Grad student finds adding fresh carbon to permafrost triggers carbon loss

1 February 2019, by Kate Petersen

Permafrost peatbog border. Storflaket, Abisko, Sweden. Credit: Dentren/Wikipedia

Permafrost underlies nearly 85 percent of Alaska and nearly a quarter of the landmass in the northern hemisphere. This perennially frozen soil contains twice as much carbon as is found in the Earth's atmosphere. Since the Arctic is warming twice as fast as the rest of the planet, understanding carbon uptake and loss in permafrost regions is crucial to improving accuracy of climate models. It also offers clues to how this region will respond and shape a future warmer world.

As the Earth's atmosphere warms and causes permafrost to thaw, carbon that's been locked away for hundreds to thousands of years is being made available to microbes. But what are microbes doing with that recently exposed carbon, how fast is it decomposing and how much of a difference does this make in the atmosphere?

To help answer these questions, Northern Arizona University doctoral candidate Elaine Pegoraro designed an experiment to measure how microbes respond to fresh carbon addition at different depths in soil collected from a field site near Healy, Alaska. Essentially, she made glucose additions to the soil three times throughout the course of a year. The results were published this month in *Soil Biology and Biochemistry*.

"Glucose is this really accessible energy source," said Pegoraro, who is part of the Center for Ecosystem Science and Society (Ecoss). "It's like giving the microbes a choice between brownies and a bag of frozen peas at the back of your freezer," where the frozen peas stand in for carbon found in permafrost. That carbon decomposes slowly because of biological, physical and chemical processes.

"Unless you were starving, you probably wouldn't touch the peas."

Adding glucose at the surface didn't produce much of a sustained response. But at deeper soil layers, where permafrost is found, Pegoraro and her team saw a "priming effect:" microbes respired twice as much soil carbon than the samples that didn't receive glucose. The microbes were eating the "brownies," and, in their sugar high, had the energy needed to decompose soil to access nutrients, releasing more carbon into the atmosphere.

When Pegoraro extrapolated these findings to the field, she found this priming effect accounted for 4-12 percent of carbon that is released into the atmosphere in a growing season.

"It's a considerable amount of carbon," she said.

As the Arctic warms, more plants are growing in these ecosystems, doing their part to remove some carbon from the atmosphere by incorporating it into their biomass.

But Pegoraro's findings suggest that plants may also contribute to some soil carbon loss by releasing glucose from their roots into soil.

"We need to consider priming effects to fully understand permafrost carbon dynamics," she said. "Otherwise we could underestimate how much carbon is being lost to the atmosphere."

More information: Elaine Pegoraro et al. Glucose addition increases the magnitude and decreases the age of soil respired carbon in a long-term permafrost incubation study, *Soil Biology and Biochemistry* (2018). DOI: 10.1016/j.soilbio.2018.10.009

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