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OC3 regional North Atlantic compilation of benthic δ^{13}C and δ^{18}O data reveal glacial and deglacial endmember composition changes in northern sourced deepwater

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The Atlantic Meridional Overturning Circulation (AMOC) during the last glacial interval was widely thought to be considerably different from modern ocean circulation, including changes in deepwater formation, position of convection sites, depth of overturning and deepwater flow strength. The common interpretation of observed changes in benthic δ^{13}C signatures from high values during warm phases to low values during cold periods in the North Atlantic proposes an incursion of less ventilated and nutrient-rich deep water from the Southern Ocean during weak AMOC phases. However, new ^{14}C and Nd isotope compilations and the combination of benthic δ^{13}C and δ^{18}O data suggest that the observed changes could also be caused by a change in the northern-hemisphere end-member composition of the deep water along with changes in the strength of AMOC. Yet, these changes are controversially discussed. The mechanistic understanding of the associated changes in deepwater convection and stratification is still sparse and its impact on carbon storage in the deep ocean remains ambiguous. For a better understanding of these changes a compilation of published and unpublished benthicgδ^{13}C and δ^{18}O data is established within the framework of the PAGES OC3 working group. The efforts of the data compilation include updates and synchronization of age models and increases in the spatial and temporal resolution of previous compilations.

Here we present a data set of benthic δ^{13}C and δ^{18}O from the North Atlantic that was established as part of the OC 3 effort. Furthermore, we combine the stable isotope data with spatially and temporally paired benthic AMS ^{14}C data to better locate the origin of the deep-water changes and deglacial deep-water distribution. The high spatial data coverage enables us to distinguish changes in the western and eastern North Atlantic basin from different deglacial time slices.

The combined benthic δ^{13}C and δ^{18}O indicate the existence of a δ^{13}C-depleted and δ^{18}O-enriched North Atlantic deep water mass traceable at depths between 4000 and 3000 m and between 50 and 20°N during the Last Glacial Maximum. During Heinrich Stadial 1 an even stronger δ^{13}C-depleted and less δ^{18}O-enriched water mass is traced at depth. Benthic^{14}C ages in the deep North Atlantic younger than the Southern Ocean and a barrier of gδ^{13}C-enriched and δ^{18}O-depleted water in the deep equatorial Atlantic exclude a southern origin of this water mass. Instead, transects across the subpolar and polar North Atlantic point toward an active deepwater formation in the Irminger Sea and/or Labrador Sea region. At the onset of the Bølling-Allerød, δ^{18}O depleted, δ^{13}C enriched North Atlantic Deep Water flushed the deep North Atlantic starting from the eastern North Atlantic Basin. The propagation of the light δ^{18}O signature into depths below 3000 m points to a decoupling of water mass density and δ^{18}O signature during the Northern Hemisphere deglaciation. During the Younger Dryas a relatively old water mass with intermediate δ^{13}C and δ^{18}O signatures occupies the deep western North Atlantic and points towards a homogenization of the deep water prior to the onset of the modern AMOC mode.