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Alder-induced stimulation of soil gross nitrogen turnover in permafrost-affected peatlands of Northeast China

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Unlike carbon dynamics, nitrogen (N) dynamics in permafrost peatlands are not well-studied. For the prediction of permafrost N climate feedbacks, a better process-based understanding of the N cycle in permafrost peatlands is however urgently needed. Therefore, we characterized and quantified soil organic matter, soil gross microbial N turnover and soil-atmosphere exchange of nitrous oxide (N_2O) on the southern edge of the Eurasian permafrost area *in situ* (www.nifroclim.de). Specifically, we sampled a tree-free lowland peatland and a lowland peatland with an N_2-fixing alder forest in Northeast China.

Nuclear magnetic resonance spectroscopy revealed more recalcitrant organic matter at greater depth and more bioavailable organic matter substrates in upper peat horizons. In line with this result, gross ammonification and nitrification generally decreased with increasing sampling depth. Gross rates of mineral N turnover in the active layers of the tree-free peatland were comparable to those of temperate ecosystems. Despite substantial gross ammonification, the low nitrification:ammonification ratios and negligible soil N_2O emissions still depicted a closed N cycle characterized by N limitation in the tree-free peatland.

In strong contrast, the peatland underneath the alder forest showed an accelerated N turnover with very high gross rates of ammonification (3.1 g N m^{-2} d^{-1}) and nitrification (0.6 g N m^{-2} d^{-1}), exceeding those of the alder-free peatland by an order of magnitude. This was accompanied by substantial N_2O emissions. The increase in gross N turnover was most pronounced in the rooted soil layer, where N inputs from biological N fixation almost doubled total N concentrations and halved the ratios of soil organic carbon to total N. The frozen ground underneath alder trees contained strongly increased ammonium concentrations prone to be released upon thaw. This study shows that alder forests that further expand on permafrost-affected peatlands with global change create hot spots of soil mineral N turnover, thereby potentially enhancing permafrost N climate feedbacks.