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Reconstruction of North Atlantic Deep Water variability during the past 450 kyr

Julia Becker and Ian Hall
School of Earth and Ocean Sciences, Cardiff University, Cardiff, United Kingdom

Abrupt changes in the strength of the Atlantic Meridional Overturning Circulation (AMOC, comprising northward flow of warm water and a cold southward return flow) are implicated in sharp climate changes in the late Pleistocene. Initiation of the AMOC occurs through the production of North Atlantic Deep Water (NADW), which consists of two main components: cold and dense Lower North Atlantic Deep Water (LNADW) forming the deepest layer and Labrador Sea Water (LSW, also known as upper NADW) at an intermediate level. These waters form the Atlantic Deep Western Boundary Current (DWBC) which transports about 13-14 Sv of NADW equatorward. During its passage it is progressively undercut by northward flowing colder and denser Southern Ocean waters (Antarctic Bottom Water, AABW). The intensity and flow characteristics of the DWBC are known to have varied in space (depth) and time, which is believed to be a response to changes in source water production.

Here we present continuous high resolution ($\sim$800 year) flow speed and foraminiferal stable isotope record for the last 450 kyr from ODP Site 1061 located at 4,050 m water depth on the Blake Bahama Outer Ridge (BBOR). Sedimentological proxy data from Site 1061 have recently been used to reconstruct the intensity/position of the DWBC during Marine Isotope Stage (MIS) 12-10 (420-360 kyr) and MIS 5 (Hall and Becker, 2007). Comparison of these data with foraminiferal stable isotope data from the same site, ODP Site 1063 (Bermuda Rise) and nearby core GPC-9 (Bahama Outer Ridge, 4,758 m water depth) suggests that the DWBC shoaled during glacial times in relation to a reduced NADW production and increased advection of southern ocean waters. The extended records from ODP Site 1061 suggest this relationship was a persistent feature of the last 450 kyr. As seen in previous studies, highest amplitude variability in the sortable silt is related to the transition into and out of a glacial, when benthic foraminiferal δ18O values exceed $\sim$3.8 ‰ and 4.5 ‰ respectively and likely be related to the transition of an ice volume threshold (e.g. McManus et al., 1999) where climate variability is possibly amplified by feedback mechanisms associated with ice sheet growth. Superimposed fluctuations in the flow speed/position of the DWBC at a semi-precession scale are persistent throughout the record and independent of the glacial state. Similar variations are seen in the δ18O of the thermocline-dwelling foraminifer Globorotalia inflata. Such semi-precession variability may indicate a low latitude origin for these changes.