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Diurnal cycles of carbon dioxide, methane and nitrous oxide fluxes from three Swiss grasslands

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The terrestrial sink for atmospheric CO_2 and the resulting alteration of its atmospheric concentration is almost compensated by CH_4 and N_2O emissions from managed terrestrial ecosystems, e.g. agriculture. Despite their relatively small atmospheric concentration both greenhouse gases (GHG) account for roughly 26 % of the global warming effect due to their high global warming potential (GWP). It remains unclear whether GHG emissions from the combined "swiss mountain agriculture" prevail GHG uptake rates and therefore lead to an increased atmospheric concentration. Thus it is essential to increase our understanding of biotic and abiotic variables and management effects on the spatial as well as temporal variability of CH_4 and N_2O fluxes, besides CO_2.

The present study aims at detecting diurnal cycles of the three major GHG fluxes (CO_2, CH_4, N_2O), potential drivers and driver combinations. Knowledge on the interaction between drivers and flux variability is important for the extrapolation of soil chamber measurements from point samples to integrated seasonal or annual budgets.

In September 2010 we measured chamber based GHG fluxes for consecutive 48 h at three Swiss grassland sites simultaneously. The combined "swiss mountain agriculture" is represented by three sites being located along an altitudinal and management gradient, ranging from an intensively managed site (Chamau, 400 m a.s.l.), to an intermediately managed site (Fruebuel, 1000 m a.s.l.) and an extensively managed site (Crap Alv, 2000 m a.s.l.). Each site is equipped with an eddy covariance (EC) setup, measuring the net ecosystem exchange of CO_2. In addition 16 static soil chambers are implemented within the footprint of the EC tower, which are used to quantify CO_2 as well as the net CH_4 and N_2O fluxes. Gas samples were analyzed by gas chromatography.

Methane uptake was measured most of the time at Fruebuel and Crap Alv. Mean ecosystem uptake rates ranged between -0.49 to -0.12 nmol $m^{-2}s^{-1}$. Still, some chambers acted as CH_4 sources ($<$0.25 nmol $m^{-2}s^{-1}$). In contrast mean ecosystem N_2O fluxes ranged from 0 to 0.4 nmol $m^{-2}s^{-1}$ and were therefore characterized as N_2O source. We found pronounced diurnal cycles for all GHG fluxes, showing a significant correlation with soil temperature for CO_2 (3.65 – 8.65 μmol m^{-2} s^{-1}) and N_2O. Our results can further be used for model parametrization when scaling fluxes from point measurements to the ecosystem or even the regional scale.