Past regional cold and warm periods linked to natural climate drivers

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Intervals of regional warmth and cold in the past are linked to the El Niño phenomenon and the so-called "North Atlantic Oscillation" in the Northern hemisphere's jet stream, according to a team of climate scientists. These linkages may be important in assessing the regional effects of future climate change.

"Studying the past can potentially inform our understanding of what the future may hold," said Michael Mann, Professor of meteorology, Penn State.

Mann stresses that an understanding of how past natural changes have influenced phenomena such as El Niño, can perhaps help to resolve current disparities between state-of the-art climate models regarding how human-caused climate change may impact this key climate pattern.

Mann and his team used a network of diverse climate proxies such as tree ring samples, ice cores, coral and sediments to reconstruct spatial patterns of ocean and land surface temperature over the past 1500 years. They found that the patterns of temperature change show dynamic connections to natural phenomena such as El Niño. They report their findings in today's issue of *Science*.

Mann and his colleagues reproduced the relatively cool interval from the 1400s to the 1800s known as the "Little Ice Age" and the relatively mild conditions of the 900s to 1300s sometimes termed the "Medieval Warm Period."

"However, these terms can be misleading," said Mann. "Though the medieval period appears modestly warmer globally in comparison with the later centuries of the Little Ice Age, some key regions were in fact colder. For this reason, we prefer to use 'Medieval Climate Anomaly' to underscore that, while there were significant climate anomalies at the time, they were highly variable from region to region."

The researchers found that 1,000 years ago, regions such as southern Greenland may have been as warm as today. However, a very large area covering much of the tropical Pacific was unusually cold at the same time, suggesting the cold La Niña phase of the El Niño phenomenon.

This regional cooling offset relative warmth in other locations, helping to explain previous observations that the globe and Northern hemisphere on average were not as warm as they are today.

Comparisons between the reconstructed temperature patterns and the results of theoretical climate model simulations suggest an important role for natural drivers of climate such as volcanoes and changes in solar output in explaining the past changes. The warmer conditions of the medieval era were tied to higher solar output and few volcanic eruptions, while the cooler conditions of the Little Ice Age resulted from lower solar output and frequent explosive volcanic eruptions.

These drivers had an even more important, though subtle, influence on regional temperature patterns through their impact on climate phenomena such as El Niño and the North Atlantic Oscillation. The modest increase in solar output during medieval times appears to have favored the tendency for the positive phase of the NAO associated with a more northerly jet stream over the North Atlantic. This brought greater warmth in winter to the North Atlantic and Eurasia. A tendency toward the opposite negative NAO phase helps to explain the enhanced winter cooling over a large part of Eurasia during the later Little Ice Age period.

The researchers also found that the model simulations failed to reproduce the medieval La Nina pattern seen in the temperature reconstructions. Other climate models focused more specifically on the mechanisms of El Niño do however reproduce that pattern. Those models favor the "Thermostat" mechanism, where the tropical Pacific counter-intuitively tends to the cold La Niña phase during periods of increased heating, such as provided by the increase in solar output and quiescent volcanism of the medieval era.

The researchers note that, if the thermostat response holds for the future human-caused climate change, it could have profound impacts on particular regions. It would, for example, make the projected tendency for increased drought in the Southwestern U.S. worse.

Provided by Penn State

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