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Passive tracers and active dynamics - a model study of hydrography and circulation in the northern North Atlantic

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With the aid of a 50 year long simulation by the numerical ocean model MICOM we have investigated the northernmost extent of the meridional overturning circulation: relationships between hydrographic anomalies such as "Great Salinity Anomalies" and ocean circulation changes in North Atlantic sector, and exchanges across the Greenland-Iceland-Scotland Ridge (GSR). The hydrographic anomalies investigated are within the range observed in the 20th century, thus fundamental changes to the circulation were not expected or found. We find the hydrographic anomalies to be passive tracers responding to the same atmospheric forcing as the circulation itself. Therefore they are indicators of circulation change even though they are not a cause of it. A division exists between the northern and southern part of the domain: in the north, temperature is the passive tracer, whereas in the south, salinity is the passive tracer. This is because salinity dominates density in the north whereas temperature does in the south. Therefore temperature can be an indicator of circulation change in the north, and salinity can be in the south. In the southern part of the domain, heat- and saltflux variations through selected sections are dominated by changes in volume flux, but in north temperature variations seem to affect heatflux, thus again reflecting the north-south division of passive tracer/active dynamics distribution.

The subpolar gyre (SPG) strength is 40Sv and positive correlated to gyre size. Hydrographic anomalies in SPG are connected to atmospheric forcing: high North Atlantic Oscillation-index (NAO) produces fresh, cold and dense gyre. Salinity is found to be a passive tracer in the inflow area, and the fresh NAO-produced anomalies propagate

into the GSR area where they are seen one year later. The SPG strengthening and widening seen 1-2 years after high NAO-forcing are not reflected in increased warm inflow thereafter.

Mean inflow of Atlantic water is 6-7 Sv, and on average 2/3 of it enters through the Faeroe-Shetland channel. The variability is 15%, which is considerable lower than the SPG strength variations. The variability in warm water flow into the Nordic Seas is not associated with a change in dense overflows across the Greenland-Scotland Ridge on these timescales. Rather, a change in warm water flow northward will immediately be associated with a change in the outflow of light Polar waters to the North Atlantic.