GEFÖRDERT VOM
Bundesministerium für Bildung und Forschung

JÜLICH FORSCHUNGSZENTRUM

Instrumental Approaches to Source Partitioning of CO_2 and H_2O Fluxes

Patrizia Ney, Maria Quade, Youri Rothfuss, Nicolas Brüggemann, Harry Vereecken, Alexander Graf

Agrosphere Institute (IBG-3), Forschungszentrum Jülich, Germany

1 Motivation

How does the biosphere react on global change and local land use management?
- land surface currently acts as a sink for anthropogenic emissions
- additional CO_2 release is caused by land use change
- sensitivities of photosynthetic CO_2 uptake and respiratory CO_2 release to environmental parameters remain uncertain

→ the only way to disentangle the flux of greenhouse gases is **source partitioning**, e.g. into **photosynthesis** and **respiration** (**CO_2**) or into **evaporation** and **transpiration** (**H_2O**).

2 Strategy

BMBF-funded project IDAS-GHG (**Instrumental and Data-driven Approaches to Source-Partitioning of Greenhouse Gas Fluxes**: Comparison, Combination, Advancement):
→ comparing and improving existing methods for partitioning of CO_2 and H_2O fluxes into their respective raw components
→ **data-driven** approaches of source partitioning use existing (raw or processed) data of typical eddy-covariance stations
→ **instrumental** approaches require additional measurements at different parts of ecosystems and different methods, e.g. soil-flux chamber measurements, profile measurements or tracer measurements (stable isotopes)

3 Methods

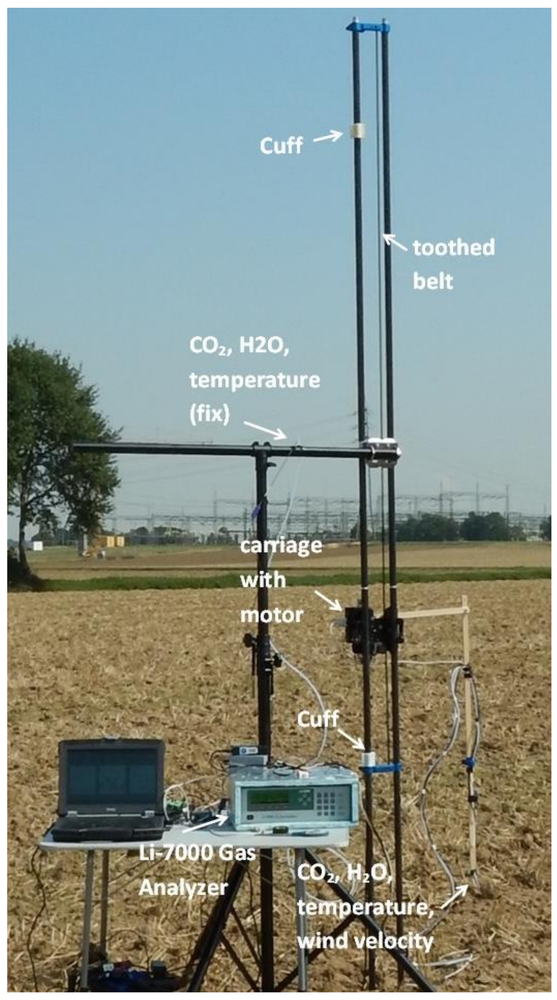

Fig. 1: Profile-measurement system set-up.

Profile-measurement system
- continuously up and down moving elevator
- measures changes in the concentration of CO_2 and H_2O at a **high vertical** and **temporal resolution between** the **soil surface**, the **plant canopy** and the **atmosphere**

Additional measurements
- eddy-covariance system
- automated soil CO_2 flux chamber system with four long-term chambers

Test site
- TERENO research site of Selhausen (Lower Rhine Embayment in the river Rur catchment (50°52'09''N, 06°27'01''E, 104.5 m.a.s.l., Germany) in a winter wheat field (April - August 2015)

Fig. 2: Profile-measurement system operating at the test site Selhausen in winter wheat (May 2015).

4 Preliminary results

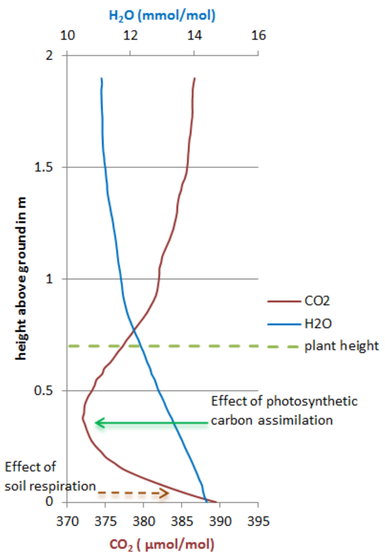

Fig. 3: Half hourly mean profiles of CO_2 and H_2O from 2015-05-20, 08.30 UTC, winter wheat field.

Growing Season:

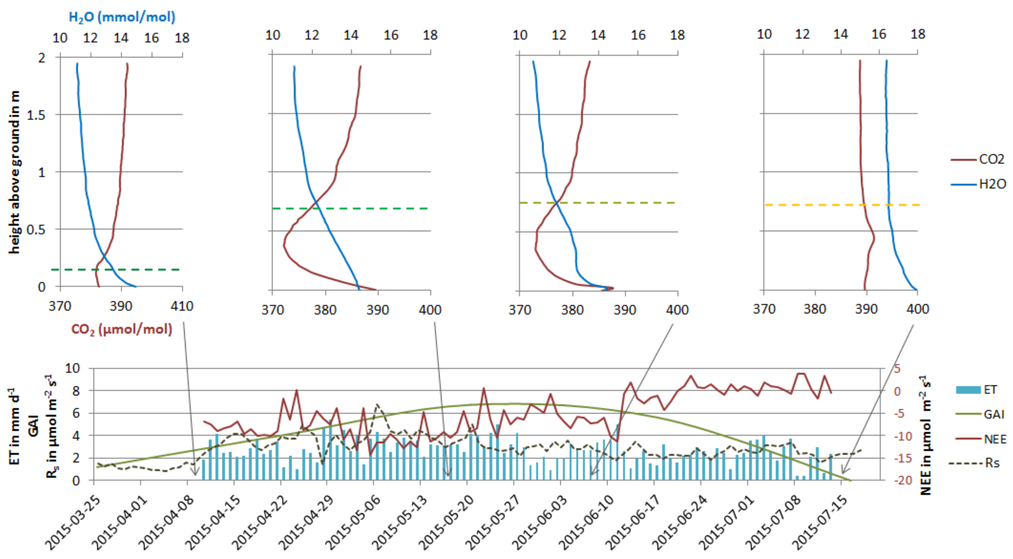

Fig. 4: Half-hourly mean profiles of CO_2 and H_2O during a growing season (top). Daily sums of evapotranspiration (ET), the green-area index (GAI), daily means of soil respiration (R_s) and net ecosystem exchange (NEE) (below).

Daily Cycle:

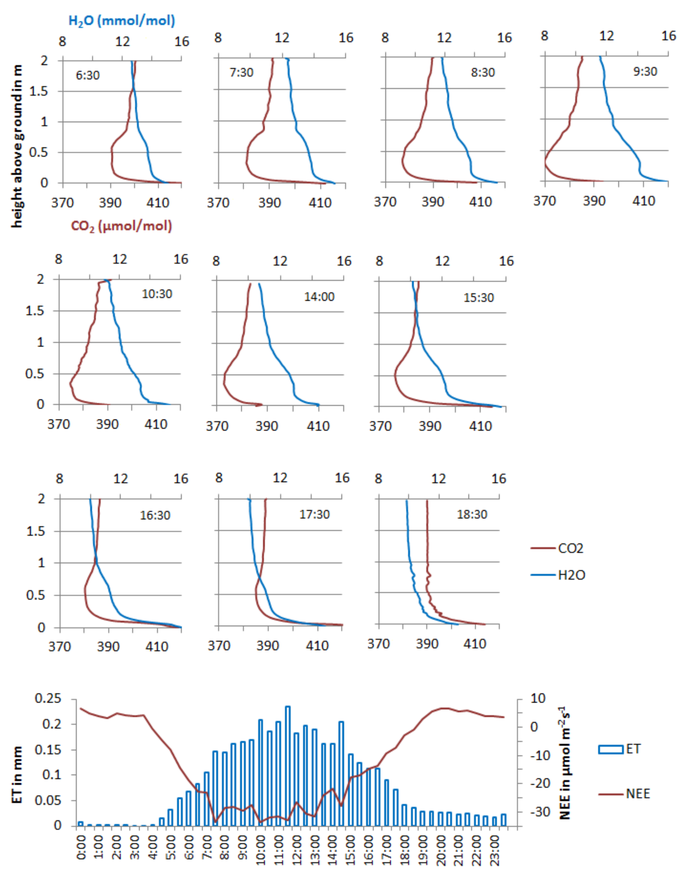

Fig. 5: Half-hourly mean profiles of CO_2 and H_2O during a daily cycle. Half-hourly sums and means of ET and NEE (below) from 2015-06-08.

First step: CO_2 and H_2O concentration results
- half hourly mean profiles of CO_2 and H_2O show the **effects of soil respiration** and **photosynthetic carbon assimilation** clearly
- CO_2 and H_2O concentration profiles varying during the daily cycle and during the growing season
- eddy-covariance measurements of NEE, latent heat and also the soil respiration corresponds to the patterns of the concentration profiles

5 Future plans

Profile-measurements:
- determination of vertical source profiles from measured concentration profiles
  → quantify sink and source strength

Additional measurements: partition CO_2 and H_2O fluxes is by measurements of concentration profiles of their stable isotopologues ($^{13}CO_2$, $^{12}C^{18}O^{16}O$, $^{1}H^{2}H^{16}O$ and $^{1}H_2{}^{18}O$):
- controlled-conditions experiments in the laboratory on soil columns in autumn and winter 2015
- a quantum-cascade dual isotope laser will be deployed at the Selhausen test site in a low-flow (i.e. soil atmosphere and chamber measurements) and high flow (i.e. EC measurements) configurations
- comparison with the above-mentioned profile measurement system.

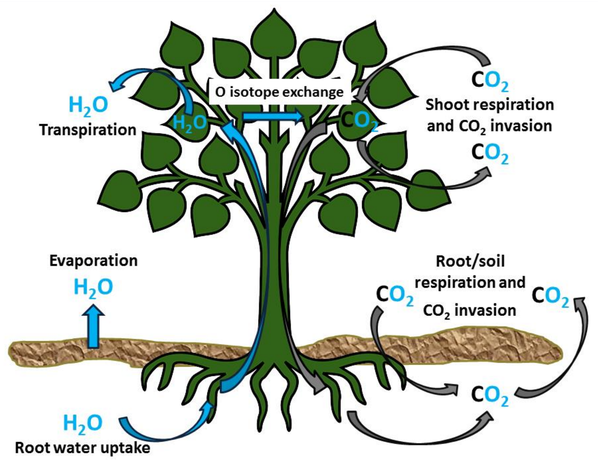

Fig. 6: Gas exchange of CO_2 and H_2O between soil, plant and atmosphere.

Acknowledgements:
Special thanks to Odilia Esser and Normen Hermes.