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A compact and stable eddy covariance set-up for methane measurements using off-axis integrated cavity output spectroscopy

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Abstract. A Fast Methane Analyzer (FMA) is assessed for its applicability in a closed path eddy covariance field set-up in a peat meadow. The FMA uses off-axis integrated cavity output spectroscopy combined with a highly specific narrow band laser for the detection of CH_4 and strongly reflective mirrors to obtain a laser path length of $2–20\times10^3$ m. Statistical testing and a calibration experiment showed high precision (7.8×10^{-3} ppb) and accuracy (<0.30%) of the instrument, while no drift was observed. The instrument response time was determined to be 0.10 s. In the field set-up, the FMA is attached to a scroll pump and combined with a 3-axis ultrasonic anemometer and an open path infrared gas analyzer for measurements of carbon dioxide and water vapour. The power-spectra and co-spectra of the instruments were satisfactory for 10 Hz sampling rates.

Due to erroneous measurements, spikes and periods of low turbulence the data series consisted for 26% of gaps. Observed CH_4 fluxes consisted mainly of emission, showed a diurnal cycle, but were rather variable over. The average CH_4 emission was 29.7 nmol m^{-2} s^{-1}, while the typical maximum CH_4 emission was approximately 80.0 nmol m^{-2} s^{-1} and the typical minimum flux was approximately 0.0 nmol m^{-2} s^{-1}. The correspondence of the measurements with flux chamber measurements in the footprint was good and the observed CH_4 emission rates were comparable with eddy covariance CH_4 measurements in other peat areas.

Additionally, three measurement techniques with lower sampling frequencies were simulated, which might give the possibility to measure CH_4 fluxes without an external pump and save energy. Disjunct eddy covariance appeared to be the most reliable substitute for 10 Hz eddy covariance, while relaxed eddy accumulation gave reliable estimates of the fluxes over periods in the order of days or weeks.

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