TiP (DFG SPP 1372) Atmosphere - Ecology - Glaciology - Cluster

Partitioning and dynamics of recent assimilates in alpine meadows on the Tibetan Plateau assessed by $^{13}CO_2$ pulse labeling

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Introduction

The grassland soils of the Tibetan Plateau (TP) store substantial amounts of carbon (C). In recent decades changes in land-use of the grasslands occur but impacts on C sequestration are uncertain. To evaluate these effects, understanding of C cycling of these grasslands is necessary. An important component of the C cycle in these ecosystems is the allocation and turnover of recently assimilated C in belowground pools (Fig. 1).

The partitioning of assimilates to belowground pools is crucial for the residence time of C in the soils. We investigated C stocks and fluxes of recent assimilates of a *Kobresia pygmaea* meadow, which is the dominating vegetation unit of the TP. The study was conducted at Kema research station in southern Tibet at 4400 m a.s.l, in summer 2010. In 2009 grazing exclosures have been established at the study site.

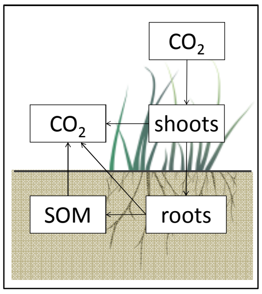

Fig 1: Schematic C fluxes traced by $^{13}CO_2$ pulse labeling.

Aims

- Determination of C stocks in plant and soil pools
- Partitioning of recently assimilated C in the plant-soil-atmosphere system
- Dynamics of C allocation and turnover

$^{13}CO_2$ pulse labeling

- 1st of July 2010
- 3 grazing treatments, 4 replicates
- Plot size 60 x 60 cm²
- 2 g Na_2CO_3 (99% ^{13}C)
- Chase period: 2 months

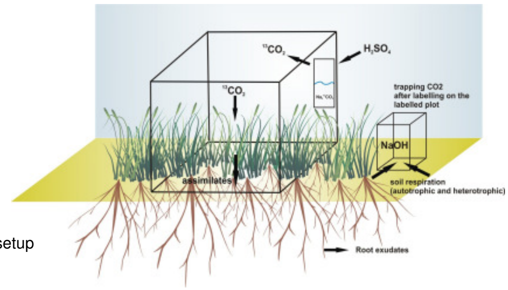

Fig. 2: Schematic experimental setup of the pulse labeling approach.

Sampling and analysis

- Pools: shoots, white roots, woody roots, SOC, belowground CO_2 efflux (static alkali absorption method)
- 2 layers belowground: 0-5 cm, 5-15 cm
- Isotope measurements: EA-IRMS

no differences between grazing treatments → data pooled for further analysis

Results and Discussion

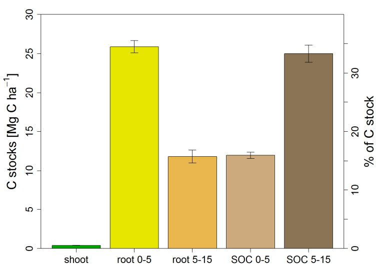

Fig. 3: absolute carbon stocks and percentage of overall stocks in the plant and soil pools.

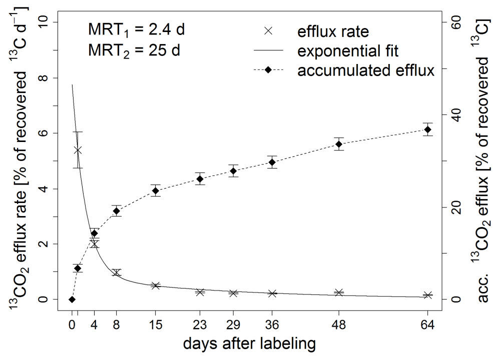

Fig. 4: Recovery of ^{13}C in the belowground CO_2 efflux. Sum of two exponential functions describes the mean residence times (MRT) of two belowground C pools. Accumulated efflux demonstrates contribution of belowground CO_2 efflux to overall partitioning.

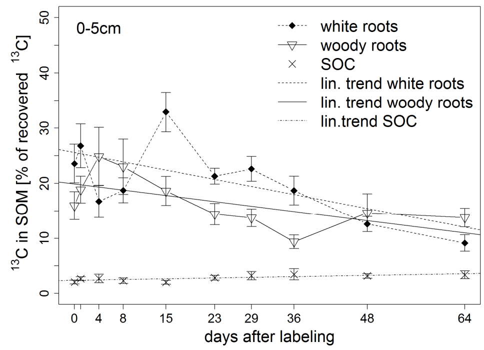

Fig. 5: Dynamic of ^{13}C in roots and SOC of the 0-5 cm layer expressed in % of ^{13}C recovered in the system immediately after the labeling. Linear regressions indicate the overall trend of ^{13}C in the pools. The amount of ^{13}C in roots declines significantly in the second half of the chase period in contrast to significant increase in SOC.

Table 1: Partitioning of ^{13}C at the end of the 2 months chase period

	depth	% of recovered ^{13}C
Shoots		9.1 ± 2.2
White roots	0-5	9.2 ± 1.5
	5-15	0.8 ± 0.2
Woody roots	0-5	13.8 ± 1.7
	5-15	5.3 ± 1.2
SOC	0-5	3.4 ± 0.7
	5-15	2.1 ± 0.6
Belowground CO_2 efflux		36.8 ± 1.4
Missing ^{13}C		19.5

Shoots have a minor contribution (0.5%) to the overall C stocks of the ecosystem. Both, roots and SOC make up to ca. 50% of the overall C stock (Fig. 3). This very high belowground C is also reflected in the high proportion of belowground allocation of assimilates (Table 1). The allocation belowground was terminated within 4 days, indicated by the stabilization of the amount of ^{13}C in the shoot. The belowground CO_2 efflux comprises C pools rapidly mineralized by root and rhizomicrobial respiration (MRT_1) and a further C pool with slower turnover (MRT_2) causing the slight and steady ^{13}C efflux over the chase period (Fig. 4). The latter corresponds to the significant decline of recovered ^{13}C in the roots in the second half of the chase period (Fig. 5). This can be attributed to decomposition of roots containing labeled C, which also explains the slight but significant increase of ^{13}C in the SOC. This increase in the SOC and the low recovery of ^{13}C in the beginning of the chase period indicate that root turnover and not stabilization of root exudates is the primary pathway for the constitution of SOC.

Conclusions

1. High proportion of assimilates is allocated belowground, belowground respiratory processes are the main fate of assimilates.
2. A subset of roots is highly dynamic with a MRT of tens of days.
3. Root turnover and not C exudation is the primary way of formation of SOC stocks

Outlook

Coupling with Eddy covariance measurements to obtain absolute C fluxes into the different compartments of the plant-soil-atmosphere system.

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