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Methane and CO_2 fluxes of moving point sources – Beyond or within the limits of eddy covariance measurements

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The eddy covariance (EC) technique has been extensively used for CO_2 and energy exchange measurements over different ecosystems. For some years, it has been also becoming widely used to investigate CH_4 and N_2O exchange over ecosystems including grazing systems. EC measurements represent a spatially integrated flux over an upwind area (footprint). Whereas for extended homogenous areas EC measurements work well, the animals in a grazing system are a challenge as they represent moving point sources that create inhomogeneous conditions in space and time. The main issues which have to be taken into account when applying EC flux measurements over a grazed system are: i) In the presence of animals the high time resolution concentration measurements show large spikes in the signal. These spikes may be filtered/reduced by standard quality control software in order to avoid wrong measurements. ii) Data on the position of the animals relative to the flux footprint is needed to quantify the contribution of the grazing animals to the measured flux.

For one grazing season we investigated the ability of EC flux measurements to reliably quantify the contribution of the grazing animals to the CH_4 and CO_2 exchange over pasture systems. For this purpose, a field experiment with a herd of twenty dairy cows in a full-day rotational grazing system was carried out on the Swiss central plateau. Net CH_4 and CO_2 exchange of the pasture system was measured continuously by the eddy covariance technique (Sonic Anemometer HS-50, Gill Instruments Ltd; FGGA, Los Gatos Research Inc.). To quantify the contribution of the animals to the net flux, the position of the individual cows was recorded using GPS (5 s time resolution) on each animal.

An existing footprint calculation tool (ART footprint tool) was adapted and CH_4 emissions of the cows were calculated. CH_4 emissions from cows could be used as a tracer to investigate the quality of the evaluation of the EC data, since the background exchange of CH_4 was very small. Daily mean CH_4 emissions compared well to emission values calculated based on animal weights and milk yields. Based on a corresponding quality analysis we investigated to which extent the presence of cows can be detected or missed in the CO_2 exchange measurements. For CO_2 a partitioning of the net flux was performed to separate the animal respiration flux from contributions of vegetation and soil (assimilation and respiration). The resulting animal related CO_2 emissions showed a considerable scatter but scaled with the animal density in the EC footprint.