Paleohydrology Reconstruction of the Tropical South America for the Past 1.6 Million Years.

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Abstract

The western Atlantic equatorial margin has been recognized as an important part of global climate change. It is responsible for the transfer of moisture to South America and, heat and fresh water to the northern hemisphere. It might hold answers to past and present global climate.

We reconstructed the last 1.6 million years of the paleoclimatic record of the Tropical South American to assess a long period of oceanic and atmospheric variability, which still remains unknown to science. Paleoclimate reconstructions of the Tropical South American are determined on a sediment core located on the Brazilian continental slope. High-resolution XRF analyses of Fe, Ti, K and Ca are used to define the paleohydrologic evolution.

Here we present elemental ratios of Ti/Ca and Fe/K, to determine variability in Tropical South America. Differences in sediment input observed on Fe/K and Ti/Ca ratios suggest periods of increased chemical weathering and precipitation. Comparison of our data with the Cariaco basin Molybdenum (Mo) records, suggests that the Intertropical Convergence Zone (ITCZ) is triggering wet periods on Tropical South America, distinguishing a clear North-South anti-phase over the last 600 ka.

Study area

The core site is located on a 2345 m deep seamount on the northern Brazilian continental slope (00° 39.6853' N, 44° 20.7723' W), 320 km from modern coastline of the Maranhão Gulf. Regional depth surrounding the seamount is about 3100 meters (**Figure 1**). This site is under the influence of modern terrigenous sediments from northeastern Brazil (Nace, Baker et al. 2014) -transported by the North Brazil Current (NBC), and sediments from the Amazon River, whose influence can reach hundreds of kilometers Eastward in the equatorial Atlantic Ocean (Silva, Araujo et al. 2007).

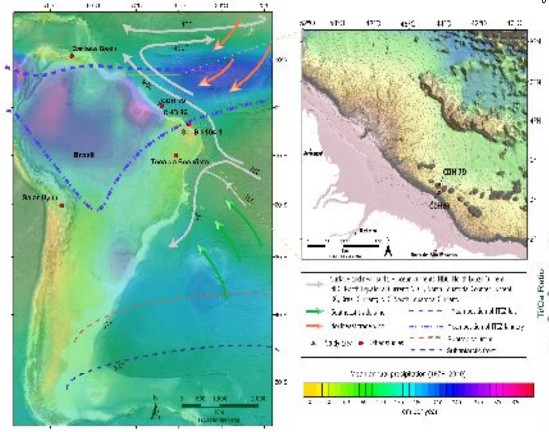


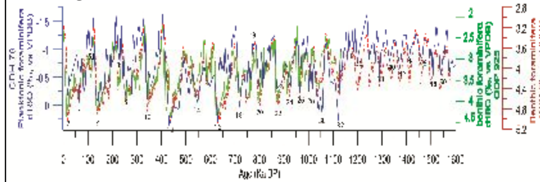
Figure 1: Location of study area, present ITCZ seasonal positions, Map of mean annual precipitation (cm per year; 1979–2010; data source: http://jisao.washington.edu/data/gpcp/), dominant wind directions and ocean surface currents. Red triangle indicates the studied core and red dots represents published data: Cariaco basin (Gibson and Peterson 2014); Geob 3104-1:(Arz, Pätzold et al. 1998); CDH 86 (Nace, Baker et al. 2014); Toca da Boa Vista (Wang, Auler et al. 2004); Salar Uyuni (Baker 2001). Grey arrows indicate dominant surface and near-surface ocean currents: NBC, North Brazil Current; NEC, North Equatorial Current; NECC, North Equatorial counter Current; BC, Brazil Current; SEC, and South Equatorial Current. The green arrow shows trade winds; the red arrow represents the northeast trade winds.

Materials and Methods

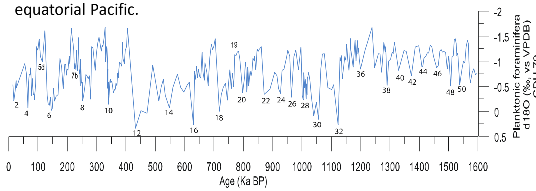
The core CDH 79 (32.20 m in length) was sampled at 10 cm intervals for foraminifers analyses. Sediment samples were wet sieved and the planktonic foraminifera species *Globigerinoides ruber* (white) was picked from the 350-500 µm size range for analysis of stable isotopes of O and C. The oxygen and carbon isotopes analysis were done at the Light Stable Isotope Mass Spectrometer laboratory in the Department of Geological Sciences, University of Florida. Sediment chemistry was analyzed on the cores, using an ITRAX X-ray fluorescence (XRF) spectrometer in the Coastal Systems lab at the Woods Hole Oceanographic Institution. Measurements were determined on split core sections at intervals of 2 mm.

Results

Age Model

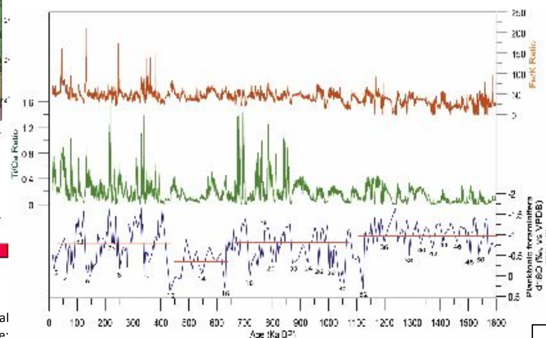


Core CDH 79 age model results from correlating planktonic foraminifera (G. Ruber white) oxygen isotope record to the LR04 oxygen isotope stack (Lisiecki and Raymo 2005), to the ODP 925 Benthic d[18]O(Bickert, Curry et al.), in western equatorial Atlantic (Ceará Rise) and to the ODP 806 d[18]O Planktonic (G. ruber white) record (de Garidel-Thoron, Rosenthal et al. 2005), in eastern equatorial Pacific.

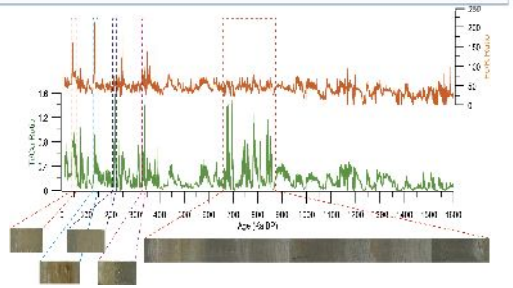


CDH 79 age model based at LR04 oxygen isotope stack with age of 1.6 millions of years before present on 32 meters core's length, correspondent to Marine isotopes stage (MIS) 1 until 51.

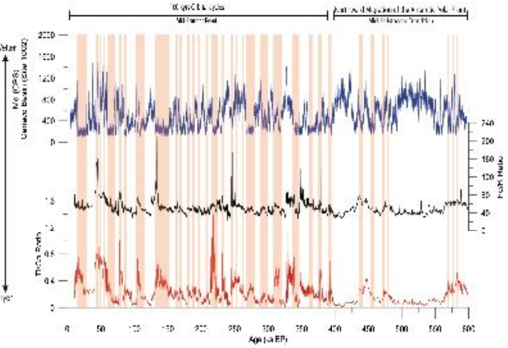
X- ray fluorescence (X-RF)



Increased precipitation over Tropical South America were identified on ~25 Ti/Ca abrupt peaks, ranging from a few thousands to 50,000 years of duration. The first 15 Ti/Ca abrupt peaks are concentrated on the last 400 Ka. The remaining 10 Ti/Ca abrupt peaks were observed between 640 and 860 Ka (in Red). Higher Fe/K ratios observed over the last 400 ka, indicates 8 different periods of increasing chemical weathering (in green).



The supply of terrigenous material as monitored by the ratio between the lithogenic particles and calcium carbonate in a sediment core shows pronounced variability throughout the record, with large, high frequency oscillations, with higher terrestrial supply during glacial terminations.



Cariaco sedimentary Scanning-XRF record of Mo(Gibson and Peterson 2014) (site 1002) compared to Fe/K and Ti/Ca from Tropical South American (TSA) during the last ~600 ka. Pink bars indicate wet periods in TSA and dry periods in Cariaco basin. White bars indicate dry periods in TSA and wet periods in Cariaco basin. We assume a migration over last 600 ka of the ITCZ.

Conclusion

- Abrupt shifts of tropical variability are temporally correlated with abrupt climate changes and atmospheric reorganization during Mid-Pleistocene Transition and Mid-Brunhes Events over Western South Atlantic margin.
- The ITCZ migrations inferred from comparison of our records to published data from Cariaco basin over the past 600 ka, supports the idea that the ITCZ is responsible for wet and dry periods in Tropical South America, presenting a clear North- South hemisfere anti-phase.
- Findings presented here, highlights that variation in rainfall pattern on orbital time scale should be further studied on the South American continent with data from other regions. It is extremely important at this stage, a joint effort of the paleoclimatology scientific community, to collect and analyze lacustrine and marine data in key regions for a better understanding of the impacts of orbital parameters on the hydrological cycle and vegetation.

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