Inter-basin freshwater exchange as a control of the global ocean thermohaline circulation

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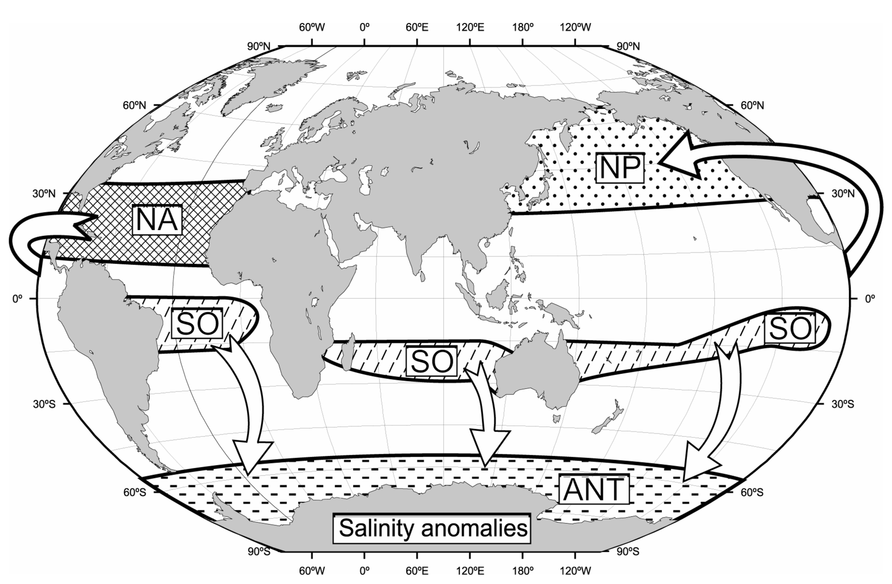
Redistribution of freshwater between the Atlantic and Pacific Oceans, both in the atmosphere and by the ocean circulation itself, has long been recognized as a major cause of the observed asymmetry in sea surface salinity (SSS) between these two basins. We introduce a hypothesis that inter-basin SSS gradients, regardless of their genesis and even with only rudiment latitudinal distributions of SSS in different basins, can account for the global character of THC. To test this hypothesis, we have used the GFDL ocean model in a series of sensitivity experiments with specified yet highly idealized patterns of inter-basin freshwater redistribution by the atmospheric flows.In numerical experiments using an ocean general circulation model, we have aggregated the observed sea surface salinity SSS in several different ways shown in Table 1 and Figure 1.



Exp.	Description of sea surface boundary conditions
1	Annual SST and SSS
2	Annual SST and SSS=const=34.25 psu everywhere
3	Annual SST and SSS=const=34.25 psu everywhere, except for North Atlantic (NA) and North Pacific (NP), i.e., only the A-P SSS contrast (2.5 psu) exists (see Fig. 1)
4	Annual SST and SSS zonally averaged (retaining no inter-basin SSS contrasts)
5	Annual SST and initial SSS=const=34.25 psu everywhere with freshwater fluxes positive in NA and negative in NP.

Figure 1. Areas of the World Ocean selected for the experiments, with area-averaged sea surface parameters.

Exp. 1 is the "control run" with annually mean ocean surface climatology; SST and SSS are from [*Levitus and Boyer*, 1994; *Levitus et al.*, 1994], and wind stress TAU is from [*Hellerman and Rosenstein*, 1983].

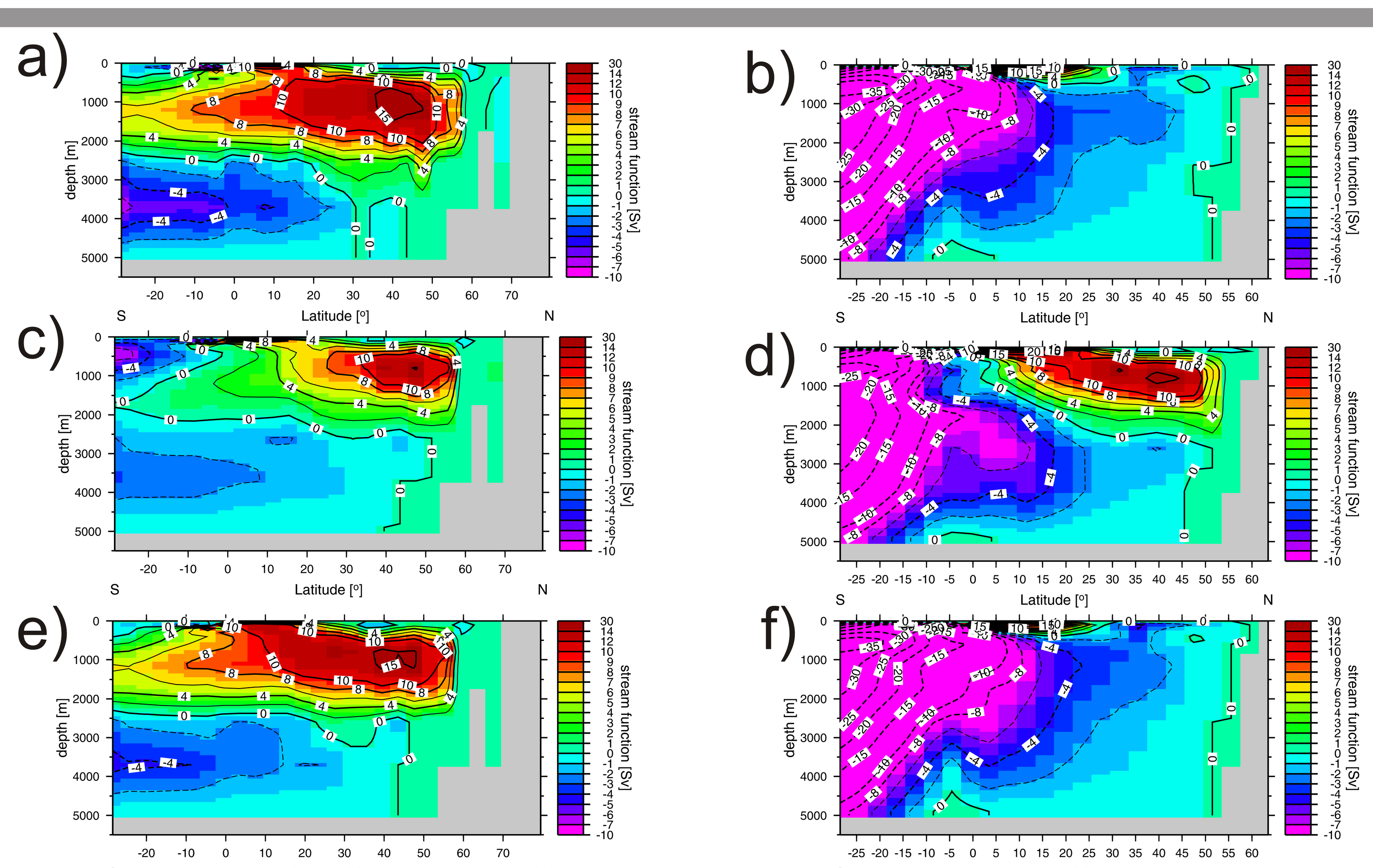


Figure 3. Meridional overturning (Sv) in Exp.1-3; Exp. 2 (Table 1) with SSS=const everywhere. There is no global conveyor, and there is a strong overturning in NP.

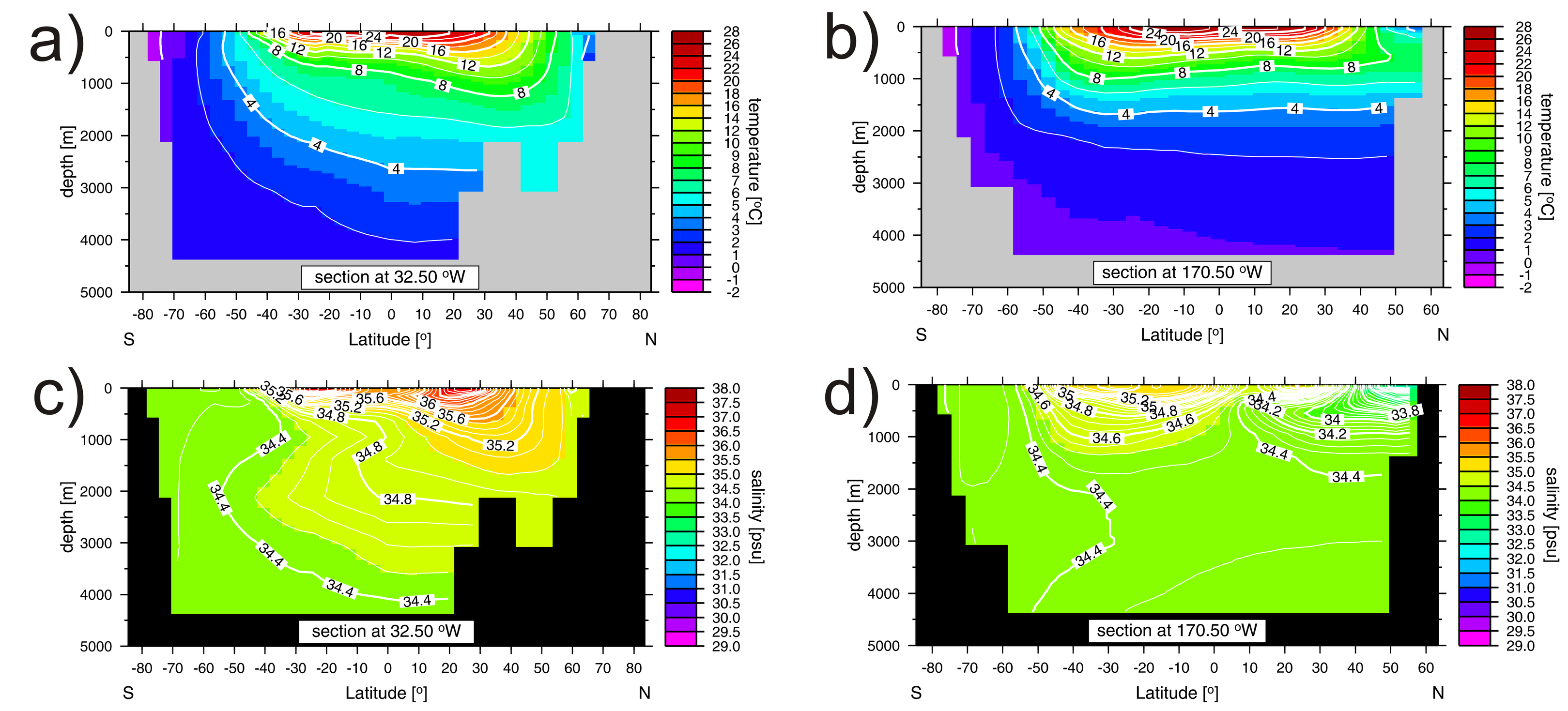


Figure 4. Temperature and salinity sections in the Atlantic Ocean at 32ºW (left panel) and in the Pacific Ocean at 170ºW (right panel) in the control case (Exp. 1; see Table 1): (a)-(b) temperature; (c)-(d) salinity.

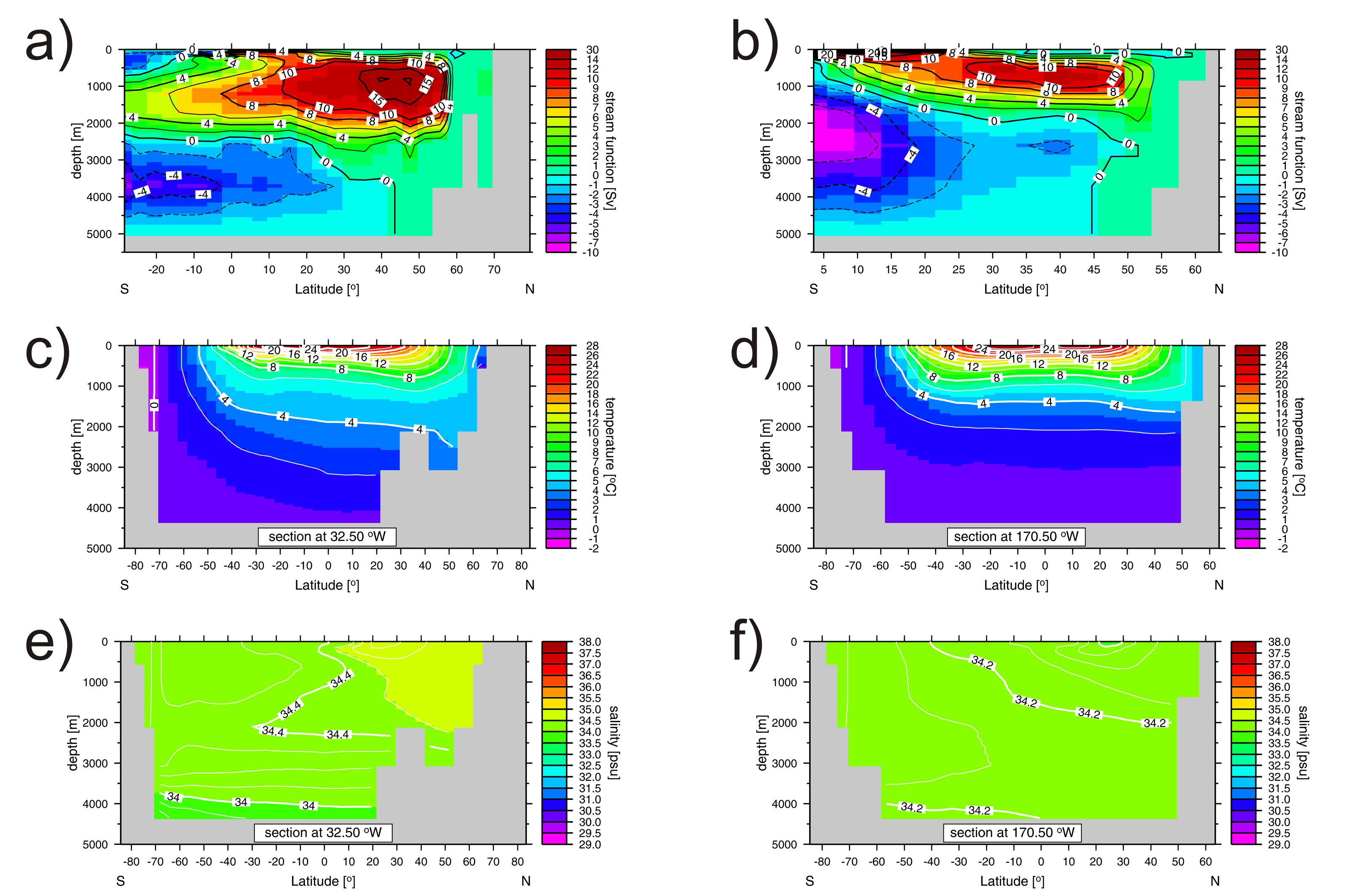


Figure 5. Temperature and salinity sections in the Atlantic Ocean at 32ºW (left panel) and in the Pacific Ocean at 170ºW (right panel) in the freshwater flux experiment (Exp. 5 in Table 1). A rudimentary global conveyor is reinstalled, if compared to Exp. 2.

Our experiments have revealed that the Atlantic-Pacific SSS asymmetry is indeed the critical element responsible for sustaining the global character of the ocean thermohaline circulation. We conclude, albeit preliminary, that high-latitudinal freshwater impacts, as a driving mechanism of the global ocean thermohaline circulation, are secondary to the inter-basin freshwater communications.

Seidov, D., and B. J. Haupt, Freshwater teleconnections and ocean thermohaline circulation, *Geophysical Research Letters*, 30, 62-61 - 62-64, 2003.
Seidov, D., and B. J. Haupt, On sensitivity of ocean circulation to sea surface salinity, *Global and Planetary Change*, 36, 99-116, 2003.