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

first results

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about

For many years, the quantification of the greenhouse gas (GHG) exchange between terrestrial ecosystems and the atmosphere using the eddy covariance method was limited to carbon dioxide. Only few specialised groups had scalar sensor for methane and nitrous oxide, the two other major GHG, at their disposal and these instruments were expensive and required a fair amount of maintenance to run even over relatively short time periods.

Eddy covariance flux measurements with these sensors were often made over sites that were believed to represent significant sources for methane, such as wetlands, or nitrous oxide, such as heavily fertilized crops in order to obtain reliable flux estimates. During the past few years, fast-response scalar sensors for, in particular, methane and nitrous oxide have matured considerably and several manufacturers now compete for customers.

Increasingly, methane and nitrous oxide flux measurements with these instruments are made over sites that are characterized by relatively small fluxes as compared to the hot spots preferably investigated in the past. With small, often close-to-zero fluxes, making methane and nitrous oxide flux measurements may be quite challenging despite recent advances in sensor sensitivity and stability. Here we report on such a study that was conducted over a temperate mountain grassland in Austria. The site is managed as a hay meadow and is cut three times per year, organic fertiliser is applied in autumn. The objectives of this study are to derive a full GHG balance by complementing carbon dioxide flux measurements ongoing at this site since 2001 with methane and nitrous oxide flux measurements.

methods

Fluxes of CH_4 and N_2O were calculated by means of the eddy covariance method.

CH_4 and N_2O flux were measured above a managed, temperate mountain grassland in Stubai Valley (Tyrol, Austria) in 5 months in 2011. Half-hourly flux values were calculated by means of the eddy covariance method using 3-dimensional wind-data of a sonic anemometer and mixing ratios of both compounds measured with a quantum cascade laser absorption spectrometer (QCL-AS). Measurements started in May 2010 and continue as of this writing. All data shown is from 2011.

The presence of water results in a cross-talk effect on the N_2O and CH_4 concentration measurements. This effect can be corrected for empirically as shown by Neftel et al. (2010).

The influence of varying humidity on the measured trace gas mixing ratios was determined experimentally and is shown in Fig. 1.

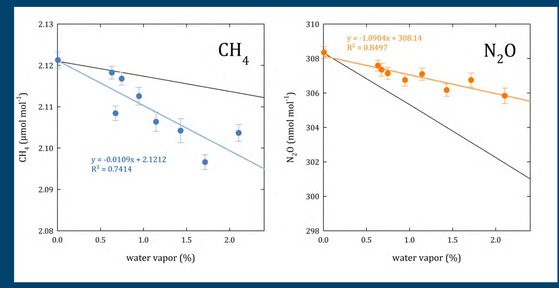

Figure 1 | The effect of varying humidity of the sample air on the measured CH_4 and N_2O mixing ratios. The colored symbols and their corresponding regression line show mixing ratios of CH_4 and N_2O normalized to dry conditions. The solid black line show the results of the same experiment as done by Tuzon et al. (2010, CH_4) and Neftel et al. (2010, N_2O).

a first look: results

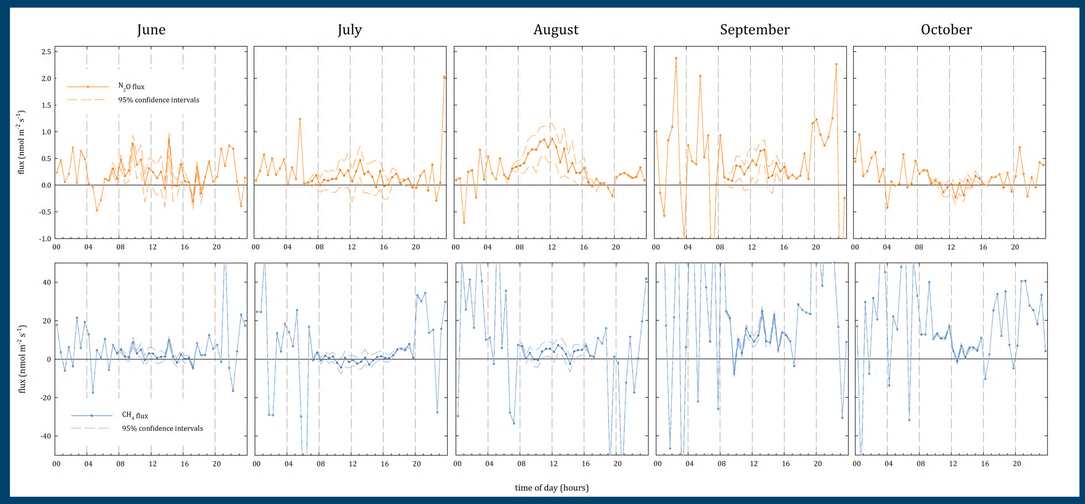

Figure 2 | Diurnal cycles of CH_4 and N_2O fluxes in 5 months of 2011.

Diurnal cycles of methane and nitrous oxide for June to October 2011 are shown in Figure 2. Emission and uptake could be observed for both compounds.

During calm and stable nighttime conditions measured concentration values were often erratic, showing distinct spikes and high mixing ratios. This propagated into the flux calculations and can therefore cleary be seen in the diurnal cycles. Further despiking may be necessary.

N_2O exhibited a clear diurnal cycle in August with emissions of up to 1 nmol m^{-2} s^{-1}. Similarily, CH_4 showed a more pronounced emission pattern in September, with observed emission fluxes of more than 20 nmol m^{-2} s^{-1}.

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REFERENCES: Karl et al. (2002) Virtual disjunct eddy covariance measurements of organic compound fluxes from a subalpine forest using proton transfer reaction mass spectrometry. Atmospheric Chemistry and Physics, 2, 279-291. | Neftel et al. (2010) N2O exchange over managed grassland: Application of a quantum cascade laser spectrometer for micrometeorological flux measurements. Agricultural and Forest Meteorology 150, 775-785.