

Air temperature varied in sync with greenhouse gases through four Ice Ages and warm spells

420,000 years of global changes frozen in Antarctic ice

Reaching a record depth of 3600 meters (2¼ miles), the three-nation ice drilling project at Vostok, Antarctica, is finished. In a 1999 report,¹ *Nature* magazine summarized the paper of J. R. Petit and co-workers,² who reported amazing changes in climate and in composition of the atmosphere, levels of dust, aridity, volcanic activity, and solar activity. The record spans four complete cycles of glacial (Ice Age) and interglacial (warm phase) climates.

They conclude that changes in the Earth's orbit and attitude caused the intensity of sunlight to change. Cycles of 100,000 and 41,000 years show up in the ice, in sync with orbital changes.

Large increases of carbon dioxide (CO₂) and methane (CH₄) were in phase with temperature rises during all four transitions from glacial to warm periods. The CO₂ increased by +60% and the methane more than doubled in all four events. They add, "The overall correlation between CO₂ levels, CH₄ levels, and Antarctic temperature is remarkable."

Whether temperature or CO₂ increased first is not known. Some say temperature increased 500 to 1,000 years before CO₂, but air bubbles have different ages than the surrounding ice, so dating is imprecise.

Entering the warm periods, CO₂ increased to 290 parts per million (ppm) (today's it's 365 ppm). Methane jumped to 700 parts per billion (ppb) (now 1700 ppb). "Present day levels of CO₂ and CH₄ are unprecedented during the last 420,000 years," Petit writes.

Petit's team believes that greenhouse gases played a key role in moving the climate out of an Ice Age by amplifying the warming caused by Earth's astronomical shifts. As ice sheets melted, newly exposed dark ground (once white and reflective) absorbed so much more solar energy, that a strong positive feedback ensued. The Earth was warm again.

1. "Cornucopia of ice core results", by B. Stauffer, *Nature*, vol. 399, 412-413, 3 Jun 1999.

2. "Climate and atmospheric history of the past 420,000 years from the Vostok ice core, Antarctica", by J. R. Petit and 18 others, *Nature*, vol. 399, 429-436, 3 Jun 1999. Online at http://www.nature.com/cgi-taf/DynaPage.taf?file=/nature/journal/v399/n6735/abs/399429a0_fs.html>

3. "400,000 years of atmospheric CO₂, methane and temperature data: What can they tell us?", Online at www.co2science.org/edit/v5_edit/v5n19edit.htm