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Atmospheric nitrous oxide uptake in boreal spruce forest soil

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Nitrous oxide (N_2O) uptake from the atmosphere has been found in forest soils but environmental factors controlling the uptake and its atmospheric impact are poorly known. We measured N_2O fluxes over growing season in a boreal spruce forest having control plots and plots with long nitrogen fertilization history. Also methane (CH_4) fluxes were measured to compare the atmospheric impact of N_2O and CH_4fluxes. Soil chemical and physical characteristics and climatic conditions were measured as background data. Nitrous oxide consumption and uptake mechanisms were measured in complementary laboratory incubation experiments using stable isotope approaches. Gene transcript numbers of nitrous oxide reductase (*nosZ*) I and II genes were quantified along the incubation with elevated N_2O atmosphere. The spruce forests without fertilization history showed highest N_2O uptake rates whereas pine forest had low emissions. Nitrous oxide uptake correlated positively with soil moisture, high soil silt content, and low temperature. Nitrous oxide uptake varied seasonally, being highest in spring and autumn when temperature was low and water content was high. The spruce forest was sink for CH_4. Methane fluxes were decoupled from the N_2O fluxes (i.e. when the N_2O uptake was high the CH_4 uptake was low). By using GWP approach, the cooling effect of N_2O uptake was on average 30% of the cooling effect of CH_4 uptake in spruce forest without fertilization. Anoxic conditions promoted higher N_2O consumption rates in all soils. Gene transcription of *nosZ*-I genes were activated at beginning of the incubation. However, atypical/clade-II *nosZ* was not detected. These results suggests, that also N_2O uptake rates have to be considered when accounting for the GHG budget of spruce forests.