Geophysical Research Abstracts
Vol. 20, EGU2018-14507, 2018
EGU General Assembly 2018

Ecosystem-scale methane exchange above a boreal forest observed by true eddy accumulation (TEA)

Lukas Siebicke, Anas Emad, and Daphne Paulmann

University of Göttingen, Bioclimatology, Faculty of Forest Sciences and Forest Ecology, Göttingen, Germany (lukas.siebicke@uni-goettingen.de)

Methane, CH_4, is the third most important greenhouse gas after water vapour and CO_2. Rising atmospheric methane concentrations contribute increasingly to climate change. While principal natural and anthropogenic methane sources and sinks are known, their magnitude remains uncertain. There is a significant gap between bottom-up methane flux estimates and top-down inverse modelling, leaving a "missing methane source" unexplained. Recent experimental evidence suggests that forests might account for a formerly underestimated source of methane, which might close the gap between measurements and models. This gap can only be closed through interdisciplinary process studies of the biological/physiological methane production/consumption of forests and the turbulent atmospheric exchange. The net ecosystem exchange of methane above the forest canopy integrates production, consumption, and diffusive (soils), conductive (trees) and turbulent (atmosphere) transport processes. We hypothesize that there is partial recycling of suspected methane emissions from trees to the upper soil horizons, fed by in-canopy turbulence, the magnitude of which is modulated by micrometeorological conditions and the coupling of the canopy with the atmosphere.

Previous studies showed that net methane fluxes above forests were often close to the detection limit of conventional micrometeorological methods and instruments. Improved methods are required.

The objectives of the study were to (1) Investigate true eddy accumulation (TEA) as a means for high precision flux measurements of trace gases with small deposition velocities such as methane, which are otherwise difficult to measure, (2) Assess method specific differences in fluxes of CH_4, CO_2 and H_2O observed by true eddy accumulation and side-by-side eddy covariance, (3) Assess drivers and quantify magnitudes of ecosystem-scale methane fluxes by micrometeorological methods (true eddy accumulation, eddy covariance), (4) Compare methane fluxes from micrometeorological methods to estimates from upscaling enclosure flux measurements from the soil, stems and shoots. The current presentation will focus on objectives (1) and (2).

The true eddy accumulation instrument sampled air conditionally into updraft and downdraft reservoirs as a function of the sign of vertical wind velocity with the flow rate being proportional to the magnitude of the vertical wind velocity. Our true eddy accumulation approach is based on a principle proposed by Desjardins in 1972 and features a modern implementation of air sampling, laser spectrometry, and a series of TEA specific processing steps and flux corrections.

The intercomparison of the TEA and EC methods showed a high correlation of the two methods for CO_2 fluxes. Assuming the air sampling is not gas specific, this finding suggests that the TEA instrument can equally sample CH_4 fluxes accurately.

30-min CH_4 fluxes from TEA typically ranged from -0.01 $\mu\mathrm{mol\,m^{-2}\,s^{-1}}$ to +0.01 $\mu\mathrm{mol\,m^{-2}\,s^{-1}}$. Fluxes were highly variable and changed sign during the course of the day. The majority of the 30-min flux values were negative, indicating the forest acted as a methane sink. However, also positive values were observed.