Geophysical Research Abstracts, Vol. 9, 03836, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-03836

North Atlantic Climate and deep-ocean Flow during the last 230 Years

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Concerns about the evolution of climate on human time scales have focussed the attention of palaeoceanographers and climate modellers to the detection of possible instabilities in the Atlantic meridional overturning circulation (MOC) during the historical past. Iceland-Scotland Overflow Water (ISOW) is one of the main precursor water masses of a deep western boundary current transporting newly formed lower North Atlantic Deep Water (NADW) to the south. Millennial scale variations in ISOW flow speed, as recorded in the sedimentological proxy 'sortable silt' mean grain size, have been linked to climate fluctuations in the North Atlantic region through the Holocene.

Here we report data from deep-sea sediment box-core RAPID-21-12B recovered from the southern Gardar Drift in the sub-polar North Atlantic (2630 m water depth) where the interaction of ISOW with the underlying sea-floor topography results in sediment focusing and enhanced sedimentation rates. ^{210}Pb-derived sedimentation rates are 2.3 mm/year. A biennial proxy flow speed record of the last 200 years from this sediment sequence is presented, which closely reflects instrumental hydrographic records of the last five decades. Most vigorous ISOW flow is observed during the extremely negative phases of the winter index of the North Atlantic Oscillation (NAO) of the 1960s. ISOW flow decelerated during the NAO reversal of the 1970s and 1980s and was slowest just after the positive NAO phase of the 1990s. These observations are consistent with deep water densities and geostrophic flows showing greater and more consistent ISOW transports during 1964 and patchy, weaker transports during 1994 and 2001, estimated from repeat hydrographic sections close to the core site.

On decadal time scales ISOW flow speeds are significantly negatively correlated with the NAO (r_{xy} = -0.42) over the last 120 years, suggesting that the NAO has co-ordinated ISOW flow not only in recent decades. Production and export of Labrador Sea Water (LSW) is largely governed by atmospheric patterns connected to the NAO. We suggest that subsequent entrainment of LSW by the downwelling ISOW in the Iceland Basin may play a major role in controlling the vigour of ISOW at our study site and ultimately the production of NADW.