Goldschmidt 2025 Abstract
https://doi.org/10.7185/gold2025.28070

Reconstructing Holocene variability of the Atlantic Meridional Overturning Circulation using $^{231}Pa/^{230}Th$

LUKAS GERBER[1], JÖRG LIPPOLD[2], FINN SÜFKE[2], OLE VALK[2], PIERRE TESTORF[3], MANUEL EHNIS[2], SASKIA TAUTENHAHN[2], LARS MAX[4], CRISTIANO M. CHIESSI[5], MARCEL REGELOUS[6], SÖNKE SZIDAT[3], OLIVER FRIEDRICH[2] AND FRERK PÖPPELMEIER[3]

[1]Institute of Earth Sciences, Heidelberg University, Heidelberg, Germany
[2]Heidelberg University
[3]University of Bern
[4]MARUM, University of Bremen
[5]University of São Paulo
[6]GeoZentrum Nordbayern, Friedrich-Alexander-Universität (FAU) Erlangen-Nürnberg, 91054 Erlangen, Germany

The Atlantic Meridional Overturning Circulation (AMOC) plays an important role in regulating Earth's climate by redistributing heat and nutrients between both hemispheres. Variations in its strength have a global impact, making it one of the planet's key climate tipping elements. While there has been evidence for large AMOC variations during glacials and their terminations, AMOC variations during the Holocene are less well constrained.

Here, we analyse the Holocene mean deep water advection strength in the North Atlantic by making use of five millennial-resolution sedimentary $^{231}Pa/^{230}Th$ records. We quantitatively estimate past AMOC volumetric flow rates from the geochemical results, by employing the proxy-enabled Bern3D Earth System Model. To achieve this, we simulated idealized freshwater perturbations and assessed the sensitivity of sedimentary $^{231}Pa/^{230}Th$ to the AMOC variations at each core site location. Based on the core-specific responses of $^{231}Pa/^{230}Th$ to the simulated AMOC variations, we converted these geochemical records into changes in AMOC strength (in Sverdrups, Sv), allowing us to establish a new composite Holocene record.

We find that the AMOC recovered from its weakened deglacial state during the Early Holocene, until 9.5 ka BP. Its pre-industrial strength (18.5 ± 1.5 Sv) was reached around 6.5 ka BP, and remained constant. No significant AMOC changes were detected during the 4.2 ka BP event. The only notable Holocene AMOC weakening occurred between 9-8 ka BP (16 ± 1.3 Sv), coinciding with the final disintegration of the Laurentide Ice Sheet and the associated meltwater pulses into the North Atlantic.

Throughout the Holocene, we found no evidence of an AMOC slowdown as severe as projections of high-emission scenarios indicate for the ongoing anthropogenic climate change.