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Arctic tundra and mountain landscapes are persistent sinks of atmospheric CH4

Jesper Christiansen (1), Renato Winkler (2), Christian Juncher Jørgensen (1,3)

(1) University of Copenhagen, Department of Geoscience and Natural Resource Management, Frederiksberg C, Denmark (jrc@ign.ku.dk), (2) Picarro Inc., Santa Clara, CA, USA, (3) Force Technology Denmark

Recent studies have shown significant rates of net uptake of atmospheric methane (CH4) in Arctic tundra soils. Oxidation of CH4 in these cold, dry soils in the Arctic region can counteract CH4 emissions from wetlands and play a potential important role for the net Arctic CH4 budget. However, significant knowledge gaps exist on the overall magnitude of the net CH4 sink in these cold, dry systems as the spatial and environmental limits for CH4 oxidation has not been determined. In particular, the extent, magnitude and drivers of CH4 oxidation in mountains and alpine landforms, which occupy large land areas in the Arctic and High Arctic has not yet been investigated leaving a potential vast CH4 sink unquantified with major potential implications for our conceptual view of Arctic CH4 budget in a changing climate.

Here we present the results from two expeditions in the summers of 2015 and 2016 from Disko Bay and in the pro-glacial landscape in vicinity of the Russell Glacier, Kangerlussuaq, Greenland, respectively. The aim of our work is to determine the magnitude and extent of net uptake of atmospheric CH4 across a variety of previously unexplored dry tundra and post-glacial landforms in the Arctic, i.e. marginal moraines and other glacial features at the Greenland ice sheet as well as mountain tops and outwash plains. We used high-precision, mobile cavity-ring-down spectrometers (e.g. model G4301 GasScouter, Picarro Inc.) to achieve reliable flux estimates in sub-ambient CH4 concentration levels with a 4-minute enclosure time per chamber measurement. Our results show a persistent net uptake of CH4 uptake in these dry, extreme environments that rival the sink strength observed in temperate forest soils, otherwise considered the primary global terrestrial sink of atmospheric CH4. In this dynamic glacial landscape the magnitude of the net CH4 uptake is mainly constrained by recent landscape evolution along glacier margins and meltwater systems.

Utilizing the high mobility and precision of a new generation of greenhouse gas analyzers, like the Picarro GasScouter, we can explore beyond our traditional field scale the spatial drivers of CH4 oxidation in the harsh Arctic landscape. Thus, our measurements highlight the importance of net CH4 uptake in tundra soils for the Arctic CH4 budget.