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Adiabatic, Constrained, Stochastic Eddy Parameterisation

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Mesoscale eddy-permitting ocean models will be needed as a component of climate ensemble projections most likely for the next decade or more. However, the kinetic energy and other measures of variability are typically an order of magnitude too weak at this nominal 0.25 degree lon-lat resolution. This is predominantly due to excessive gridscale damping of momentum, needed for computational stability, which is believed to kill a large fraction of the energy source of the kinetic energy inverse cascade. The KE inverse cascade is associated with the generation of intrinsic chaotic variability and ensemble spread, hence the estimation of potential predictability, but also with slower, larger-scale variability associated with climate. The familiar Gent and McWilliams (1990) eddy parameterisation is problematic when applied to eddy-permitting models, where eddies are partially resolved, and it also tends to damp variability rather than energise it. In response to this problem, several recent studies have focussed on the KE backscatter problem, which each attempt to increase the upscale transfer of KE, either deterministically or stochastically.

Stochastic parameterisation of sub-gridscale eddies has recently become a popular approach in ocean modelling, having been used in atmospheric modelling for many years, but there is still a diverse range of approaches for constraining either the underlying physics (how the forcing is applied) or the statistics (the spatiotemporal signature of the forcing). This study explores some basic recipes for constructing the stochastic model from statistics of either observations or higher-resolution models. The stochastic forcing, representing the sub-gridscale effects of eddies in our eddy-permitting simulations, is also applied adiabatically – to mimic the predominant behaviour of mesoscale eddies in the ocean interior and to preserve large-scale watermasses. A theoretical challenge, which we explore, is to connect the applied, weakly imbalanced forcing, to a response in kinetic energy and upscale transfer. This must also be applied without generating numerical instability.