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Singular vectors of North Atlantic Ocean and implications for variability and predictability

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The variability and the predictability of the Atlantic meridional overturning circulation (MOC) and sea surface temperature (SST) are examined by evaluating singular vectors in an ocean GCM with an idealized configuration. Despite the stable linearized dynamics, significant transient amplifications of MOC and SST anomalies occur due to the non-normal dynamics. The mechanisms responsible for the growth of anomalies are analyzed. The MOC is found to be most sensitive to high latitudes deep density perturbations and is reaching a maximum amplification after 7.5 years. This implies that initial conditions and model errors in the deep ocean might limit the predictability of the MOC to less than a decade. MOC anomalies are found to grow faster when deep ocean perturbations are allowed rather than when only the surface is perturbed such that most predictability experiments in which only the atmospheric state is perturbed may overestimate of the predictability time in the Atlantic. MOC and SST anomalies growth mechanisms are fully 3D with the participation of westward propagating thermal Rossby waves. Ocean dynamics is found to participate actively in the amplification of SST and MOC anomalies rather than to passively integrate over the imposed initial forcing such that one may need to consider non-normal effects when inspecting SST trends in the next decades.