A significant revision to the climate impact of increasing concentrations of methane

Human activity has led to more than a doubling of the atmospheric concentration of methane since the 18th century. Methane is a powerful greenhouse gas. It is the second most important greenhouse gas driving human-induced climate change, after carbon dioxide. Its warming effect had been calculated to be about one-quarter of that due to carbon dioxide. Methane emissions due to human activity come from agricultural sources, such as livestock, soil management and rice production, and from the production and use of coal, oil and natural gas.

New research on methane's climate impact has been performed at the Department of Meteorology at the University of Reading, UK and the Center for International Climate and Environmental Research - Oslo (CICERO) in Norway; it indicates that the climate effect of changes in methane concentrations due to human activity has been significantly underestimated. The new calculations indicate that the direct effect of increases in the concentration of methane on climate is 25% higher than previously thought, making it one-third as powerful as carbon dioxide. The research is reported in the American Geophysical Society's journal *Geophysical Research Letters*[*].

Previous calculations had focused attention on the role of methane in the "greenhouse" trapping of infrared energy emitted by the Earth and its atmosphere, primarily at wavelengths of around 7.5 microns. The vital element in the new research is that detailed account is taken of the way methane absorbs infrared energy emitted by the Sun, at wavelengths between 1 and 4 microns.

The effect of this additional absorption of Sun's infrared radiation is complicated, as it depends on the altitudes at which the additional energy is absorbed. This determines whether the extra absorption enhances or opposes the greenhouse trapping. It has been known for many years that the absorption of the Sun's energy by carbon dioxide reduces its climate effect by about 4%, because much of the additional absorption happens high in the atmosphere.

The new calculations of the effect of methane indicate that much of the extra absorption is in the lower part of the atmosphere, where it has a warming effect. The research shows that clouds play a particularly important role in causing this enhanced warming effect. Clouds scatter some of the sun's rays back into space; it is the additional absorption of these scattered rays by methane that drives the warming effect, a factor that had not been included in earlier studies.

The new calculations are important for not only quantifying methane's contribution to human-induced climate change, but also for the operation of the Kyoto Protocol to the United Nations Framework Convention on Climate Change (UNFCCC). This takes into account emissions of many greenhouse gases in addition to carbon dioxide. The emissions of these other greenhouse gases are given a "carbon-dioxide equivalence" by multiplying them by a quantity called the "100-year Global Warming Potential" GWP(100); a similar approach is

likely to be adopted by most countries for the operation of the UNFCCC's more recent Paris Agreement.

The GWP(100) for methane includes not only its direct impact on the Earth's energy budget, but methane's indirect role, via chemical reactions, on the abundance of other atmospheric gases, such as ozone. Applying the results of the new calculations to the value of the GWP(100) presented in the Intergovernmental Panel on Climate Change's (IPCC) most recent (2013) assessment, enhances it by about 15%. This means that a 1-tonne emission of methane would be valued the same as 32 tonnes of carbon dioxide emissions, up from the IPCC's most recent value of 28. Hence for countries with large emissions of emissions of methane due to human activity, it would lead to a significant re-valuing of their climate effect, relative to emissions of carbon dioxide.

The research team identified a number of uncertainties in the calculation of this enhanced absorption by methane, which will require further research to reduce. The new results are unlikely to be recommended for adoption in international treaties until they have been fully considered by the assessment process of the Intergovernmental Panel on Climate Change.

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