

High-latitude forcing of interhemispheric anti-phased precipitation during the last glacial-interglacial cycle

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A high resolution oxygen isotopic record of cave calcite, spanning the last 90,000 years, was obtained from Caverna Botuverá, southern Brazil. The record broadly follows local insolation changes and shows significant millennial-scale variation with amplitudes as large as 3 per mil. Tests for equilibrium conditions show that oxygen isotopic variations are primarily caused by climate change. We interpreted the oxygen isotopic variations in terms of meteoric precipitation changes at this low-latitude location. Established with independent absolute-dated uranium series chronologies, our record anti-correlates remarkably with the contemporaneous oxygen isotopic records of cave calcite from eastern China [e.g. 1-3] (anti-phase precipitation changes), but positively correlates with the record of speleothem growth periods from northeastern Brazil [4] (in-phase precipitation changes) on millennial time scales.

These observations suggest that a rainfall seesaw may have existed between the southern and northern low latitudes on millennial time scales in the past. This interhemispheric anti-phasing of rainfall is probably caused by feedbacks between North Atlantic thermohaline circulation and the intertropical convergence zone (ITCZ), with affecting not only North Atlantic climate but also the displacement of the mean position of the ITCZ and associated asymmetry of the Hadley cell. The Brazilian speleothem records further indicate that millennial-scale abrupt climate change is largely tied to meridional shifts rather than zonal shifts, and are therefore unlikely to have been triggered by tropical Walker circulation changes. The modern appearance of a strong El Niño-Southern Oscillation (ENSO) signal in tropical Atlantic climate was perhaps induced by the current intermediate state of the mean ITCZ position and relatively weak asymmetry of the Hadley circulation, which can be monitored by the differences in speleothem calcite oxygen isotopic compositions.

References

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