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# Modeling Nitrous Oxide emissions and identifying emission controlling factors for a spruce forest ecosystem on drained organic soil

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High Nitrous Oxide (N2O) emission has been identified in hemiboreal forests on drained organic soils. However, the controlling factors regulating the emissions have been unclear. To examine the importance of different factors on the N2O emission in a spruce forest on drained organic soil, a process-based model, CoupModel, was calibrated by the generalized likelihood uncertainty estimation (GLUE) method. The calibrated model reproduced most of the high resolution data (total net radiation, soil temperature, groundwater level, net ecosystem exchange, etc.) very well, as well as accumulated measured N2O emissions, but showed difficulties to capture all the measured emission peaks. Parameter uncertainties could be reduced by combining selected criteria with the measurement data. The model showed the N2O emissions during the summer to be controlled mainly by the competition between plants and microbes while during the winter season snow melt periods are important.

The simulated N budget shows >100 kg N ha-1 yr-1 to be in circulation between soil and plants and back again. Each year the peat mineralization adds about 60 kg N ha-1 and atmospheric deposition 12 kg N ha-1. Most of the mineralized litter and peat N is directly taken up by the plants but only a part accumulates in the plant biomass. As long as no timber is harvested the main N loss from the system is through nitrate leaching (30 kg N ha-1 yr-1) and gas emissions (20 kg N ha-1 yr-1), 55% as NO, 27% as N2O and 18% as N2. Regarding N2O gas emissions, our modeling indicates denitrification to be the most responsible process, of the size 6 kg N ha-1 yr-1, which could be compared to 0.04 kg N ha-1 yr-1 from nitrification. Our modelling also reveal 88% of the N2O mainly to be produced by denitrification in the capillary fringe (c.a. 40-60 cm below soil surface) of the anaerobic zone using nitrate produced in the upper more aerobic layers. We conclude N2O production/emission to be controlled mainly by the complex interaction between soil N availability, mediated by mineralization, nitrification, and plant growth together with soil anaerobicity controlled by the groundwater level.

The model is currently used for modelling greenhouse gas emissions from drained organic soils over the entire forest cycle, from plantation to harvest. Different land use and plant production are compared like Spruce, Willow and Reed Canary Grass as well as rewetting options.

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