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## **New study explains the rise and rise of methane**

The most comprehensive study yet of global methane shows that human activities are emitting as much methane as all natural sources together, largely from fossil fuel extraction and processing, livestock, and rice cultivation.

The three-year international study, published today in the journal *Nature Geoscience*, traces and attributes the natural and man-made sources, the mechanisms that help to moderate methane's influence, and describes how it is changing atmospheric composition.

Methane is also the second most important greenhouse gas, and is responsible for about 20% of the direct warming caused by long-lived gases since pre-industrial times.

Co-author on the study and Executive-Director of the Global Carbon Project, CSIRO's Dr Pep Canadell, said that atmospheric methane was stable from the late 1990s to 2006.

"This was most likely due to decreasing-to-stable fossil fuel emissions, particularly industrial and mining fugitive emissions and emissions from rice cultivation, combined with stable-to-increasing microbial emissions.

"Since 2006 to the present, we show that the rise in natural wetland emissions and fossil fuel emissions are likely to explain the renewed increase in global methane levels," Dr Canadell said.

He said year-to-year fluctuations in methane concentrations are largely driven by changes in wetland emissions in the tropics and cold regions of the Northern Hemisphere, and to lesser extent by large-scale fires.

"Any changes brought about by climate change that alter rainfall and temperature, which effect wetland extend and fire regimes, will therefore have significant implications for methane emissions," he said.

When methane is removed from the atmosphere by natural oxidation it produces ozone, itself a potent greenhouse gas, resulting in further indirect warming of the atmosphere.

Dr Canadell said that although most sources and sinks of methane have been identified, their relative contributions to atmospheric methane levels are highly uncertain. As such, the factors responsible for the observed stabilisation of atmospheric methane levels in the early 2000s, and the renewed rise after 2006, had been unclear until now.

The study found that -

- human sources of methane emissions account for 50–65% of total emissions. By including natural geological methane emissions such as seeps in the Arctic Ocean that were not accounted for in previous budgets, the fossil component of the total methane emissions such as those related to leaks in the fossil fuel industry and natural geological leaks are now estimated to amount to about 30% of the total methane emissions.
- Long-term trends in methane emissions are dominated by trends in agriculture (largely rice cultivation and livestock) and landfills, now responsible for ~60% of all emissions from human activities, followed by emissions from fossil fuels at ~30%.
- Methane hydrates and permafrost soils are estimated to play a very small role in the global

budget of methane, but their contribution can accelerate under global warming.

Dr Canadell said the potential intensive exploitation of natural gas from shale formations around the world may lead to significant additional methane release into the atmosphere, although the potential magnitude of these emissions is still debated.

"Such additional emissions, and combustion of this "new" fossil fuel source, may offset mitigation efforts and accelerate climate change.

"In the longer term, the thawing of permafrost or hydrates could increase methane emissions significantly, and introduce large positive feedbacks to long-term climate change. A better quantification of the global methane budget, with regular updates as done for carbon dioxide, will be key to both embracing the opportunities and meeting the challenge," he said.

Dr Paul Krummel, also a CSIRO co-author of the study and leader of the CSIRO greenhouse measurement program, said the global network of monitoring sites for atmospheric greenhouse gases, including Australia's Cape Grim, is a critical part of the international program in allowing measurement and analysis of trends in methane release and destruction.

The study was led by the Laboratoire des Sciences du Climat et de l'Environnement in France as part of the Global Carbon Project activities, with other CSIRO Australian authors Drs Paul Fraser, Paul Steele and Ray Lagenfelds.

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