Geophysical Research Abstracts
Vol. 18, EGU2016-15069, 2016
EGU General Assembly 2016

The Arctic CH4 sink and its implications for the permafrost carbon feedbacks to the global climate system

Christian Juncher Jørgensen (1), Jesper Christiansen (1), Tue Mariager (1), and Gustaf Hugelius (2)

(1) University of Copenhagen, Department of Geoscience and Natural Resource Management, Frederiksberg C, Denmark, (2) Stockholm University, Department of Physical Geography, Stockholm Sweden

Using atmospheric methane (CH4), certain soil microbes are able to sustain their metabolism, and in turn remove this powerful greenhouse gas from the atmosphere. While the process of CH4 oxidation is a common feature in most natural and unmanaged ecosystems in temperate and boreal ecosystems, the interactions between soil physical properties and abiotic process drivers, net landscape exchange and spatial patterns across Arctic drylands remains highly uncertain. Recent works show consistent CH4 comsumption in upland dry tundra soils in Arctic and High Arctic environments (Christiansen et al., 2014, Biogeochemistry 122; Jørgensen et al., 2015, Nature Geoscience 8; Lau et al., 2015, The ISME Journal 9). In these dominantly dry or barren soil ecosystems, CH4 consumption has been observed to significantly exceed the amounts of CH4 emitted from adjacent wetlands. These observations point to a potentially important but largely overlooked component of the global soil-climate system interaction and a counterperspective to the conceptual understanding of the Arctic being a only a source of CH4.

However, due to our limited knowledge of spatiotemporal occurrence of CH4 consumption across a wider range of the Arctic landscape we are left with substantial uncertainites and an overall unconstrained range estimate of this terrestrial CH4 sink and its potential effects on permafrost carbon feedback to the atmospheric CH4 concentration. To address this important knowledge gap and identify the most relevant spatial scaling parameters, we studied in situ CH4 net exchange across a large landscape transect on West Greenland. The transect representated soils formed from the dominant geological parent materials of dry upland tundra soils found in the ice-free land areas of Western Greenland, i.e. 1) granitic/gneissic parent material, 2) basaltic parent material and 3) sedimentary deposits.

Results show that the dynamic variations in soil physical properties and soil hydrology exerts an overriding control on the net CH4 consumption both within and across these well-aerated soil systems. Quite surprisingly, we found high CH4 sink rates in conditions when soils were both extremely thin (< 10 cm to bedrock), very dry (< 5-10 % soil moisture), weakly developed and exposed to harsh environmental conditions such as mountain tops, alpine tundra and abrasion plateaus, which are historically overlooked "extreme soils" regarding CH4 exchange. The results show that the physical areas and landforms where CH4 oxidation and net CH4 deposition occurs has not been delimited for the Arctic. This calls for a revised understanding of the role of CH4 consumption in natural drylands and extreme environments for the net CH4 budget at the circumpolar scale. In these sensitive regions, changes towards warmer and drier soil conditions in some areas as a consequence of a warming Arctic could favor the activity of the CH4 oxidizing bacteria, leading to future increase in net atmospheric CH4 consumption in dry and barren land areas. This could have far-reaching implications for the permafrost carbon feedback to the global climate system and how we integrate the soil CH4 consumption feedback in Earth Systems Model simulating the Artic CH4 budget.