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Local quantification of numerically-induced mixing and dissipation

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The discretisation of the advection terms in transport equations introduces truncation errors in numerical models. These errors are usually associated with spurious diffusion, i.e. numerically-induced mixing of the advected quantities or dissipation of kinetic energy associated with the advection of momentum. Especially the numerically-induced diapycnal mixing part is very problematic for realistic model simulations.
Since any diapycnal mixing of temperature and salinity increases the reference potential energy (RPE), numerically-induced mixing is often quantified in terms of RPE. However, this global bulk measure does not provide any information about the local amount of numerically-induced mixing of a single advected quantity.
In this talk we will present a recently developed analysis method that quantifies the numerically-induced mixing of a single advected quantity locally (Klingbeil et al., 2014***). The method is based on the local tracer variance decay in terms of variance fluxes associated with the corresponding advective tracer fluxes. Because of its physically sound definition, this analysis method provides a reliable diagnostic tool, e.g., to assess the performance of advection schemes and to identify hotspots of numerically-induced mixing. At these identified positions the model could be adapted in terms of resolution or the applied numerical schemes. In this context we will demonstrate how numerically-induced mixing of temperature and salinity can be substantially reduced by vertical meshes adapting towards stratification.

*** Klingbeil, K., M. Mohammadi-Aragh, U. Gräwe, H. Burchard (2014) . Quantification of spurious dissipation and mixing – Discrete Variance Decay in a Finite-Volume framework. Ocean Modelling. doi:10.1016/j.ocemod.2014.06.001.