Exchanges
- Selected Research Papers -

The Arctic-Subarctic Ocean Flux Study (ASOF): Rationale, Scope and Methods[1]

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According to the last IPCC projections (2001), the ocean – and in particular the Atlantic – response to an increase of greenhouse gases would result in a slow-down of the Meridional Overturning Circulation (MOC) in the North Atlantic.

Regional models have highlighted specific "vulnerabilities" of the MOC to changes in the Arctic heat and freshwater budget (Wadley and Bigg, 2002) nevertheless questions remain as to whether they yet deal adequately with the complexities of the ocean's thermohaline circulation and its many sources of variability. These controls on the MOC are believed to include: the poleward flux of warm and salty Atlantic surface water; the freshwater and ice flux out of the Arctic; the speed and density of the deep overflows crossing the Greenland-Scotland ridge; open-ocean convection; mixing near the ocean margins, including the sea surface; ice-ocean and atmosphere-ocean interactions; freshwater input from the atmosphere and rivers.

These processes and transports are poorly observed and understood. We have no measurements of the freshwater flux between the Arctic Ocean and the Atlantic by either of its two main pathways; we have new measurements of the heat and salt flux to the Arctic Ocean but not yet of its variability on any scale; we have a growing knowledge of the long-term variability of the hydrography of the dense water overflows which "drive" the MOC but embryonic ideas as to their causes, etc…; and our present observations of the MOC (in the North Atlantic or anywhere else) are insufficient to detect whether it is changing. Understandably then, we would take the view that these key mechanisms and processes are too crudely represented in the present generation of the global climate models.

It is the aim of ASOF to supply these missing observations. More specifically: to measure and model the variability of the fluxes between the Arctic Ocean and the Atlantic Ocean with a view to implementing a long-term system of critical measurements needed to understand the high latitude ocean's steering role in decadal climate variability.

The ASOF domain is illustrated in figure 1 in terms of the 6 main tasks around which this programme is structured. ASOF does not intend to cover the whole or even a large part of the thermohaline circulation of the North Atlantic. Instead, the focus is on understanding the broad range of upstream influences that may impose changes on the Deep Western Boundary Current (DWBC). Since we cannot yet identify which may be the dominant upstream influences on the DWBC, the strategy of the ASOF observing programme propose simultaneous rather than sequential observations for a period long enough to identify the slow shifts of global change. The various ocean measurements techniques that very

Fig. 1: The ASOF domain. (1) Warm water inflow to Nordic Seas; (2) Exchanges with Arctic Ocean; (3) Ice and fresh water outflow; (4) Greenland-Scotland Ridge exchanges; (5) Overflows and storage basins to Deep Western Boundary Current (DWBC); (6) Canadian Arctic Archipelago (CAA) throughflow.

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recently have made considerable advances in the field will allow, with some degree of confidence to make all the observations needed to measure in ASOF.

The are several other reason for implementing ASOF in addition to those mentioned before: (a) the modelling and paleo-evidence that anthropogenic effects on the stability of the thermohaline circulation may be rapid in their onset (Stoker and Schmittner, 1997); (b) the fact that we are beginning to know what the "fingerprint" of the anthropogenic climate change should look like in the ocean (Banks and Wood, 2002); c) the recent observational evidence that large scale decadal changes are already passing through the Atlantic thermohaline system (Dickson et al., 2002; fig. 2). As such an extended and extensive effort would be beyond the resources of any single institute or nation, ASOF implementation will benefit from the several agencies from different countries that are currently contributing to the study of the ocean's role in rapid climate change (the UK RAPID thematic programme, the Norwegian NOClim project, aspects of EC Framework 5 and programme solicitations of the NSF Office of Polar Programmes and the interagency SEARCH programme).

The ASOF International Scientific Steering Group will meet for the second time in October 18-19, 2002 in Hamburg. In the agenda of the meeting there is the discussion and the eventual approval of the ASOF structure as divided in 6 regional tasks with the selection of Chairmen and Teams for each component. The ISSG will also discuss the ASOF data policy which will conform the data management model for CLIVAR in order to ensure that ASOF can access the multidisciplinary data sets that will be generated by CLIVAR and the datasets generated by the individual regional tasks of ASOF will be directed into CLIVAR data stream and available to the wider community. More information on ASOF can be found at: http://asof.npolar.no/

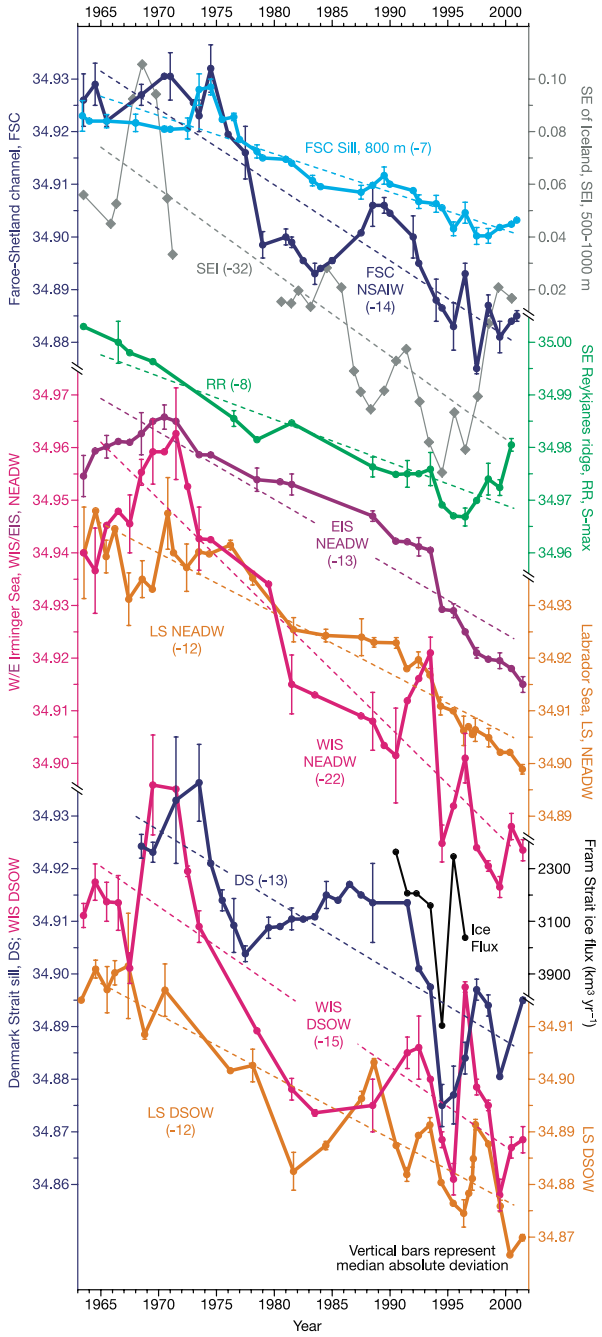

Fig. 2: Evidence that the following change in the upper Nordic Seas, the entire system of overflow and entrainment that ventilates the deep Atlantic has steadily changed in character over the past four decades, resulting in a sustained and widespread freshening of the deep and abyssal ocean (Dickson et al., 2002).

References

Banks, H., and R. Wood, 2002: Where to look for Anthropogenic Change in the Ocean. *J. Climate*, **15**, 879-891.

Dickson, R. R., I. Yashayaev, J. Meinke, W. Turrell, S. Dye, and J. Holford, 2002: Rapid Freshening of the Deep North Atlantic Ocean over the past four decades. *Nature*, **416**, 832-837.

IPCC, 2001: Climate Change 2001: The Scientific Basis. J.T. Houghton, Y. Ding, D.J. Griggs, M. Noguer, P.J. van der Linden, and D. Xiaosu (Eds.), Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press.

Stocker, T.F., and A. Schmittner, 1997: Influence of CO_2 emission rates on the stability of the thermohaline circulation. *Nature*, **388**, 862-865.

Wadley M.R., and G.R. Bigg, 2002: Impact of flow through the Canadian Archipelago and Bering Strait on the North Atlantic and Arctic Circulation. *Q. J. Roy. Met. Soc.*, submitted.