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Past increases in Antarctic temperature and CO₂ levels coincided

The increase in temperature and in carbon dioxide (CO₂) concentration in the Antarctic during the last deglaciation (20,000 to 10,000 years ago) happened simultaneously. These are the conclusions of the analysis of five Antarctic ice cores by a European team led by French researchers from CNRS, CEA, and Universités Versailles Saint-Quentin-en-Yvelines and Joseph Fourier - Grenoble¹. These findings contradict previous work, which showed that CO₂ increases lagged behind rises in Antarctic temperature. These results therefore suggest that CO₂ may be a possible cause for warming. They are published in the journal *Science* dated March 1.

The polar ice sheets provide an excellent record of past variations in the polar atmosphere and climate. The ice cores extracted until now cover 800,000 years of Antarctic history², enabling researchers to better understand past variations in the climate. It has been shown that there is a correlation between past Antarctic temperatures and CO₂ concentrations: temperatures were generally higher during periods when CO₂ concentrations were high, and vice versa. However, did the greenhouse effect due to CO₂ cause the warming, or was it the other way round?

To make headway on this issue, the researchers attempted to determine whether it was CO₂ or temperature that changed first when they rose or fell in tandem. This is a complex question because temperature and CO₂ concentration of a specific age are not read off at the same level in an ice core: the temperature is recorded at the surface of the polar ice sheets, whereas atmospheric gases such as CO₂ are trapped at a depth of approximately 100 meters, which is where the gas bubbles form (the depth depends on climate conditions). In other words, the gas bubbles are always younger than the ice in which they are embedded.

Until now, the depth at which the air bubbles are trapped as well as the time lag between CO₂ and temperature were determined from models of snow compaction. Earlier research thus showed that increases in Antarctic CO₂ at the end of the last glaciation (20,000 to 10,000 years ago) began 800 years after temperatures began to rise.

A team of scientists led by two French laboratories, the Laboratoire de Glaciologie et de Géophysique de l'Environnement (LGGE³, CNRS/UJF) and the Laboratoire des Sciences du Climat et de l'Environnement

¹ The French laboratories involved are the Laboratoire de Glaciologie et de Géophysique de l'Environnement (LGGE, CNRS/UJF) and the Laboratoire des Sciences du Climat et de l'Environnement (IPSL/LSCE, CNRS/CEA/UVSQ).

² See <http://www2.cnrs.fr/presse/communiqu/1339.htm>

³ Observatoire des Sciences de l'Univers de Grenoble (OSUG)



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(IPSL/LSCE, CNRS/CEA/UVSQ), developed a different technique to estimate the time lag. The scientists determined the depth at which gases were trapped from the amount of the isotope nitrogen-15 present in the air bubbles. Nitrogen-15 is enriched by gravitation in proportion to the depth at which the air is trapped. The team also applied an innovative statistical method to determine the temperature in the Antarctic and the extent to which it led or lagged behind the CO₂.

According to their findings, CO₂ and temperature varied simultaneously at the end of the last glaciation, to the nearest 200 years. The discovery implies that the hypothesis that CO₂ was at least partly responsible for Antarctic warming at the end of the last glaciation is probably correct. However, new data and new simulations will be necessary to precisely determine the various contributions to this past natural climate warming. The scientists plan to study other periods and analyze other ice cores using the same methods.



At Talos Dome in 2005-2006, the ice corer with a fresh ice core © Frédéric Parrenin, LGGE (CNRS / UJF)



At Talos Dome in 2005-2006, Frédéric Parrenin seen cutting an ice core prior to packing it up © Frédéric Parrenin, LGGE (CNRS / UJF)

Additional images are available on demand.

Reference

Synchronous Change of Atmospheric CO₂ and Antarctic Temperature During the Last Deglacial Warming, F. Parrenin, V. Masson-Delmotte, P. Köhler, D. Raynaud, D. Paillard, J. Schwander, C. Barbante, A. Landais, A. Wegner, J. Jouzel, *Science*. 1 March 2013.

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