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# The effect of anaerobicity and temperature on $N_2$ and $N_2O$ dynamics in forestry drained boreal peat soils

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Molecular nitrogen ($N_2$) is the dominant end-product of microbial denitrification in soils; however, due to difficulties in measuring $N_2$ exchange, the emissions of $N_2$ from terrestrial ecosystems are largely unknown. In boreal peatland soils, the combination of high soil carbon and nitrogen contents, fluctuating water-table and high decomposition activity of the peat make these soils potentially large emitters of N gases via microbial denitrification processes. This motivated us to quantify the $N_2$ and nitrous oxide ($N_2O$) losses from boreal drained peat soils varying in fertility status.

Soil samples were collected from two drained peatland forests: a nutrient-rich (Lettosuo) and a nutrient-poor (Kalevansuo) site, both located in the boreal zone of Southern Finland. $N_2$ and $N_2O$ emissions from intact soil cores were measured using the helium gas flow soil core method. Two incubation experiments were conducted focusing on the effects of anaerobicity and temperature on $N_2$ and $N_2O$ dynamics of the top-soil (experiment 1), and the effect of anaerobicity on $N_2$ and $N_2O$ dynamics in the peat profile (experiment 2). Soil samples in experiment 1 were incubated under 1) cold (2˚C) aerobic (20% $O_2$, 80% He), 2) cold (2˚C) anaerobic (0% $O_2$, 100% He), and 3) warm (15˚C) anaerobic conditions, while those in experiment 2 were incubated under 1) warm aerobic and 2) warm anaerobic conditions. Dynamics of $N_2$ and $N_2O$ fluxes for each incubation condition were followed until fluxes stabilized.

In general, the $N_2$ and $N_2O$ fluxes in the nutrient-rich Lettosuo peat were higher and more variable than those at the nutrient-poor Kalevansuo peat. In the nutrient-rich Lettosuo, both the $N_2$ and $N_2O$ emissions increased dramatically after the change from aerobic to anaerobic conditions, and again after the temperature rise from 2 to 15˚C. This latter peak in emissions was followed by a switch from $N_2O$ production to $N_2O$ consumption and a simultaneous sharp decrease in $N_2$ emissions. Although, the $N_2$ and $N_2O$ fluxes in the nutrient-poor Kalevansuo peat were small and close to the detection limit, the change from the aerobic to anaerobic conditions induced significant $N_2O$ uptake, which was even more pronounced under warm anaerobic conditions. At the nutrient-rich Lettosuo, all the three soil layers (10-15 cm, 15-20 cm, 40-45 cm) were equally active in $N_2$ and $N_2O$ production or consumption. Overall, $N_2$ emissions from both sites always exceeded $N_2O$ emissions, and when the fluxes were positive and above their detection limits, the ratio of $N_2$:$N_2O$ ranged between 1 and 180.