

First 2000-year temperature reconstructions for individual continents published

An international team of 78 researchers has published the most comprehensive reconstruction of past temperature changes at the continental scale.

The research confirms an overall cooling trend across nearly all continents during the last one to two thousand years. This trend was reversed by distinct warming, beginning in some regions at the end of the 19th century, say the authors in the journal *Nature Geoscience*.

The researchers, coordinated by the Past Global Changes (PAGES) project based in Switzerland, reached their conclusions by integrating records from tree rings, pollen, corals, lake and marine sediments, ice cores, stalagmites and historical documents at 511 locations across seven continental-scale regions.

Temperature variations across continents were noticeably more similar within the hemispheres than between the Northern and Southern Hemisphere. "Distinctive periods, such as the Medieval Warm Period or the Little Ice Age stand out, but do not show a globally uniform pattern on multi-decadal time scales," says co-author Professor Heinz Wanner of the University of Bern.

By around 1500 AD temperatures fell below the long-term mean nearly everywhere. However, in the Arctic, Europe and Asia this temperature drop occurred centuries earlier than in North America and the Southern Hemisphere. "These new findings will certainly stimulate vibrant discussions within the research community," says Professor Wanner.

The most consistent feature across the regions was a long-term cooling trend. The researchers suggest that a combination of factors contributed to the trend such as an overall increase in volcanic activity, a decrease in solar activity, changes in land cover, and slow changes in the Earth's orbit.

The cooling came to an end towards the end of the 19th century. Warming in the 20th century was on average twice as large in the northern regions as it was in the Southern Hemisphere. Only one continent, Antarctica, has bucked the warming trend.

An analysis of the average temperatures over 30-year periods indicates that the interval from 1971 to 2000 was probably warmer than any other 30-year period in the last 1400 years. Going back further, some regions experienced warmer 30-year intervals. In Europe, a period during the Roman Empire between 21 and 80 AD was likely warmer than the period 1971-2000.

Cooler 30-year periods between the years 830 and 1910 AD were particularly pronounced during weak solar activity and strong tropical volcanic eruptions. Both phenomena often occurred simultaneously and led to a drop in the average temperature during five distinct 30- to 90-year intervals between 1251 and 1820.

African climate records remain sparse. Lead author Professor Darrell Kaufman, Northern Arizona University in Flagstaff, said, "There were too few records to accurately determine long-term temperature changes for that continent."

Nevertheless, the researchers expect the expansive new dataset will be used in future studies, including for comparisons with the output of climate models used to help project future climate change.

"Previous attempts to reconstruct temperature changes focused on hemispheric or global-scale averages, which are important, but overlook the pronounced regional-scale differences that occur along with global changes," said Professor Kaufman.

"A key aspect of the consortium effort was to engage regional experts who are intimately familiar with the evidence for past climate changes within their regions," he added.

"Several mathematical procedures were applied to reconstruct the continental temperature time series and they were compared to assess the extent to which the main conclusions of the study stood up to the different analytical approaches."

PAGES was established in 1991 to facilitate international research into understanding climatic and environmental dynamics by studying the past. The program receives funding mainly from the Swiss and US national science foundations. In 2006, scientists in the PAGES network decided to organize an initiative to reconstruct the climate of the last 2000 years in unprecedented quality – the PAGES 2k Network.

Reference

"Continental-scale temperature variability during the last two millennia", PAGES 2k Consortium, *Nature Geoscience*, to be published online 21 April 2013, DOI: 10.1038/NGEO1797

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