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Greenhouse gas budget (CO_2, CH4 and N2O) of intensively managed grassland following restoration

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The first full greenhouse gas (GHG) flux budget of an intensively managed grassland in Switzerland (Chamau) is presented. The three major trace gases, carbon dioxide (CO_2), methane (CH4) and nitrous oxide (N2O) were measured with the eddy covariance (EC) technique. For CO_2 concentrations, an open-path infrared gas analyzer was used, while N2O and CH4 concentrations were measured with a recently developed continuous-wave quantum cascade laser absorption spectrometer (QCLAS). We investigated the magnitude of these trace gas emissions after grassland restoration, including ploughing, harrowing, sowing and fertilization with inorganic and organic fertilizers in 2012.

Large peaks of N2O fluxes (20 – 50 nmol m-2 s-1 compared to a < 5 nmol m-2 s-1 background) were observed during thawing of the soil after the winter period and after mineral fertilizer application followed by re-sowing in the beginning of the summer season. N2O fluxes were controlled by nitrogen input, plant productivity, soil water content and temperature. Management activities led to increased variations of N2O fluxes up to 14 days after the management event as compared to background fluxes measured during periods without management (< 5nmol m-2 s-1). Fluxes of CO_2 remained small until full plant development in early summer 2012. In contrast methane emissions showed only minor variations over time. The annual GHG flux budget was dominated by N2O (48 % contribution) and CO_2 emissions (44 %). CH4 flux contribution to the annual budget was only minor (8 %).

We conclude that recently developed multi-species QCLAS in an EC system open new opportunities to determine the temporal variation of N2O and CH4 fluxes, which further allow to quantify annual emissions. With respect to grassland restoration, our study emphasizes the key role of N2O and CO_2 losses after ploughing, changing a permanent grassland from a carbon sink to a significant carbon source.