Seasonal Variation of CO_2, CH_4 and N_2O Fluxes on Three Grasslands Along an Altitudinal Gradient

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Greenhouse gas management in European land use systems

Motivation:

Along with carbon dioxide, methane and nitrous oxide represent potent greenhouse gases that are being exchanged particularly between managed ecosystems and the atmosphere. In order to account for an annually integrated global warming potential (GWP) of such ecosystems (e.g. grasslands), net fluxes of methane and nitrous oxide must be added to annual carbon dioxide balances. Within the PhD project, we aim at:

- Determining the spatial and temporal contribution of methane and nitrous oxide fluxes to the GWP of three Swiss grasslands
- Understanding interactions between biotic and abiotic variables in modulating flux magnitudes
- Considering effects of management

Fig. 1 (below): Placement of static soil chambers along transects situated within the source areas of eddy covariance towers.

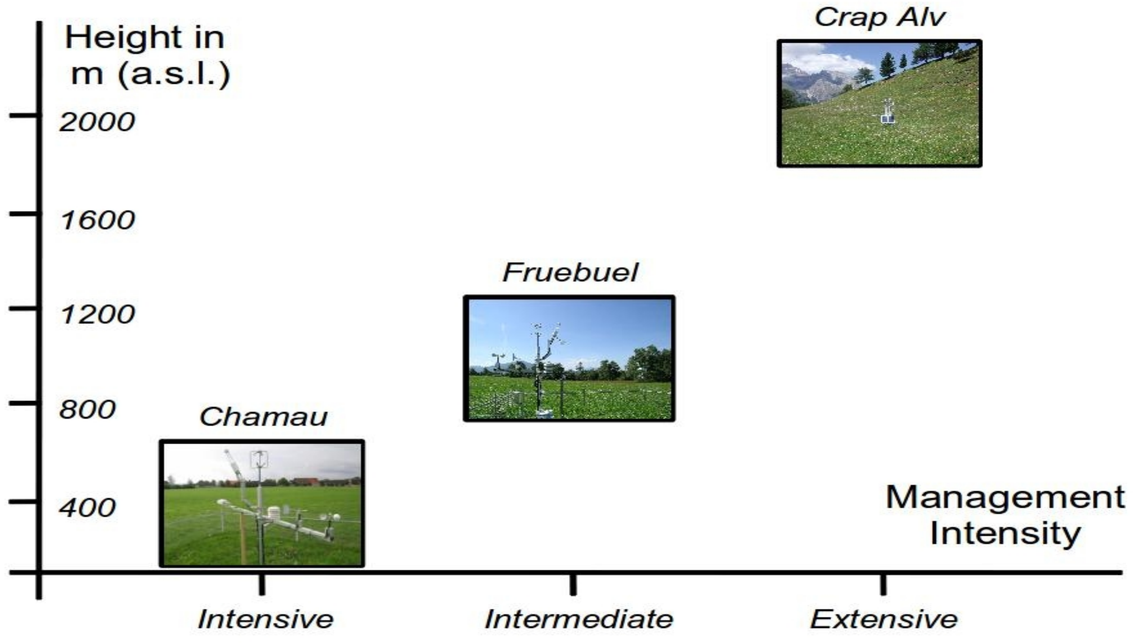
Crap Alv (GR), 2000 m a.s.l.

Fruebuel (ZG), 1000 m a.s.l.

Methods:

We measure carbon dioxide, methane and nitrous oxide fluxes at three sites representing the Swiss 'three-stages-farming' system. At each site 16 static soil chambers were installed along transects inside the eddy covariance (EC) source areas, allowing for cross-validation of measurements made. During the growing period flux and leaf area index measurements were carried out every week. In winter, measurements were made every two to three weeks.

Fig. 2 (below): Eddy covariance setups at the three sites (photos), as well as the height of the site above sea level, and the management intensity of the grassland.



Results:

Figure 3 (a-c) depicts the seasonal courses of carbon dioxide, methane and nitrous oxide at all three sites. For nitrous oxide mostly efflux was measured. For methane some sporadic emissions at the chamber scale were measured, however integrated ecosystem fluxes were mostly negative, i.e. oxidation. Respiratory fluxes show a temperature and management dependence.

Conclusions:

At all three sites, seasonal variations in methane and nitrous oxide fluxes are most pronounced after management events. Carbon dioxide efflux is mainly modulated by changes in temperature. Yet, the magnitude of methane oxidation and nitrous oxide evolution is small. Thus the GWP is mainly controlled by net ecosystem exchange of carbon dioxide.

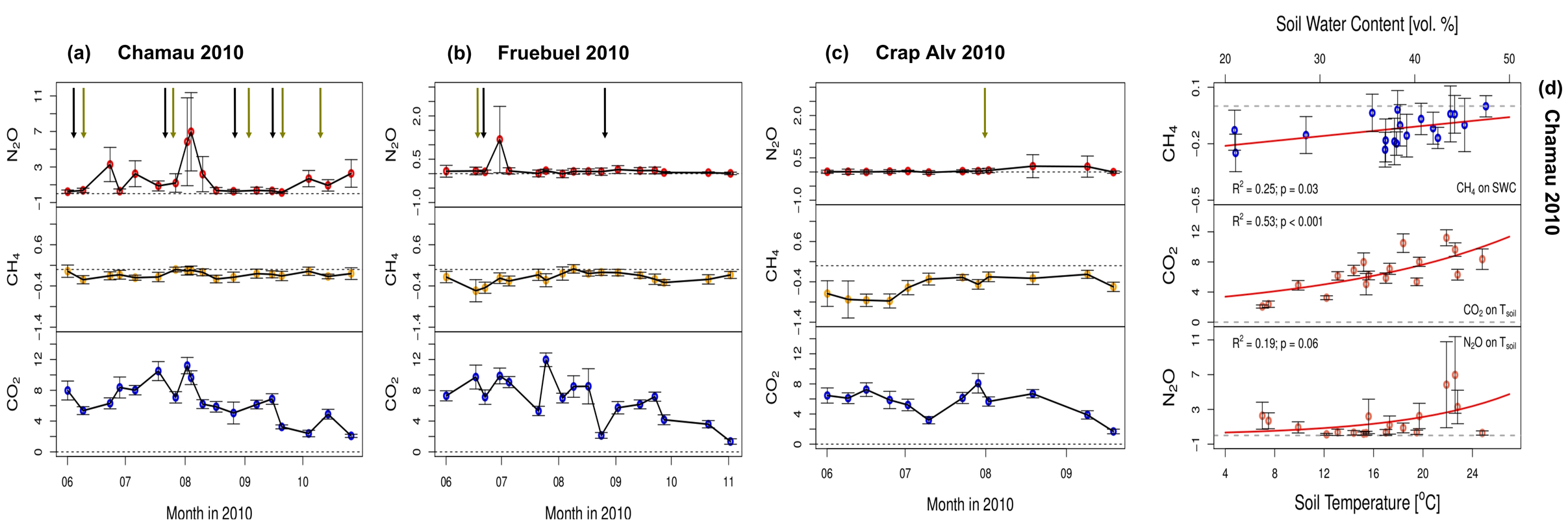


Fig. 3 (top):
Seasonal courses of the three GHGs, measured with soil chambers at all three sites. Carbon dioxide fluxes are given in µmol m^{-2} s^{-1}, methane and nitrous oxide fluxes are in nmol m^{-2} s^{-1}. Arrows indicate management (black = harvest, green = fertilization) Note the larger y-axis for nitrous oxide fluxes at Chamau (a). Seasonal response curves for all three greenhouse gases are depicted in the right side panel (d). Blue dots represent the response of methane fluxes to changes in SWC (vol. %), brown dots show changes in carbon dioxide and nitrous oxide fluxes in relation in soil temperature changes (both; SWC and Tsoil measured at -4 cm).