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Methane fluxes above the Hainich forest by True Eddy Accumulation and Eddy Covariance

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Understanding the role of forests for the global methane cycle requires quantifying vegetation-atmosphere exchange of methane, however observations of turbulent methane fluxes remain scarce.

Here we measured turbulent fluxes of methane (CH_4) above a beech-dominated old-growth forest in the Hainich National Park, Germany, and validated three different measurement approaches: True Eddy Accumulation (TEA, closed-path laser spectroscopy), and eddy covariance (EC, open-path and closed-path laser spectroscopy, respectively). The Hainich flux tower is a long-term Fluxnet and ICOS site with turbulent fluxes and ecosystem observations spanning more than 15 years. The current study is likely the first application of True Eddy Accumulation (TEA) for the measurement of turbulent exchange of methane and one of the very few studies comparing open-path and closed-path eddy covariance (EC) setups side-by-side.

We observed uptake of methane by the forest during the day (a methane sink with a maximum rate of 0.03 μmol m^{-2} s^{-1} at noon) and no or small fluxes of methane from the forest to the atmosphere at night (a methane source of typically less than 0.01 μmol m^{-2} s^{-1}) based on continuous True Eddy Accumulation measurements in September 2015.

First results comparing TEA to EC CO_2 fluxes suggest that True Eddy Accumulation is a valid option for turbulent flux quantifications using slow response gas analysers (here CRDS laser spectroscopy, other potential techniques include mass spectroscopy). The TEA system was one order of magnitude more energy efficient compared to closed-path eddy covariance. The open-path eddy covariance setup required the least amount of user interaction but is often constrained by low signal-to-noise ratios obtained when measuring methane fluxes over forests. Closed-path eddy covariance showed good signal-to-noise ratios in the lab, however in the field it required significant amounts of user intervention in addition to a high power consumption.

We conclude, based on preliminary evidence, that the Hainich forest acted as a moderate net sink for methane during the investigation. This supports earlier findings from chamber measurements at the Hainich forest site and is similar to findings from other forest sites.

Our observations will be continued through 2016 and beyond to provide longer-term methane flux time series spanning entire seasons. However, the current data set already provides a basis for further consolidating methods of measurements and analysis of turbulent methane fluxes using eddy covariance and true eddy accumulation.