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UNIVERSITÄT BAYREUTH

BayCEER
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Outline of instruments and objectives of the subproject TP5 integrated in the FORKAST project

Investigation of carbon turnover in grass-lands in Northern Bavarian low mountain ranges under extreme climate conditions

FORKAST

UBT AES

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Introduction

Grassland in low mountain ranges is considered as important carbon storage, but one question is to be asked: Can this good news be affirmed in times of climate change? Already the word “change” suggests no certainty, but investigation of typical fundamental processes in grassland ecosystems. Thereby the carbon cycle is ranked first and involved the adaptability of the divers plant community's species. This is where subproject TP5 is integrated into the FORKAST project, which on the whole serves the evaluation of climatic impacts on ecosystems and adaptation strategies.
Micrometeorological flux measurement techniques (eddy covariance and relaxed eddy accumulation) and tracing of ^{13}C transport in plant and soil, based on ^{13}C pulse labelling, help to achieve these objectives. Completely new is the consideration of atmospheric background (^{13})CO_2 fluxes on executing tracing experiments.

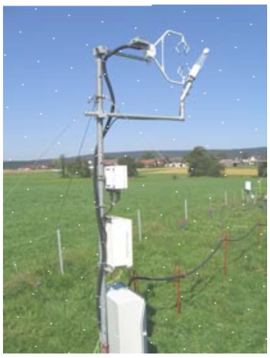
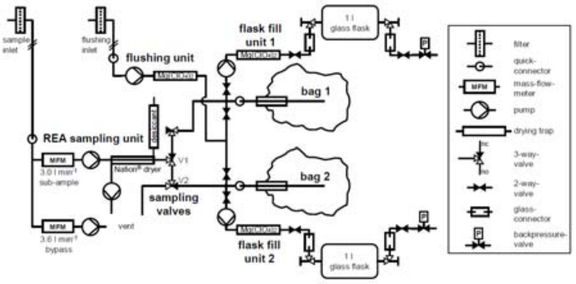


Figure 2. Turbulence measurements at the Voitsumra investigation site – providing more than two years continuous CO_2, latent and sensible heat flux measurements and further meteorological parameters
(Running measurements since July 2009)



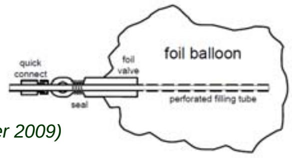
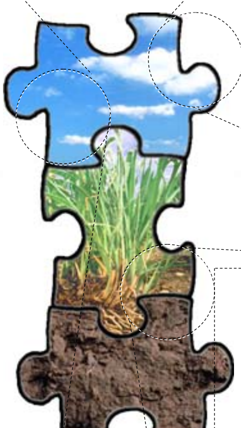


Figure 1. Design of the whole-air REA system for isotope flux measure-ments with foil balloon bags as intermediate reservoirs (Rupert 2009)
(First laboratory tests, September 2009)



$^{13}CO_2$ flux measurements

When fast high precision chemical sensors are not available for eddy covariance (EC) flux measurements, relaxed eddy accumulation technique (REA) can be used to measure trace gas fluxes in the boundary layer. The collection of updraft and downdraft whole-air samples using REA, allows simultaneously determining trace gas concentrations and isotope ratios by high precision laboratory analysis. Measuring the isotopic composition of CO_2-fluxes provides additional information on ecosystem gas exchange processes, when those, like e.g. assimilation, discriminate against heavier isotopes. Consequently different mass-balances for bulk CO_2 and its $^{13}CO_2$ or $CO^{18}O$ isotopes can be used to separate respiration from photosynthetic assimilation. Those elaborate and expensive measurements can not be carried out permanently but in times of drought, what is suited to bear reference to climate change scenarios.

The stable isotope ^{13}C as tool

The isotopic carbon composition of soil, biosphere and atmosphere varies in different time scales. Changes in carbon dioxide isotopic composition are strongly connected to ecosystem air CO_2 concentration. The dimension of metabolism changes in the biosphere, depends on biotic factors like ecosystem structure and plant community composition. $^{13}CO_2$ pulse labelling gives evidence about influences on and reactions of the latter, depending on the recovery rates in the particular species. The principal of our labelling experiments is illustrated in Figure 3. Subsequent sampling and determination of recovery rates in diverse ecosystem compartments is state-of-the-art of science.

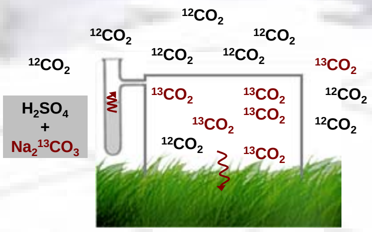


Figure 3. $^{13}CO_2$ pulse labelling as a tool to separate microbal from root respiration and to find out different species reactions to drougt spells
(First field tests in China, August 2009, starting experiment spring 2010)

A noteworthy edge condition of ^{13}C pulse labelling experiments

Climate and related parameters like elevation and relief as abiotic factors are important framework requirements for ecosystem metabolism as well as anthropogenic influences like in our case the mowing of grasslands. Isotope signatures of air, biosphere and soil components result from interacting fractionation processes during atmospheric transport, CO_2 transport in plants, respiration and assimilation. Already given complexity indicates that common ^{13}C pulse labelling and tracing can not be suitable for contemporary science. Thus, recovery rates have to be assessed with an important edge condition: size, direction and variability of atmospheric (^{13})CO_2 fluxes. Those influences on turnover in the biosphere and related tracer dislocation during the sampling period are to be investigated. Our research takes place before, during and after dry spells, what simulates climate change in a natural way. Determination of the ^{13}C recovery rate in different plant species, combined with the mentioned improvements, provides information about resistance and adaptability to drought stress and finally about the resilience of the whole ecosystem and associated shifts in the plant community.

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