Vertical structure of transport by ocean mesoscale turbulence

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Ocean mesoscale eddies -vortices of size tens of kilometers- play a significant role in the transport of heat, salt and tracers across latitudes. Despite this significant impact on the global ocean, most climate models do not resolve mesoscale vortices and rely on crude parametrizations of the associated turbulent transport.

We revisit this turbulent transport problem based on the asymptotic dynamics of rotating stratified flows. We propose a direct derivation of the diffusion tensor relating the turbulent fluxes to the background gradients of an arbitrary tracer, together with constraints on the vertical structure of the associated transport coefficients [2]. Based on these constraints, we derive a perturbative prediction for the vertical structure of the turbulent heat flux within the water column. We quantitatively validate these predictions by comparison with Direct Numerical Simulations of an isolated patch of ocean [3]. The resulting physically-based parametrization is currently being implemented in a global ocean model.

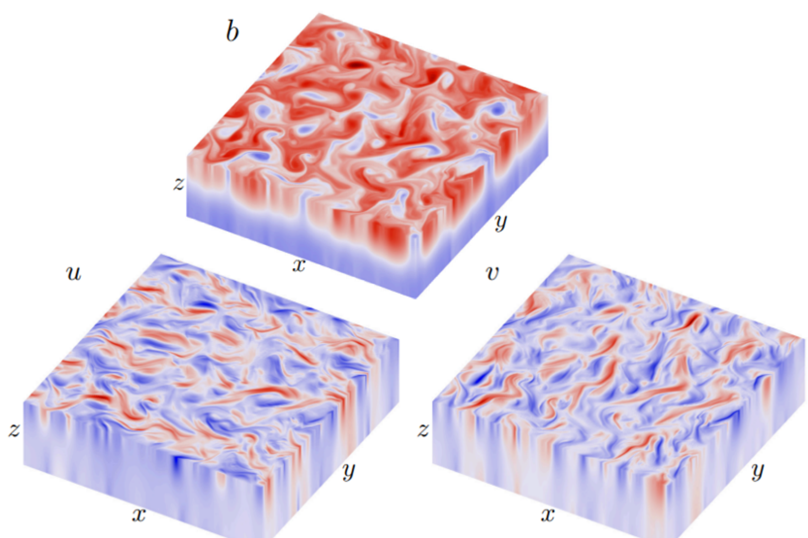

Figure 1. Visualisations of mesoscale eddies in a simulation of an idealized patch of ocean: snapshots of buoyancy departure b, zonal velocity departure u and meridional velocity departure v.

References

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2. Meunier J, Miquel B, Gallet B., A direct derivation of the Gent–McWilliams/Redi diffusion tensor from quasi-geostrophic dynamics, *J. Fluid Mech.*, **963**, A22 (2023).
3. Meunier J, Miquel B, Gallet B., Vertical structure of buoyancy transport by ocean baroclinic turbulence, *Geophysical Research Letters*, **50**, e2023GL103948 (2023).