Seasonal increase of methane emissions linked to warming in Siberian tundra

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Methane (CH_4) is a strong greenhouse gas that accelerates climate change, yet its emissions from wetlands in general and Arctic permafrost-affected wetlands in particular remain very uncertain in the global CH_4 budget. Arctic CH_4 sources and the expected effect of permafrost thaw on these sources have gained much attention by the public, media, policy makers, and researchers during the past decade, but neither inversion nor process-based models provide clear trends in emissions and there has not been any observational evidence for increasing CH_4 emissions from Arctic permafrost ecosystems.

Here, we provide this observational evidence.

Based on the longest record of direct Arctic CH_4 flux observations acquired since 2002 at a Siberian tundra site using the eddy covariance method, we found an increase in the early summer (June and July) CH_4 emissions by 1.9 ± 0.7 % yr^{-1} since 2004 along with a strong increase in June air temperatures of 0.3 ± 0.1 °C yr^{-1}. Although the tundra's maximum source strength in August has not yet changed and the overall mean annual emissions of 171.5 ± 12.3 mmol m^{-2} yr^{-1} remain in the lower half of the published range, the increase in early summer methane emissions shows that atmospheric warming has begun to affect the methane flux dynamics of permafrost-affected ecosystems in the Arctic. This is especially noteworthy, given the very thick and cold continuous permafrost in the study area compared to most other observational sites.
While the observed changes clearly happen in the early warm season, we also estimate 39 % of the annual emission to originate from the re-freezing and frozen period, highlighting the importance of the cold season for annual permafrost CH_4 emission estimates and the substantial challenges in achieving continuous data coverage in the Arctic winter.

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