Optimal surface salinity perturbations of the meridional overturning circulation

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Recent observations and modeling studies have stressed the influence of sea surface salinity (SSS) perturbations on the North Atlantic circulation. To investigate this question, Generalized Stability Analyses (GSAs) are performed in a hierarchy of ocean circulation models (going from a 2D latitude-depth model to a ocean general circulation model in a realistic global configuration). In the GSAs, the optimality is defined with respect to the meridional overturning circulation intensity. The influence of the large scale meridional gradient of SSS anomaly located in the North Atlantic is highlighted in every models. Although the steady states are asymptotically stable in every experiments, the models are able to generate some transient growth due to optimal initial perturbation of the SSS or variability due to optimal stochastic perturbation of the SSS.

In the ocean general circulation model (OPA), an optimal mechanism leading to a transient growth of the meridional overturning circulation is described. The transient growth appears for a delay of 10.5 yr after the perturbation by the optimal initial SSS anomaly. This optimal initial anomaly is located north of 50°N. The transient growth mechanism shows the importance of the large scale zonal gradient of the mean temperature in the North Atlantic. The optimal surface salinity perturbations studied herein yield upper bounds on the intensity of the response in meridional overturning circulation. Using typical amplitudes of the Great Salinity Anomalies, the upper bound for the associated variability is 0.8 Sv (11% of the mean circulation).