Late Pleistocene hydroclimatic and vegetation changes in Northeast Brazil: which role played the western tropical Atlantic?

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Nowadays, the hydroclimate of the semi-arid Northeast Brazil is tightly linked with, inter alia, temperature of the adjacent Atlantic Ocean and its interactions with the Atmosphere. The short humid season peaks in April while (i) the intertropical convergence zone (ITCZ) is at its southernmost position, (ii) the southern tropical Atlantic is warm and (iii) the southeast trade winds are weak. Uncertainties remain on past long-term hydroclimate changes and on the drivers controlling these variations in the NE Brazil region. One of the reasons is the lack of available long-term paleoclimate records.

Very recently, we reconstructed ocean temperature changes in the western tropical Atlantic on glacial-interglacial time scales and highlighted relatively cold (warm) upper ocean waters during glacial (deglacial and interglacial) intervals over the last 300 000 kyr¹. It remains unknown how these changes impacted the NE Brazilian hydroclimate on orbital time scales. This work aims at examining the response of continental vegetation to variations in the western tropical Atlantic heat content over the last two climatic cycles. We used the same sedimentary core (GL-1180) collected off the NE Brazilian margin on which temperature reconstructions were conducted.

We developed a multi-proxy approach at a 2 kyr temporal resolution to reconstruct the sources and the composition of the sedimentary organic matter (OM) produced on-land and within the water column at both bulk and molecular scales. We first investigated the organic signature of present-day dry (caatinga) and humid (Atlantic tropical forest) vegetation in our study area using modern litter samples. After statistical investigations, we developed new local vegetation proxies based on the relative abundance of long-chain n-alkanes \((n-C_{33}/(n-C_{29}+n-C_{31}+n-C_{33}))\), n-alkenes \((n-C_{27}/(n-C_{27}+n-C_{28}))\) and n-alkan-1-ols \((n-C_{28}/(n-C_{28}+n-C_{30}))\). Secondly, we reconstructed vegetation dynamics and hydroclimate changes using these new proxies together with the bulk elemental (\%Corg, \%Ntot) and isotopic \((\delta^{13}C_{org}, \delta^{15}N_{tot})\) composition and the molecular isotopic composition \((\delta^{13}C)\) of specific \(C_{29}\) and \(C_{31}\) n-alkanes. We found that a caatinga-like dry vegetation expanded during arid glacial periods while humid conditions prevailed over interglacial intervals in agreement with previous regional studies. Comparing our vegetation and upper ocean
temperature records, we highlighted that continental humid (arid) conditions occurred during intervals of warm (cold) western tropical Atlantic and weak (strong) southeast trade winds.

In conclusion, our work highlights glacial-interglacial vegetation and hydroclimate changes in NE Brazil. It further shows that the heat content of the tropical Atlantic was a major driver of these changes over the last 300,000 kyr. In addition, we suggest that the three major features (Atlantic heat content – ITCZ – SE trades) were likely controlling together hydroclimate changes and vegetation dynamics over, at least, the last two climatic cycles.

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