

Research sheds new light on the role of sea ice in controlling atmospheric carbon levels

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A new study has highlighted the crucial role that sea ice across the Southern Ocean played in controlling atmospheric carbon dioxide levels during times of past climate change, and could provide a critical

resource for developing future climate change models.

For the study an international team of researchers, led by Keele University and including experts from the University of Exeter, demonstrated that seasonal growth and destruction of sea ice in a warming world enhances the amount of marine life present in the sea around Antarctica, which draws down carbon from the atmosphere and stores it in the [deep ocean](#).

Having captured half of all human-related carbon that has entered the [ocean](#) to date, the Southern Ocean around Antarctica is crucial for regulating carbon dioxide levels resulting from human activity, so understanding the processes that determine its effectiveness as a carbon sink through time are crucial to reducing uncertainty in future climate change models.

To understand this process further, the researchers studied data relating to one period where atmospheric CO₂ levels changed rapidly.

This occurred after the Last Ice Age, around 18,000 years ago, when the world transitioned naturally into the warm interglacial world we live in today.

During this period, CO₂ rose rapidly from around 190 parts per million (ppm) to 280 ppm over around 7,000 years, but one period in particular stands out; a 1,900 year period where CO₂ levels plateaued at a nearly constant level of 240 ppm.

The cause of this plateau, which occurred around 14,600 years ago, is unknown, but understanding what happened during this period could be crucial for improving climate change projections.

Professor John Love, from Exeter's Biosciences department and co-

author of the study said: "My research group and I are very excited about being part of this important investigation. We developed new techniques in cell biology to find, collect and analyze the rare and very tiny particles and cells that had been frozen in the ice for millennia.

"Like flies in amber, these minute fragments give us a unique window into past events, enabling our colleagues in the Earth, Atmosphere and Ocean sciences to develop a better understanding of climate change then, and now."

Lead author Professor Chris Fogwill, Director of Keele University's Institute for Sustainable Futures said: "The cause of this long plateau in global atmospheric CO₂ levels may be fundamental to understanding the potential of the Southern Ocean to moderate atmospheric CO₂."

To resolve this question, researchers traveled to the Patriot Hills Blue Ice Area of Antarctica to develop new records of evidence of marine life that are captured in ice cores, with support from Antarctic Logistics and Expeditions (ALE).

Blue ice areas are the perfect laboratory for Antarctic scientists due to their unique topography. Created by fierce, high-density katabatic winds, the top layer of snow is effectively eroded, exposing the ice below. As a result, ice flows up to the surface, providing access to ancient ice below.

Professor Chris Turney, a visiting Fellow at Keele's Institute for Liberal Arts and Sciences from UNSW Sydney said: "Instead of drilling kilometers into the ice, we can simply walk across a blue ice area and travel back through time.

"This provides the opportunity to sample large amounts of ice for studying past environmental changes in detail. Organic biomarkers and DNA from the Southern Ocean are blown onto Antarctica and preserved

in the ice, providing a unique record in a region where we have few scientific observations."

Using this approach the team discovered that there was a marked increase in the number and diversity of marine organisms present across the 1,900 year period when the CO₂ plateaued, an observation which had never been recorded before.

This provides the first recorded evidence of increased biological productivity and suggests that processes in the high latitude Southern Ocean may have caused the CO₂ plateau. However, the driver of this marked change remained unknown, and the researchers used climate modeling to better understand the changes in the Southern Ocean to understand the potential cause.

This modeling revealed that the plateau period coincided with the greatest seasonal changes in sea ice during a pronounced cold phase across the Southern Ocean known as the Antarctic Cold Reversal. During this period, sea ice grew extensively across the Southern Ocean, but as the world was warming rapidly, each year the sea ice would be rapidly destroyed during the summer.

The researchers will now use these findings to underpin the development of future climate change models. The inclusion of sea ice processes that control climate-carbon feedbacks in a new generation of models will be crucial for reducing uncertainties surrounding climate projections and will help society adapt to future warming.

The study is published in *Nature Geoscience*.

More information: Southern Ocean carbon sink enhanced by sea-ice feedbacks at the Antarctic Cold Reversal, *Nature Geoscience*, [DOI: 10.1038/s41561-020-0587-0](https://doi.org/10.1038/s41561-020-0587-0) ,

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