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Continuous analysis of stable carbon isotopes in CO_2 and CH_4 fluxes with an automatic chamber flux system at Mer Bleue bog

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Northern peatlands are one of the largest natural sources for methane (CH_4) to the atmosphere and thus patterns and controls of CH_4 fluxes from these systems are intensively studied. To understand the atmospheric CH_4 budget, different isotopic signatures are typically assigned to specific sources. However, isotopic signatures of CH_4 from wetlands may not be stable and instead vary with methanogenic and emission pathways which influence sources of carbon and fractionation. The aim of this study was to assess the temporal and spatial variability in the isotopic composition of CH_4 and carbon dioxide (CO_2) emitted throughout the growing season at Mer Bleue, a temperate ombrotrophic bog in Canada. To this end, laser based stable isotope analyzers for ^{13}C in CO_2 and CH_4 were attached to an automated flux chamber system operated at the site. Using 12 different transparent chambers, we measured differences in isotopic composition of CO_2 and CH_4 and compared the observed patterns to vegetation characteristics and air and soil temperatures. We specifically compared sedge dominated chambers (affected by aerenchyma gas transport), shrub (mostly Chamaedaphne calyculata), and Sphagnum moss dominated chambers.

The CH_4 fluxes in the sedge dominated chambers were much higher than the other vegetation types, as expected, but also had a different isotopic composition, presumably due to the different gas transport mechanisms. In the presence of aerenchyma, the methanotrophic layer is effectively bypassed and aerobic CH_4 oxidation is significantly reduced. This lead to lower δ13C values (in the range of 5-10 ‰ in CH_4 emitted on sedge dominated plots, compared to less negative δ13C values observed at plots dominated by shrubs or Sphagnum. As the chamber system uses transparent chambers, δ13C values in CO_2 were predominantly driven by photosynthetic activity, heterotrophic and autotrophic respiration. Data analysis is still ongoing to attempt to identify the effects of CH_4 oxidation δ13C values in CO_2. Overall our study demonstrates the value of online, laser-based stable isotope analysis in CH_4 and CO_2, although the accuracy and calibration of such instruments at low atmospheric concentrations remains challenging.