Geophysical Research Abstracts
Vol. 21, EGU2019-15647, 2019
EGU General Assembly 2019

Towards constraining the circumpolar nitrous oxide budget

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Arctic soils and sediments are well known for their huge carbon stocks and the significant positive feedback carbon dioxide (CO_2) and methane (CH4) emissions can have on climate change. However, the vast amounts of nitrogen (N) and possible emissions of the strong greenhouse gas nitrous oxide (N2O) from Arctic soils are much less considered in this context. Arctic soils have been neglected in global N2O accounting, since their N2O emissions were traditionally thought to be low due to the general N-limitation of biological processes. Recent results suggest, however, that this assumption is unwarranted and needs to be revised. Still, although we know about the risk for increasing N2O emissions from the Arctic with warming, data are available only from a handful of sites and we are lacking any estimate on the circumarctic N2O budget even under the present climate. This presentation will introduce our plan to produce the first circumarctic N2O budget, an important baseline scenario against which changes in circumarctic N2O emissions can be observed with ongoing warming and global change. In order to estimate the first circumarctic N2O budget, we synthesize existing data and organize large-scale surveys of N2O fluxes across the Circumarctic. In our synthesis effort, we collect published and unpublished data on N2O emissions and N2O soil gas concentrations and analyze the data for driving variables and mechanisms underlying the N2O fluxes from various sites with different soil and vegetation characteristics. In addition, we organize measurement campaigns (via the INTERACT remote access program) to quantify N2O fluxes across a wide variety of Arctic sites using a network of collaborator stations with simple, standardized methods, and combine this N2O screening with GIS approaches to scale up the N2O fluxes step-wise from plot to regional and circumarctic levels. Ultimately, these data will be combined with existing data-sets and archived in a database that will be made available for process modelers in order to develop and improve the performance N2O models for permafrost soils.
N2O flux data were published in 21 articles from 16 Arctic sites. In the frame of this project, N2O flux measurements were conducted in 2018 at 18 study sites located in Russia, Scandinavia, Svalbard, Canada and Alaska. First analyses show that N2O is released from a range of environmentally distinct sites and at variable magnitudes with soil N content, soil C/N ratios, vegetation cover, water availability, and nutrient content likely playing significant roles. Ultimately, this project will not only provide a valuable input towards the first estimate of the circumarctic N2O budget but also towards understanding the controls of Arctic N2O fluxes which is necessary for future projections. There is urgent need for collaboration among partners in this effort and we would thus like to invite interested researchers to contribute with further published or unpublished data on N2O fluxes/concentrations from Arctic sites to support our synthesis effort. Scientists are also highly requested to sample additional N2O data from "their" Arctic sites with the simple methods introduced here, in order to help us filling large data gaps.