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First steps to ocean energy backscatter on unstructured grids

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Ocean models with eddy permitting grid resolution, i.e. around 1/10°-1/4°, generally suffer from unrealistically strong energy dissipation. While some of the larger eddies may be explicitly resolved, closures with high viscosities overdamp the system resulting in reduced eddy kinetic energy and consequently weakened eddy induced transports. The necessity to apply such viscosity closures originates to a large degree from numerical stability criteria.

The recently proposed concept of energy backscatter in ocean models allows to reinject part of the spuriously dissipated energy into the flow through an additional negative viscosity term. By modelling the exchange between dissipated resolved flow energy and reinjected sub-grid energy, sub-grid eddy energy can be backscattered in such a way that model stability is not compromised.

In this study we show first results of the backscatter parametrization in the finite volume model FESOM2 that allows for unstructured grid configurations. The setup is a periodic mid-latitude channel test case with boundaries in the north and south and 24 vertical layers. Resolution can be either constant throughout the channel or it can be increased locally. The impact of energy backscatter on different grid configurations is investigated. The new implementations lead to strongly increased eddy kinetic energy that corresponds to simulations with higher resolution, simultaneously being computationally much more efficient than a resolution increase. Furthermore, vertical buoyancy fluxes and horizontal energy spectra are diagnosed for different resolutions to analyse how backscatter and grid refinement affect spatial flow structures including energy cascades and transfers. Future perspectives and applications will be discussed.