

# Northern permafrost region emits more greenhouse gases than it captures, study finds

April 15 2024, by Saima May Sidik

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Credit: Justine Ramage

Permafrost underlies about 14 million square kilometers of land in and around the Arctic. The top 3 meters contain an estimated 1 trillion metric tons of carbon and 55 billion metric tons of nitrogen. Historically, the northern permafrost region has been a sink for carbon, as frozen soils

inhibit microbial decomposition. But rising temperatures contribute to thawing permafrost and enhance the biogeochemical activities that exacerbate climate change by releasing greenhouse gases such as carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>), and nitrous oxide (N<sub>2</sub>O).

Data on how much this region will—or already has—affected the course of climate change are difficult to gather due to the complexity of the landscape. [The study](#), published in *Global Biogeochemical Cycles*, synthesized greenhouse gas measurements of the northern permafrost region between 2000 and 2020 to provide a carbon balance for the region, as well as the first comprehensive assessment of the quantities of [greenhouse gases](#) the area takes up and emits.

The researchers' work, done as part of the Regional Carbon Cycle Assessment and Processes (RECCAP2) project, used a bottom-up approach, focusing on estimating emissions based on specific source categories. Their results suggest that the area has already shifted from a sink to a small source of carbon.

The researchers compiled many past estimates of greenhouse gas flux in various sections of the northern permafrost region to reveal how the entire area is responding to [climate change](#). They found that the study area was a net source of CH<sub>4</sub> and N<sub>2</sub>O between 2000 and 2020.

Wetlands were some of the largest methane emitters, and lakes contributed substantially as well. Dry tundra was the biggest driver of N<sub>2</sub>O release, and permafrost bogs were a close second.

However, the researchers were unable to say definitively whether the region was a net source or sink of CO<sub>2</sub>. Terrestrial ecosystems, particularly [boreal forests](#), still take up CO<sub>2</sub>. But this is offset by fires, abrupt permafrost thaw, and [inland waters](#), which emitted an estimated 12 million metric tons of CO<sub>2</sub>.

The researchers estimate that the northern permafrost region emitted 38 million metric tons of CH<sub>4</sub> and 670,000 metric tons of N<sub>2</sub>O into the atmosphere between 2000 and 2020. When accounting for lateral fluxes such as erosion, the region was also a source of 144 million metric tons of carbon and 3 million metric tons of nitrogen. That's very little compared with the emissions of a major industrialized country, but the pace may accelerate as the world warms.

**More information:** Justine Ramage et al, The Net GHG Balance and Budget of the Permafrost Region (2000–2020) From Ecosystem Flux Upscaling, *Global Biogeochemical Cycles* (2024). [DOI: 10.1029/2023GB007953](https://doi.org/10.1029/2023GB007953)

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