Cool evidence confirms unnatural rise in methane

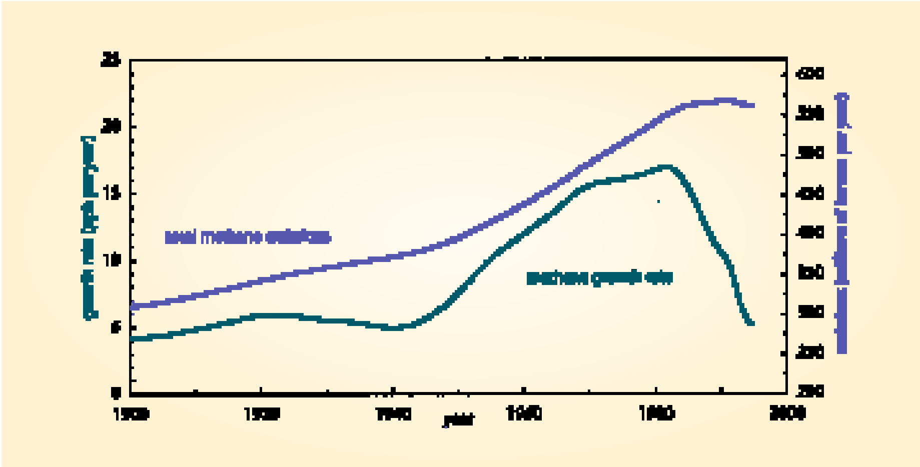
Latest analysis of air bubbles trapped in Antarctic ice cores has confirmed a dramatic surge in atmospheric methane concentrations since pre-industrial times and a puzzling trend towards their stabilisation since 1980.

The ice cores, some more than one-kilometre deep, were drilled by the Australian National Antarctic Research Expeditions at Law Dome, an icy plateau inland of Australia's Casey Base.

David Etheridge, leader of the team that analysed the cores, says Law Dome was chosen for the drilling because ice formation there is extremely rapid. Faster ice formation reduces both the age spread of air bubbles trapped in each ice core sample, and the extent of changes to their original chemistry.

Etheridge and his colleagues at CSIRO Atmospheric Research have been studying Antarctic ice cores for 10 years. Earlier samples from different Antarctic locations had contained up to a 50-year spread in the age of trapped air bubbles. This resolution is too coarse to reveal much about methane growth rates in the past 200 years, or to make historical comparisons that might discount or confirm links between climate change and human activity.

Air bubbles contained in the Law Dome samples have a spread of only 10 years and have enabled Etheridge's team to produce a high-resolution record of methane fluctuations dating back to 1000 AD.



Methane growth rates (bottom curve), high for most of this century, have recently decreased as a result of the stabilisation of total methane emissions (top).

This has been coupled with data from Greenland ice cores and archived air samples from Tasmania's Cape Grim Atmospheric Baseline Monitoring Station.

The records reveal a modest rise in methane during the Mediaeval Warm Period (1000–1300 AD), then a small dip during the Little Ice Age (1550–1800 AD). Etheridge attributes these fluctuations to natural climate variability.

'Methane levels in the atmosphere are sensitive to climate change,' he says. 'Warmer or wetter conditions can increase emissions from natural sources.'

Etheridge says the fact that these natural increases were relatively small strongly implicates human activity as the cause of the dramatic and sustained rise in methane emissions after about 1800.

The measurements also show that since about 1980, the rate of increase in atmospheric methane has slowed markedly. If this situation continues, methane concentrations would stabilise in about 2006. The level of stabilisation, however, would be more than 2.5 times higher than the pre-Industrial Revolution level of about 700 parts per billion.

Etheridge says the stabilisation is a positive sign, because it offers hope that there is a greenhouse gas with the potential to decrease. He says methane, molecule for molecule, is more active at absorbing radiation than carbon dioxide and accounts for about 20% of greenhouse forcing attributable to human activity. But it is also shorter lived.

Fungal faux pas

IN the January–March issue of *Ecos*, the captions for these two fungi pictures, in the article 'Hearts of darkness', were reversed.

On the right is an Australian coral fungus, *Ramaria versatilis*, one of the many fungi contributing to nutrient cycling and soil and plant health in eucalypt forests (photo by Neale Bougher). *On the left is Hypholoma* sp., a saprophytic wood decay fungus (photo by Ken Thomas).

Thank you to the readers who brought the error to our attention.

'We don't have to reduce emissions of methane very much to decrease concentrations because its lifetime in the atmosphere is only 10 years, whereas the carbon dioxide lifetime is about a century,' Etheridge says. 'By pulling down methane levels we could offset some of the warming effects of the rise in carbon dioxide.'

But Etheridge warns that the trend has not continued long enough for us to be complacent. 'We haven't yet found the smoking gun,' he says.

The stabilisation was not anticipated by scientists and the reasons behind it can only be speculated upon. Etheridge says it may relate to the attitude shift in recent decades when methane became increasingly tapped as a fuel source, rather than being released as a waste product of oil extraction and urban landfill.

Methane levels are also determined by its rate of loss from the atmosphere, through reaction with the hydroxyl radical. Hydroxyl is often referred to as the atmosphere's 'natural detergent'. But despite having to deal with the large increases in emissions of gases such as carbon monoxide, hydrocarbons, and methane itself, during the industrial period, hydroxyl levels are estimated to have remained remarkably stable. The cause of the observed methane changes therefore rests mainly with changes in the methane source.

The CSIRO team is now trying to obtain more detailed information about the changes in global sources of methane by analysing carbon isotope ratios in the ice samples.

Different sources of methane have distinct isotopic signatures. For example, methane derived from bacterial emissions such as from animals, rice paddies and wetlands contains lower levels of carbon-13 than methane derived from the burning of biomass or fossil fuels. But methane originating from fossil fuels does not contain carbon-14. Also, the reaction of atmospheric methane with hydroxyl favours the lighter isotope (carbon-12). The resulting levels of carbon-12, carbon-13, and carbon-14 in atmospheric methane reflect these source and sink contributions. Measurements back in time would help to allow the changes in methane sources to be unravelled.

The Law Dome records can also help climatologists to study feedback effects which may amplify the enhanced greenhouse effect. For example, Arctic warming could release large volumes of methane stored in the frozen tundra, driving further global warming and methane release.

They also provide the necessary records of greenhouse gases for global climate models to simulate observed climate change this century, and to predict future climate.

A researcher from the Australian Antarctic Division takes an ice core sample.

More about methane

Etheridge DM LP Steele RJ Francey and RL Langenfelds (1998) Atmospheric methane between 1000 AD and present: Evidence of anthropogenic emissions and climatic variability, *Journal of Geophysical Research*, 103, D13, 15 979-15 993.

Contact: David Etheridge, CSIRO Atmospheric Research, (03) 9239 4400, fax (03) 9239 4444, email: david.etheridge@dar.csiro.au.