Carbon dioxide level highest in 650,000 years
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Carbon dioxide levels are now 27 percent higher than at any point in the last 650,000 years, according to research into Antarctic ice cores published on Thursday in *Science*.

Analysis of carbon dioxide in the ancient Antarctic ice showed that at no point in the past 650,000 years did levels approach today's carbon dioxide concentrations of around 380 parts per million (ppm). The Intergovernmental Panel on Climate Change (IPCC) projects that atmospheric carbon dioxide levels could reach 450-550 ppm by 2050, possibly resulting in higher temperatures and rising sea levels (see "Ocean levels rising twice as fast"). There is fear that climate change could create a class of environmental refugees displaced from their homes by rising oceans, increasingly catastrophic weather, and expanding deserts.

Carbon dioxide is the principal "greenhouse" gas thought to be driving global warming. Humans boost carbon dioxide levels primarily by the combustion of fossils fuels and deforestation, and accordingly, atmospheric concentrations have risen sharply since the industrial revolution. Today the United States, the world's largest economy and consumer of energy, produces about 24% of global carbon dioxide emissions.

Below are two news releases from organizations involved in the Antarctic ice core research, American Association for the Advancement of Science and Oregon State University.

New evidence extends greenhouse gas record from ice cores by 50 percent, adding 210,000 years
American Association for the Advancement of Science release
24-Nov-2005

Today's atmospheric carbon dioxide levels are highest in 650,000 years, Science studies say

With the first in-depth analysis of the air bubbles trapped in the "EPICA Dome C" ice core from East Antarctica, European researchers have extended the greenhouse gas record back to 650,000 years before the present.

This 210,000-year extension of atmospheric carbon dioxide and methane records -- encompassing two full glacial cycles -- should help scientists better understand climate change and the nature of the current warm period on Earth. The record may also aid researchers in reducing uncertainty in predictions of future climate change and help to clarify when humans began significantly changing the balance of greenhouse gasses in

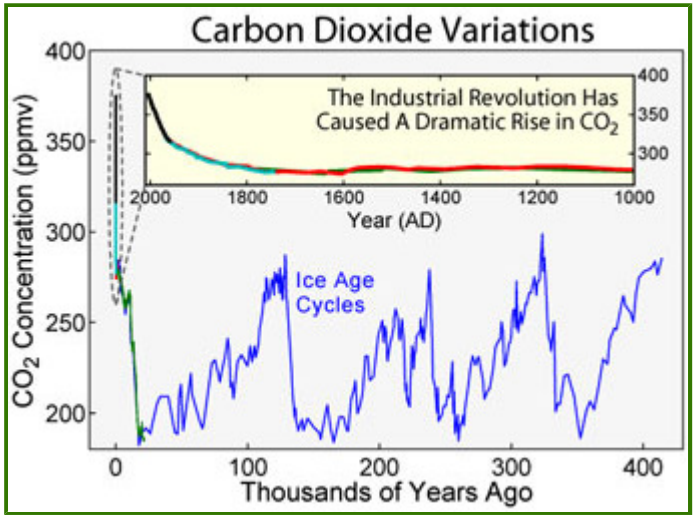
Earth's atmosphere.

EPICA is the European Project for Ice Coring in Antarctica. The new ice core, initially described in 2004, is from a site in East Antarctica known as EPICA Dome C. This work represents a long-term European research collaboration and appears in two studies and an accompanying "Perspective" article in the 25 November 2005 issue of the journal Science, published by AAAS the nonprofit science society.

One study chronicles the stable relationship between climate and the carbon cycle during the Pleistocene (390,000 to 650,000 years before the present). The second one documents atmospheric methane and nitrous oxide levels over the same period. .

The analysis highlights the fact that today's rising atmospheric carbon dioxide concentration, at 380 parts per million by volume, is already 27 percent higher than its highest recorded level during the last 650,000 years, said Science author Thomas Stocker of the Physics Institute of the University of Bern, in Bern, Switzerland, who serves as the corresponding author for both papers.

"We have added another piece of information showing that the timescales on which humans have changed the composition of the atmosphere are extremely short compared to the natural time cycles of the climate system," Stocker explained.



This figure shows the variations in concentration of carbon dioxide (CO2) in the atmosphere during the last 400 thousand years. Throughout most of the record, the largest changes can be related to glacial/interglacial cycles within the current ice age. Although the glacial cycles are most directly caused by changes in the Earth's orbit (i.e. Milankovitch cycles), these changes also influence the carbon cycle, which in turn feeds back into the glacial system.

Since the Industrial Revolution, circa 1800, the burning of fossil fuels has caused a dramatic increase of CO2 in the atmosphere, reaching levels unprecedented in the last 400 thousand years. This increase has been implicated as a primary cause of global warming.

Image credit: "Dragons flight" at Wikipedia.org

The new work confirms the stable relationship between Antarctic climate and the greenhouse gasses carbon dioxide and methane during the last four glacial cycles. The new ice core analysis also extends this relationship back another two glacial cycles, to a time when the warm "interglacial" periods were milder and longer than more recent warm periods, according to the European researchers.

The fact that carbon dioxide and methane levels were lower during the relatively mild warm periods of the two additional cycles, compared to the warmer warm periods of the last 400,000 years, is especially interesting for the study of climate sensitivity, which is a measure of how the climate system reacts when atmospheric carbon dioxide concentrations double, explained Science author Dominique Raynaud from LGGE in Grenoble, France.

The new atmospheric and climate records from the EPICA Dome C ice core also indicate that the response of the natural carbon cycle to climate warming remains the same over time – in terms of the mechanism involved and the degree to which greenhouse gasses further amplify climate change, explained Science author Jean Jouzel from LSCE and Institut Pierre Simon Laplace in France.

The EPICA Dome C ice core contains hundreds of thousands of years-worth of atmospheric air samples within tiny bubbles trapped in the ice. The air bubbles form when snowflakes fall, and they contain a record of global greenhouse gas concentrations.

The new ice core record described in the two Science papers provides some overlap with a similar record from the Vostok ice core – now, the second longest ice core record -- and extends the Vostok record by 210,000 years.

The nitrous oxide record in EPICA Dome C is more fragmented and less clear than the carbon dioxide and methane records due to artifacts in the ice that appear related to the dust levels.

The new ice core analysis provides insights on our present interglacial warm period through a glimpse into Antarctic climate and greenhouse gas concentrations during the most recent warm period that is relatively similar to our current warm period. Known as Marine Isotope Stage 11 or MIS 11, this analog warm period occurred between 420,000 and 400,000 years and is not completely covered by the Vostok record.

The similarities between our current warm period and MIS 11 are primarily due to a similar configuration of the orbits of the Earth around the Sun: the relative positions of the Earth and Sun are thought to be the key driver of ice age cycles.

"MIS 11 shows us that the climate system can indeed reside in a warm period for 20,000 or 30,000 years, something that we can't say based on the last three warm phases which are no longer than about 10,000 years each," said Stocker.

We are currently about 10,000 years into our current warm period.

The new papers also document MIS 13 and 15 -- two warm periods more distant than MIS 11 that may have been about as long. The idea that MIS 13 and 15 were long warm periods contrasts the argument scientists have made in the past suggesting that our current warm period is exceptionally long.

The authors note, however, that the records for MIS 13 and 15 are not as clear as they are for MIS 11. One complicating factor is that the ice core records do not exactly match records from marine sediments that are used to help date the ice core data.

New insights important for understanding the impact early human activities such as land clearing and rice culture had on atmospheric greenhouse gas concentrations, the topic of several recent studies, are also now available, thanks to the methane and carbon dioxide records from the EPICA Dome C ice core. The new record shows that natural variability can result in significant oscillations in greenhouse gasses during some interglacial periods and raises the possibility that early human activities may not be responsible for the greenhouse gas variability seen as early as 10,000 years ago, writes Ed Brook from Oregon State University in Corvallis, Oregon in a related "Perspective" article.

The greenhouse gas record from EPICA Dome C during past ice ages also provides indirect evidence for abrupt climate

Massive climate change rocked ecosystems, animals 55 million years ago Continued increases in greenhouse gas concentrations in the atmosphere from the combustion of fossil fuels could trigger large-scale changes in global biodiversity and require thousands of years of recovery according to recent research on an extreme global warming episode 55 million years ago

Coral reefs decimated by 2050, Great Barrier Reef's coral 95% dead Australia's Great Barrier Reef could lose 95 percent of its living coral by 2050 should ocean temperatures increase by the 1.5 degrees Celsius projected by climate scientists. The startling and controversial prediction, made last year in a report commissioned by the World Worldwide Fund for Nature (WWF) and the Queensland government,

change in the past, the authors found. This suggests that abrupt climatic events on time scales relevant to societies may be common features of the last climatic cycles.

The stable relationship between carbon dioxide, methane and Antarctic climate over the last 650,000 years highlights one of the major unsolved mysteries of climate change -- the origins of climate-greenhouse gas relationships. Organic decomposition in subtropical wetlands remains a strong candidate for explaining the climate-methane relationship. On the other hand, oceans seem to play a critical role in the climate-carbon dioxide relationship; and the new work strengthens the idea that high latitude Southern Ocean processes are important for controlling glacial-interglacial variations in carbon dioxide, according to the "Perspective" author who says that retrieval and analysis of even older ice cores may provide more definitive answers.

is just one of the dire scenarios forecast for reefs in the near future. The degradation and possible disappearance of these ecosystems would have profound socioeconomic ramifications as well as ecological impacts says Ove Hoegh-Guldberg, head of the University of Queensland's Centre for Marine Studies.

14.5 degree increase in Earth's temperature possible finds new model

If humans continue to use fossil fuels in a business-as-usual manner for the next few centuries, the polar ice caps will be depleted, ocean sea levels will rise by seven meters and median air temperatures will soar to 14.5 degrees warmer than current day.

"Stable Carbon Cycle-Climate Relationship During the Late Pleistocene," by U. Siegenthaler, T.F. Stocker, E. Monnin, D. Lüthi, J. Schwander and B. Stauffer at University of Bern, in Bern, Switzerland; D. Raynaud and J.-M. Barnola at Laboratoire de Glaciologie et de Géophysique de l'Environnement (CNRS) St Martin d'Hères Cedex, France; H. Fischer at Alfred-Wegener-Institute for Polar and Marine Research (AWI) in Bremerhaven, Germany; V. Masson-Delmotte and J. Jouzel at LSCE and Institut Pierre Simon Laplace in France.

"Atmospheric Methane and Nitrous Oxide of the Late Pleistocene from Antarctic Ice Cores," by R. Spahni, T. Stocker, G. Hausammann, K. Kawamura, J. Flückiger and Jakob Schwander at University of Bern, in Bern, Switzerland; J. Chappellaz, L. Loulergue and D. Raynaud at Laboratoire de Glaciologie et de Géophysique de l'Environnement (CNRS) in St Martin d'Hères Cedex, France; V. Masson-Delmotte, J. Jouzel at LSCE and Institut Pierre Simon Laplace in France. K. Kawamura is now at Scripps Institution of Oceanography, University of California, San Diego, La Jolla, United States. J. Flückiger is now at Institute of Arctic and Alpine Research, University of Colorado at Boulder in Colorado, United States.

The accompanying "Perspective" article "Tiny Bubbles Tell All," is by E. Brook from Oregon State University in Corvallis, Oregon, United States.

The work described in the Siegenthaler et al. and Spahni et al. Science papers is a contribution to the "European Project for Ice Coring in Antarctica" (EPICA), a joint ESF (European Science Foundation)/EC scientific programme, funded by the European Commission and by national contributions from Belgium, Denmark, France, Germany, Italy, the Netherlands, Norway, Sweden, Switzerland and the United Kingdom. The researchers acknowledge long-term financial support by the Swiss NSF, the University of Bern and the Swiss Federal Agency of Energy, and EC Project EPICA-MIS. Support was also provided by the French programme PNEDC (INSU-CNRS).

The American Association for the Advancement of Science (AAAS) is the world's largest general scientific society, and publisher of the journal, Science (www.sciencemag.org). AAAS was founded in 1848, and serves some 262 affiliated

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This is a modified press release from the American Association for the Advancement of Science