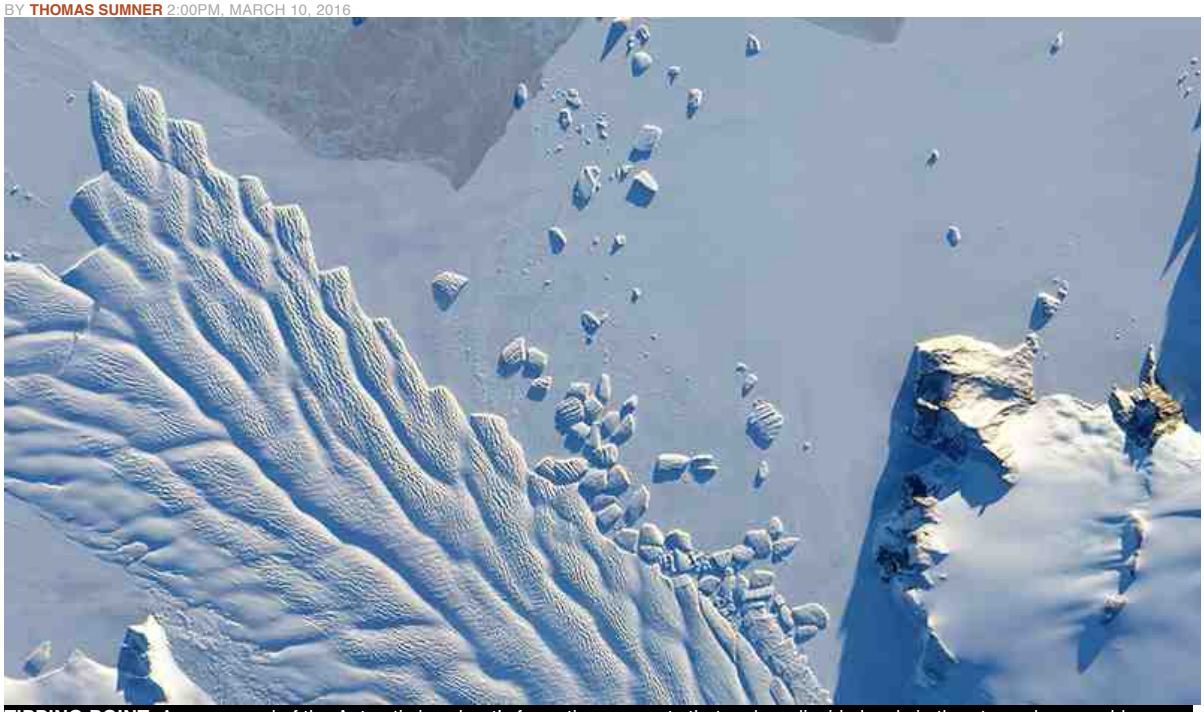
Antarctic history suggests ice sheet ‘danger’ threshold

Carbon dioxide levels above 600 parts per million could induce rapid melting, analysis finds

BY **THOMAS SUMNER** 2:00PM, MARCH 10, 2016



TIPPING POINT A new record of the Antarctic ice sheet’s formation suggests that carbon dioxide levels in the atmosphere could soon reach a tipping point that will make the ice sheet more vulnerable to melting. That includes ice in East Antarctica, such as Matusevich Glacier (shown).

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Assembling a detailed timeline surrounding the Antarctic ice sheet’s inception around 34 million years ago, scientists have identified a carbon dioxide “danger zone” for the ice sheet’s demise.

Based on CO_2 levels when the ice sheet formed, the researchers report that Antarctica’s ice will be “dramatically” more vulnerable to melting once CO_2 surpasses 600 parts per million in the atmosphere. Concentrations of the greenhouse gas reached 400 ppm last year, well above its 280 ppm preindustrial level.

“With present-day emission rates, it’s expected that we’ll reach 600 ppm before the end of this century,” says study coauthor Simone Galeotti, a paleoclimate scientist at the University of Urbino in Italy. The ice sheet stockpiles enough water to raise sea levels by around 60 meters and reshape Earth’s coastlines.

The new work, published online March 10 in *Science,* provides the best estimate yet for the CO_2 threshold that fostered the Antarctic ice sheet’s appearance, Galeotti says. Scientists previously traced the ice sheet’s beginnings using indirect measurements such as falling sea levels. Those methods aren’t definitive, however.

Galeotti and colleagues studied a roughly 900-meter-long ocean sediment core drilled in 1999 off the coast of East Antarctica. The core provided a detailed record of the Antarctic ice sheet’s size from around 34 million to 31 million years ago. As the ice sheet expanded, sediments piled up along its outermost edge. Using the sediment core, the researchers discovered that the ice sheet formed in two stages.

Sedimentary story

Researchers gleaned new insights about the Antarctic ice sheet's origins using a sediment core collected in the Ross Sea off the coast of East Antarctica. The roughly 900-meter-long core offered clues about the stability of the early ice sheet at different levels of atmospheric carbon dioxide.

CAPE ROBERTS PROJECT

When CO_2 levels fell below 750 ppm and the Antarctic ice first appeared 34 million years ago, the ice sheet was small and only on land, the researchers found. Susceptible to fluctuations in the amount of solar heat that warmed Earth, this early ice sheet underwent large-scale changes in size.

Once CO_2 dropped below 600 ppm around 32.8 million years ago, the ice sheet became more resilient to climate change, expanded in size and lowered sea levels. If CO_2 levels once again rise above 600 ppm, the Antarctic ice sheet will again become vulnerable to rapid melting, the researchers warn.

"As we go forward to a warmer world, we're essentially running this in reverse," says Thomas Wagner, a cryosphere scientist at NASA headquarters in Washington, D.C., who was not involved in the research. "This work shows us what the world looked like back then that we're now heading toward."

But Caroline Lear, a paleoclimate scientist at Cardiff University in Wales, says the 600 ppm threshold for the ice shelf may not hold true in reverse. "I don't think you can use the same CO_2 threshold," she says. "Antarctica was different 34 million years ago."

Lear and Dan Lunt, a paleoclimate scientist at the University of Bristol in England, published a perspective piece on the new research in the same issue of *Science*. The work does reinforce the notion that dwindling CO_2 facilitated the ice sheet's formation, Lunt says. The expanding ice may have in turn lowered CO_2, he says. Ice reflects sunlight that would otherwise warm the ground. This mirror-like effect could redirect winds and ocean currents, possibly boosting the drawdown of CO_2 into Earth's oceans. Understanding these interactions will help scientists better predict how Antarctica's ice will fare in the future, he says.

Citations

S. Galeotti et al. Antarctic Ice Sheet variability across the Eocene-Oligocene boundary climate transition. *Science*. Published online March 10, 2016. doi: 10.1126/science.aab0669.

C.H. Lear and D.J. Lunt. How Antarctica got its ice. *Science*. Published online March 10, 2016. doi: 10.1126/science.aad6284.