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Glacial-interglacial changes of foraminiferal oxygen isotopes in the Atlantic Ocean due to water-mass and sea-level effects

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Depth transects of benthic foraminiferal oxygen isotopes from the Atlantic Ocean show that glacial-interglacial changes are larger at deep (below about 2000 m) than at intermediate water levels. We used the Massachusetts Institute of Technology general circulation model (MITgcm) including a water isotope package in order to differentiate between the effects of water-mass vs. sea-level changes. The model was run in forward and inverse modes, and the output was checked against recent sea-surface temperature estimates and planktonic and benthic oxygen isotope reconstructions for the pre-industrial/present day and the Last Glacial Maximum (LGM).

According to our results a shoaling of the water-mass boundary between the northern source and southern source waters to about 2000 m depth is accompanied by the expansion of a cold (close to the freezing point) southern source water in the abyssal ocean, which causes a relatively larger glacial-interglacial oxygen isotope difference in the deep Atlantic Ocean. In addition, an analysis based on the forward model suggests that the glacial sea-level lowering of about 120 m led to warmer temperatures of around 1 °C and hence a relatively smaller glacial-interglacial oxygen isotope difference in the upper 1000 m of the water column.