The spatial and temporal characteristics of the adjustment of the thermohaline circulation, in response to the removal of surface freshwater forcing in a coupled general circulation model

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The spatial distributions of precipitation and evaporation at the ocean surface are predicted to change, as the climate system adjusts in response to the increased radiative forcing provided by greenhouse gases. This could have a major impact on the thermohaline circulation (THC), due to the role played by the net freshwater flux in maintaining salinity structures and, in turn, the vertical stratification. The modified THC could further alter the climate system, giving the possibility of rapid climate changes, as seen in the past. Nevertheless, the relevant feedback mechanisms and adjustment timescales are poorly understood.

We present an investigation of the mechanisms which maintain the salinity field in a coupled atmosphere-ocean general circulation model. We compare two 100-year integrations, initiated from the same present-day thermohaline structure. A perturbed simulation, in which the net freshwater flux into the ocean is prescribed to be zero at each ocean gridpoint and each timestep, is compared with a control run which has interactive freshwater exchange. The radiative forcing is constant in both runs. The strength of the North Atlantic meridional overturning circulation in the perturbed simulation is greatly reduced by the end of the integration. We investigate the mechanisms associated with this THC slowdown, and assess the impacts on the dominant modes of interannual climate variability in the North Atlantic ocean.

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