Are Greenhouse Gases Causing Climate To Destabilize?

Ice Core Drilling In Antarctic Reveals Worrying Truth

By Steve Connor
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The deepest and oldest ice core yet drilled in the Antarctic suggests that the world's climate is headed for an unprecedented period of turmoil brought about by man-made greenhouse gases.

Chemical analysis of the ice within the core - nearly 2 miles long - has revealed details of the eight previous ice ages that have affected the Earth durin the past 740,000 years. Scientists say that the present climate most closely resembled the warm "interglacial" period about 470,000 years ago, but with the difference that this time temperatures were set to spiral upwards as a result of global warming.

In a study published today in the journal Nature, the international team of scientists from 10 European countries warns that the Earth's climate would now be in a highly stable period if it were not for the extra carbon dioxide being pumped into the atmosphere from human activities. "Given the similarities between this earlier warm period and today, our results may imply that without human intervention, a climate similar to the present one would extend well into the future," the scientists say.

Eric Wolff, a senior member of the team from the British Antarctic Survey in Cambridge, said that anyone who suggested human-

induced global warming was beneficial because it would avert the next ice age was misguided. "If the climate is left to its own devices, we have about another 15,000 years to go before the next ice age. If people say global warming is good because it stops us going into another ice age, they are wrong because we are not about to go into another ice age," Dr Wolff said.

The deepest ice cores were drilled at a site known as Dome C, where the East Antarctic ice sheet is about 3.4km (2 miles) thick. It is one of two sites being drilled on the frozen continent as part of the European Project for Ice Coring in Antarctica (Epica), which began field work in 1996.

Tiny bubbles of air were trapped in the ice when it formed from snow falling on the Antarctic ice sheet. That ancient air is being analysed to see how much carbon dioxide and other greenhouse gases such as methane were present in the atmosphere over many hundreds of thousands of years.

The ice cores retrieved from the Epica study will double the length of the record of greenhouse gases in the atmosphere, making it possible to judge just how unusual are today's high concentrations of carbon dioxide - the principal greenhouse gas behind global warming. "We've never seen greenhouse gas concentrations anything like as high as that we're seeing today," Dr Wolff said.

Levels of methane, another greenhouse gas, were about two and a half times as high as historic levels, said Thomas Stocker of the University of Bern in Switzerland, another senior member of the team.

Dr Stocker said concentrations of carbon dioxide in the air today stood at about 375 parts per million (ppm), whereas the typical level for a similar interglacial period over the past half million years was about 280ppm. "Today, we have levels of carbon dioxide that exceed by 30 per cent the levels that we have ever had over the past 400,000 years," Dr Stocker said.

Professor James White of the University of Colorado at Boulder, said that the ice core retrieved from Dome C was telling scientists not just about greenhouse gases from the past, but also helping them to estimate global temperatures at the time the ice formed and how these were linked with changes in the composition of the atmosphere. "This has the potential to separate the human-caused

impacts from the natural and place them in a much clearer context," Professor White said. "We're living in an unusual time. In the past 430,000 years, the percentage of time the climate was as warm as it is today is quite small, about 5 to 10 per cent, and before that, it appears to never have been that warm."

The data from the ice cores show that, typically, the warm period between two ice ages lasted about 6,000 years, but the current warm period since the last ice age had already lasted 12,000 years, Professor White said. That has led some commentators to speculate that we are about to be plunged into another ice age, with the suggestion that global warming is to be welcomed.

"Humans have been active in messing with the carbon cycle for a long period of time. Here, we are warming the planet, while at the same time, climatologists will tell us that we are perhaps long overdue for a glacial period," Professor White said. However, the interglacial period of four ice ages ago lasted much longer, about 28,000 years. That was also the time most like the interglacial period that we were now experiencing, the scientists said.

"One of our biggest scientific questions is: is glaciation overdue? For our future it is very important that we understand how these huge glaciers start," Professor White said.

The ice sheet of Dome C is one of the most inhospitable places on Earth with average surface temperatures of minus 54C. At an altitude of 3,233m above sea level, the ice station at Dome C is so cold and dark for much of the year that the scientists can only carry out drilling for two out of every 12 months.

The second Epica drilling station is at Dronning Maud Land, which is at a slightly lower altitude of 2,892m above sea level, where average surface temperatures are a relatively balmy minus 44C. About 300km north of dome C is a third, much older, drilling site called Vostok, which was established by Russian scientists 40 years ago. That is the place where the previous oldest and deepest Antarctic ice core was retrieved, descending about 400,000 years.

Unfortunately for the scientists the Vostok ice core finishes just at the very moment in history when the Earth appears to have been in a very similar orbit around the Sun to the orbit to that it is on currently, making the climate, then and now, very, similar. The limitation arose because the Vostok site is above an ice-covered

lake, making it impossible to drill any deeper.

Epica scientists decided, therefore, to explore the much thicker ice sheet covering Dome C, which is on solid bedrock. The scientists believe that the hole drilled into the ice sheet of Dome C is now only about 100m above the ground, which has been covered in ice for so long that it has not been exposed to the atmosphere for at least 1 million years.

Chemical analysis of the water and the trapped bubbles of air in the Dome C ice core has revealed something of the nature of the eight previous ice ages and warm interglacial periods that have dominated life on Earth over the past 800,000 years.

The core shows clearly, for instance, that during the past half a million years the Earth has settled into a period where there are glacial cycles lasting about 100,000 years which match, to some extent, the cyclical nature of the planet's elliptical orbit around the Sun.

In the half million years before about 450,000 years ago, the extremes between the middle of an ice age and the middle of an interglacial period were less pronounced and the cycles were shorter, lasting about 40,000 years.

Scientists do not know how to explain the difference between the two periods. One possibility is that the world's ice sheets and glaciers have grown progressively bigger, making it more difficult for the ice to respond to a planetary shorter cycle.

Life for the 50 scientists trying to answer those questions at Dome C can be bleak and isolated, although conditions are made as comfortable as possible with a sauna and unrestricted access to hot showers. Much of the physically strenuous work is focused on the mechanics of getting the core to the surface. The ice is collected in a metal tube 3.5m long and 10 cm wide, which is attached to a mechanical drill bit.

Each stage of the drilling brings its own problems. Ice extracted from the first 1,000m, for example, is so brittle that the sudden release of pressure can cause it to shatter with an explosive force. In 1998, the drill became irretrievably stuck in its hole when chips of ice formed by the grinding process froze solid around the bit. The scientists then had to begin a fresh hole at a nearby site.

This time, they reduced the length of the ice core pulled up to the surface to less than 3m. It is a time-consuming process, given that it can take up to an hour to bring a sample to the surface from a hole more than 3km deep.

This December - at the height of the Antarctic summer - drilling will resume at Dome C when the scientists hope to complete a core dating back more than 900,000 years.

The final 100m before they reach solid bedrock poses one of the most difficult technical problems because, at its extreme depth, The ice is near to melting point due to the geothermal heat coming from the ground, which can quickly refreeze around the drill, causing it to seize up.

No doubt the scientists will celebrate when the finally reach rock bottom of the deepest ice hole in the world. Dominique Raynaud of the French national research centre said: "None of us knows what we'll find at the bottom of Dome C: that's why it's exciting."

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