



Isotopic partitioning of net ecosystem CO₂ exchange reveals the importance of methane oxidation in a boreal peatland

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Partitioning net ecosystem CO₂ exchange (NEE) into its different flux components is crucial as it provides a mechanistic framework to better assess how the terrestrial carbon cycle may respond to projected environmental change. This is especially important for northern boreal peatlands, which store approximately one-quarter of the world's soil carbon and yet at the same time are projected to experience some of the greatest environmental changes in the future. Using an experimental setup with automated chambers for measuring NEE (transparent chambers), ecosystem respiration (Reco; opaque chambers) and heterotrophic respiration (Rh; opaque chambers on vegetation-free trenched plots) in combination with continuous measurements of $\delta^{13}\text{C}$ using near-infrared, diode-laser-based cavity-ring down spectroscopy (Picarro G1101-i analyzer), we partitioned NEE of CO₂ into gross primary productivity (GPP), ecosystem respiration (Reco), heterotrophic respiration (Rh) and autotrophic respiration (Ra) using two different approaches (i.e. chamber- and isotope-based methods) in a boreal peatland in northern Sweden (Degerö). Given that $\delta^{13}\text{C}$ was continuously measured in each chamber, we were also able to further partition Rh into soil organic matter (SOM) mineralization by saprotrophic microbes and the oxidation of methane (CH₄) by methanotrophic bacteria. During the ten day measurement period (in late July 2014), the average daily NEE flux at the mire was $-0.6 \text{ g C m}^{-2} \text{ d}^{-1}$. Overall, the two partitioning approaches yielded similar estimates for the different NEE component fluxes. Average daily fluxes of Rh and Ra were similar in magnitude, yet these two flux components showed contrasting diurnal responses: Ra was greatest during the day whereas there was little diurnal variation in Rh. In general, average ^{13}C signature of CO₂ efflux from the Rh chambers ($-41.1 \pm 0.6 \text{ ‰}$) was between the ^{13}C signature of SOM ($-25.8 \pm 0.6 \text{ ‰}$) and CH₄ in pore water ($-69.0 \pm 0.8 \text{ ‰}$). Assuming that the ^{13}C signature derives from a combination of SOM and pore water CH₄ and applying a two-source mixing model, we found that roughly one-third of Rh was the result of methane oxidation whereas the remaining two-thirds came from the mineralization of SOM. Given that Rh represented ca. 50% of total Reco during the measurement period, we provide some of the first in situ measurements that highlight the important role methanotrophic bacteria may play in CO₂ fluxes in a northern boreal peatland.