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How to determine the GHG budget of a pasture field with grazing animals

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Up to now the scientific investigation and description of the agriculture related greenhouse gas (GHG) exchange has been largely separated into (i) direct animal related and (ii) ecosystem area related processes and measurement methods. An overlap of the two usually separated topics occurs for grazed pastures, where direct animal and pasture area emissions are relevant. In the present study eddy covariance (EC) flux measurements on the field scale were combined with a source location attribution (footprint) model and with GPS position measurements of the individual animals. The experiment was performed on a pasture field in Switzerland under a rotational full grazing regime with dairy cows. The exchange fluxes of CH4, CO_2, and N2O were measured simultaneously over the entire year. The observed CH4 emission fluxes correlated well with the presence of cows in the flux footprint. When converted to average emission per cow, the results agreed with published values from respiration chamber experiments with similar cows. For CO_2 a sophisticated partitioning algorithm was applied to separate the pasture and animal contributions, because both were in the same order of magnitude. The N2O exchange fully attributable to the pasture soil showed considerable and continuous emissions through the entire seasonal course mainly modulated by soil moisture and temperature. The resulting GHG budget shows that the largest GHG effect of the pasture system was due to enteric CH4 emissions followed by soil N2O emissions, but that the carbon storage change was affected by a much larger uncertainty.
The results demonstrate that the EC technique in combination with animal position information allows to consistently quantify the exchange of all three GHG on the pasture and to adequately distinguish between direct animal and diffuse area sources (and sinks). Yet questions concerning a standardized attribution of animal related emissions to the pasture GHG budget still need to be resolved.