A 1.5 Myr History of the Atlantic Meridional Overturning Circulation from Nd isotopes

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One of Wally Broecker's many enduring legacies is his recognition of the importance on the global climate system of the 'great ocean conveyor', driven by the formation and southward transport of North Atlantic Deep Water (NADW). The shallow return flow of Atlantic Meridional Overturning Circulation (AMOC) brings heat from the tropics to the high latitudes, and its temporal variability has major impacts on ice age cycles. We have constructed north-south profiles using deep sea cores from the North Atlantic to the Southern Ocean, covering the past ~1.5 Ma or so, including the interval prior to and including the Mid-Pleistocene Transition (MPT), the interval of 'lukewarm interglacials' following the MPT, and to the present-day, using Nd isotopes in Fe-Mn oxide encrusted foraminifera and fish debris. Some important observations show that our Nd isotope records indeed reflect the AMOC variability, rather than regional Nd sources or alteration effects. Firstly, throughout the time interval and at all sites, the εNd-values show glacial-interglacial 'zig-zags', indicating stronger AMOC during interglacials and weaker AMOC during glacials. Secondly, going from north to south the data show increasingly weaker NADW signals at all points in time. Thirdly, all of the εNd-values are those expected from seawater Nd sources. The εNd-values at North Atlantic DSDP Site 607 during interglacials are almost always between -13 and -14.5, similar to present-day NADW both before and after the AMOC-crisis, thus indicating that the normal NADW range during interglacials has remained similar since the middle Pleistocene. Fourthly, at all times, the εNd-values throughout the transect remain sandwiched by the global North Atlantic and North Pacific end-member values. These observations are what are required if the data reflect the glacial-interglacial waxing and waning of the AMOC, but are unexpected for virtually any other scenario.