



The Forgotten Methane Source

Researchers at the Max Planck Institute for Nuclear Physics in Heidelberg make a surprising discovery: plants themselves produce methane and emit it directly into the atmosphere

In the last few years, more and more research has focused on the biosphere; particularly, on how gases which influence the climate are exchanged between the biosphere and atmosphere. Researchers from the Max Planck Institute for Nuclear Physics have now carefully analysed which organic gases are emitted from vegetation. They made the surprising discovery that plants release methane, a greenhouse gas - and this goes against all previous assumptions. Equally surprising was that methane formation is not hindered by the presence of oxygen. This discovery is important not just for plant researchers but also for understanding the connection between global warming and increased greenhouse gas production (Nature, January 12, 2006).



Image 1: A plant chamber used to investigate methane formation in plants -- in this example, in ryegrass (*Lolium perenne*).

Image: Max Planck Institute for Nuclear Physics

Methane is the greenhouse gas which has - apart from the major natural greenhouse gas water - the second greatest effect on climate, after carbon dioxide. The concentration of methane in the atmosphere has almost tripled in the last 150 years. Methane is best known as natural gas, currently an important energy source. Nonetheless, only part of the methane uptake in the atmosphere is due to industrial activities connected to energy production and use. More important for the increase

Max Planck Society
for the Advancement of Science
Press and Public Relations Department

Hofgartenstrasse 8
D-80539 Munich

PO Box 10 10 62
D-80084 Munich

Phone: +49-89-2108-1276
Fax: +49-89-2108-1207
presse@gv.mpg.de
Internet: www.mpg.de

Responsibility for content:
Dr. Bernd Wirsing (-1276)

Executive Editor:
Dr. Andreas Trepte (-1238)

Online-Editor:
Michael Frewin (-1273)

ISSN 0170-4656

of methane in the atmosphere is the increase in so-called "biogenic" sources, e.g., rice cultivation or domestic ruminants related to the rise in the world's population. Nowadays, methane in the atmosphere in fact is largely of biogenic origin.

Until now, it has been assumed that biogenic methane is formed anaerobically, that is, via micro-organisms and in the absence of oxygen. In this way, acetate or hydrogen and carbon dioxide are transformed into methane; they themselves are created in the anaerobic decomposition of organic materials. The largest anoxic sources of methane are wetlands and rice fields, as well as the digestion of ruminants and termites, waste disposal sites, and the gas produced by sewage treatment plants. According to previous estimates, these sources make up two-thirds of the 600 million tonnes worldwide annual methane production.

Scientists from the Max Planck Institute for Nuclear Physics have now discovered that plants themselves produce methane and emit it into the atmosphere, even in completely normal, oxygen-rich surroundings. The researchers made the surprising discovery during an investigation of which gases are emitted by dead and fresh leaves. Then, in the laboratory and in the wild, the scientists looked at the release of gases from living plants like maize and ryegrass (see image 1). In this investigation, it turned out that living plants let out some 10 to 1000 times more methane than dead plant material. The researchers then were able to show that the rate of methane production grew drastically when the plants were exposed to the sun.

Although the scientists have some first indications, it is still unclear what processes are responsible for the formation of methane in plants. The researchers from Heidelberg assume that there is an unknown, hidden reaction mechanism, which current knowledge about plants cannot explain - in other words, a new area of research for biochemistry and plant physiology.

In terms of total amount of production worldwide, the scientists' first guesses are between 60 and 240 million tonnes of methane per year. That means that about 10 to 30 percent of present annual methane production comes from plants. The largest portion of that - about two-thirds - originates from tropical areas, because that is where the most biomass is located. The evidence of direct methane emissions from plants also explains the unexpectedly high methane concentrations over tropical forests, measured only recently via satellite by a research group from the University of Heidelberg.



Image 2: *A tropical rainforest in Suriname. Tropical regions are particularly large contributors to the atmosphere's methane budget, according to the latest research from the Max Planck Institute for Nuclear Physics.*

Image: Max Planck Institute for Nuclear Physics/B. Scheeren

But why would such a seemingly obvious discovery only come about now, 20 years after hundreds of scientists around the globe started investigating the global methane cycle? "Methane *could not* really be created that way," says Dr. Frank Keppler. "Until now all the textbooks have said that biogenic methane can only be produced in the absence of oxygen. For that simple reason, nobody looked closely at this."

The fact is that, in order to determine the quantity of emissions, scientists indeed have to make very careful measurements. The researchers from Heidelberg conducted most of their experiments in methane-free air, in order to factor out the high natural background of methane. Furthermore they used isotope analysis to show beyond doubt that this was an undiscovered process of methane production. By "looking closely" - despite established opinion - they made a discovery that will require textbooks to have their passages about methane production rewritten.

Following up on this discovery, the scientists now will continue laboratory work, as well as field and remote sensing studies, to better quantify the strength of these methane emissions. A related exciting question is which role the biosphere has played in methane production in the history of the earth, and what kind of influence rising global temperatures and carbon dioxide concentration have on the production of methane from plants. Answers to these questions are important for understanding the feedback mechanisms between climate change and greenhouse gas production.

[EC]

Original work:

Frank Keppler, John T. G. Hamilton, Marc Brass and Thomas Röckmann
Methane emissions from terrestrial plants under aerobic conditions
Nature, January 12, 2006

Contact:

Dr. Frank Keppler
[Max Planck Institute for Nuclear Physics, Heidelberg](#)
Tel.: +49 6221 516-575
Fax: +49 6221 516
E-mail: frank.keppler@mpi-hd.mpg.de

Prof. Thomas Röckmann
[Institute for Marine and Atmospheric Research, Utrecht, The Netherlands](#)
Tel.: +31 30 253-3858
Fax: +31 30 254-3163
E-mail: t.roeckmann@phys.uu.nl