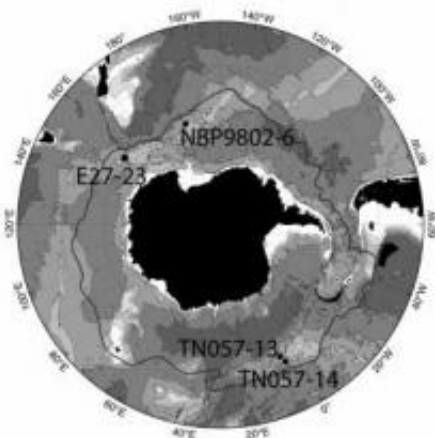


Wind shifts may stir CO₂ from Antarctic depths

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This pictures shows the locations of cores showing Antarctic upwelling. Credit: Robert Anderson, Lamont-Doherty Earth Observatory

Natural releases of carbon dioxide from the Southern Ocean due to shifting wind patterns could have amplified global warming at the end of the last ice age--and could be repeated as manmade warming proceeds, a new paper in the journal *Science* suggests.

Many scientists think that the end of the last ice age was triggered by a change in Earth's orbit that caused the northern part of the planet to warm. This partial climate shift was accompanied by rising levels of the

[greenhouse gas CO2](#), [ice core](#) records show, which could have intensified the warming around the globe. A team of scientists at Columbia University's Lamont-Doherty Earth Observatory now offers one explanation for the mysterious rise in CO2: the orbital shift triggered a southward displacement in [westerly winds](#), which caused heavy mixing in the [Southern Ocean](#) around Antarctica, pumping dissolved carbon dioxide from the water into the air.

"The faster the ocean turns over, the more deep water rises to the surface to release CO2," said lead author Robert Anderson, a geochemist at Lamont-Doherty. "It's this rate of overturning that regulates CO2 in the atmosphere." In the last 40 years, the winds have shifted south much as they did 17,000 years ago, said Anderson. If they end up venting more CO2 into the air, manmade warming underway now could be intensified.

Scientists have been studying the oceans for more than 25 years to understand their influence on CO2 levels and the [glacial cycles](#) that have periodically heated and chilled the planet for more than 600,000 years. Ice cores show that the ends of other ice ages also were marked by rises in CO2.

Two years ago, J.R. Toggweiler, a scientist at the National Oceanic and Atmospheric Administration (NOAA), proposed that westerly winds in the [Southern Ocean](#) around Antarctica may have undergone a major shift at the end of the last ice age. This shift would have raised more CO2-rich deep water to the surface, and thus amplified warming already taking place due to the earth's new orbital position. Anderson and his colleagues are the first to test that theory by studying sediments from the bottom of the Southern Ocean to measure the rate of overturning.

The scientists say that changes in the westerlies may have been triggered by two competing events in the northern hemisphere about 17,000 years ago. The earth's orbit shifted, causing more sunlight to fall in the north,

partially melting the ice sheets that then covered parts of the United States, Canada and Europe. Paradoxically, the melting may also have spurred sea-ice formation in the North Atlantic Ocean, creating a cooling effect there. Both events would have caused the westerly winds to shift south, toward the Southern Ocean. The winds simultaneously warmed Antarctica and stirred the waters around it. The resulting upwelling of CO₂ would have caused the entire globe to heat.

Anderson and his colleagues measured the rate of upwelling by analyzing sediment cores from the Southern Ocean. When deep water is vented, it brings not only CO₂ to the surface but nutrients. Phytoplankton consume the extra nutrients and multiply.

In the cores, Anderson and his colleagues say spikes in plankton growth between roughly 17,000 years ago and 10,000 years ago indicate added upwelling. By comparing those spikes with ice core records, the scientists realized the added upwelling coincided with hotter temperatures in Antarctica as well as rising CO₂ levels.

In the same issue of *Science*, Toggweiler writes a column commenting on the work. "Now I think this really starts to lock up how the CO₂ changed globally," he said in an interview. "Here's a mechanism that can explain the warming of Antarctica and the rise in CO₂. It's being forced by the north, via this change in the winds."

At least one model supports the evidence. Richard Matear, a researcher at Australia's Commonwealth Scientific and Industrial Research Organisation, describes a scenario in which winds shift south and produce an increase in CO₂ venting in the Southern Ocean. Plants, which incorporate CO₂ during photosynthesis, are unable to absorb all the added nutrients, causing atmospheric CO₂ to rise.

Some other climate models disagree. In those used by the

Intergovernmental Panel on Climate Change, the westerly winds do not simply shift north-south. "It's more complicated than this," said Axel Timmermann, a climate modeler at the University of Hawaii. Even if the winds did shift south, Timmermann argues, upwelling in the Southern Ocean would not have raised CO₂ levels in the air. Instead, he says, the intensification of the westerlies would have increased upwelling and plant growth in the Southeastern Pacific, and this would have absorbed enough atmospheric CO₂ to compensate for the added upwelling in the Southern Ocean.

"Differences among model results illustrate a critical need for further research," said Anderson. These, include "measurements that document the ongoing physical and biogeochemical changes in the Southern Ocean, and improvements in the models used to simulate these processes and project their impact on atmospheric CO₂ levels over the next century."

Anderson says that if his theory is correct, the impact of upwelling "will be dwarfed by the accelerating rate at which humans are burning fossil fuels." But, he said, "It could well be large enough to offset some of the mitigation strategies that are being proposed to counteract rising CO₂, so it should not be neglected."

More information: "Wind-Driven Upwelling in the Southern Ocean and the Deglacial Rise in Atmospheric CO₂," *Science*

Source: The Earth Institute at Columbia University

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