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NICK STOCKTON SCIENCE 03.13.17 12:00 PM

PLANTS MIGHT HAVE SAVED EARTH FROM PERMANENT ICE AGE



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IN THE LAST 800,000 years, Earth has chilled and thawed its way through eight ice ages, each lasting tens of thousands of years. But why? Why didn't Earth just freeze the one time and stay that way?

You're glad it didn't, because the periods between glaciations are when you get things like agriculture, city-states, plumbing, sunbathing, and the Nintendo Switch. Human civilization happened because *something* reversed a cooling trend about 20,000 years ago.

A new study, published today in *Nature Geoscience*, has a hypothesis what that something was: plants. Or, more specifically, a complicated process in which plants wear down certain kinds of rocks, and how those rocks remove carbon dioxide from the atmosphere as they wear down—leaving just enough CO₂ out there to trap solar warmth, and gradually bring summer back.

Over the course of its 4.5 billion year history, Earth has trended hot. Ice ages are relatively rare, and could happen for many reasons. For instance, the Earth's tilt relative to the sun might shift, so the poles receive less heat. Or the orbit might swing further from the sun. Continental drift might mess with the ocean currents, or uplift a mountain range to interrupt atmospheric flow. The most recent ice age, known as the Pleistocene, began about 2.6 million years ago and was actually a series of many, 10- to 20 thousand year-long smaller ice ages interrupted by so-called interglacials—relatively short warm periods like the present.

The big clue in this study's theory of how those interglacials come about came from ice core data taken from Antarctica. That ice is old enough to record global carbon dioxide levels from the past 800,000. "Everybody focuses on the fact that temperature and CO₂ go up and down together through the eight ice ages recorded in these samples," says Eric Galbraith, co-author of the study and paleoclimatologist at the Catalan Institution for Research and Advanced Studies in Barcelona. "Nobody had really noticed that the lowest points of these ice ages always had the same lowest value of atmospheric CO₂ concentrations."

This might seem like an obvious thing to look for, given that every science-literate person on the planet knows how carbon dioxide and temperature are related. However, in extremely cold situations, carbon dioxide levels can take pretty big jumps without making much of a dent in the temperature. What really caught Galbraith's attention is the fact that the carbon dioxide levels never really got lower than 180 parts per million. Something, he thought must be keeping holding it from going lower.

Galbraith and his coauthor, Sarah Eggleston, at the Universitat Autònoma in Barcelona, looked into several possible explanations. For instance, maybe deep sea water (which can't physically get below -2 degrees C) was acting like a reservoir of warmth. But no, no, there wouldn't have been enough deep sea water interacting with the atmosphere to force that kind of change. Besides, this ignored the CO₂ signal.

Several other competing hypotheses came and went, until finally Galbraith recalled a paper published several years ago by the late Mark Pagani, former director of Yale University's Climate & Energy Institute. "He made a similar argument based on much older data at much longer time scales," says Galbraith. "His idea suggested that plants were changing the rate at which rocks weathered."

The connection between rocks turning to dirt and ice ages isn't an obvious one, but the geochemistry is solid. When rainclouds form in the atmosphere, carbon dioxide gets pulled into the millions of little droplets. When that rain falls on silicate rocks—which make up about 90 percent of the Earth's crust—the rocks dissolve and react to create carbonic acid. This flows into streams, rivers, and finally the ocean, where single-celled organisms use the carbon to make shells.

So where do plants fit into this? Attached to the roots of ocean, where single-celled organisms use the carbon to make shells.

So where do plants fit into this? Attached to the roots of many plants are microscopic fungi called mycorrhizae that, among other things, help increase the rate at which silicate rocks weather. When the weather gets cold, the plants die off, the fungi do less weathering—the weather itself stops raining so much—and the levels of CO₂ stay stable.

But wait, there's more. Another type of microscopic ocean critter called cyanobacteria eat the single-celled, carbon-shelled organisms. When the weathering slows down, and less carbon flows into the ocean, these little guys start to starve. As a result, the dead carbon-shelled critters don't get eaten by cyanobacteria—which would keep the carbon stored in the ocean long term—but instead stay floating free in the water, to decompose and, wave by wave, flush back into the atmosphere.

From there, the story should be familiar: Carbon dioxide traps solar energy, and more solar energy, and several thousand years more solar energy, and eventually it's time for the agricultural revolution.

Climate change-doubting wags will no doubt point to this study as evidence that, even if humans are warming the planet, some vegetational failsafe will keep things from getting prohibitively warm. Plants will just grow more and slurp up all that atmospheric carbon before it permanently borks Earth's climate, right? Not so fast. "Of course plants do grow faster when there's more CO₂, but the rate at which they do that is not enough to keep up with human emissions," Galbraith says. The time frame for the plant-carbon-antifreeze cycles described above is thousands of years. Anthropogenic warming is happening at the century scale. And the geophysical, chemical, and biological mechanisms involved in Earth's temperature modulation work very differently when the planet is very cold versus when it is warm-ish and heating up rapidly. Like now.

This study isn't the be all-end all of ice age termination. For one thing, nobody has any solid evidence for the cycle as Galbraith describes it. His idea is just the best one to explain the correlation between ultra-low ice age temperatures and the apparent minimum level of Pleistocene-era CO₂ levels. So now he's going to be looking at other periods, such as the Carboniferous Ice Age, when Earth's temperatures were roughly the same, but CO₂ levels were much higher. In other words, he's just getting warmed up.

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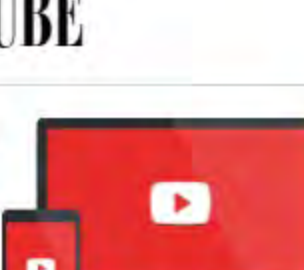
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