EFFECT OF SUMMER DROUGHT ON THE COUPLING OF PHOTOSYNTHESIS AND SOIL RESPIRATION UNDER CURRENT AND FUTURE CLIMATE

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1. Introduction & Motivation

Ecosystem CO₂ fluxes such as GPP and soil respiration play an important role in balancing the CO₂ concentration in the atmosphere. We think that future climate will increase GPP, soil respiration and their coupling and that the effect of drought and the recovery from drought will be amplified in a future climate.

2. Methodology

2.1 Field Setup

We simulated future climate (+3°C, +300ppm above ambient) and drought conditions in the field.

2.2 Measurement Setup

2.2.1 Ecosystem CO₂ Fluxes

We calculated ecosystem CO₂ fluxes (GPP, Res, NEE) by measuring CO₂ concentration changes inside the chamber. We traced the fate of carbon from GPP to soil respiration by making the plant assimilate labeled CO₂ for photosynthesis.

2.2.2 Soil Respiration and Recent Carbon Respired (Pulse-labeling)

Then we measured soil respiration and recent carbon (¹³C) in soil respiration using a laser isotope spectrometer.

2.3 System Setup

We ended the drought with artificial precipitation (40 mm).

3. Results

3.1 Ecosystem CO₂ Fluxes

Figure 1: Gross Primary Productivity (GPP), Ecosystem Respiration (GPP), and Net Ecosystem Exchange of CO₂ (NEE) during drought and 4, 11 days after rewetting.

3.2 Soil Respiration and Recent Carbon Respired

Figure 2: a) Soil respiration, soil water content (SWC), soil temperature during drought (top) and recovery period (bottom). b) cumulative soil respiration (GPP).

Figure 3: Soil respiration (top) and recent carbon respired (in % relative to initial uptake) during drought and 4 days after rewetting and 11 days after rewetting.

3.3 Net Ecosystem Exchange

Figure 4: Recent carbon respired (in % relative to initial uptake) during rewetting (bottom)

4. Conclusion

In a future climate, warming and elevated CO₂ have a stronger influence on belowground than on aboveground CO₂ fluxes, which resulted in an increased carbon allocation to soil respiration.

Drought reduces carbon uptake and soil respiration. In a future climate, the effect of drought was amplified through enhanced soil moisture reduction. Furthermore, the future climate induces a faster recovery of carbon uptake and allocation from drought.