Drought and rewetting responses of CO_2 production and emission dynamics in a future climate

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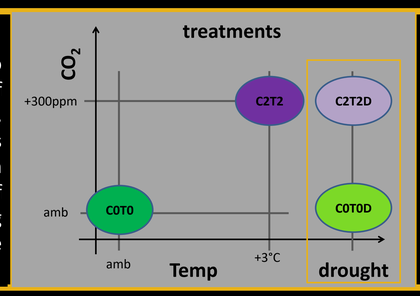
Background

Soil respiration (Rs) is the largest source of CO_2 emitted from terrestrial ecosystems to the atmosphere. While effects of drought on Rs have been repeatedly studied, less is known how a **future warmer climate under elevated CO_2** (C2T2) will modify drought responses.

Approach

The ClimGrass project aims to understand the effects of changes in temperature, atmospheric CO_2 concentrations and of extreme drought on biogeochemical cycles of managed C3 grasslands by using a multilevel & interactive manipulation experiment.



Soil CO_2

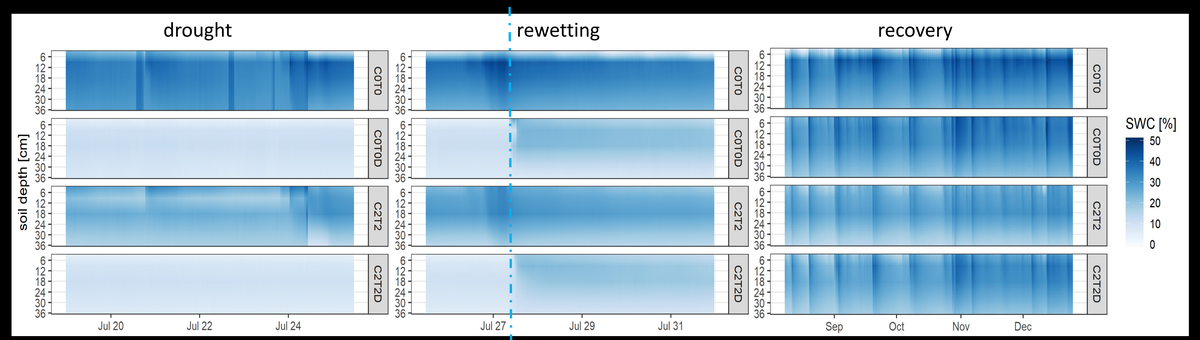
High resolution in-situ measurements of soil CO_2 concentrations using a multiplexed membrane tube system. Fluxes and production modelled via the Flux-gradient approach. Rs obtained by automated chambers.

Drought

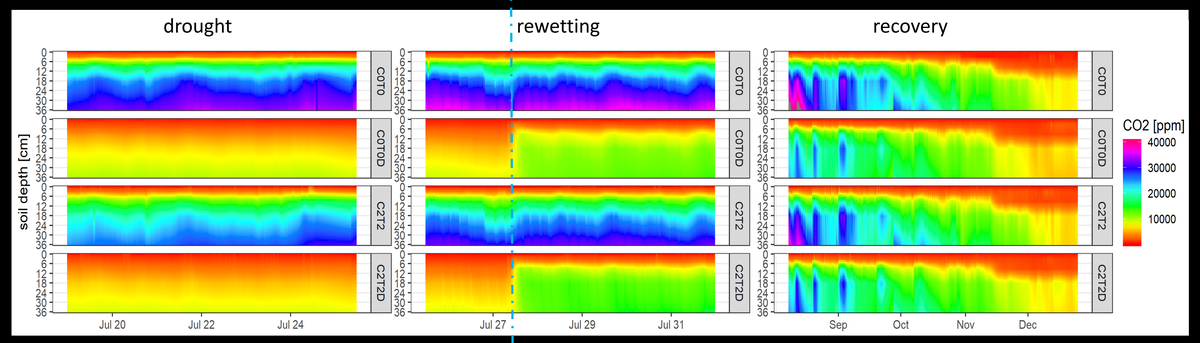
Simulated by automated rainshelters and terminated by controlled rewetting (40mm*m^{-2}) after 6 weeks of rain exclusion.

ClimGrass field site

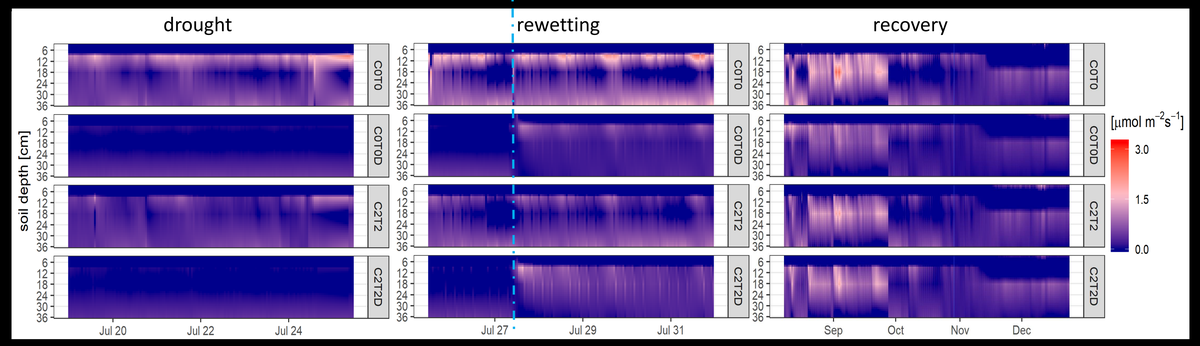
Soil profile



Soil moisture was strongly reduced by drought in the C0T0D and C2T2D treatments, with slightly lower values in C2T2D. After rewetting only the 3cm layer in C0T0 recovered from drought. Soil layers in the future climate scenario took several weeks to fully recover their soil moisture conditions.

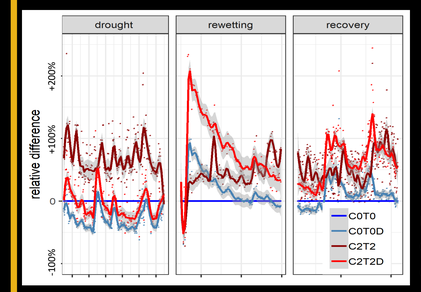


Soil CO_2 concentrations. At rewetting, 40mm*m^{-2} of previously collected rainwater were added to the drought treatments. Nevertheless, it still took five months in total to recover soil moisture- and soil CO_2 conditions through the profile, with slower recovery with increasing soil depth.



CO_2 production of was inhibited by drought, resulting in a downward shift of CO_2 production into deeper soil layers. Rewetting pulses of soil CO_2 production could be assigned to a soil depth around 10cm, which constitutes the main rooting horizon. This indicates strong coupling with autotrophic soil respiration.

Soil respiration



Under future climate, Rs rates appeared to be generally higher and were reduced more strongly by drought.

High Rs rates, rewetting pulses and longer recovery largely altered seasonal flux and emission dynamics under future vs. current climate.

Conclusions

- **Reduction of Rs, rewetting pulses and overshooting of fluxes after the drought were higher under future than current climate**
- **CO_2 production indicates strong autotrophic coupling after rewetting**
- **Combination of drought responses under future climate has potential to offset CO_2 budgets of grasslands**

This conference attendence was funded by the Doctoral Program: Alpine Biology and Global Change

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