Soil microbes accelerate global warming

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More carbon dioxide in the atmosphere causes soil to release the potent greenhouse gases methane and nitrous oxide, new research published in this week's edition of *Nature* reveals. "This feedback to our changing atmosphere means that nature is not as efficient in slowing global warming as we previously thought," said Dr Kees Jan van Groenigen, Research Fellow at the Botany department at the School of Natural Sciences, Trinity College Dublin, and lead author of the study.

Van Groenigen, along with colleagues from Northern Arizona University and the University of Florida, gathered all published research to date from 49 different experiments mostly from North America, Europe and Asia, and conducted in forests, grasslands, wetlands, and agricultural fields, including rice paddies. The common theme in the experiments was that they all measured how extra carbon dioxide in the atmosphere affects how soils take up or release the gases methane and nitrous oxide.

The research team used a statistical technique called meta-analysis, or quantitative data synthesis, a powerful tool for finding general patterns in a sea of conflicting results. "Until now, there was no consensus on this topic, because results varied from one study to the next," explained Professor Craig Osenberg of the University of Florida and co-author of the study. "However, two strong patterns emerged when we analysed all the data: firstly more CO_2 boosted soil emissions of nitrous oxide in all the ecosystems, and secondly, in rice paddies and wetlands, extra CO_2 caused soils to release more methane." Wetlands and rice fields are two major sources of methane emissions to the atmosphere.

The culprits are specialised microscopic organisms in soil, that respire the chemicals nitrate and carbon dioxide, like humans respire oxygen. The microbes also produce methane, a greenhouse gas 25 times more powerful than carbon dioxide, and nitrous oxide, 300 times more potent than carbon dioxide. Their oxygen-free habit is one of the reasons these microorganisms flourish when atmospheric carbon dioxide concentrations increase. Van Groenigen explained: "The higher CO_2 concentrations reduce plant water use, making soils wetter, in turn reducing the availability of oxygen in soil, favoring these microorganisms."

The other reason these microorganisms become more active is that increasing CO_2 makes plants grow faster, and the extra plant growth supplies soil microorganisms with extra energy, pumping up their metabolism. This extra plant growth is one of the main ways ecosystems could slow climate change. With more CO_2, plants grow more, soaking up carbon dioxide through photosynthesis, and, the hope is that they also lock away carbon in wood and soil. But this new work shows that at least some of that extra carbon also provides fuel to microorganisms whose byproducts, nitrous oxide and methane, end up in the atmosphere and counteract the cooling effects of more plant growth.

"It's an ecological point and counterpoint: the more the plants soak up CO_2, the more microbes release these more potent greenhouse gases," said Bruce Hungate, Professor at Northern Arizona University and co-author on the study. "The microbial counterpoint is only partial," continued Hungate, "reducing the cooling effect of plants by about 20%."

But it's an ecological surprise, too, and one that climate models will need to reckon with as they further refine pictures of the climate of the future. "By overlooking the key role of these two greenhouse gases, previous studies may have overestimated the potential of ecosystems to

mitigate the greenhouse effect," van Groenigen concluded.

More information: Van Groenigen, K.J., et al. (2011) 'Increased soil emissions of potent greenhouse gases under increased atmospheric CO2'. *Nature*, published 14 July. DOI: 10.1038/nature10176

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