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Application of the EOF reduction method to idealized models for the wind-driven ocean and the thermohaline circulation

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To get an acceptable solution from an ocean model, a considerable amount of computational resources is required. Alternatively, it is possible to expand almost every field in terms of EOFs because they form a complete orthogonal basis. This has the consequence that application of an EOF reduction method to the ocean model possibly facilitates a relatively accurate solution with less computational resources due to its necessity of a small and finite number of EOFs.

In this work the formulation and testing of the EOF reduction method to spectral models for the wind-driven ocean and the thermohaline circulation are discussed. The comparison to the solution of the reference model is conducted by solving numerically the model equations at a high spectral resolution. In the first case it is the barotropic vorticity equation with free-slip conditions at the boundaries in an idealized rectangular ocean, which is forced by steady zonal winds and damped by lateral friction. In the second case the spectral model comprises vorticity, temperature and salinity equations describing the meridional overturning forced by heat and fresh-water fluxes.

For this study in particular, an EOF model solution was calculated by using different numbers of EOFs, (from 5 to 100). The differences between these and the reference solution are calculated showing in a certain setup the sufficiency of 40 EOFs for reproducing the dynamics for a model with 1724 spectral coefficients relatively well. These results indicate that EOF reduction is suitable for simplification of idealized ocean models in some cases. This is beside the reduced computational effort also of benefit for a better understanding of the system dynamics.