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# Root growth and root respiration of a perennial grassland subjected to future climate change and extreme event

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## INTRODUCTION



Future climate scenarios suggest not only an increase in atmospheric CO<sub>2</sub> concentration and air temperature, but also more frequent and severe extremes events, such as summer heat wave and severe drought. An increase of atmospheric CO<sub>2</sub> may improve plant growth through its primary effects on both leaf photosynthesis and stomatal conductance. The aim of this work was to test the hypothesis that elevated CO<sub>2</sub>, combined with air warming and severe soil drought, improves root growth and root respiration through its direct effects on leaf photosynthesis and plant transpiration and indirect effects on soil water content.



## METHODS

Forty-eight grassland monoliths coming from an upland site in France were divided in 12 replicate units and exposed, from May 2010 until December 2011, to a future scenario reproducing air temperature and precipitation (P) expected for the period 2040-2060 (Control: C, +3.5°C, -10% P, annual based). Since March 2011, 6 units were maintained at ambient CO<sub>2</sub> (380C) and 6 units at +180 ppm [CO<sub>2</sub>] (520C). In addition, 3 units per [CO<sub>2</sub>] (380E, 520E) were subjected during summer 2011 to a heat wave (15 days at +6.7°C) combined with a severe P reduction (-100%). Root growth rate was estimated with the in-growth core method (IGC, 15cm depth, 0.754 L). Root respiration (SRR, Licor6400-09 chamber system) and root dry matter content (RDMC) collected in the IGC were measured before, during and after the extreme event.

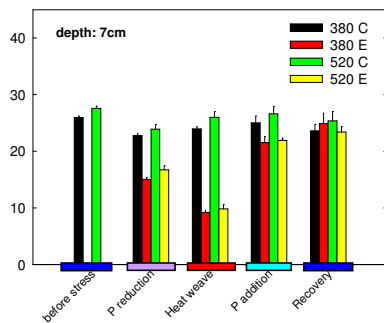
TREATMENTS	BEFORE STRESS	P REDUCTION	HEAT WEAVE	P ADDITION	RECOVERY	AVERAGE April-Nov
Warming vs actual climate (°C)	All: 3.2	All: 2.5	C: 3.3 E: 6.7	All: 3.1	All: 3.8	All: 3.7
P reduction vs actual climate (%)	≈ 0	C: -35 E: -54	C: +67 E: -100	C: -22 E: -54	C: -61 E: -59	C: -26 E: -39
Duration (days)	84	26	13	42	49	214



Root respiration

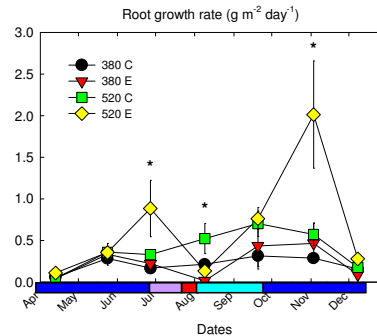


## SOIL WATER CONTENT



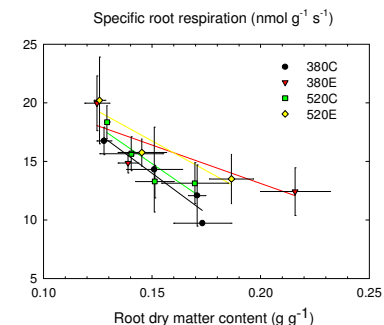
- Elevated CO<sub>2</sub> slightly increased (7%) soil water content (SWC) whatever the period.
- During P reduction but before the heat wave, the effect of elevated CO<sub>2</sub> on SWC was more pronounced (+12%)
- During heat wave, rehydration and recovery periods, this effect disappeared
- Drought stress combined with heat wave reduced SWC to values lower than 10%

## ROOT GROWTH RATE



- Before stress period, there was no differences between treatments
- At the beginning of P reduction, and after heat wave, root growth rate was higher under elevated CO<sub>2</sub>
- Heat wave sharply decreased root growth, but the recovery was 4 fold higher under elevated CO<sub>2</sub>

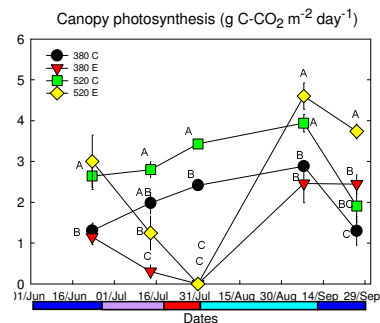
## ROOT RESPIRATION AND MORPHOLOGY



- A trade-off was observed between specific root respiration (SRR) and root dry matter content (RDMC)
- RDMC slightly increased in extreme treatments, whereas SRR was unaffected by treatments

## CANOPY PHOTOSYNTHESIS

- Elevated CO<sub>2</sub> increased canopy photosynthesis during the experiment in the control treatment
- The CO<sub>2</sub> effect was maintained during P reduction and sharply increased during the recovery period and was even higher than the control (520E > 520C) at the end of the recovery period



## CONCLUSIONS

Upland grasslands are expected to better recover from a summer extreme event under elevated CO<sub>2</sub> combined with warmer and drier climate than actually. Higher canopy photosynthesis and soil water content contributed to higher root growth rate. Thus faster recovery of the below-ground compartment is expected to contribute to grassland survival in future climate.