As Ice Age ended, greenhouse gas rise was lead factor in melting of Earth's glaciers

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Improved dating methods reveal that the rise in carbon dioxide levels was the primary cause of the simultaneous melting of glaciers around the globe during the last Ice Age. The new finding has implications for rising levels of man-made greenhouse gases and retreating glaciers today. Credit: National Science Foundation

A fresh look at some old rocks has solved a crucial mystery of the last Ice Age, yielding an important new finding that connects to the global retreat of glaciers caused by climate change today, according to a new study by a team of climate scientists.

For decades, researchers examining the glacial meltdown that ended 11,000 years ago took into account a number of contributing factors, particularly regional influences such as solar radiation, ice sheets and ocean currents.

But a reexamination of more than 1,000 previously studied glacial boulders has produced a more accurate timetable for the pre-historic meltdown and pinpoints the rise in carbon dioxide - then naturally occurring - as the primary driving factor in the simultaneous global retreat of glaciers at the close of the last Ice Age, the researchers report in the journal *Nature Communications*.

"Glaciers are very sensitive to temperature. When you get the world's glaciers retreating all at the same time, you need a broad, global reason for why the world's thermostat is going up," said Boston College Assistant Professor of Earth and Environmental Sciences Jeremy Shakun. "The only factor that explains glaciers melting all around the world in unison during the end of the Ice Age is the rise in greenhouse gases."

The researchers found that regional factors caused differences in the precise timing and pace of glacier retreat from one place to another, but carbon dioxide was the major driver of the overall global meltdown, said Shakun, a co-author of the report "Regional and global forcing of glacier retreat during the last deglaciation."

"This is a lot like today," said Shakun. "In any given decade you can always find some areas where glaciers are holding steady or even

advancing, but the big picture across the world and over the long run is clear - carbon dioxide is making the ice melt."

While 11,000 years ago may seem far too distant for a point of comparison, it was only a moment ago in geological time. The team's findings fix even greater certainty on scientific conclusions that the dramatic increase in manmade greenhouse gases will eradicate many of the world's glaciers by the end of this century.

"This has relevance to today since we've already raised CO2 by more than it increased at the end of the Ice Age, and we're on track to go up much higher this century—which adds credence to the view that most of the world's glaciers will be largely gone within the next few centuries, with negative consequences such as rising sea level and depleted water resources," said Shakun.

The team reexamined samples taken from boulders that were left by the retreating glaciers, said Shakun, who was joined in the research by experts from Oregon State University, University of Wisconsin-Madison, Purdue University and the National Center for Atmospheric Research in Boulder, Colo.

Each boulder has been exposed to cosmic radiation since the glaciers melted, an exposure that produces the isotope Beryllium-10 in the boulder. Measuring the levels of the isotope in boulder samples allows scientists to determine when glaciers melted and first uncovered the boulders.

Scientists have been using this process called surface exposure dating for more than two decades to determine when glaciers retreated, Shakun said. His team examined samples collected by multiple research teams over the years and applied an improved methodology that increased the accuracy of the boulder ages.

The team then compared their new exposure ages to the timing of the rise of carbon dioxide concentration in the atmosphere, a development recorded in air bubbles taken from ice cores. Combined with computer models, the analysis eliminated regional factors as the primary explanations for glacial melting across the globe at the end of the Ice Age. The single leading global factor that did explain the global retreat of glaciers was rising carbon dioxide levels in the air.

"Our study really removes any doubt as to the leading cause of the decline of the glaciers by 11,000 years ago - it was the rising levels of carbon dioxide in the Earth's atmosphere," said Shakun.

Carbon dioxide levels rose from approximately 180 parts per million to 280 parts per million at the end of the last Ice Age, which spanned nearly 7,000 years. Following more than a century of industrialization, carbon dioxide levels have now risen to approximately 400 parts per million.

"This tells us we are orchestrating something akin to the end of an Ice Age, but much faster. As the amount of carbon dioxide continues to increase, glaciers around the world will retreat," said Shakun.

Provided by Boston College

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