-4}m^{2}s^{-1} east of 67°W, designated Drake Passage. Distributions of κ_z based on microstructure measurements do not reproduce as closely the quantity and distribution of diapycnal mixing experienced by the tracer. We conclude that instantaneous mixing values measured by microstructure do not appear to be large enough to account for the time and spatially averaged mixing implied by the tracer measurements.