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Investigation of C distribution after assimilation by combining stable isotope labeling and micrometeorological tools

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Introduction

There is still disagreement whether grassland ecosystems are considerable carbon sinks. Separation of the C flux into several pools may advance research on this topic. We combined established methods of both, atmospheric and soil science to determine absolute C allocation in plant and soil C pools. Therefore, we chose the most intensive growth phase with respect to C uptake within the vegetation period 2010 (see Figure 2 black box and Figure 3) to conduct the following experiments:

Experiment I

- Determination of the Net Ecosystem Exchange (NEE) by eddy covariance (EC) technique and turbulence software TK2 (Mauder and Foken, 2004)

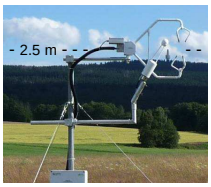


Fig.1: EC station (LI-COR LI-7500 & Campbell CSAT3)

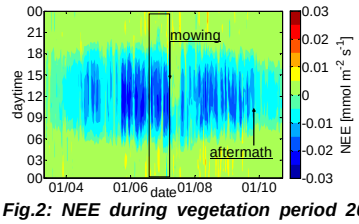


Fig.2: NEE during vegetation period 2010 (22 day experiment period was highlighted)

- Separation of NEE into ECOsystem Respiration (R_{ECO}) and Gross Ecosystem Photosynthesis (GEP) by a model based on Michaelis-Menton and Lloyd-Taylor functions (see Figure 3)
- Validation of the model derived GEP by comparison with chamber measurement determined GEP (= NEE – R_{ECO} ; see Figure 4 and 5)

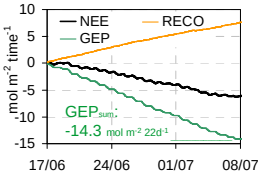


Fig.3: Result of NEE separation into GEP and R_{ECO}

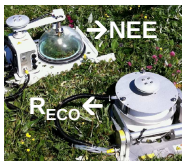


Fig.4: LI-COR 8100-104 (transp.) and 8100-101

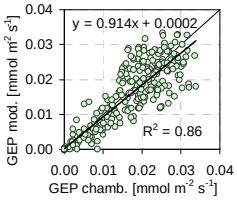


Fig.5: Modeled vs. chamber-measured GEP

- **Final result I: <u>absolute</u> C input into grassland ecosystem during 22 days of experiment: 14.3 mol m^{-2} 22d^{-1} = 7.5 µmol m^{-2} s^{-1}**

Experiment II

- Pulse labeling of green above ground biomass with $^{13}CO_2$ and detection of the tracer in several carbon pools afterwards: soil respiration, green above ground and root biomass, rhizosphere and bulk soil

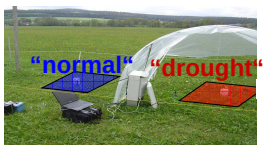


Fig.6: Pre labeling treatment "drought" and "normal" (n=5 each)

Fig.7: $^{13}CO_2$ pulse labeling chambers - cooled with thermal packs and fans

- 38 days drought treatment ("1000-year-drought") was established for further investigation considering local climate change; the combination with EC on this poster is only possible for "normal" results (EC-footprint!)
- Observation of the development of the tracer excess ($\delta^{13}C$ sample - $\delta^{13}C$ natural abundance) after the labeling until a steady state is reached:

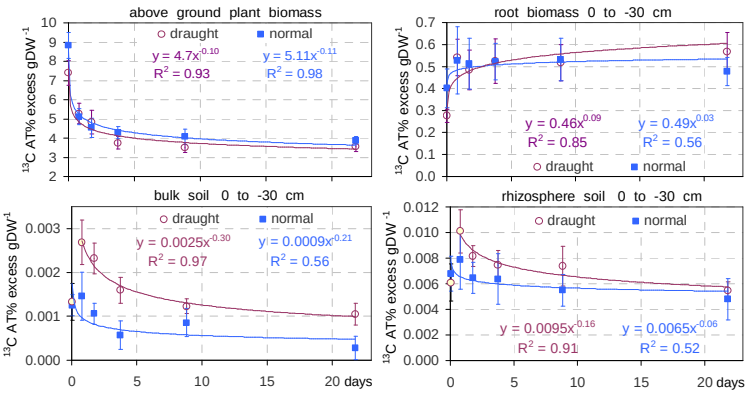


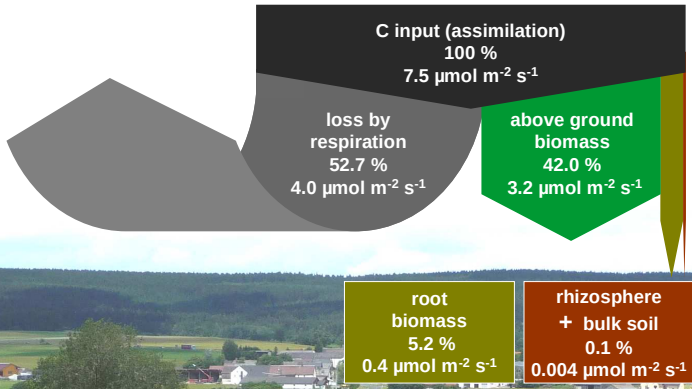
Fig.8: Excess of ^{13}C in four ecosystem C-pools → balance after 22 days describes percentage of C stored in different plant and soil C pools

- **Final result II: <u>relative</u> C allocation after assimilation [%]:**

C input (assimilation)	loss by respiration	above ground biomass	root biomass	rhizosphere and bulk soil
100	52.7	42.0	5.2	0.1

Take home message

- Combining CO_2 flux measurements with isotopic labeling is predestined to quantify C sequestration in soil and C allocation within the ecosystem



Outlook

- Further model validation by NEE-separation with atmospheric $^{13}CO_2$ fluxes determined by REA measurements (Ruppert, 2009; Wichura 2009) and consideration of other recently published separation methods
- Comparison with C fluxes determined by tracer recovery in total C pool size
- Separation of "loss by respiration" into soil and shoot respiration
- C allocation into microbial biomass

Literature

- Mauder M, Foken T. 2004. Documentation and instruction manual of the eddy covariance software package TK2, Work Report University of Bayreuth, Dept. of Micrometeorology, 26, 42 pp. University of Bayreuth: ISSN 1614-8916.
- Ruppert J. 2009. CO_2 and Isotope Flux Measurements above a Spruce Forest. Dissertation, Pub. University of Bayreuth.
- Wichura B. 2009. Untersuchungen zum Kohlendioxid-Austausch über einem Fichtenwaldbestand; Hyperbolic-Relaxed-Eddy-Accumulation Messungen für das stabile Kohlenstoffisotop ^{13}C und Waveletanalysen des turbulenten Kohlendioxid-Austausches, Bayreuther Forum Ökol. 114, 295.

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