Effect of local airflow on flux chamber measurements

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Introduction

Studying soil gas exchange at the interface soil/atmosphere is of particular interest in the current debate of climate change. The most common method to measure gas fluxes at this interface is the chamber method. However, studies reported that this method presents limitations. During rain periods, the soil inside the collar can be drier than the soil outside. During high wind speed periods, overpressure or underpressure inside the measurement chamber can influence the measured flux.

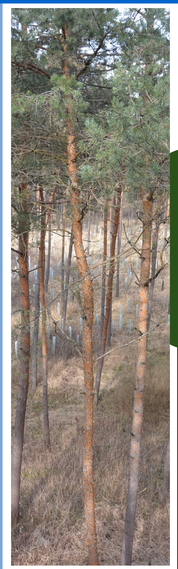
Quantifying these effects using natural gases is often difficult since CO_2, CH_4 and N_2O fluxes vary with time and the production and comsumption of these gases are affected by soil temperature and moisture.

Objective:

Assess artefacts of flux measurements with the chamber method *e.g.* the effect of airflow around the chamber by using an inert tracer gas.

► Are flux measurements with chamber biased by wind effects?

Material & Methods



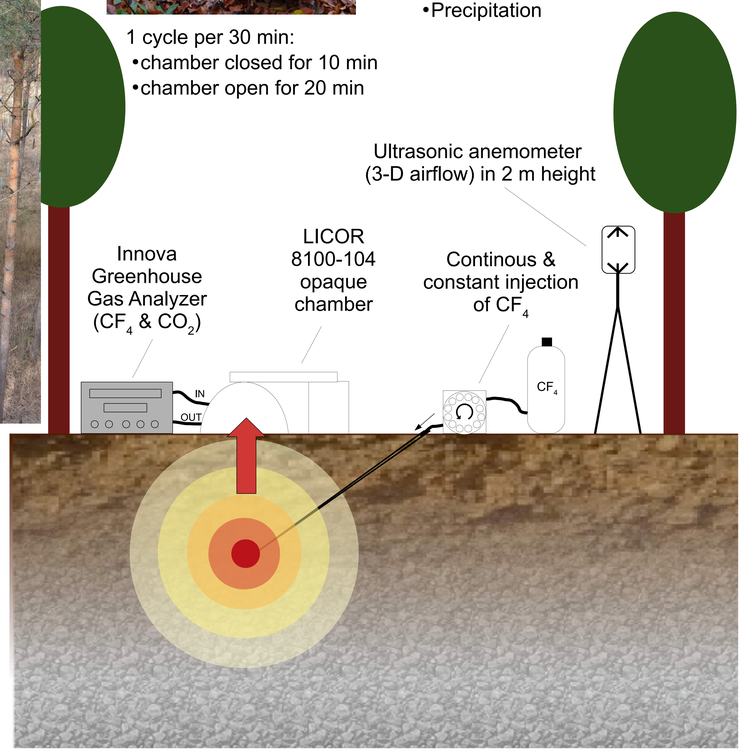
1) Continous flux measurement

1 cycle per 30 min:
- chamber closed for 10 min
- chamber open for 20 min

2) Additional measurements
- Barometric pressure
- Air temperature in 2 m
- Soil air temperature
- Soil moisture in -10 cm depth
- Precipitation

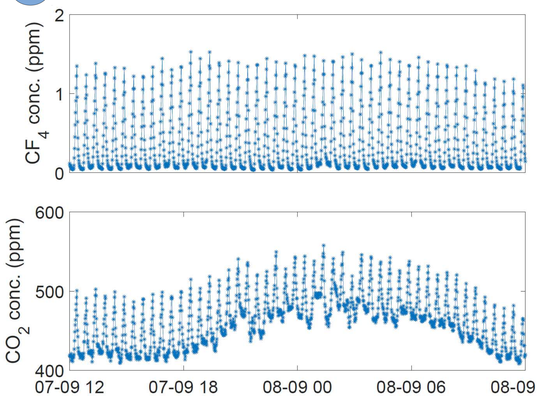
3) Experimental site
- Hartheim (SW Germany)
- *Pinus sylvestris* (L.) forest
- Haplic regosol (WRB)

4) Data analysis
- **A** CF_4 and CO_2 fluxes proportional to the increasing concentration slope
- **B** CF_4 and CO_2 minimal concentrations before each chamber close
- **C** Multiple linear regression analysis for the CF_4 and CO_2 fluxes (dry period of 6 days)



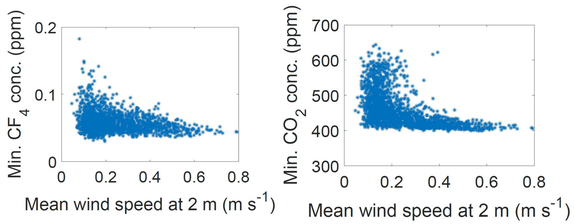
Results & Discussion

A **CF_4 and CO_2 concentrations over time**



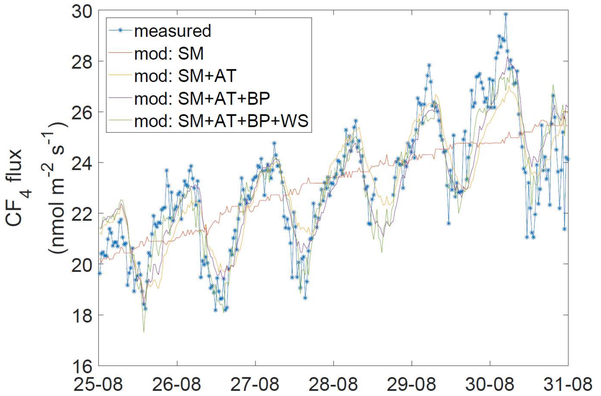
- ► Minimal CF_4 concentration stable over time
- ► Daily pattern for the maximum CF_4 concentration
- ► Daily patterns for the minimum and maximum CO_2 concentration

B **CF_4 and CO_2 minimum concentration vs. wind speed at 2 m**



- ► **Minimal CF_4 and CO_2 concentrations** clearly reached a limit value with increasing **wind speed** : air above ground flushed by above-ground airflow

C **Multiple linear regression for the CF_4 and CO_2 fluxes**



Predictors	R^2 Measured CF_4 fluxes *vs* Modeled CF_4 fluxes	R^2 Measured CO_2 fluxes *vs* Modeled CO_2 fluxes
Soil moisture (SM)	0.44	0.33
SM **+ air temperature (AT)**	0.71	0.47
SM + AT **+ barometric pressure (BP)**	0.77	0.47
SM + AT + BP **+ wind speed at 2 m (WS)**	0.83	0.52

- ► $F(CF_4) = 390 - 2.5 \times$ **SM** $- 0.2 \times$ **AT** $- 0.3 \times$ **BP** $- 7.2 \times$ **WS**
- ► $F(CO_2) = -2.2 - 0.3 \times$ **SM** $- 0.02 \times$ **AT** $- 1E\text{-}3 \times$ **BP** $- 0.6 \times$ **WS**
- ► 0 m/s < WS < 1 m/s:
7.2/24 (CF_4) & 0.6/2 (CO_2) ≈ 30**% of chamber effect (!)**

Conclusions

► Yes, flux measurements by chamber are biased but the effect up to 1 m/s is limited (~30%)

- ► Effect clearly visible in reduced CF_4 fluxes, more difficult in CO_2 fluxes

Advantages of the use of a inert tracer gas:
- ► No distinctive daily variation in its minimum concentration
- ► Ability to identify hot moments in soil gas transport *e.g.* during wind events and during/after rain events