New insights on the early sources of greenhouse methane

About one-tenth of the ice in a core sample is trapped air, which can be extracted and analysed to show the past composition of the atmosphere. CSIRO Marine and Atmospheric Research

An international study into how methane levels in the atmosphere have evolved during the past 2000 years has given atmospheric researchers new insight into the history of both the Earth's climate and one of the most influential greenhouse gases.

In the 9 September edition of the journal *Science*, leading climate scientists from Australia, New Zealand and the US revealed why methane concentrations have more than doubled in the atmosphere over the past 250 years. Its increases have had the second highest impact on climate change over this period, accounting for about 20 per cent of the warming from all greenhouse gases. Methane does this by slowing the release of radiated heat away from the earth.

The concentration rise was confirmed as due to particular breakdowns of agricultural sources, leakage during fossil fuel use, and other human sources, as well as the burning of vegetation. The research also identified wild variations in the carbon isotope (molecule configuration) ratio of methane over the last 2000 years – a surprising finding as it had previously been thought to have been steady before the industrial revolution.

'This is a great result that generated some scientific surprises and will help us to understand what controls methane in the atmosphere and its links with climate,' says Dr David Etheridge, from CSIRO Marine and Atmospheric Research, who was involved.

According to Dr Etheridge, , the study attempted to answer some important questions from the analysis of carbon 13 isotopes, including why the atmospheric composition of methane has changed, how much of that change was due to human factors, and why pre-industrial levels were apparently so stable. The answers will help assess how the composition may change in future and what could be done to manage methane emissions.

The international research partnership was led by Dr Dominic Ferretti of both the University of Colorado, USA and National Institute of Water and Atmospheric Research (New Zealand) and included scientists from CSIRO Marine and Atmospheric Research, the Australian Antarctic Division, Antarctic Climate and Ecosystem Cooperative Research Centre, and the University of Colorado.

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The team used their expertise in ice core research, chemical analyses and modelling of atmospheric composition to analyse air bubbles trapped in Antarctic ice from the Law Dome ice sheet near Casey Station, together with air samples collected since 1979 from the Cape Grim Baseline Air Pollution Station in Tasmania – a joint responsibility of the Bureau of Meteorology and CSIRO.

The picture of methane levels is now being extended by another team of scientists, from the Australian Nuclear Science and Technology Organisation (ANSTO), who have just arrived in Antarctica to collect more ice cores from which to analyse the signature of carbon 14 methane. This related and technically difficult work will shed more background light on both industrial and pre-industrial levels of methane from fossil sources, such as natural coal seam releases and upwellings.

Dr Andrew Smith, ANSTO's Expedition leader and Chief Investigator, explained 'Following the termination of the last Ice Age, the Northern Hemisphere began to cool again, an event known as the Younger Dryas. This period of cooling lasted for about 1000 years then temperatures climbed again and so did methane levels.

'Clues to the source of this early methane can be found by analysing the isotopes of carbon from which the methane is composed and we will be applying the same technique to study the detailed evolution of methane sources during the industrial era.'

Similar methods are being applied in the US to assess the huge deposits of methane trapped in frozen water sheets, called clathrates, which look like ice lying on deep sea beds around the Earth's coastal regions.

Dr Smith also explained that when these deposits are brought closer to the surface, for instance by falling sea levels, or come into contact with warmer water, they begin to disintegrate, releasing methane gas.

'If a significant amount of clathrates are disturbed and destabilised it could further increase global warming,' he said.

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