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Implications of Large Scale Analysis of Peat Chemical Properties Along a Climate and Nitrogen Deposition Gradient

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The effect of atmospheric nitrogen (N) deposition in peatlands is an important research topic in order to predict changes in global N and carbon (C) cycles due to climate change and N pollution. In particular peatlands in Europe have received high N inputs from anthropogenic emissions. To improve our understanding of N cycling and its relation to decomposition in peatlands, this study addresses patterns in peat chemical properties across Europe created by N deposition and climatic gradients. We sampled 32 peat cores in 16 countries spanning a latitudinal difference of 22 degrees (from Slovenia to northern Sweden) and a longitudinal difference of 38 degrees (from Ireland to eastern Finland).

C and N contents and Fourier-transformed infrared (FTIR) spectra were obtained at a resolution of 5 cm for each core, interpolated N deposition values for the past 30 years were obtained from the Integrated Deposition Model (IDEM) of the European Monitoring and Evaluation Programme (EMEP) and climate data from the WorldClim database.

A principal component analysis (PCA) was performed on the spectral data for each depth layer in order to reveal main gradients in peat chemistry. In addition, partial least squares regression (PLSR) was applied to relate N contents to the spectral data for two different N deposition levels revealed by cluster analysis and for two different depth intervals (0 to 10 cm and 10 to 20 cm). The PLSR enabled identifying FTIR active functional groups related to N content.

Of our dataset, climatic conditions were main drivers of differences in peat chemistry. N deposition levels were also related to spectroscopic characteristics but also correlated with mean annual temperature indicating that the effect of N deposition on peat chemistry may interfere with climatic effects. Higher relative contribution of polysaccharides in the uppermost 5 cm was related to lower temperatures and higher N depositions. In deeper peat layers, higher contribution of polysaccharides was related to lower N depositions and higher precipitation. Relative to polysaccharides, aromatics were related to intermediate temperatures and precipitation and for both depth layers positively related to N deposition. This pattern probably reflects the interplay of biomass production and decomposition and indicates that higher N deposition levels co-occur with higher decomposition rates. PLSR revealed similar patterns for the different N deposition levels and depth layers. The model coefficients indicate that polysaccharide-type structures were related to N content for all investigated sites in peat of a depth up to 10 cm; in deeper peat layers polysaccharide structures were only related to N content for peatlands belonging to the higher N deposition cluster. Contributions of phenolic moieties were negatively related to N content, but only at higher N depositions. The results are in accordance with our current understanding of reduced phenolic production, higher N availability and peat decomposition in peatlands under high N deposition levels. The study thus provides insight into impacts of elevated nitrogen deposition on the N and C cycles in peatlands.