New study shows three abrupt pulse of C02 during last deglaciation

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CORVALLIS, Ore. - A new study shows that the rise of atmospheric carbon dioxide that contributed to the end of the last ice age more than 10,000 years ago did not occur gradually, but was characterized by three "pulses" in which $C0_2$ rose abruptly.

Scientists are not sure what caused these abrupt increases, during which $C0_2$ levels rose about 10-15 parts per million - or about 5 percent per episode - over a period of 1-2 centuries. It likely was a combination of factors, they say, including ocean circulation, changing wind patterns, and terrestrial processes.

The finding is important, however, because it casts new light on the mechanisms that take the Earth in and out of ice age regimes. Results of the study, which was funded by the National Science Foundation, appear this week in the journal Nature.

"We used to think that naturally occurring changes in carbon dioxide took place relatively slowly over the 10,000 years it took to move out of the last ice age," said Shaun Marcott, lead author on the article who conducted his study as a post-doctoral

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researcher at Oregon State University. "This abrupt, centennial-scale variability of CO_2 appears to be a fundamental part of the global carbon cycle."

Some previous research has hinted at the possibility that spikes in atmospheric carbon dioxide may have accelerated the last deglaciation, but that hypothesis had not been resolved, the researchers say. The key to the new finding is the analysis of an ice core from the West Antarctic that provided the scientists with an unprecedented glimpse into the past.

Scientists studying past climate have been hampered by the limitations of previous ice cores. Cores from Greenland, for example, provide unique records of rapid climate events going back 120,000 years - but high concentrations of impurities don't allow researchers to accurately determine atmospheric carbon dioxide records. Antarctic ice cores have fewer impurities, but generally have had lower "temporal resolution," providing less detailed information about atmospheric CO_2.

However, a new core from West Antarctica, drilled to a depth of 3,405 meters in 2011 and spanning the last 68,000 years, has "extraordinary detail," said Oregon State paleoclimatologist Edward Brook, a co-author on the Nature study and an internationally recognized ice core expert. Because the area where the core was taken gets high annual snowfall, he said, the new ice core provides one of the most detailed records of atmospheric CO_2.

"It is a remarkable ice core and it clearly shows distinct pulses of carbon dioxide increase that can be very reliably dated," Brook said. "These are some of the fastest natural changes in CO_2 we have observed, and were probably big enough on their own to impact the Earth's climate.

"The abrupt events did not end the ice age by themselves," Brook added. "That might be jumping the gun a bit. But it is fair to say that the natural carbon cycle can change a lot faster than was previously thought - and we don't know all of the mechanisms that caused that rapid change."

The researchers say that the increase in atmospheric CO_2 from the peak of the last ice age to complete deglaciation was about 80 parts per million, taking place over 10,000 years. Thus, the finding that 30-45 ppm of the increase happened in just a few centuries was significant.

The overall rise of atmospheric carbon dioxide during the last deglaciation was thought to have been triggered by the release of CO_2 from the deep ocean - especially the Southern Ocean. However, the researchers say that no obvious ocean

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mechanism is known that would trigger rises of 10-15 ppm over a time span as short as one to two centuries.

"The oceans are simply not thought to respond that fast," Brook said. "Either the cause of these pulses is at least part terrestrial, or there is some mechanism in the ocean system we don't yet know about."

One reason the researchers are reluctant to pin the end of the last ice age solely on CO_2 increases is that other processes were taking place, according to Marcott, who recently joined the faculty of the University of Wisconsin-Madison.

"At the same time CO_2 was increasing, the rate of methane in the atmosphere was also increasing at the same or a slightly higher rate," Marcott said. "We also know that during at least two of these pulses, the Atlantic Meridional Overturning Circulation changed as well. Changes in the ocean circulation would have affected CO_2 - and indirectly methane, by impacting global rainfall patterns."

"The Earth is a big coupled system," he added, "and there are many pieces to the puzzle. The discovery of these strong, rapid pulses of CO_2 is an important piece."

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