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Sensitivity of the thermohaline circulation to global freshwater forcing.

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The future climate scenarii simulations using state-of-the-art coupled models (IPCC 2001) display a wide diversity of behaviors for the thermohaline circulation (THC). Most of the spread in the simulated evolution of the THC is likely due to an important sensitivity of these models to the global freshwater forcing. In the scenarii simulations, two opposing mechanisms compete: (i) an increase of evaporation in the Atlantic tropics increases the Northward salt advection (Nsa) to the convection sites (Labrador, Irminger an GIN Seas) thus increasing the THC, (ii) the increase of precipitation in the Northern Atlantic decreases the Southward salt advection (Ssa) from the Artic and increases the local precipitation above the convection sites which tends to slow down the THC.

The relative effect of this two opposite mechanisms is evaluated in the IPSL-CM4 ocean-atmosphere-sea-ice coupled model (used in IPCC AR4). Sensitivity experiments have been integrated for 100 years under modern conditions. Different freshwater forcing are set to zero for the ocean during the coupling procedure. The effect and time scale of process (i) and (ii) are thus evaluated. It is shown that the convection sites exhibit different sensitivity to these processes. The Labrador Sea shows a dominant sensitivity to local forcing and Ssa in 10 years whereas the Irminger Sea is mostly sensitive to Nsa with a 20 years time constant. GIN Seas are sensitive to the two effects with nearly the same magnitude with a time scale of 10 years for Nsa and 20 years for Ssa. In this model, the global freshwater forcing damps the THC on time scale of 100 years. This result is mostly due to the difference of advective times scales between process (i) and (ii). This analysis can help understand the diversity of the THC behavior in IPCC scenarii simulations.