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Extent of high northern latitude forcing on tropical/subtropical South American precipitation during the last glacial

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The hydrologic system of South America underwent millennial-scale oscillations due to shifts in the position in the Intertropical Convergence Zone (ITCZ) during the last glacial (1,2,3,4,5). Corresponding variations in precipitation patterns have been reported to occur during Heinrich (H) events and Dansgaard/Oeschger (D/O) cycles in the northern tropics (2), but only during H events in the southern tropics (1,3,4,5). Here, we present evidence from a marine sediment core from the western tropical Atlantic for variations in Northeast (NE) Brazilian precipitation patterns during D/O cycles. Furthermore, we provide data from marine sediment cores and terrestrial pollen, stalagmite and ice core records from 4°S to 28°S to assess the spatial pattern of precipitation changes during H events and D/O cycles.

Ti/Ca and Fe/Ca ratios of marine sediment core GeoB 3910, indicating rates of terrestrial influx from NE Brazil into the tropical Atlantic, show shifts coincident with D/O cycles. This suggests variations in NE Brazilian precipitation rates during D/O cycles caused by shifts in the position of the ITCZ. Western tropical Atlantic sea surface temperatures (SST), calculated from foraminiferal Mg/Ca measurements, show changes coincident with D/O cycles as well. The relation between western tropical Atlantic SST and NE Brazilian precipitation patterns, however, is not uniform throughout the record. Whereas SST show minima during some D/O stadials but maxima during others, there is an increase in NE Brazilian precipitation during all D/O stadials. This suggests tropical Atlantic SST, which largely define interannual shifts in

the position of the ITCZ in the modern climate system, do not govern the position of the ITCZ on millennial timescales. However, we demonstrate the position of the ITCZ is strongly coupled to the temperature gradient between the North and tropical Atlantic on millennial timescales. Shifts in this gradient, mainly caused by the huge temperature changes in the high northern latitudes, trigger hemispheric-wide changes of the atmospheric circulation (6,7). These include shifts in the position of the ITCZ and in the strength of the Northeastern trades (6,7), which finally change precipitation patterns in the South American tropics.

Precipitation records from the interior NE Brazilian mountains (4), the East Brazilian coast (8) and the Bolivian Andes (9,10,11) show millennial-scale shifts during H events only. These regions are situated further away from the southern border of the ITCZ than our NE Brazilian site in the modern climate system and during interstadials. Therefore, precipitation patterns in these regions only change due to major shifts in the position of the ITCZ. These occur during stadials associated with H events, because the temperature gradient between the North and tropical Atlantic is greatest then. As millennial-scale variability plays a minor role in these records only, the dominant changes in precipitation patterns coincide with solar cycles (mainly austral summer insolation) (9,10).

New Ti/Ca and Fe/Ca analyses from sediment core GeoB 2107 from the western tropical/subtropical Atlantic (28°S) indicate changes in terrestrial sediment input coincident with the eccentricity cycle. There is no millennial-scale oscillation present in this record. Continental stalagmite and pollen records records from Southeast Brazil possibly indicate small changes in precipitation patterns during H events north of 27°S (12,13). However, millennial-scale oscillations in precipitation patterns play a subordinate role only. Precipitation patterns mainly show changes coincident with austral summer insolation (12). Pollen records from 30°S do not show any shifts in precipitation patterns during the Younger Dryas and H1 (Behling, unpublished data). Combined with the results from GeoB 2107, this suggests the impact of millennial-scale shifts in the position of the ITCZ, and therefore the impact of high northern latitude temperature changes, extends to about 28°S along the eastern South American coast.

1. Arz, H. W., Pätzold, J. & Wefer, G. Quaternary Research 50, 157-166 (1998).

2. Peterson, L. C., Haug, Gerald H., Hughen, Konrad A., Röhl, Ursula. Science 290, 1947-1951 (2000).

3. Behling, H., Arz, H. W., Pätzold, J. & Wefer, G. Quaternary Science Reviews 19, 981-994 (2000).

4. Wang, X. et al. Nature 432, 740-743 (2004).

5. Jennerjahn, T. C. et al. Science 306, 2236-2239 (2004).

6. Chiang, J. C. H., Biasutti, M. & Battisti, D. S. Paleoceanography 18 (2003).

7. Chiang, J. C. H. & Bitz, C. M. Climate Dynamics 25, 477-496 (2005).

8. Behling, H., Arz, H. W., Pätzold, J. & Wefer, G. Palaeogeography, Palaeoclimatology, Palaeoecology 179, 227-243 (2002).

9. Thompson, L. G. et al. Science 269, 46-50 (1995).

10. Thompson, L. G. et al. Science 282, 1858-1864 (1998).

11. Baker, P. A. et al. Nature 409, 698-701 (2001).

12. Cruz, F. W. et al. Nature 434, 63-66 (2005).

13. Behling, H., Pillar, V. D., Orloci, L. & Bauermann, S. G. Palaeogeography, Palaeoclimatology, Palaeoecology 203, 277-297 (2004).