Dusty rainfall records reveal new understanding of Earth's long-term climate

May 24 2018

Weijian Zhou (left) of the Institute of Earth Environment, Chinese Academy of Sciences in Xi'an and Warren Beck (right) of the University of Arizona at a cross-section of a hill near Xi'an, China. The layers of loess soil shown in the photo represent thousands of years of soil deposition. Credit: 2009 Xian Feng, Institute of Earth Environment, Chinese Academy of Sciences

Ancient rainfall records stretching 550,000 years into the past may upend scientists' understanding of what controls the Asian summer monsoon and other aspects of the Earth's long-term climate, reports a University of Arizona-led international team of researchers in the May 25 issue of the journal *Science*.

The standard explanation of the Earth's regular shifts from ice ages to warm periods was developed by Milutin Milankovitch in the 1920s. He suggested the oscillations of the planet's orbit over tens of thousands of years control the climate by varying the amount of heat from the sun falling above the Arctic Circle in the summer.

"Here's where we turn Milankovitch on its head," said first author J. Warren Beck, a UA research scientist in physics and in geosciences. "We suggest that, through the monsoons, low-latitude climate may have as much effect on high-latitude climate as the reverse."

During the northern summer, the subtropics and tropics north of the equator warm and the tropics and subtropics south of the equator cool.

Modern observations show the difference in heat propels atmospheric changes that drive the intensity of the monsoon. Beck said the monsoon can affect wind and ocean currents as far away as the North Atlantic and Arctic Oceans.

The Asian monsoon season is the biggest annual rainfall system on Earth and brings rainfall to about half the world's population. The monsoon season occurs approximately April to September.

This hill of soil near Xi'an, China represents tens of thousands of years of deposition of a soil called loess. The researchers are collecting samples to use to reconstruct a record of the region's climate stretching 550,000 years into the past. Credit: © 2010 J. Warren Beck

Beck and his colleagues found that over tens of thousands of years the changes in the intensity of the Asian summer monsoon corresponded to the waxing and waning of the polar ice caps.

The researchers suggest those long-term changes in the monsoon drove global changes in wind and ocean currents in ways that affected whether the polar ice caps grew or shrank.

Beck said this new explanation of the Earth's past climate cycles will help climate modelers figure out more about the world's current and future climate.

The new explanation of what drives the Earth's climate system stems from a decade-long effort by Beck and his colleagues to develop a new record of rainfall in Asia reaching far back into the past.

Scientists have been trying to develop a quantitative proxy for ancient precipitation for more than 30 years, he said.

By analyzing thousands of years of dust from north-central China for an element called beryllium-10, Beck and his colleagues developed the first quantitative record of the region's monsoon rainfall for the past 550,000 years.

Soil called loess has accumulated over tens of thousands of years near Xi'an, China. The layered nature of the loess deposits allows researchers to use the elements within the loess to reconstruct a record of the region's climate stretching 550,000 years into the past. Credit: © 2010 J. Warren Beck

The team studied the deposits of fine soil called loess that blow year after year from central Asian deserts into north-central China. The layer-cake-like deposits, hundreds of feet thick, are a natural archive extending back millions of years.

The researchers cut stepwise into the side of a hill of loess to expose a 55-meter span of loess representing 550,000 years. The researchers collected a loess sample every five centimeters. Five centimeters represents about 500 years.

Scientists can use the amount of beryllium-10 in soil as a proxy for precipitation, because when it rains the element washes out of the atmosphere on dust particles. Because more rain means more beryllium-10 deposited on the soil, the amount of beryllium-10 deposited at a particular time reflects the intensity of the rainfall.

To put together the ancient rainfall history of the area, team members analyzed the samples for beryllium-10 at the UA Accelerator Mass Spectrometry Laboratory and for magnetic susceptibility at the Chinese Academy of Sciences Institute of Earth Environment in Xi'an.

Other investigators used the natural archive of oxygen isotopes within stalagmites from several Chinese caves to reconstruct the region's past climate. Those records only partially agree with the rainfall-based records of ancient climate developed by Beck and his colleagues.

Beck and his colleagues suggest their new explanation of the forces driving the Earth's long-term climate cycles reconciles the climate record from Chinese stalagmites and modern observations of the monsoon with the new ancient rainfall record from Chinese loess.

More information: J. Warren Beck et al, A 550,000-year record of East Asian monsoon rainfall from10Be in loess, *Science* (2018). [DOI: 10.1126/science.aam5825](https://doi.org/10.1126/science.aam5825)

Provided by University of Arizona