45 mm

VARIABILITY OF THE BRAZIL-MALVINAS CONFLUENCE SINCE THE LAST GLACIAL MAXIMUM

Cristiano M. Chiessi[1]; Jeroen Groeneveld[2]; Stefan Mulitza[3]; Debora C. Redivo[1]; Luiz F.C. Sabanay[1]
chiessi@usp.br
[1]- Escola de Artes, Ciências e Humanidades, Universidade de São Paulo, Brazil; [2]- MARUM Excellence Cluster, Alfred Wegener Institute for Polar and Marine Research, Germany; [3]- MARUM-Center for Marine Environmental Sciences, University of Bremen, Germany
Av. Arlindo Bettio 1000, CEP03828-000, São Paulo, SP, Brazil

Key-words: *South Atlantic, Late Quaternary, planktonic foraminifera, stable oxygen isotopes, Mg/Ca-paleothermometry*

1. INTRODUCTION AND REGIONAL SETTING

The upper-level circulation in the western South Atlantic is dominated by the Brazil-Malvinas Confluence (BMC) that is formed by the encounter of southward-flowing Brazil Current (BC) and northward-flowing Malvinas (Falkland) Current (MC) (Peterson and Stramma, 1991; Stramma and England, 1999). At the confluence, both currents are deflected from the continental margin and flow south-eastward, forming the South Atlantic Current. Very steep gradients in upper water column (down to ca. 500 m water depth) temperature, salinity and in nutrient content are found in the confluence (Antonov et al., 2010; Garcia et al., 2010; Locarnini et al., 2010).
These conditions contribute to make the region (i) an important site of water exchange between the Southern Ocean and the subtropical basins (Boddem and Schlitzer, 1995), (ii) a major ventilation area for much of the South Atlantic thermocline (Gordon, 1981), (iii) a zone of high primary productivity (Garcia et al., 2004), (iv) a major sink for atmospheric CO_2 (Feely et al., 2001), and (v) a region that exerts a significant influence on precipitation over southeastern South America (Robertson and Mechoso, 2000).
The BMC migrates latitudinally on different time scales (e.g., Olson et al., 1988; White and Peterson, 1996; Wainer et al., 2000). Apparently, the position of the BMC is linked to the latitude of the northern boundary of the southern westerly wind belt (e.g., Sijp and England., 2008). Still, not much is understood about the dynamics behind variations in the position of the BMC on multidecadal and longer time scales. Reconstructions of the position of the BMC for climatic conditions different from the present might shed some light in the forcing factors behind variations of the BMC (Chiessi et al., 2007; Laprida et al., accepted). This is a particularly important issue since the southern westerly wind belt was reported to migrate southwards in recent decades (e.g., Hurrell and van Loon, 1994; Hansen et al., 2006; Toggweiler and Russell, 2008) with possible effects on the BMC.

45 mm

Here, we will present (i) a new Mg/Ca-calcification temperature calibration for the planktonic foraminifera *Globorotalia inflata* based on a suite of core tops from the South Atlantic (Groeneveld and Chiessi, 2011), a crucial step in order to accurately reconstruct the variability of the BMC, and (ii) unpublished Mg/Ca, $\delta^{18}O_{calcite}$ and $\delta^{18}O_{seawater}$ (a proxy for salinity) records based on *G. inflata* spanning the last ca. 19 kyr from a site located below the modern BMC off northern Argentina, in order to reconstruct the variability of the BMC since the Last Glacial Maximum.

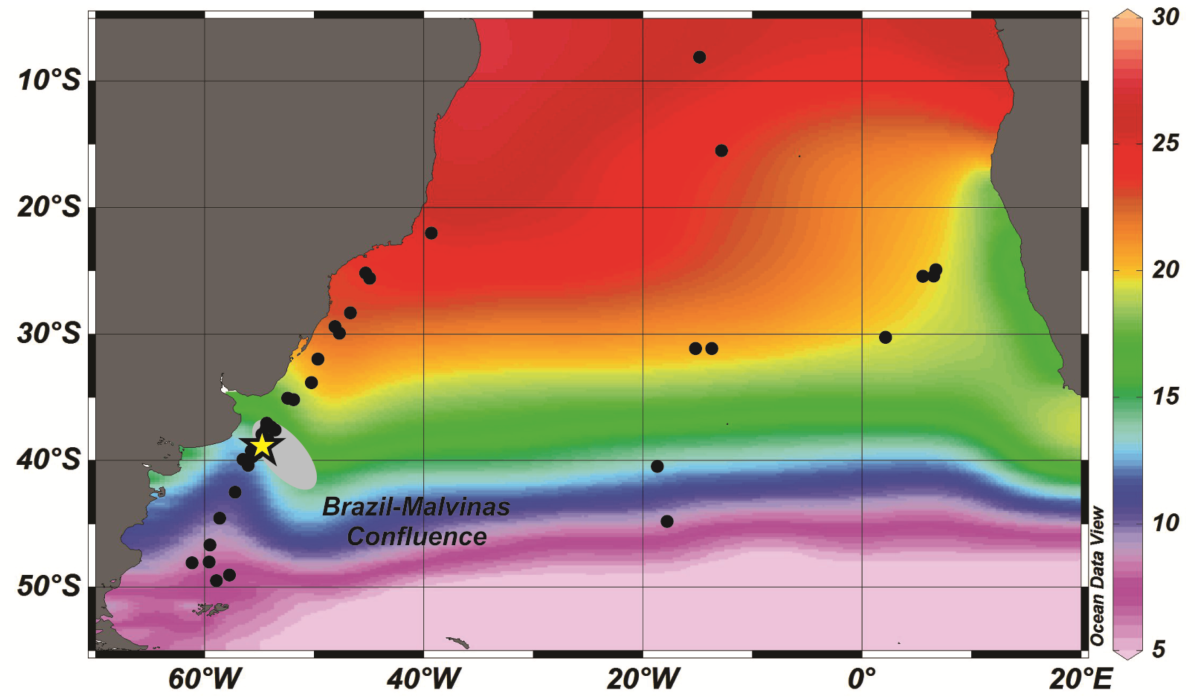

Figure 1. Map with locations of the surface samples (black circles) and cores GeoB6308-1/3 (yellow star) used in this study, showing the mean annual temperature (°C) at the sea surface (Locarnini et al., 2010). The mean annual position of the Brazil-Malvinas Confluence is depicted by the grey ellipse. The map was generated with the Ocean Data View software (Schlitzer, 2010).

2. MATERIALS AND METHODS

We used a set of 38 core tops retrieved between 8°S and 49°S, 6°E and 60°W, covering water depths between ca. 500 and 3800 m (Figure 1) to establish the Mg/Ca-calcification temperature calibration. Gravity core GeoB6308-3 (39.30°S/53.96°W/3623 m water depth) and the companion multicore GeoB6308-1 (39.30°S/53.97°W/3620 m water depth) (Bleil et

45 mm

al., 2001) (Figure 1) were used to produce our Mg/Ca, $\delta^{18}O_{calcite}$ and $\delta^{18}O_{seawater}$ downcore records.
Globorotalia inflata Mg/Ca ratios were determined via ICP-OES after applying the cleaning protocol from Barker et al., (2003). Calcification temperatures were obtained for each surface sample location based on site-specific apparent calcification depths (Groeneveld and Chiessi, 2011). Stable oxygen isotope analyses for *G. inflata* were performed using a Finnigan MAT 251 mass spectrometer with an automated carbonate preparation device. Both groups of analyses were performed at the Department of Geosciences, University of Bremen, Germany. The species *G. inflata* occurs in high amounts at subtropical to subpolar conditions, and shows an apparent calcification depth of 350-400 m in the South Atlantic (Groeneveld and Chiessi, 2011, which qualifies it for reconstructions of the BMC.

3. OUTLOOK

In our presentation we will show both the new Mg/Ca-calcification temperature calibration for *G. inflata* from the South Atlantic and the high temporal-resolution downcore Mg/Ca, $\delta^{18}O_{calcite}$ and $\delta^{18}O_{seawater}$ records from the BMC zone. Additionally, we will discuss the possible relations between the reconstructed variability in the BMC and changes in the northern boundary of the southern westerly wind belt, as well as changes in continental precipitation over southeastern South America.

REFERENCES

Antonov, J. I., D. Seidov, T. P. Boyer, R. A. Locarnini, A. V. Mishonov, H. E. Garcia, O. K. Baranova, M. M. Zweng, and D. R. Johnson, 2010. World Ocean Atlas 2009, Volume 2: Salinity. S. Levitus, Ed. NOAA Atlas NESDIS 69, U.S. Government Printing Office, Washington, D.C., 184 pp.

Barker, S., Greaves, M., & Elderfield, H., 2003. A study of cleaning procedures used for foraminiferal Mg/Ca paleothermometry. *Geochemistry Geophysics Geosystems*, vol. 4, 8407, doi:10.1029/2003GC000559.

Bleil, U., and Cruise Participants, 2001. Report and preliminary results of Meteor Cruise M46/3, Montevideo - Mar del Plata, January 4 - February 7, 2000. Berichte, Fachbereich Geowissenschaften, 172. Universität Bremen, Bremen, 161 pp.

Boddem, J., & Schlitzer, R., 1995. Interocean exchange and meridional mass and heat fluxes in the South Atlantic. *Journal of Geophysical Research*, vol. 100, pp. 15 821–15 834.

45 mm

Chiessi, C. M., Ulrich, S., Mulitza, S., Pätzold, J., & Wefer, G., 2007. Signature of the Brazil-Malvinas Confluence (Argentine Basin) in the isotopic composition of planktonic foraminifera from surface sediments. *Marine Micropaleontology*, vol. 64, pp. 52-66.

Feely, R. A., Sabine, C. L., Takahashi, T., & Wanninkhof, R., 2001. Uptake and Storage of Carbon Dioxide in the Ocean: The Global CO_2 Survey. *Oceanography*, vol. 14, pp. 18-32.

Garcia, C. A. E., Sarma, Y. V. B., Mata, M. M., & Garcia, V. M. T., 2004. Chlorophyll variability and eddies in the Brazil–Malvinas Confluence region. *Deep-Sea Research, Part II. Topical Studies in Oceanography*, vol. 51, pp. 159–172.

Garcia, H. E., R. A. Locarnini, T. P. Boyer, J. I. Antonov, M. M. Zweng, O. K. Baranova, and D. R. Johnson, 2010. World Ocean Atlas 2009, Volume 4: Nutrients (phosphate, nitrate, silicate). S. Levitus, Ed. NOAA Atlas NESDIS 71, U.S. Government Printing Office, Washington, D.C., 398 pp.

Gordon, A.L., 1981. South Atlantic thermocline ventilation. *Deep-Sea Research, Part A. Oceanographic Research Papers*, vol. 28, pp. 1239–1264.

Groeneveld, J., & Chiessi, C. M., 2011. Mg/Ca of *Globorotalia inflata* as a recorder of permanent thermocline temperatures in the South Atlantic. *Paleoceanography*, vol. 26, PA2203, doi:10.1029/2010PA001940.

Hansen, J., Sato, M., Ruedy, R., Lo, K., Lea, D. W., & Medina-Elizade, M., 2006. Global temperature change. *Proceedings of the National Academy of Sciences*, vol. 103, pp. 14288-14293.

Hurrell, J. W. & van Loon, H., 1994. A modulation of the atmospheric annual cycle in the Southern Hemisphere. *Tellus A*, vol. 46, pp. 325–338.

Laprida, C., Chapori, N. G., Chiessi, C. M., Violante, R. A., Watanabe, S., and Totah, V., (accepted for publication). Middle Pleistocene sea surface temperature in the Brazil-Malvinas Confluence Zone: Paleoceanographic implications based on planktonic foraminifera. *Micropaleontology*.

Locarnini, R. A., A. V. Mishonov, J. I. Antonov, T. P. Boyer, H. E. Garcia, O. K. Baranova, M. M. Zweng, and D. R. Johnson, 2010. World Ocean Atlas 2009, Volume 1: Temperature. S. Levitus, Ed. NOAA Atlas NESDIS 68, U.S. Government Printing Office, Washington, D.C., 184 pp.

45 mm

Olson, D. B., Podestá, G. P., Evans, R. H., & Brown, O. B., 1988. Temporal variations in the separation ofBrazil and Malvinas Currents. *Deep-Sea Research, Part A. Oceanographic Research Papers,* vol. 35, pp. 1971–1990.

Peterson, R. G., & Stramma, L., 1991. Upper-level circulation in the South Atlantic Ocean. *Progress in Oceanography*, vol. 26, pp. 1–73.

Robertson, A. W., & Mechoso, C. R., 2000. Interannual and interdecadal variability in the South Atlantic convergence zone. *Monthly Weather Review,* vol. 128, pp. 2947–2957.

Schlitzer, R., Ocean Data View, http://odv.awi.de, 2010.

Sijp, W. P., & England, M. H., 2008. The effect of a northward shift in the southern hemisphere westerlies on the global ocean. *Progress in Oceanography,* vol. 79, pp. 1–19.

Stramma, L., & England, M., 1999. On the water masses and mean circulation of the South Atlantic Ocean. *Journal of Geophysical Research,* vol. 104, pp. 20 863–20 883.

Toggweiler, J. R., & Russell, J., 2008. Ocean circulation in a warming climate. *Nature*, vol. 451, pp. 286-288.

Wainer, I., Gent, P., & Goni, G., 2000. Annual cycle of the Brazil–Malvinas confluence region in the National Center for Atmospheric Research Climate System Model. *Journal of Geophysical Research,* vol. 105, pp. 26 167–26 177.

White, W.B., & Peterson, R.G., 1996. An Antarctic circumpolar wave in surface pressure, wind, temperature and sea-ice extent. *Nature,* vol. 380, pp. 699–702.