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Holocene evolution of the North Atlantic subsurface transport

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Abstract

The Supporting information gives extended description of the methods used in the study and additionally discusses potential overprints on the foraminifera signal.

S1 Potential overprints on the foraminifera signal

Recently, discussions about the potential seasonal overprints on foraminifera calcite evolved, given the potential of seasonal bias between foraminifera blooms [e.g. Schneider et al., 2010]. The bloom of *G. ruber w*. in the North Atlantic region is bound to the warmest period of the year that occurs in August and did not change between glacial and interglacial times [Fraile et al., 2009]. Thus, we assume that Mg/Ca and $\delta^{18}O$ reconstructions from *G. ruber w*. are not biased by changes in the growth season. Potential overprints on Mg/Ca and $\delta^{18}O$ signals of shells from subsurface dwelling *G. truncatulinoides* might originate from its complex life cycle. *G. truncatulinoides* migrates from thermocline depth where reproducing to intermediate depth as juvenile forms and migrate back to thermocline depth. There, *G. truncatulinoides* adds a secondary calcite to its shells that accounts fore more than 50- 70 % of the shell weight [Lohmann and Schweitzer, 1990; McKenna and Prell, 2004] before it ascends again for reproduction [Schiebel et al., 2002]. Furthermore, Schiebel et al. [2002a] suggested that *G. truncatulinoides* might be transported juvenile form from the Sargasso Sea with the NAC. Given the high amount of secondary calcite, we assume that the Mg/Ca signal of *G. truncatulinoides* is mainly driven by local conditions at the Azores coring site. Although transport of individual specimens cannot be ruled out for our interpretation this would not matter as we associate the warming to increased transport of warm waters within the AC.

The most pronounced trend in the subsurface record is the warming trend between 10.5 and 8 ka BP. Assuming that the subsurface temperature signal recorded in *G. truncatulinoides* mainly reflect the conditions at the AF, observed subsurface warming could be caused a) by the migration of *G. truncatulinoides* to shallower, warmer water depth b) by thermocline shoaling or c) warming of the thermocline by increased warm water inflow. Within our records observed subsurface warming coincides with an increase in *G. ruber* w. abundances (figure 2b, 3c), which is a clear indicator for a northward migration of the STG. Assuming that a northward displacement of the STG would lead to a deepening of the thermocline that is related to a warming, it is unlikely that this signal is produced by the migration of *G. truncatulinoides*. Thus we assume that our *G. truncatulinoides* temperature signal is mainly reflecting the conditions at thermocline depth with no or only minor influence of foraminifera depth migration. Warming of the thermocline due to shoaling of the thermocline might be detected using the difference between the $\delta^{18}O$ signal of *G. ruber* w. and *G. truncatulinoides* under the assumption that a decreasing this difference is reflecting a shoaling of the thermocline. Within the methodological error the general difference between the $\delta^{18}O$ signal of *G. ruber* w. and *G. truncatulinoides* shows no changes though individual differences shows strong fluctuations. Thus a thermocline shoaling can be excluded as a reason for the subsurface warming.

Excluding migration and thermocline shoaling, two different mechanisms of ocean circulation changes can explain the subsurface temperature changes, a northward displacement of the STG or increases in warm water transport within the AC, or a combination of both mechanisms.

The warming of the subsurface between 10.5 to 8 ka BP coincides with a northward displacement of the STG. Such a northward displacement of the STG would lead to an increased warm water transport at the Azores coring position that leads to a subsurface temperature maximum. Such changes in water mass distribution can also explain the differences in stratification modes from thermal (11-8 ka BP) over more haline (8 to 6 ka BP) to thermohaline (6 to 0 ka BP). Between 6 ka BP and the late Holocene a slight subsurface cooling is apparent which seems not to be as strong at surface.

References

Fraile, I., M. Schulz, S. Mulitza, U. Merkel, M. Prange, and A. Paul (2009), Modeling the seasonal distribution of planktonic foraminifera during the Last Glacial Maximum, Paleoceanography, 24(2), PA2216, 10.1029/2008pa001686.

Lohmann, G. P., and P. N. Schweitzer (1990), Globorotalia truncatulinoides' Growth and chemistry as probes of the past thermocline: 1. Shell size, Paleoceanography, 5(1), 55-75, 10.1029/PA005i001p00055.

Martin, P. A., and D. W. Lea (2002), A simple evaluation of cleaning procedures on fossil benthic foraminiferal Mg/Ca, Geochemistry, Geophysics, Geosystems, 3(10), 8401, 10.1029/2001GC000280.

McKenna, V. S., and W. L. Prell (2004), Calibration of the Mg//Ca of Globorotalia truncatulinoides (R) for the reconstruction of marine temperature gradients, Palaeoceanography, 19, PA2006, doi:10.1029/2000PA000604.

Schiebel, R., B. Schmuker, M. Alves, and C. Hemleben (2002a), Tracking the Recent and late Pleistocene Azores front by the distribution of planktic foraminifers, Journal of Marine Systems, 37(1-3), 213-227,

Schiebel, R., J. Waniek, A. Zeltner, and M. Alves (2002b), Impact of the Azores Front on the distribution of planktic foraminifers, shelled gastropods, and coccolithophorids, Deep Sea Research Part II: Topical Studies in Oceanography, 49(19), 4035-4050,

Schneider, B., G. Leduc, and W. Park (2010), Disentangling seasonal signals in Holocene climate trends by satellite-model-proxy integration, Paleoceanography, 25(4), PA4217, 10.1029/2009pa001893.