Supporting Information

Stríkis et al. 10.1073/pnas.1717784115

Precipitation at the Study Site

The mean annual precipitation at the study sites located in CE Brazil was estimated based on data from eight local meteorological stations from 1936 to 2014. The rainfall dataset was obtained from the National Brazilian Meteorological Institute (Instituto Nacional de Meteorologia, INMET) website (www.inmet.gov.br/portal) and from the Agência Nacional de Água (ANA) website (www.ana.gov.br/). As each of these records is discontinuous, we applied a regional vector following the Brunet–Moret method using the software HYDRACCESS (1). This method, developed by the French Institute of Research for Development, consists of the construction of a synthetic station, which takes into account the gap of the records and calculates an annual index exerting a mean value equal to 1 throughout the record (Fig. S2).

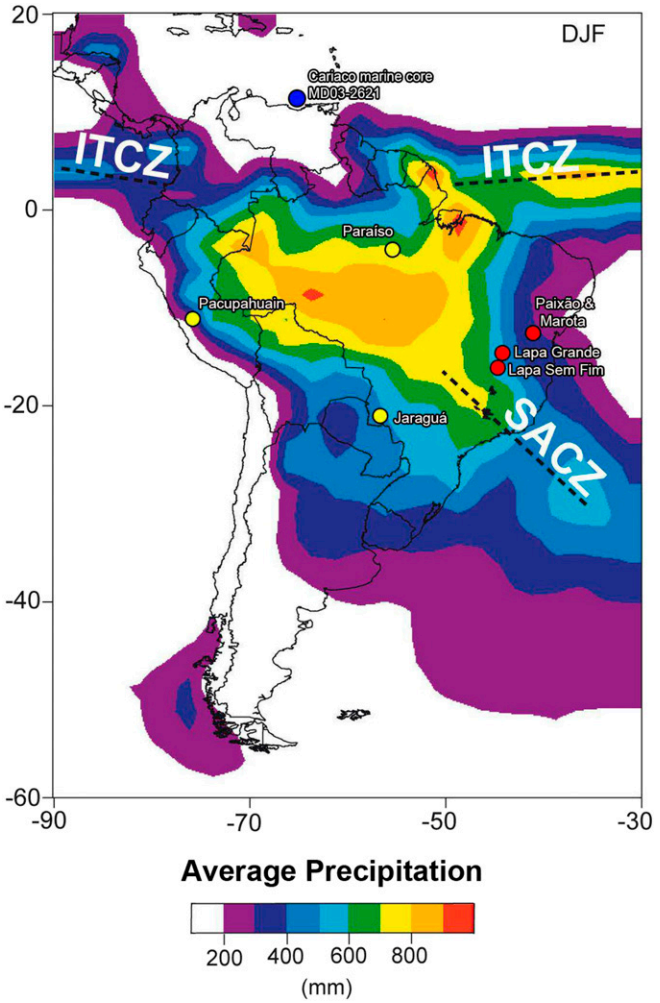

Fig. S1. Schematic diagram showing long-term mean (1979–2000) austral summer (December–January–February) precipitation in South America from the Climate Prediction Center's Merged Analysis of Precipitation. Dashed lines indicate the main climatological features of the South American Monsoon System: South Atlantic Convergence Zone (SACZ), and ITCZ. Red dots indicate our study sites, yellow dots refer to other cave sites discussed in this paper, and the blue dot indicates the location of Cariaco marine record.

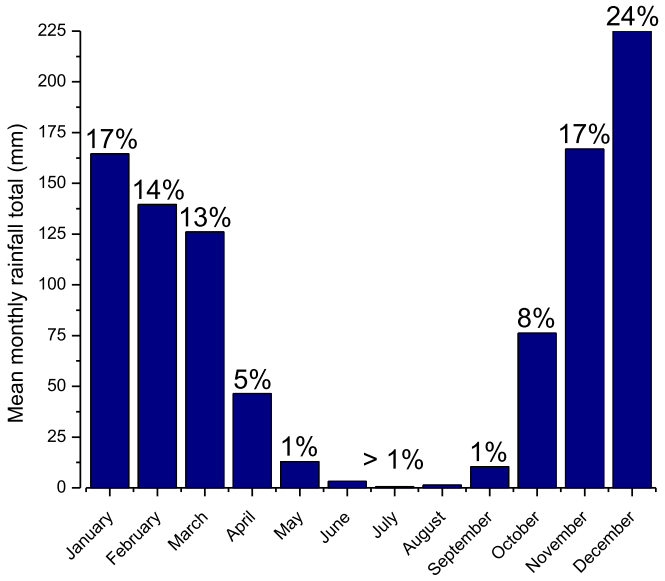

Fig. S2. Long-term monthly mean rainfall averaged over eight local meteorological stations. Source: ANA and INMET.

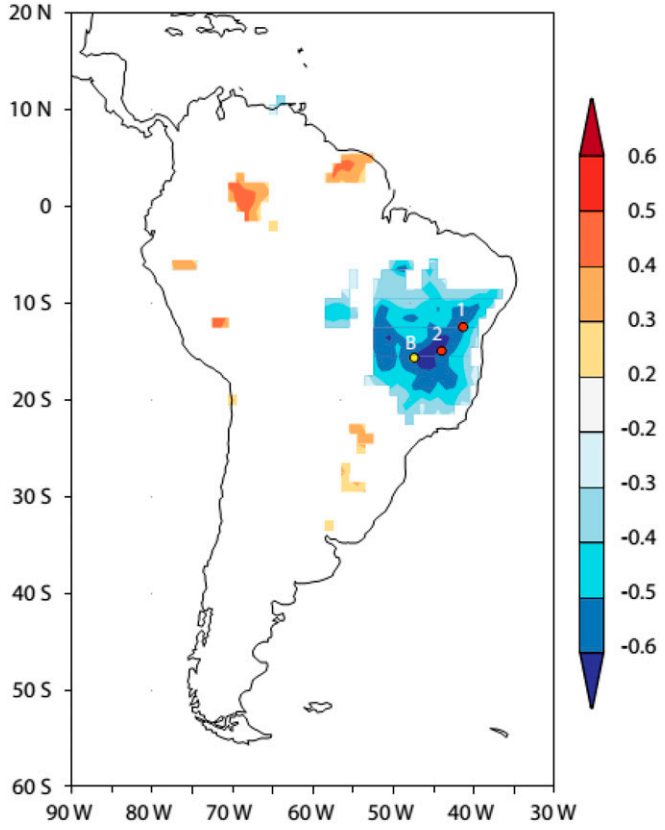

Fig. S3. Spatial correlation during austral summer (DJFM) between monthly $\delta^{18}O$ anomalies at IAEA/GNIP station Brasilia (*B*, yellow dot) and monthly precipitation anomalies from GPCC V7 1.0 over South America. Time period of analysis is 1965–1987, with a gap from 1977 to 1982. Shaded areas indicate significant correlations ($P < 0.1$). Figure created in Climate Explorer. Red dots indicate cave locations: 1 (LG and LSF) and 2 (PX and MAG).

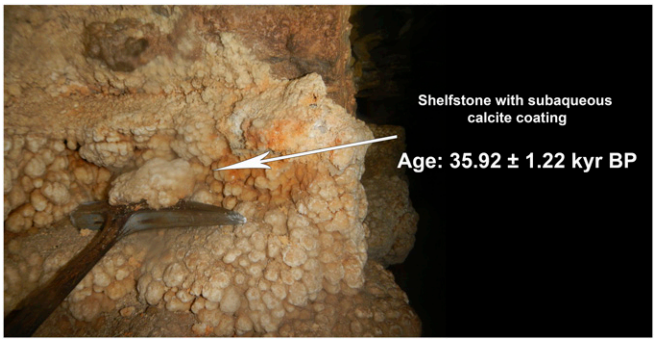

Fig. S4. Shelfstone deposit from LG cave with subaqueous calcite coating. The speleothem records a past water-table fluctuation of the vadose zone on a current dry conduit.

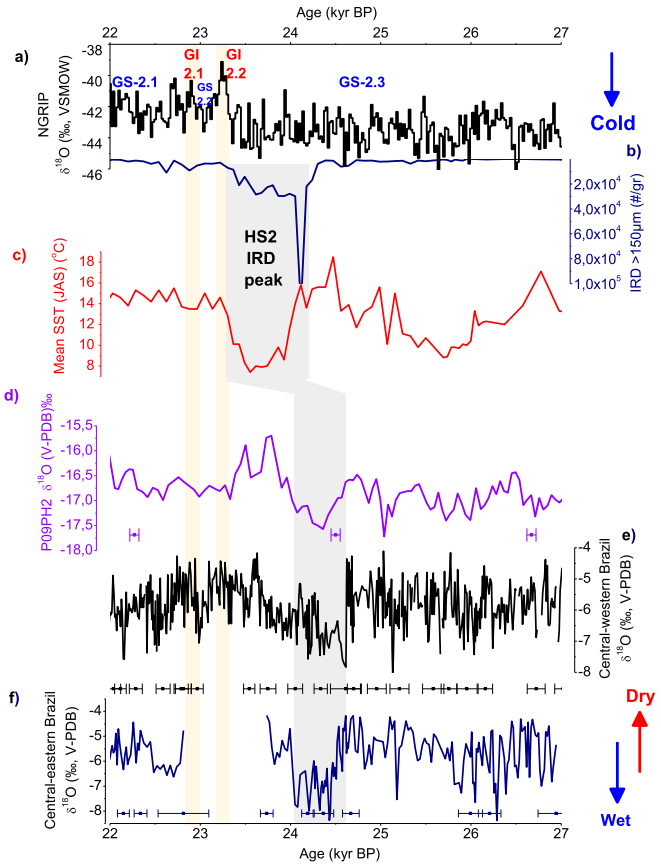

Fig. S5. Comparison between: (*A*) Greenland ice core $\delta^{18}O$ record on the annual-layer-counted GICC05 (3), (*B*) IRD from Iberian Margin (core MD95-2040) (15), and (*C*) summer SST reconstruction from Iberian Margin based on planktonic foraminiferal census counts (core MD95-2040) (36,17). The time series of MD95-2040 was synchronized with GISP2 on the GICC05 timescale. (*D*) $\delta^{18}O$ speleothem record from Peruvian Andes (30). (*E*) $\delta^{18}O$ speleothem record from Central-West Brazil (41); (*F*) Paleo-monsoon reconstruction from CE and NE Brazil based on $\delta^{18}O$ isotope profile from speleothem (this study).

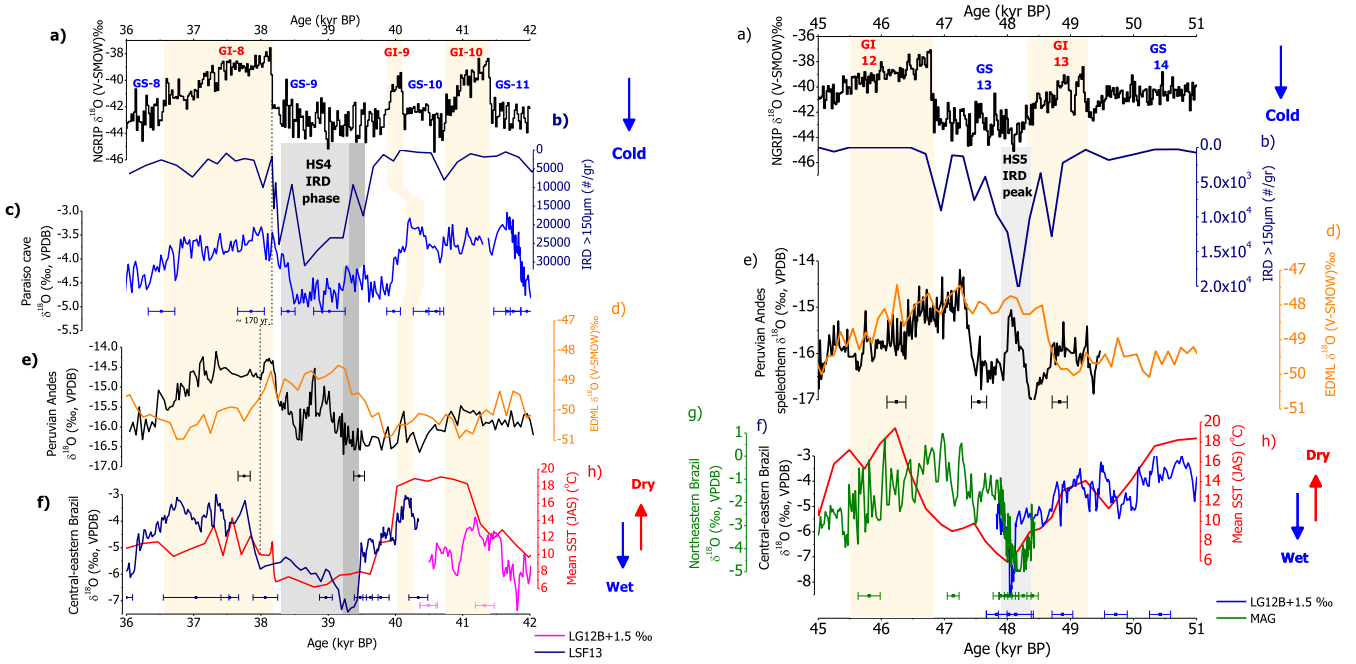

Fig. S6. South American monsoon precipitation and Antarctic warming: (*A*) Greenland ice core $\delta^{18}O$ record in the annual-layer-counted GICC05 (3). (*B*) IRD from Iberian Margin (core MD95-2040) (35). (*C*) Paraíso Cave speleothem $\delta^{18}O$ record (32) (eastern Amazon); (*D*) EPICA Dronning Maud Land (EMDL) ice core $\delta^{18}O$ record on the GICC05 timescale (46). (*E*) $\delta^{18}O$ record from speleothem from Peruvian Andes (30). (*F* and *G*) Paleo monsoon reconstruction from CE and NE Brazil based on speleothem $\delta^{18}O$ isotope profile from LSF, LG, and MAG (this study). (*H*) Summer SST reconstruction from Iberian Margin based on planktonic foraminiferal census count (core MD95-2040) (35,16). The time series of MD95-2040 was transferred to the GICC05 timescale.

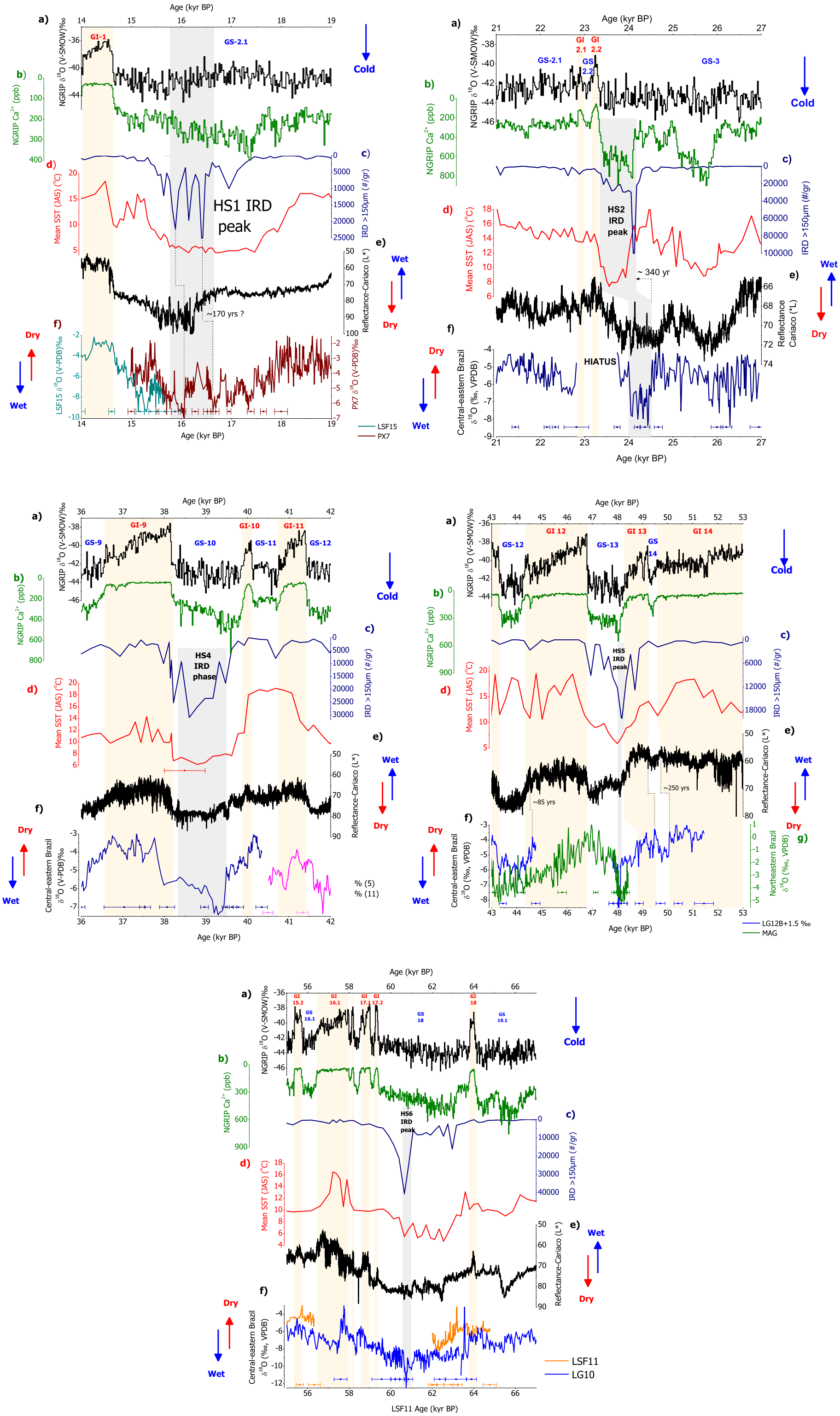

Fig. S7. Comparison between (*A*) Greenland ice core $\delta^{18}O$ record in the annual-layer-counted GICC05) (3). (*B*) Greenland ice core Ca^{2+} record in the annual-layer-counted GICC05 (3). (*C*) IRD from Iberian Margin (core MD95-2040) (15). (*D*) Summer SST reconstruction from Iberian Margin based on planktonic foraminiferal census counts (core MD95-2040) (36,17). The time series of MD95-2040 was synchronized with Greenland climate records on the GICC05 timescale; (*E*) Terrigenous versus carbonate content in sediments from the Cariaco drainage basin based on total reflectance core (MD03-2621), a proxy for changes in ITCZ position (44). (*F* and *G*) Paleo monsoon reconstruction from CE and NE Brazil based on $\delta^{18}O$ isotope profile from speleothems (this study).

Other Supporting Information Files

Dataset S1 (XLS)