Impact of variable clover/grass fractions of managed grassland on soil organic carbon under climate change

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Motivation

- Grassland can act as a sink for atmospheric CO_2
- Clover affects Nitrogen (N) and Carbon (C) cycles, thus promotes grassland productivity, litter production and the accumulation of soil organic C (SOC).

Questions

- What is the sensitivity of SOC-accumulation with respect to the fraction of clover (f) in managed grasslands under present climatic conditions?
- What is the potential for C-sequestration at different f under different climate change scenarios?

The model

Pasim, the Pasture Simulation Model (Fig. 1).

Specific settings:

- fixed value for f
- dry matter production & C-, N- & energy-fluxes
- 3 soil-C pools, with turnover rates of
  - k ~ 3 - 5 y^{-1} (active)
  - k ~ 20 – 30 y^{-1} (slow)
  - k ~ 1000 y^{-1} (passive)

Procedure

- Apply the model to the experimental site of Oensingen, Switzerland (coordinates: 7°44'E, 47°17'N, 450 m a.s.l., 1100 mm annual rainfall, 9°C mean annual T)
- Drive PaSim with 30 y of data for current conditions (scenario R) or T and CO_2 scenarios (S1 - S3; Fig. 1)
- For each scenario vary the clover/grass fraction f (20%, 40% and 60%)
- Compare the SOC-accumulation at the end of the 30 y with the initial SOC-stock values (5.9 kg C/m^2)

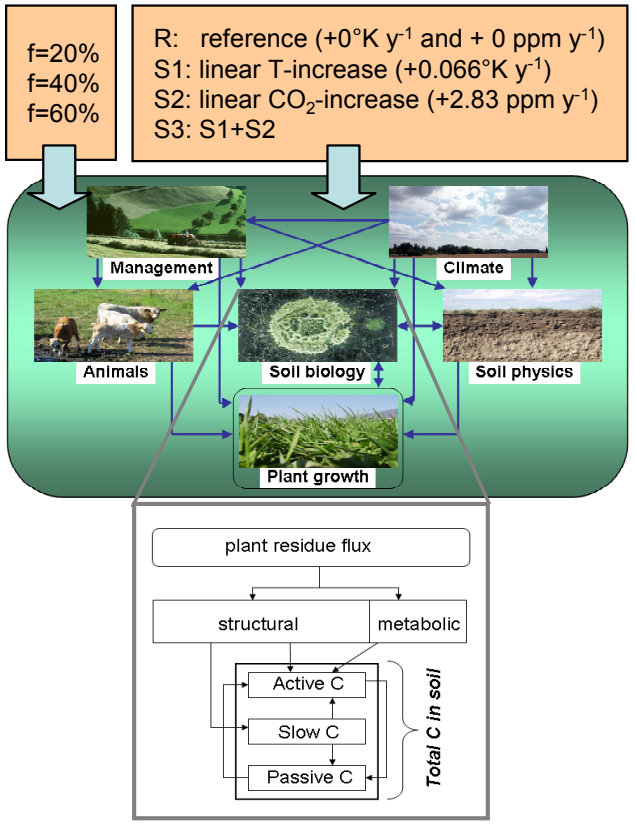

Fig. 1: Different clover/grass fractions f and scenarios for temperature and CO_2 (top), the model structure of Pasim (middle) and the concept of transferring C from plant residues to 3 conceptual soil pools for SOC (bottom).

Results

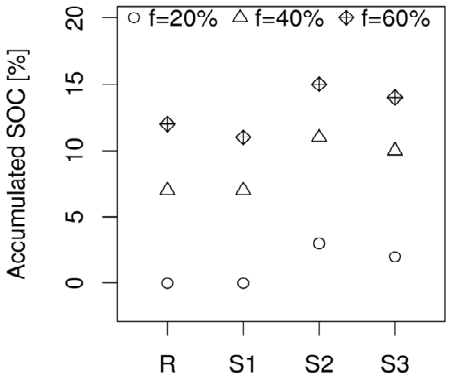

Fig. 2: Accumulation of SOC at year 30 for the scenarios R, S1, S2 and S3 and different clover/grass fractions f relative to the initial SOC-stocks.

- SOC-accumulation is more strongly affected by CO_2 than T
- SOC-accumulation increases with the clover/grass fraction f
- Marked increase in SOC-accumulation when f > ~ 30 %
- SOC-stocks (kg C/m^2) over 30 y:
  - 5.9 – 6.0 for f=20%
  - 6.2 – 6.3 for f=40%
  - 6.3 – 6.4 for f=60%

Conclusions & Outlook

- C-sequestration preferably under elevated CO_2
- Maintenance of adequate average clover fraction by management in temperate grassland is important for C-sequestration
- Incorporation of a seansonally variable fraction for clover into the model is the next step

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