A warm climate is more sensitive to changes in atmospheric CO2

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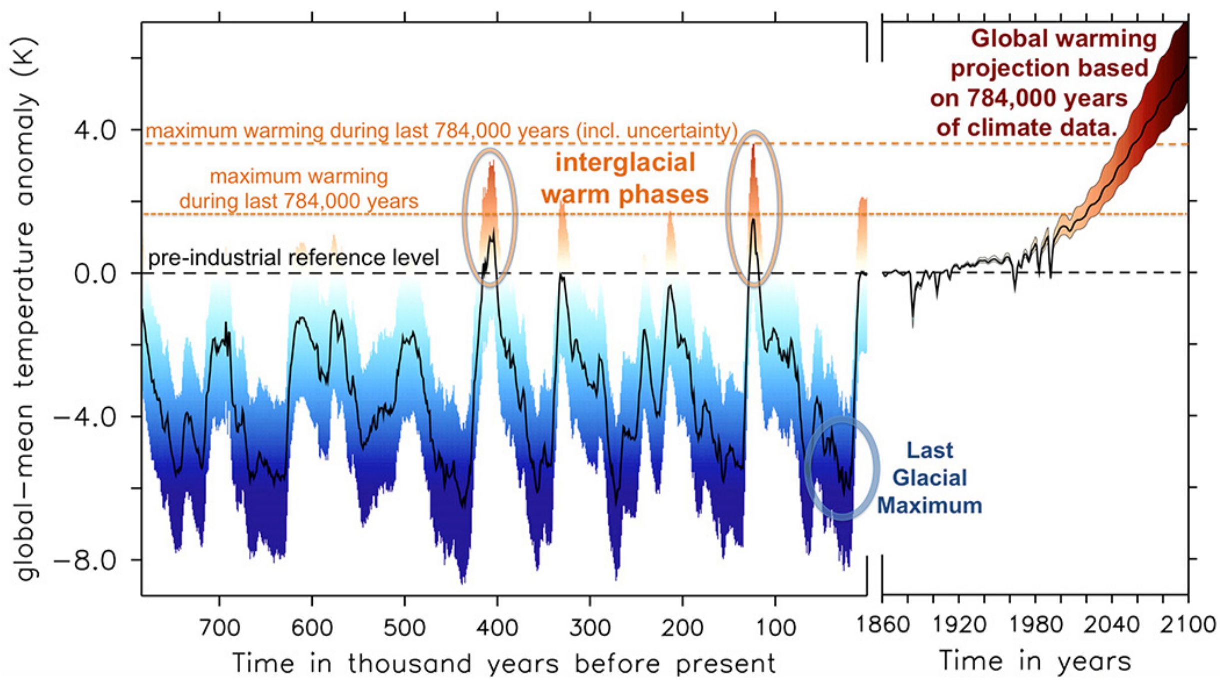

Global mean temperature anomaly with respect to preindustrial reference level. Left panel: Reconstruction of last 784,000 yrs. Right panel: Global warming projection to 2100 based on newly calculated paleoclimate sensitivity. Credit: Friedrich, et al. (2016)

It is well-established in the scientific community that increases in atmospheric CO2 levels result in global warming, but the magnitude of the effect may vary depending on average global temperature. A new study, published this week in *Science Advances* and led by Tobias Friedrich from the International Pacific Research Center (IPRC) at the University of Hawai?i at Mānoa (UHM), concludes that warm climates are more sensitive to changes in CO_2 levels than cold climates.

Increasing atmospheric CO_2 concentrations cause an imbalance in the Earth's heat budget: more heat is retained than expelled, which in turn generates global surface warming. Climate sensitivity is a term used to describe the amount of warming expected to result after an increase in the concentration of CO_2. This number is traditionally calculated using complex computer models of the climate system, but despite decades of progress, the number is still subject to uncertainty.

The new study, which included scientists from the University of Washington, the University at Albany, and the Potsdam Institute for Climate Impact Research, took a different approach in calculating climate sensitivity: using data from the history of Earth. The researchers examined various reconstructions of past temperatures and CO_2 levels to determine how the climate system has responded to previous changes in its energy balance.

"The first step was to reconstruct the history of global mean temperatures for the last 784,000 years, using combined data from marine sediment cores, ice cores, and computer simulations covering the last eight glacial cycles," said Friedrich, a post-doctoral researcher at IPRC.

The second step involved calculating the Earth's energy balance for this time period, using estimates of greenhouse gas concentrations extracted from air bubbles in ice cores, and incorporating astronomical factors, known as Milankovitch Cycles, that effect the planetary heat budget.

"Our results imply that the Earth's sensitivity to variations in atmospheric CO_2 increases as the climate warms," explained Friedrich. "Currently, our planet is in a warm phase—an interglacial period—and the associated increased climate sensitivity needs to be taken into account for future projections of warming induced by human activities."

Using these estimates based on Earth's paleoclimate sensitivity, the authors computed the warming over the next 85 years that could result from a human-induced, business-as-usual greenhouse gas emission scenario. The researchers project that by the year 2100, global temperatures will rise 5.9°C (~10.5°F) above pre-industrial values. This magnitude of warming overlaps with the upper range of estimates presented by the Intergovernmental Panel on Climate Change (IPCC).

"Our study also allows us to put our 21st century temperatures into the context of Earth's history. Paleoclimate data can actually teach us a lot about our future," said Axel Timmermann, co-author of the study and professor at UHM.

The results of the study demonstrate that unabated human-induced greenhouse gas emissions are likely to push Earth's climate out of the envelope of temperature conditions that have prevailed for the last 784,000 years.

"The only way out is to reduce greenhouse gas emissions as soon as possible," concluded Friedrich.

More information: "Nonlinear climate sensitivity and its implications for future greenhouse warming," *Science Advances*, DOI: 10.1126/sciadv.1501923

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