Geophysical Research Abstracts
Vol. 20, EGU2018-9813, 2018
EGU General Assembly 2018

Factors behind the high variation in nitrous oxide emissions in northern managed peatlands

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In pristine peatlands high water table (WT) and associated anaerobic conditions result in a low decomposition rate and carbon accumulation as peat. These natural peatlands are sources of methane (CH_4) to the atmosphere but have negligible emissions of nitrous oxide (N_2O). Drainage is necessary when utilizing peatlands for agricultural cultivation, forestry or peat extraction. Drainage lowers the WT level and the peat is exposed to oxygen, which accelerates peat decomposition and mineralization processes leading to net losses of carbon dioxide (CO_2) and decreases in CH_4 emissions. Simultaneously, the N_2O emissions may increase significantly especially in nutrient rich peatlands. However, there is high variation in the N_2O emission rates between Northern drained peatlands[1] but the reasons for this variation are not well understood.

Water table level is a well known factor regulating N_2O emissions in peatlands. Besides WT, also the peat carbon to nitrogen (C/N) ratio is an important parameter for interpreting N_2O emissions. The highest N_2O emissions occur when the C/N ratio ranges between 15 and 30, whereas N_2O emissions are generally low above this range. However, WT, C/N ratio and nitrogen (N) content of the peat do not fully explain the large variation in N_2O emissions between different sites. This implies that there are also other factors, which regulate N dynamics and N_2O emissions in managed peatlands.

We selected 11 peatland sites in Finland, Sweden and Iceland covering 5 different land-use types: forested, cultivated or only drained peatlands as well as cultivated peatlands that were either abandoned or afforested. In all sites, the peat C/N ratio was between 15 and 30 and annual N_2O emission data was available. Because a major part of the annual N_2O emissions may occur during wintertime[2], the selected sites had data on year-round N_2O emissions. We measured N_2O production, soil microbial biomass C as well as gross N mineralization and gross nitrification rates, and complemented this data with a wide array of measurements on soil physical and chemical properties, including soil trace elements.

Our results show that N_2O emissions vary also within, not only between, the land use types. Despite the low C/N ratio, the availability of mineral N is an essential factor in regulating N_2O emissions. In addition, the availability of phosphorus (P) and copper (Cu) seem to affect N_2O production/emissions.

References

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