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Investigation of carbon turnover in and above a temperate grassland site

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Introduction

Conservation of grasslands carbon storage characteristics is desirable in times of climate change. But ecosystem function and species composition of temperate grasslands are likely to respond to precipitation change (IPCC). As long-time climate measurements suggest precipitation deficits in southern German low mountain ranges mainly during spring, FORKAST project investigates local carbon cycle during artificially induced drought periods.

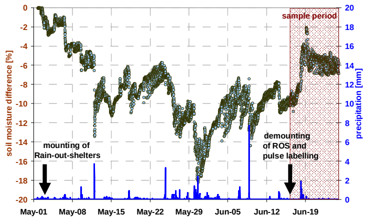

Fig.1: Induced soil moisture difference between "drought" and "normal" plots reached a value of 10% at point of labelling. All in all 135mm precipitation have been excluded from "drought" plots.

Pulse labelling experiment

The site "Voitsumra" is located on an extensively managed pasture, 624 m a.s.l. After artificial 1000-year-drought period and demounting of the rain-out-shelters (Fig. 2) the plots have been labelled with stable isotope tracer (Fig. 3).

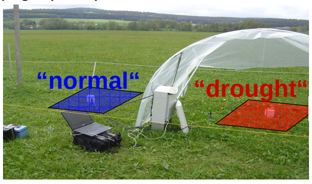

Fig.2: Experiment setup: "Normal" and "drought"-plots alternating arranged in a row (5 repetitions each). Soil temp. and moisture have been logged on both.

Fig. 3: $^{13}CO_2$ pulse labelling chambers - cooled with thermal packs and fans - carbon tracer and acid reservoirs inside.

1. Preliminary results of the labelling Experiment

Up to now about one-fifth of the samples has been analysed. The experiment setup worked well as a significant enrichment compared to the natural abundance values could be found in all compartments. Tracer is shifted from green above-ground biomass (Fig.4) into root system and soil. Roots in low depth showed more and earlier enrichment before values get more and more equal. Soil samples show also an enrichment which stays constant during first five days of sampling (Fig.5a/b).

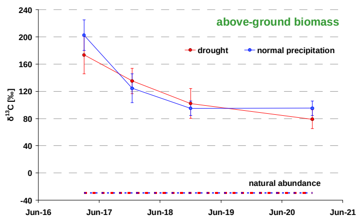

Fig.4: δ¹³C-values of labelled above-ground biomass compared to natural abundance value.

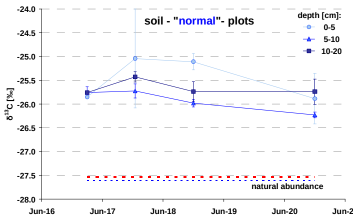

Fig.5a: δ¹³C-values of soil on normal plots

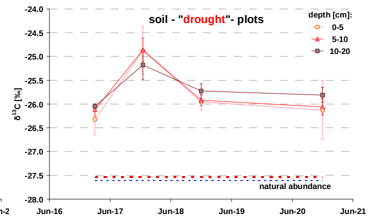

Fig.5b: δ¹³C-values of soil on drought plots

First results let expect no difference between treated and untreated plots. This should not be assigned to spring drought effects in general. Climate measurements on our site show spring 2010 as unusual cold with high atmospheric humidity. Under those conditions vegetation dealt well with missing precipitation and less soil moisture.

2. Atmospheric C-fluxes

Atmospheric CO_2 flux measurements (by Eddy Covariance, EC) can not provide separate fluxes from normal and drought plots, but a site specific background flux. This applies also to $^{13}CO_2$ flux measurements (by Hyperbolic Relaxed Eddy Accumulation, HREA). But those allow to differentiate between respiration and assimilation and to determine the contribution of both to the Net Ecosystem Exchange NEE.

The first two experiment results are illustrated in Figure 6 and 7. Upward fluxes, off the biosphere, contain more heavy isotopes, due to discrimination during assimilation. Turbulent mixing countervails soil close ^{13}C-enrichement and finally adjusts up- and downstream values when assimilation decreases in evening hours. This result is supported by continuous EC-CO_2-flux measurements: Highest downward fluxes (most negative values) come along with highest ^{13}C enrichment in the above ground air.

Our future challenge is to evaluate the influence of atmospheric $^{(13)}CO2$ fluxes on tracer translocation in biosphere and soil.

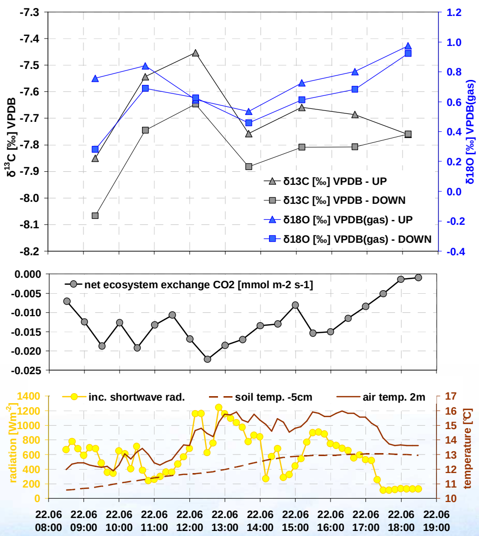

Fig.6: Atmospheric $^{13}CO_2$ measurements at June-22nd, accompanied by climate and EC-based CO_2-flux measurements

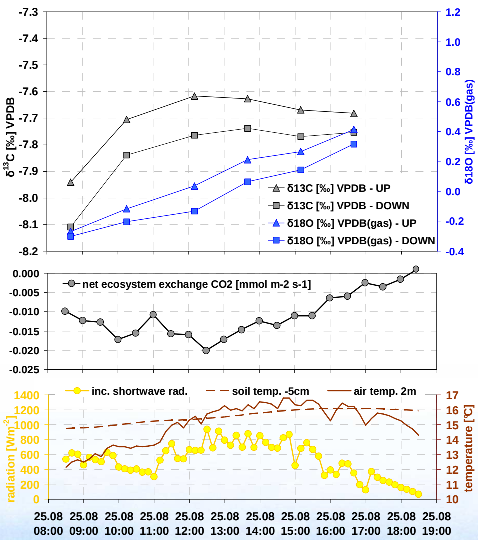

Fig.7: Atmospheric $^{13}CO_2$ measurements at August-25th, accompanied by climate and EC-based CO_2-flux measurements

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