Inter-Basin Freshwater Exchange as a Control of the Global Ocean Thermohaline Conveyor

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There is an ongoing discussion of the role of freshwater transport in the global ocean thermohaline circulation (THC). It is often presumed that the meridional freshwater transport and northern high-latitudinal freshwater impacts in the Atlantic Ocean are the most critical for THC dynamics. This presentation shows that such a presumption underrates the role of inter-basin freshwater redistributions.

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. However, it has not yet been examined whether it is this asymmetry that accounts for the functioning of the global ocean conveyor, and whether there is a threshold that would trigger such a conveyor.

In a series of recent publications, we have shown that even if the SSS is zonally averaged in individual ocean basins, and thus retains only basin-scale inter-basin SSS contrasts, such contrasts can yield a fully functional global conveyor. Moreover, our results favor zonal versus meridional SSS contrasts as critical for building up and maintaining the global THC.

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.

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.