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# Non-normal dynamics of the Atlantic ocean circulation in an idealized GCM

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An idealized configuration of the MIT-General Circulation Model (MITgcm) is used to investigate the non-normal dynamics of the Atlantic ocean circulation.

In a double-hemisphere ocean basin, we examine the existence of optimal perturbations leading to a maximum amplification, via non-normal growth, of different quantities such as available potential energy, density or sea surface temperature. In most cases, we find that appropriate initial conditions concentrated at the northern boundary of the subtropical gyre can lead to large amplification of these quantities on timescales of years. The model is in a stable regime, and therefore this perturbation eventually decays.

The transient growth found is evidence for a significant non-normality of the stable linearized dynamical operator. The optimal initial conditions leading to the transient amplification are obtained by solving a generalized eigenvalue problem. Their evaluation is achieved by using the tangent linear and adjoint models of MITgcm as well the ARPACK software aimed to solve large scale eigenvalue problems.

The impact of such perturbations on the model heat and volume transport is analyzed. Our results suggest that transient amplification of ocean thermohaline and wind driven circulation perturbations due to stochastic forcing may be an efficient way to excite ocean variability on interannual timescale and may limit predictability of the ocean circulation to about 5-10 years.