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Non-homogeneous N2O emissions of a grazing system – Comparison of chamber and eddy covariance measurements using a Lagrangian footprint model

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Pastures with cattle grazing are considerable sources of the greenhouse gas nitrous oxide (N2O). However, animal excreta lead to local emission hot-spots resulting in a non-homogeneous source distribution. The strong spatial and temporal variability of the gaseous emissions represents an inherent problem for the quantification of gaseous emissions from pastures with chamber techniques [1]. For this reason, the eddy covariance (EC) method integrating emissions over a larger domain seems better suited to quantify the total N2O emissions of grazed fields. In contrast, chamber methods can be advantageous to study the underlying processes and to measure the spatial and temporal variability of individual emission sources (urine and dung patches). We present results of a pasture experiment with dairy cows in Switzerland where N2O fluxes were measured during an entire grazing season. Field-scale emissions were obtained with the EC technique using fast response Quantum cascade lasers (QCL) for N2O detection. Small scale emissions of N2O from dung and urine patches as well as from “background” surface areas were quantified using an optimized ’fast box’ chamber technique [2]. In combination with a fast response QCL analyser, it allowed to measure a flux value within 60-90 s. We carried out these measurements at selected intensive observation areas within the pasture on naturally and artificially applied urine and dung patches. High temporal and spatial dynamics of the N2O emissions were observed and related to driving parameters (type and age of excreta, soil moisture and temperature).
A Lagrangian flux footprint model [3] was applied to estimate the contribution of different sub-plots of the rotational grazing field to the half-hourly EC fluxes. Accordingly, the small-scale chamber fluxes were up-scaled to match the footprint area of the EC fluxes in order to allow a meaningful comparison. The results showed a good agreement between the two methods during grazing periods. They also highlight the advantages of a combined chamber-EC approach to understand the contribution of different small-scale sources and their dynamics to pasture N2O emissions.

[1] Flechard C.R., and many others, 2007. Effects of climate and management intensity on nitrous oxide emissions in grassland systems across Europe. Agric. Ecosys. Environ., 121, 135-152.
[2] Hensen A., Groot T.T., van der Bulk W.C.M., Vermeulen A.T., Olesen J., Schelde E.K., 2006. Dairy farm CH4 and N2O emissions, from one square metre to the full farm scale. Agric. Ecosys. Environ., 112, 146–152.
[3] Häni, C., 2017. bLSmodelR - An atmospheric dispersion model in R. R package version 2.4.1. URL: www.agrammon.ch/documents-to-download/blsmodelr/ (last access 9 Jan 2017).