Climate in northern Europe reconstructed for the past 2,000 years

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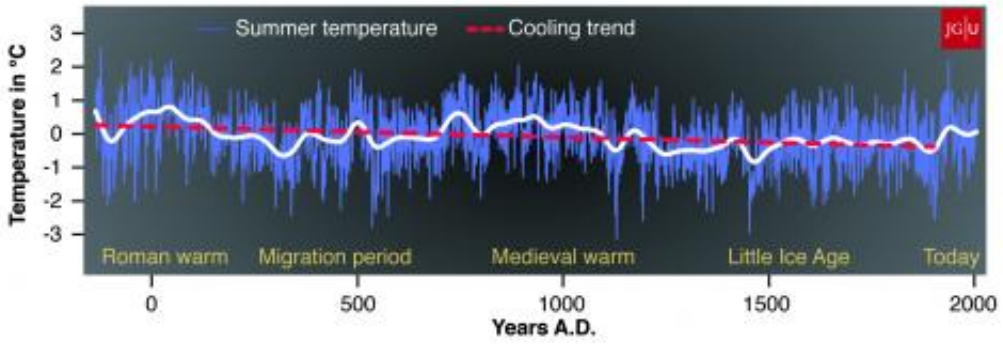

The reconstruction provides a high-resolution representation of temperature patterns in the Roman and Medieval warm periods, but also shows the cold phases that occurred during the Migration Period and the later Little Ice Age.

An international team that includes scientists from Johannes Gutenberg University Mainz (JGU) has published a reconstruction of the climate in northern Europe over the last 2,000 years based on the information provided by tree-rings.

Professor Dr. Jan Esper's group at the Institute of Geography at JGU used tree-ring density measurements from sub-fossil pine trees originating from Finnish Lapland to produce a reconstruction reaching back to 138 BC. In so doing, the researchers have been able for the first time to precisely demonstrate that the long-term trend over the past two

millennia has been towards climatic cooling. "We found that previous estimates of historical temperatures during the Roman era and the Middle Ages were too low," says Esper. "Such findings are also significant with regard to climate policy, as they will influence the way today's climate changes are seen in context of historical warm periods." The new study has been published in the journal *Nature Climate Change*.

Was the climate during Roman and Medieval times warmer than today? And why are these earlier warm periods important when assessing the global climate changes we are experiencing today? The discipline of paleoclimatology attempts to answer such questions. Scientists analyze indirect evidence of climate variability, such as ice cores and ocean sediments, and so reconstruct the climate of the past. The annual growth rings in trees are the most important witnesses over the past 1,000 to 2,000 years as they indicate how warm and cool past climate conditions were.

Researchers from Germany, Finland, Scotland, and Switzerland examined tree-ring density profiles in trees from Finnish Lapland. In this cold environment, trees often collapse into one of the numerous lakes, where they remain well preserved for thousands of years.

The international research team used these density measurements from sub-fossil pine trees in northern Scandinavia to create a sequence reaching back to 138 BC. The density measurements correlate closely with the summer temperatures in this area on the edge of the Nordic taiga; the researchers were thus able to create a temperature reconstruction of unprecedented quality. The reconstruction provides a high-resolution representation of temperature patterns in the Roman and Medieval Warm periods, but also shows the cold phases that occurred during the Migration Period and the later Little Ice Age.

In addition to the cold and warm phases, the new climate curve also

exhibits a phenomenon that was not expected in this form. For the first time, researchers have now been able to use the data derived from tree-rings to precisely calculate a much longer-term cooling trend that has been playing out over the past 2,000 years. Their findings demonstrate that this trend involves a cooling of -0.3°C per millennium due to gradual changes to the position of the sun and an increase in the distance between the Earth and the sun.

"This figure we calculated may not seem particularly significant," says Esper, "however, it is also not negligible when compared to global warming, which up to now has been less than 1°C. Our results suggest that the large-scale climate reconstruction shown by the Intergovernmental Panel on Climate Change (IPCC) likely underestimate this long-term cooling trend over the past few millennia."

More information: J. Esper et al., Orbital forcing of tree-ring data, Nature Climate Change, 8 July 2012. doi:10.1038/NCLIMATE1589 . www.nature.com/nclimate/journa … ll/nclimate1589.html

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