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Nitrogen deposition affects C and N balance in mesocosms of five European peatlands

Katarzyna Zajac (1) and Christian Blodau (2)

(1) Limnological Research Station, Department of Hydrology, University of Bayreuth, Universitaetsstrasse 30, 95440 Bayreuth, Germany (katarzyna.zajac@uni-bayreuth.de), (2) Department of Environmental Sciences, University of Guelph, Axelrod Building, Guelph, Canada (cblodau@uoguelph.ca)

Peatlands store significant amounts of global soil carbon and are particularly sensitive to nitrogen enrichment. Chronic nitrogen deposition can influence the C and N cycling and lead to an increase in transformation rates and fluxes. It is therefore important to understand how C and N cycling in these ecosystems will respond to changing climate and long-term nitrogen deposition. In our experiment, intact peat cores (30cm x 40cm) were collected in three replicates from lawns of five sites in Britain, Sweden, Denmark and Germany, spanning the range in European atmospheric N deposition from 0-30 kg N ha-1 y-1. All cores were placed in a climate chamber at a constant temperature (20°C) and humidity (∼60% rH) and exposed to 12 h light/dark cycles. Each mesocosm received an equivalent of 30 kg N ha-1 y-1 in the form of NH415NO3. Additionally, all cores were undergoing a dry period (water table ∼ 30cm below the peat surface) and wet period (water table ∼ 10cm below the peat surface) for 80 days each. We recorded nitrogen transformations (to NH4+, NO3-, DON, N2O, PON), and translocation of the tracer in pore water and air every other week during the experiment. We measured trace gas exchange (N2O, CO2, CH4) with the closed chamber technique at the same time interval.

We observed an increase in vascular plant biomass in comparison to mosses at all sites over the course of the experiment. This change was especially visible in the most polluted site and after raising the water level. The most N polluted site also showed a considerable increase of ammonium and DON concentration over time. Methane emissions stayed very low (<3 mmol m-2 d-1) during dry conditions but were restored following rewetting after about 5 days for high and intermediate N sites and after about 10 days for low N sites. All sites responded to the water table change with a higher photosynthesis rates, although the British sites showed on average higher rates in comparison to continental ones. At the end of the experiment GEP reached 800 mmol m-2 d-1. Lowest ecosystem respiration (70 mmol m-2 d-1) was observed at an intermediate N site and highest (385 mmol m-2 d-1) at the most N polluted site. We didn't record a substantial decrease in ecosystem respiration after raising the water table at any site. However, considering that the highest quantities of CO2 are typically produced in upper most centimetres of peat, and that our water table after the flooding was still 10cm below the peat surface, predominating CO2 production in the shallow peat may not have been affected by the water table change. The CO2 sinks increased at 4 sites over the course of experiment. This trend could be caused by both higher biomass availability and the wetter conditions that we induced. Only the most N polluted site was a permanent carbon source. This finding supports our hypothesis that above a certain N deposition threshold, the C sink function of peatlands may be impaired and peatlands be converted to a carbon source.