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Boreal mire carbon exchange – long term effects of climate change and nitrogen and sulphur additions

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Boreal peatlands are important long-term sinks of atmospheric carbon and in the same time a significant source of methane to the atmosphere. A changing climate as well as deposition of anthropogenically derived nitrogen and sulphur has the potential to affect the processes that control the carbon exchange in peatlands. Much of the anticipated responses in the peatland carbon biogeochemistry are driven by changes in the plant community composition. This presentation summarizes, major findings from a long-term field manipulation experiment, established 1995, at Degerö Stormyr, a nutrient poor minerogenic mire in Northern Sweden. After an initial lag-time of ∼5 years with only minor changes the plant community composition have changed substantially and is still changing after 12 years of green house treatment and addition of nitrogen and sulphur. Addition of nitrogen reduced the Sphagnum cover from 100% to <20% in favour of dwarf shrubs and the sedge Eriophorum vaginatum, which increased from 30%-70% coverage. Also the green-house treatment favoured the dwarf shrub Vaccinium oxycoccus, and the sedge Eriophorum vaginatum. The nitrogen treatment also resulted in a shorter distance between the mire surface and the water table due to the loss of the Sphagnum cover. This effect on the vertical extension of the oxic zone will most likely affect both the cumulative decomposition as well as the emission of methane. These profound effects on the vegetation were also reflected in significant responses in the methane biogeochemistry while the CO2 exchange and the carbon accumulation were less affected. The short-term and long term effects of nitrogen addition on methane emission were contradictory. During the three first years addition of nitrogen resulted in steadily decreasing emission rates while after 10-11 years the emission of methane had increased, most likely as a response to the increase in sedge cover. Initially the green house treatment caused an increase in methane emission while after 10-11 years the emission rate was reduced by ∼30% relative to the controls. The long-term effects on the methane emission rates were also supported by the responses in production and consumption of methane in laboratory incubations. The long term nitrogen additions increased the substrate availability for methane production which was also reflected by increased potential methane production. To the contrary the green house treatment decreased the methane production both without and with addition of an external carbon source. The major effect of long-term sulphur addition was a shift in the vertical distribution of the sulphur reducing bacteria, i.e. in the plots receiving extra sulphur the methane production rate was reduced at the depth just above the depth of maximal methane production. Both the ecosystem respiration and laboratory CO2 production increased in response to nitrogen addition while neither gross primary production nor net ecosystem exchange were affected. The zero treatment effect on NEE was also supported by the results from surface peat core carbon accumulation since the start of the experiment. Even if not significant the trend in the results rather indicated increased accumulation after 12 years of nitrogen addition. The observed effects on carbon accumulation, combined with data on the net ecosystem carbon balance (NECB) at the same mire, indicate that the rate of carbon accumulation after 12 years of nitrogen addition remains at least as high, as the estimated NECB of 23±5 (SD) g C m-2 year-1 at the untreated mire.

For details see:
Granberg, G., Sundh, I., Svensson, B.H. and M. Nilsson (2001) Methane emission from a boreal mire: temperature, nitrogen and sulfur deposition effects. Ecology, 82:1982-1998.
Gunnarsson, U., G. Granberg and M. Nilsson (2004) Growth and interspecies specific competition in Sphagnum after temperature, nitrogen and sulphur treatments on a boreal mire. New Phytologist, 163:349-359
Gauci V, Matthews E, Dise N, Walter B, Koch D, Granberg G, Vile M 2004 Sulfur pollution suppression of the

wetland methane source in the 20th and 21st centuries. Proceedings of the National Academy of Sciences of the United States of America (PNAS) 101:12583-12587
Wiederman, M., A. Nordin, U. Gunnarsson, MB Nilsson, L. Ericsson (2007) Global change shifts vegetation and plant–parasite interactions in a boreal mire. Ecology 88:454–464.
Wiedermann, M.M., Gunnarsson, U., Nilsson, M.B., Nordin, A. and L. Ericsson (2009) Can small-scale experiments predict ecosystem responses? An example from peatlands. Oikos, 118, 449-456.
Granath G, Wiedermann MM, Strengbom J 2009 Physiological responses to nitrogen and sulphur addition and raised temperature in Sphagnum balticum, OECOLOGIA 161:481- 490.
Eriksson, T., M. Öquist and M. B. Nilsson (2010) Production and oxidation of methane in a boreal mire after a decade of increased temperature and nitrogen and sulfur deposition Global Change Biology, 16, 2130–2144, doi: 10.1111/j.1365-2486.2009.02097.x
Eriksson, T., M. G. Öquist, and M. B. Nilsson (2010), Effects of decadal deposition of nitrogen and sulfur, and increased temperature, on methane emissions from a boreal peatland, Journal of Geophysical Research, 115, G04036, doi:10.1029/2010JG001285.