Stalagmites in Northeast Brazilian Caves Confirm 9,000-Year Model of Diminishing Rainfall

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(PhysOrg.com) -- Until recently, researchers studying climate history in Brazil's dry Nordeste region expected it to have wet and dry periods similar to the rest of South America. But over the past 9,000 years, the region has shown just the opposite, drought when rain was expected, and vice versa. Geoscientists from the University of Massachusetts Amherst and the University of Sao Paolo, Brazil, with others, report this week that they've identified the cause as a surprising air circulation pattern.

As Stephen Burns, a UMass Amherst geoscientist explains, “In general, the Northern Hemisphere tropics have been getting drier and the Southern Hemisphere tropics have been getting wetter as maximum summer solar heating shifts southward. But Northeast Brazil has been acting like a Northern Hemisphere site and it’s been getting steadily drier from about 9,000 years ago to today.” Millions of people there must cope with severely disruptive, recurring droughts, Burns and colleagues point out. A more accurate model of past conditions could help predict what to expect in the future.

In their paper published this week in Nature Geoscience, Burns and co-investigators Francisco Cruz of the University of Sao Paolo and Mathias Vuille of the State University of New York, Albany, say they have discovered an unexpected east-west atmospheric circulation pattern that fits their new data and explains the Nordeste anomaly.

For this study, the researchers collected speleothems, in this case stalagmite segments a few inches long from five formations in three different caves in Brazil’s dry northern interior, where the country bulges out into the Atlantic. Speleothems are cave features formed over tens of thousands of years by water seeping through cracks in bedrock and dissolving limestones rich in calcite and aragonite. Depending on cave temperature, carbon dioxide level and other factors, the mineral deposits precipitate out as stalagmites, stalactites, ribbons, domes or even delicate straws, for example.

The researchers cut each stalagmite sample in half, polish it and subsample for radioactive isotopes to determine age and stable oxygen isotopes to learn about past rainfall over many centuries in the Nordeste region. “We then seek to determine what has caused the observed variations at various timescales, from just a few years up to tens of thousands of years,” Burns says.

“Our speleothem records are really the first long, high-resolution records of rainfall for this region. As we pieced the record together, what we found surprised us. We had not expected this area to show a pattern of changes in rainfall that was different—in fact opposite—from the rest of the Southern Hemisphere tropics in South America.”

Burns’ and Cruz’s co-authors at the University of Minnesota dated the samples using radiometric methods, and the stable isotope analyses were done by Burns at his UMass Amherst lab. They compared the oxygen isotopic record over the past 26,000 from the stalagmite samples to proxy rainfall records for the tropics of South America.

Their data fit a model of air circulation that wasn’t suspected before, Burns says. “The reason for the unusual rainfall pattern, with opposite dry and wet periods than expected, turned out to be a heretofore unobserved change in zonal (east-west) atmospheric circulation. Increased heating of the Amazon basin and the associated increase in rising moist air causes increased rainfall in that area. Our results suggest that this increase in convective heating over the Amazon Basin is associated with an increase in sinking air over northeast Brazil that results in drier conditions there.”

In simple terms, all rising air must fall somewhere, and sinking air in high pressure systems becomes dry, he adds. With so much sinking air over the Nordeste region, it ends up unexpectedly dry when most other areas are wet.

Burns has been using speleothems to study climate for more than 15 years in Oman, Yemen, Austria, Central and South America. He began the work in Brazil almost six years ago with Cruz, who conducted his post-doctoral research under Burns’ supervision at UMass Amherst. Cruz is now on the faculty at the University of Sao Paolo. Vuille also has UMass Amherst connections as a post-doc and then research faculty for

seven years.

More information: *Nature Geoscience* paper: www.nature.com/ngeo/journal/va … nt/full/ngeo444.html

Provided by University of Massachusetts Amherst

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