B53C-0678

Interannual and seasonal variability of CH_4 and N_2O exchange over a temperate mountain grassland

Lukas Hörtnagl
Georg Wohlfahrt

Institute of Ecology
University of Innsbruck, Austria
www.biomet.co.at

about

The quantification and understanding of the greenhouse gas (GHG) exchange between terrestrial ecosystems and the atmosphere is crucial when trying to assess the effect of anthropogenic and biogenic controls on a future climate. Using the eddy covariance method, fluxes of CO_2 have been measured over a wide array of ecosystems, while measurements of the other two major GHG, methane (CH_4) and nitrous oxide (N_2O), were only conducted by few groups due to expensive scalar sensors and their time-consuming maintenance. These first measurements mainly focused on ecosystems that were believed to represent significant sources for CH_4 (e.g. wetlands) or N_2O (e.g. heavily fertilized crops).

With CH_4 and N_2O measurement devices now being widely available, more measurements are made over sites that are characterized by relatively small and often close-to-zero fluxes, and despite recent advances in sensor sensitivity and stability, the quantification of these two GHG remains challenging.

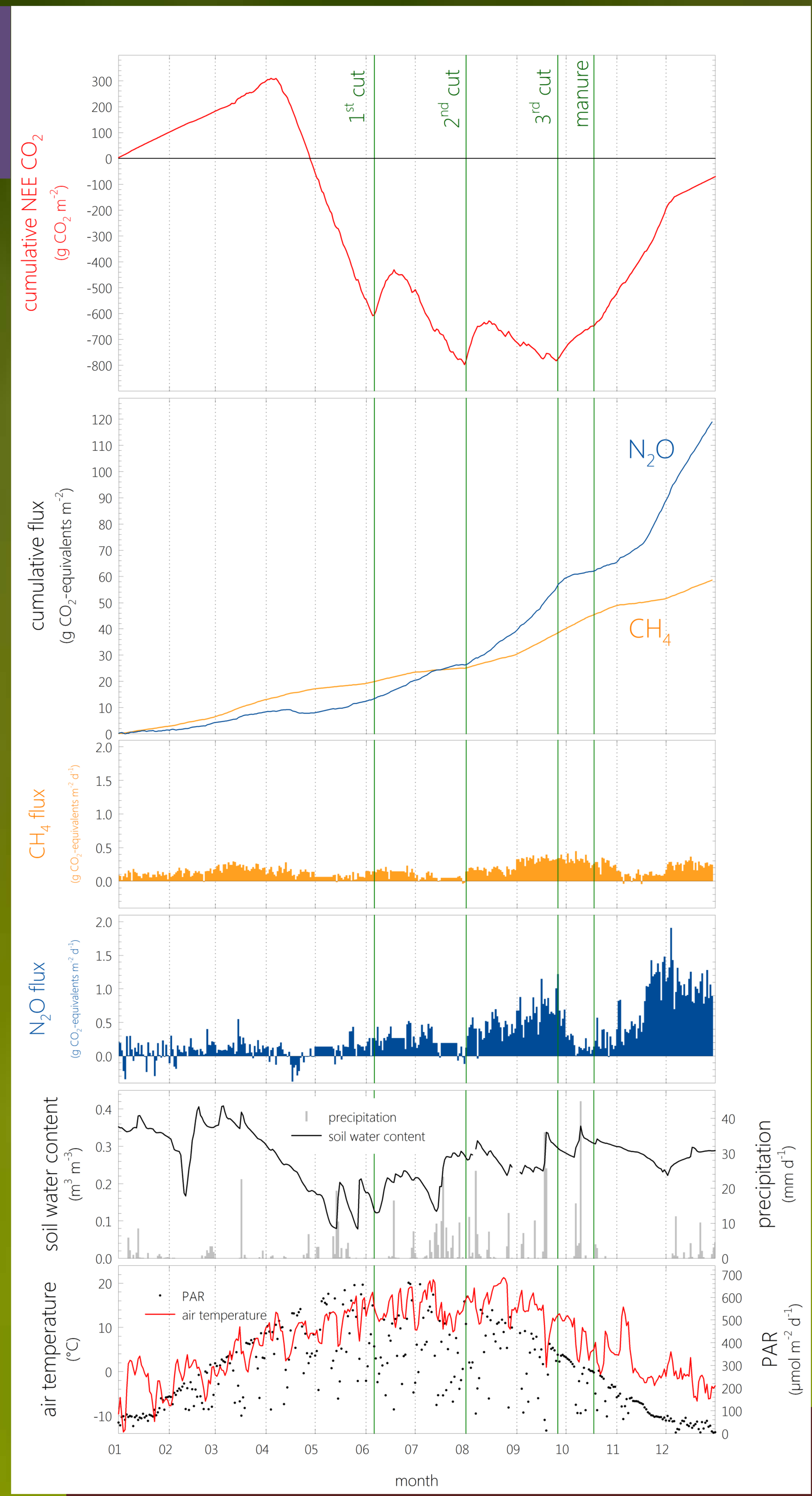
methods

Here we report on the CO_2, CH_4 and N_2O exchange measured in 2011 at a temperate mountain grassland managed as a hay meadow near the village Neustift in the Stubai Valley, Austria, by means of the eddy covariance method. The three wind components, the speed of sound and the CO_2 mole densities were acquired at a time resolution of 20 Hz and used to calculate true eddy covariance CO_2 fluxes.

CH_4 and N_2O mixing ratios were recorded at 2 Hz by a quantum cascade laser absorption spectrometer (QCL-AS), resulting in a disjunct time series when compared to the 20 Hz wind data. Fluxes of both compounds were then calculated using the virtual disjunct eddy covariance method (vDEC). Mixing ratios of CH_4 and N_2O were then corrected for the cross-talk effect of water as described in earlier studies.

Due to difficulties regarding the calculation of 2010 fluxes only results from 2011 are shown.

Figure 1



cumulative fluxes 2011 | Figure 1

Cumulative fluxes of CO_2 resulted in a net uptake of -70.4 g CO_2 m^{-2}.

Net uptake of CH_4 was observed on only 9 days in 2011 with average uptake rates of -0.02 g CO_2-equivalents m^{-2} d^{-1}. Peak emission rates of up to 0.45 g CO_2-equivalents m^{-2} d^{-1} were found in October, about 10 days after the 3rd cutting of the meadow. Cumulative fluxes showed a net emission of CH_4 in 2011 with 58.6 g CO_2-equivalents m^{-2}.

Deposition for N_2O was recorded on 38 days with fluxes of up to -0.38 g CO_2-equivalents m^{-2} d^{-1} during a period of 7 consecutive days with nitrogen uptake in April. Emission rates of more than 1.30 g CO_2-equivalents m^{-2} d^{-1} were found around the end of November. In total, the meadow was a source of N_2O and emitted 118.9 g CO_2-equivalents m^{-2} in 2011.

The calculation of CH_4 and N_2O exchange rates at the study site in Neustift remains challenging due to erratic nighttime fluxes, numbers given here should be treated with caution.

CO_2	-70	GHG-Total +107
CH_4	+59	
N_2O	+119	

numbers are given in g CO_2-equivalent m^{-2} yr^{-1}

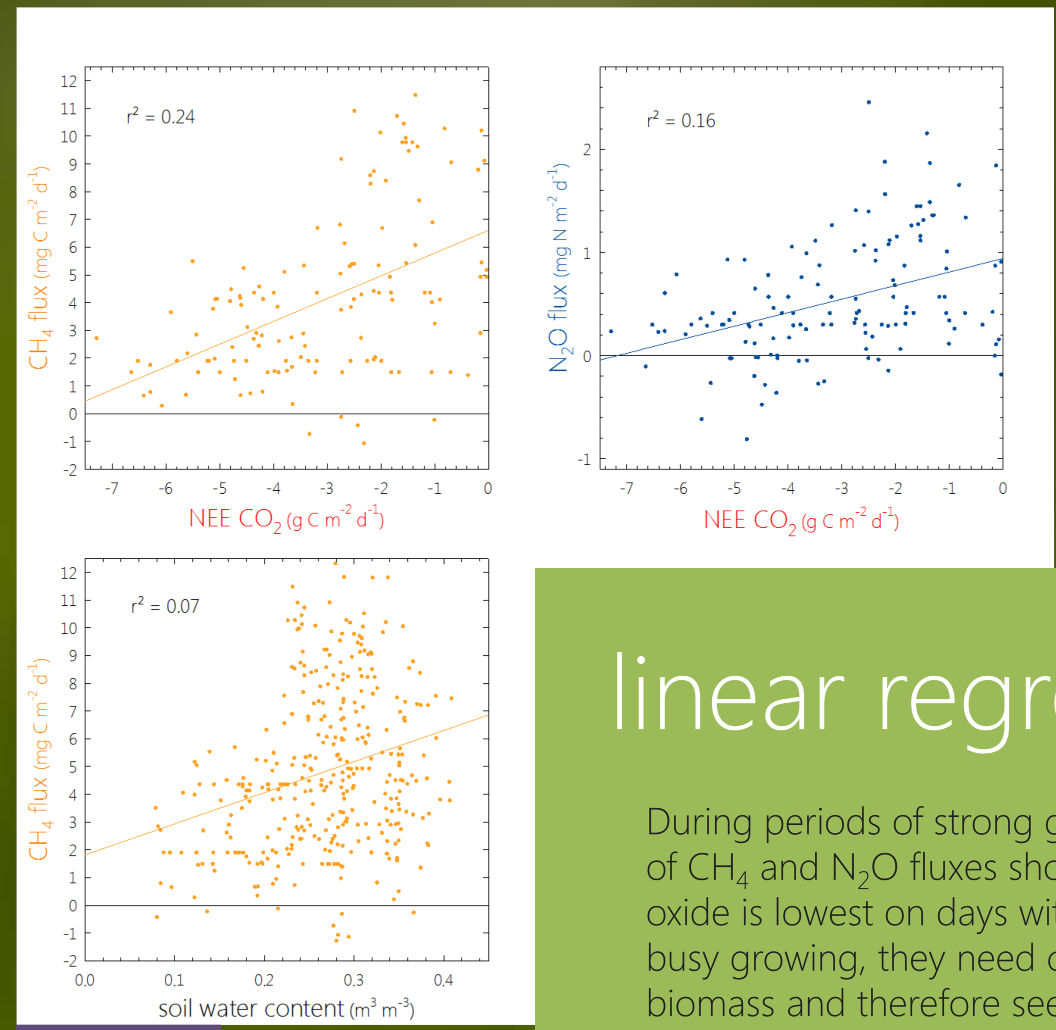


Figure 2

linear regression | Figure 2

During periods of strong growth the uptake of CO_2 is highest. First results of CH_4 and N_2O fluxes showed that the emission of methane and nitrous oxide is lowest on days with high CO_2 uptake rates. While the plants are busy growing, they need carbon and nutrients for the accumulation of biomass and therefore seem to minimize CH_4 and N_2O emissions.

CH_4 emissions are often associated with wetlands. At our study site we often found low methane emissions during relatively dry periods (soil water content SWC = low) and higher emissions with increasing SWC.

diurnal cycles

Figure 3

Figure 3 shows diurnal cycles of methane and nitrous oxide from April to October 2011. Nighttime fluxes of both compounds were often erratic, mainly because of calm and stable nighttime conditions and resulting unsteady mixing ratios, especially for CH_4.

The combination of environmental conditions, sometimes erratic concentration values, disjunct timeseries and low fluxes can pose difficulties when trying to determine the proper lag time during certain time periods and can result in flux spikes, like pictured in Figure 3.

Figure 3

However, clear diurnal cycles could be seen during certain timeframes on a half-hourly timescale for both compounds, on a daily scale especially N_2O showed distinct periods of uptake (April: up to -0.7 nmol m^{-2} s^{-1}) and emission (August: up to 0.8 nmol m^{-2} s^{-1}).

Diurnal cycles of CH_4 were less pronounced and more error-prone due to spikes in methane mixing ratios and fluxes, but nevertheless showed a tendency of methane release during the day, around noon up to 7.8 nmol m^{-2} s^{-1} in August and 10.1 nmol m^{-2} s^{-1} in September.

Study site near Neustift, Austria

universität innsbruck
BIOMETinnsbruck
FWF Der Wissenschaftsfonds.
AGU FALL MEETING San Francisco | 3-7 December 2012