Researchers create more accurate model for greenhouse gases from peatlands

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Peatlands in Denali National Park, Alaska. Argonne researchers announced a new model for the greenhouse gas emissions of peatlands in the Arctic. Credit: Zicheng Yu

Scientists at the U.S. Department of Energy's Argonne National Laboratory have created a new model to more accurately describe the greenhouse gases likely to be released from Arctic peatlands as they warm. Their findings, based on modeling how oxygen filters through soil, suggest that previous models probably underestimated methane emissions and overrepresented carbon dioxide emissions from these regions.

Peatlands, common in the Arctic, are wetlands filled with dead and decaying organic matter. They are the result of millions of years of plants dying and breaking down into rich soil, so they contain a massive amount of carbon.

"Peatlands cover about four percent of all land, but they hold 20 percent of all carbon stored on land," said Argonne scientist Zhaosheng Fan, who led the study.

Cold temperatures keep the carbon locked in the soil. As the ground warms, however, microbes come to life and begin to decompose all that organic matter, which releases carbon into the atmosphere.

Unfortunately, the extreme northern regions of the world are where warming has accelerated the most quickly—and it's expected to pick up in the future. Scientists are concerned that Arctic warming could spiral quickly into a self-reinforcing cycle that dumps an enormous amount of carbon into the atmosphere.

Scientists create complex models to estimate how this might unfold, combining data taken on the ground with varying emissions scenarios to forecast climate change far into the future.

One area of particular interest is which form of carbon will be released. Microbes can create either CO2 or methane, and each gas has different effects on the atmosphere. CO2 is a long-lived greenhouse gas, staying in the atmosphere for up to a century or more. Methane delivers a powerful punch—its impact is about 20 times greater than CO2—but filters out of the atmosphere in about 12 years. Accurately predicting how much of each gas will be released, therefore, is important.

Down in the ground, the conditions that microbes find themselves in will affect what form of carbon they release. If there's a lot of oxygen and water available, microbes will only produce CO2. If there isn't enough oxygen, they will produce methane and CO2.

Up until now, researchers had been using a simple model that assumed water was the primary divider; soil above the water table would produce microbes that made CO_2, and microbes below would produce methane.

"But experiments had been showing that there could be significant limits on oxygen availability above the water table, and this would affect what form of carbon microbes release," Fan said.

The size and characteristics of soil particles matter. If the oxygen gets trapped in air bubbles and consumed by other microbes or can't filter down through soil, soil microbes will produce methane even if they're above the water table.

"So we set out to make a model that would take these findings into account," Fan said.

The team used experimental data from peatland taken near Fairbanks, Alaska and plugged it into their model. The results showed their new model was much more accurate and suggested that more methane is produced and proportionally less CO_2—than predicted by older water table-based models.

"Revising this calculation will substantially affect current greenhouse gas production models in the Arctic," Fan said.

Next, Fan said, they are looking into adding other soil characteristics, such as nutrients like nitrogen, into the model to see how they might affect microbe output.

The study, "Transport of oxygen in soil pore-water systems: Implications for modeling emissions of carbon dioxide and methane from peatlands," was published in *Biogeochemistry.*

More information: "Transport of oxygen in soil pore-water systems: implications for modeling emissions of carbon dioxide and methane from peatlands." Zhaosheng Fan, Jason C. Neff, Mark P. Waldrop, Ashley P. Ballantyne, Merritt R. Turetsky. *Biogeochemistry*. link.springer.com/article/10.1007%2Fs10533-014-0012-0#page-1

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