Team investigates how warming affects uptake and release of carbon dioxide in subarctic grassland

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First author Kathiravan Meeran conducts measurements at the Icelandic test site near a geothermal rift line. Credit: University of Innsbruck

Soil is the largest natural carbon storage in the world. In Northern ecosystems particularly large amounts of carbon are stored, but they are

also particularly strongly affected by global warming. A study recently published in *Global Change Biology* by an international team led by Michael Bahn of the University of Innsbruck investigated how ongoing warming affects the uptake and release of carbon dioxide in subarctic grassland. The researchers used a geothermally active area in Iceland as a natural "climate chamber."

Subarctic ecosystems store large amounts of carbon. As the climate continues to warm, more and more carbon is being released into the atmosphere. There are uncertainties concerning the extent to which the loss of carbon from soil can be compensated by the uptake of carbon through plant photosynthesis.

"After all, if warming increases the decomposition of soil organic matter and thus also the supply of nutrients to plants, then plants should grow better and absorb more carbon dioxide from the atmosphere," says Bahn of the Department of Ecology. "Surprisingly, this may not be the case, as our recent study shows."

Geothermal rifts in Iceland provide ideal conditions for researchers to explore the longer-term effects of climate warming on ecosystems in the far north. A team led by Bahn used a geothermally active site in Iceland as part of an international project to study the effect of warming and nitrogen supply on the carbon cycle.

"The research plots were located at different distances from the rift line and, accordingly, warmed to a greater or lesser extent," Bahn explains. "By fertilizing part of the plots with nitrogen we were able to study the interactive effects of warming and nitrogen supply on the carbon cycle."

Warming accelerates the carbon cycle

Warming led to a massive loss of carbon in the soil. "In the area we

studied in Iceland, up to 40% of the carbon was released into the atmosphere in the first few years after warming," says Bahn. "In the subsequent years, the microbial biomass adjusted and the soil carbon balance stabilized again."

To understand the path carbon takes in this cycle from the atmosphere through the plants and soil and back to the atmosphere, the research team added the stable carbon isotope ^{13}C during the experiment. "Using the isotope, we were able to trace the path of the carbon as it moves through the ecosystem," explains the ecologist. "We observed that with increasing warming, the carbon taken up by the plants was transferred more strongly to the microbes and released more rapidly from the soil.

"From the fertilization experiments it can further be concluded that under warming plant productivity became increasingly nitrogen limited. In consequence, the photosynthetic uptake of carbon dioxide by the ecosystem decreased. As warming also accelerated the release of carbon from soil, the ecosystem's ability to store carbon was thus gradually reduced."

More information: Kathiravan Meeran et al, Individual and interactive effects of warming and nitrogen supply on CO2 fluxes and carbon allocation in subarctic grassland, *Global Change Biology* (2023). DOI: 10.1111/gcb.16851

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