Methane production and oxidation patterns along a hydrological gradient in Luther Bog, Ontario

Leandra Praetzel[1], Sina Berger[1], Beatrice Biro[1], Christian Blodau[1]

EGU General Assembly 2016, Vienna
Poster-No.: EGU2016-9130

Introduction

Methane emissions from natural peatlands contribute significantly to the global budget of atmospheric CH_4 (Mikaloff Fletcher et al. 2004). In the northern hemisphere, where climate models predict rising temperatures and precipitation rates, these emissions are likely to rise (IPCC 2013). So far, little is known about the change of processes of methane production and oxidation, which influence the total amount of methane emissions, in peatland soils under warmer and wetter climate conditions. This study focuses on anaerobic CH_4 production and aerobic CH_4 oxidation processes along a hydrological gradient in an ombotrophic bog in Ontario, Canada. We aim to quantify the amount of (a) anaerobic CH_4 and CO_2 production, (b) aerobic CH_4 oxidation and (c) their contribution to the total ecosystem respiration flux.

Study area and Methods

Luther Bog is located in the Luther Marsh Conservation Area in Southern Ontario (43.9° N, 80.4° W). We established four sites along a hydrological gradient differing in water table levels and dynamics and vegetation patterns, whereas water table fluctuations increase from site 1 to site 4 due to a reservoir at the northern end of the bog. From May to September 2015, we examined depth profiles of CO_2 and CH_4 concentrations and delta ^{13}C isotope ratios in the peat using silicon samplers, dialysis chambers and multi-level piezometers. In addition to that, we determined carbon fluxes with chamber flux measurements using a Los Gatos Ultraportable Greenhouse Gas Analyzer.

Fig. 1: View of Site 1 in May

Results and Discussion

Both CH_4 and CO_2 fluxes are overall higher at sites 3 and 4 than at the reference sites 1 and 2. CO_2 fluxes are increasing over the summer except from site 2, where they are decreasing (see Fig. 2). DIC concentration in the peat is rising over time whereas CH_4 concentrations are more stable. Altogether, DIC concentrations are lowest at site 4 and CH_4 concentrations are highest at site 4 (see Fig. 4). δ ^{13}C signatures of CH_4 increase with time at all sites, δ ^{13}C values for CO_2 do not show such patterns (see Fig. 3).

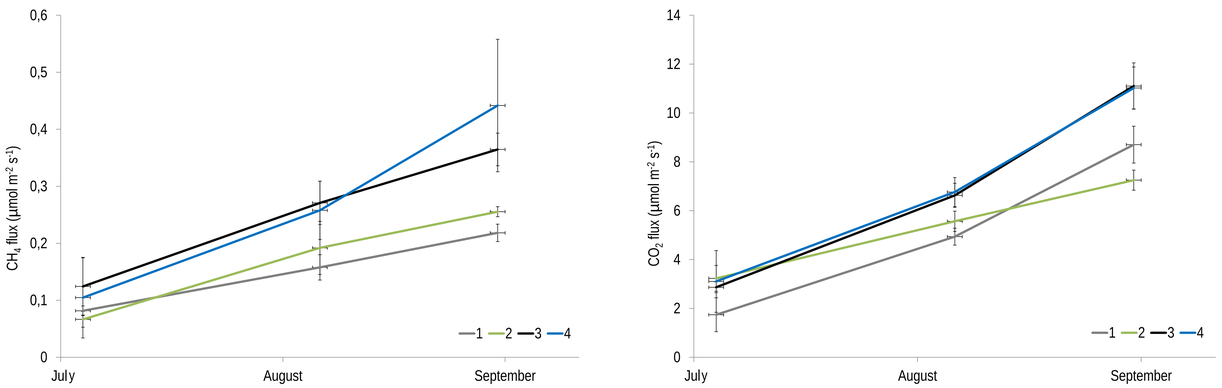

Fig. 2: Cumulated CH_4 and CO_2 fluxes at sites 1-4 from July to September.

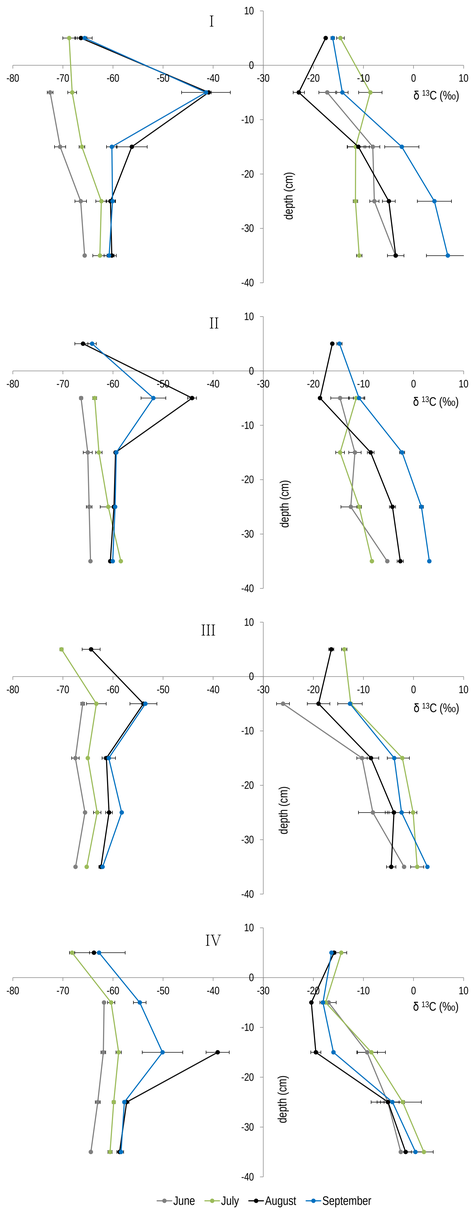

Fig. 3: δ ^{13}C signatures of CH_4 (left) and CO_2 (right) in the peat and from chamber measurements at sites 1-4.

Both DIC and CH_4 concentrations in the upper soil level are reflecting water table dynamics. In case of low water tables, the emerging aerobic conditions lead to CH_4 oxidation in the upper soil, which is also reflected in the δ $^{13}CH_4$ values (see Fig. 3). Moreover, at all sites, the CH_4 production pathway changes with depth from aceticlastic to hydrogenotrophic methanogenesis (cf. Whiticar et al. 1986). This shift arises because with increasing depth, the organic matter becomes more hardly decomposable (Miyajima et al. 1997).

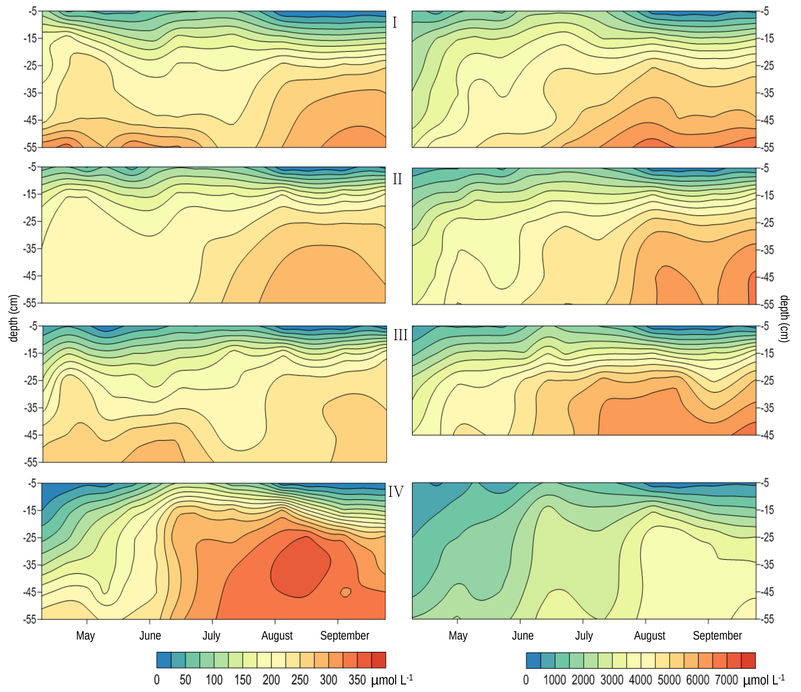

Fig. 4: Concentration profiles of CH_4 (left) and DIC (right) in the peat at sites 1-4.

Conclusion and Outlook

Water table dynamics seem to have an impact on methane and DIC dynamics and differ in-between the four sites. To quantify turnover rates, next steps to accomplish are calculating isotope mass balances as suggested in Landsdown et al. (1992) and estimating gas transport in the soil by Fickian diffusion.

[1] Institute of Landscape Ecology, University of Münster
Ecohydrology and Biogeochemistry Research Group
E-Mail: leandra.praetzel@uni-muenster.de

IPCC, 2013: Climate Change 2013: The Physical Science Basis
Lansdown, J. M., Quay, P. D., King, S. L., 1992: CH4 production via CO2 reduction in a temperate bog: A source of 13C-depleted CH4
Mikaloff Fletcher, S.E., Tans, P.P., Bruhwiler, L.M., Miller, J.B., Heimann, M., 2004: CH4 sources estimated from atmospheric observations of CH4 and its C-13/C-12 isotopic ratios: 1. Inverse modeling of source processes.
Miyajima, T., Wada, E., Hanba, Y.T., Vijarnsorn, P., 1997: Anaerobic mineralization of indigenous organic matters and methanogenesis in tropical wetland soils
Whiticar, M.J., Faber, E., Schoell, M., 1986: Biogenic methane formation in marine and freshwater environments: CO2 reduction vs. Acetate fermentation - isotope evidence