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Effects of tropospheric ozone on methane and carbon dioxide fluxes from peatland mesocosms

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Tropospheric ozone is currently the third most important greenhouse gas, and also the most important gaseous air pollutant globally in terms of effects on vegetation world-wide. At present levels it poses a significant threat to crop yield and forest productivity of sensitive species, while background ozone concentrations are expected to increase further during the next decades. The potential importance of ozone in reducing carbon assimilation, and consequently in increasing atmospheric carbon dioxide concentrations, has been recognised. However, regional modelling studies are based on the impact of ozone on photosynthetic rates and above-ground growth, and do not consider effects of ozone on belowground carbon fluxes. The limited experimental data on the long-term effects of ozone on belowground carbon processes, mainly from arable crop and forest systems, are a major constraint to understanding the impacts of ozone on global carbon fluxes. Very little attention has been paid to ozone effects on peatland carbon dynamics, though northern peatlands store a third of the global soil organic carbon pool and are an important source of atmospheric methane. The aims of this study were to assess the long-term effects of elevated ozone on carbon dioxide and methane fluxes in temperate peatland mesocosms and to identify underlying plant, soil and microbial processes.

Mesocosms from a wet heath (Isle of Skye, UK) with vegetation dominated by the peat moss Sphagnum papillosum and the sedge Schoenus nigricans have been exposed to ambient (control) and three elevated levels of ozone in open-top chambers from May 2008. Methane emission, carbon dioxide fluxes and relevant plant and soil variables were measured every 6 weeks (growing season) or 8 weeks (winter).

Methane emissions were significantly reduced by elevated ozone over the first 18 months of the experiment. Ecosystem respiration only showed a significant increase in response to ozone in the second growing season, while gross photosynthesis has been enhanced by elevated ozone up till now. The latter may partly be explained by higher net biomass Sphagnum production observed at elevated ozone. Leaf biomass and stomatal conductance of Schoenus nigricans were not affected by ozone. Additional soil and plant data will be presented that may help unravel the mechanisms underling the observed changes in greenhouse gas fluxes.

Hence, the results imply that increases in global background ozone concentrations that are predicted by models in the northern hemisphere over the 21st century may lead to a negative feedback on methane emissions from peatland ecosystems. This study will be continued with methane emission and high-frequency carbon dioxide flux measurements and more detailed process studies, including stable isotope tracer studies, providing key information for long-term predictions of ozone impacts on carbon dynamics in peatland ecosystems.