Glacial-to-Anthropocene interactions between ocean circulation and rainfall recorded at the tropical Atlantic margin

Stefan Mulitza, *MARUM, University of Bremen, Germany*
(smulitza@marum.de)

Cristiano M. Chiessi, School of Arts, Sciences and Humanities, University of São Paulo, Brazil; Christoph Häggi, MARUM - Center for Marine Environmental Sciences, University of Bremen, Germany; Jörg Lippold, University of Bern, Institute of Geological Sciences, Switzerland; Jean Lynch-Stieglitz, School of Earth and Atmospheric Sciences, Georgia Institute of Technology, Atlanta, USA; Andreas Mackensen, Alfred Wegener Institute for Polar and Marine Research, Bremerhaven, Germany; André Paul, MARUM - Center for Marine Environmental Sciences, University of Bremen, Germany; Daniela Pittauer, MARUM - Center for Marine Environmental Sciences, University of Bremen, Germany; Matthias Prange, MARUM - Center for Marine Environmental Sciences, University of Bremen, Germany; Kira Rehfeld, Alfred Wegener Institute for Polar and Marine Research, 14473 Potsdam, Germany; Rodrigo Portilho Ramos, School of Arts, Sciences and Humanities, University of São Paulo, Brazil; André O. Sawakuchi, Institute of Geosciences, University of São Paulo, Brazil; Enno Schefuß, MARUM - Center for Marine Environmental Sciences, University of Bremen, Germany; Michael Schulz, MARUM - Center for Marine Environmental Sciences, University of Bremen, Germany; Tilmann Schwenk, MARUM - Center for Marine Environmental Sciences, University of Bremen, Germany; Ralf Tiedemann, Alfred Wegener Institute for Polar and Marine Research, Bremerhaven, Germany; Ines Voigt, MARUM - Center for Marine Environmental Sciences, University of Bremen, Germany; Martin Werner, Alfred Wegener Institute for Polar and Marine Research, Bremerhaven, Germany; Yancheng Zhang, MARUM - Center for Marine Environmental Sciences, University of Bremen, Germany;

The present-day circulation in the Atlantic Ocean is characterized by the cross-equatorial near-surface flow of warm waters from the South Atlantic into the North Atlantic. Much of this transport takes place along the western boundary through the North Brazil Current, which is a major component of the upper branch of the modern Atlantic Meridional Overturning Circulation (AMOC). The associated northward heat transport leads to a northerly location of the Intertropical Convergence Zone (ITCZ) and the associated rainfall maximum for much of the year. Beyond the southern and northern seasonal limits of the ITCZ, semi-arid conditions prevail in the Sahel and in Northeast Brazil (Nordeste). Climate models project a significant slowdown of the AMOC until the end of this century with uncertain consequences for rainfall in tropical and subtropical regions.
The AMOC underwent substantial variations during the last deglaciation. High-resolution sediment records from tropical Atlantic Ocean margins offer the opportunity to study interactions between ocean circulation, continental climate and atmospheric circulation. We present data derived from sediment cores recently retrieved from the continental margins off NE Brazil and off NW Africa

covering the last deglaciation with sedimentation rates up to 1 mm/year. XRF elemental ratios of bulk sediments and dD of plant wax were used to characterize terrestrial climate. Protactinium/Thorium (Pa/Th) ratios on bulk sediments and carbon isotopes ratios of benthic foraminifera were used to infer the state of the AMOC and deep water nutrient content.

Our data indicate that the mean position of the ITCZ during the Last Glacial Maximum was close to the modern mean location. During Heinrich stadial 1, when the AMOC was substantially reduced, we observe dry conditions in the Sahel and wet conditions in NE Brazil consistent with a southward displacement of the ITCZ. Off NE Brazil, synchronous changes in Pa/Th ratios and dD of plant waxes indicate that AMOC strength and precipitation were tightly coupled over Heinrich stadial 1, with increasing precipitation during AMOC slowdown. We show that this response pattern agrees with the results of climate model simulations which suggest that the location of the ITCZ is rapidly adjusting to changes in the Atlantic meridional heat transport, in proportion to the associated change in the Atlantic meridional SST gradient.

The records off NE Brazil and NW Africa indicate a continuous drying trend over the Holocene with driest conditions in the latest Holocene. We show that these trends are not the result of an AMOC-driven latitudinal ITCZ displacement, but are rather caused by changes in local insolation. We extend our discussion to high resolution records covering the last decades from the Amazon submarine delta and the Senegal mudbelt. A comparison with pre-Anthropocene core sections suggests that the amount of terrestrial material deposition has increased on both sides of the Atlantic in recent decades due to increased river suspension input (off NE South America) and dust mobilization (off NW Africa). However, the relative effects of anthropogenic climate change and intensified land use are yet difficult to disentangle in the sedimentary record.