

Direct evidence for a positive feedback in climate change

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A new study has confirmed the existence of a positive feedback operating in climate change whereby warming itself may amplify a rise in greenhouse gases resulting in additional warming.

The study, published in the journal *Nature Climate Change*, shows that in addition to the well understood effect of greenhouse gases on the Earth's temperature, researchers can now confirm directly from ice-core data that the [global temperature](#) has a profound effect on atmospheric [greenhouse gas concentrations](#). This means that as the Earth's temperature rises, the positive feedback in the system results in additional warming.

It has been known for a while that the Earth has historically had higher levels of greenhouse gases during warm periods than during ice ages.

However, it had so far remained impossible to discern cause and effect from the analysis of gas bubbles contained in ice cores.

Professor Tim Lenton from the University of Exeter said: "Our new results confirm the prediction of [positive feedback](#) from the climate models, the big difference is that now we have independent data based evidence for it."

An international team of researchers led by Egbert van Nes from Wageningen University (Netherlands) used a novel mathematical insight developed to have a fresh look at the data. The analysis reveals that the glacial cycles experienced by the planet over the past 400,000 years are governed by strong internal feedbacks in the Earth system. Slight variations in the Earth orbit known as Milankovitch cycles, functioned merely as a subtle pacemaker for the process.

"A fundamental insight by George Sugihara from the USA on how one can use observed dynamics in time series to infer causality caused a big splash in the field," explains Egbert van Nes. "It immediately made us wonder whether it could be used to solve the enigma of the iconic correlated temperature and gas history of the Earth."

Indeed this riddle has proven hard to solve. A slight lead of Antarctic temperature over CO₂ variations has been argued to point to temperature as a driver of CO₂ changes. However, more recent studies cast doubt on the existence of a significant time-lag between CO₂ and temperature.

"It can be highly misleading to use simple correlation to infer causality in complex systems," says George Sugihara from Scripps Institution of Oceanography (USA). "Correlations can come and go as mirages, and cause and effect can go both ways as in a kind of chicken and egg problem, and this requires a fundamentally different way to look at the

data."

As direct evidence from data has been hard to achieve, Earth system models are used as a less direct alternative to quantify causality in the climate system. However, although the effects of [greenhouse gases](#) on the Earth's temperature are relatively well understood, estimating the actual strength of this effect is challenging, because it involves a plethora of mechanisms that are difficult to quantify and sometimes oppose each other.

More information: "Causal feedbacks in climate change" Nature Climate Change 2015. Egbert H. van Nes, Marten Scheffer, Victor Brovkin, Timothy M. Lenton, Hao Ye, Ethan Deyle and George Sugihara [dx.doi.org/10.1038/nclimate2568](https://doi.org/10.1038/nclimate2568)

Provided by University of Exeter

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