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## **Elevated CO<sub>2</sub> enhances short-term recovery after extreme drought and heat in a temperate grassland.**

Catherine Picon-Cochard, J. Roy, D. Landais, Marie-Lise Benot, C. Piel, M. Defosse, C. Escape, S. Devidal, O. Ravel, M. Bahn, et al.

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Research  
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## INTRODUCTION



Under warmer and drier climatic conditions, increase of atmospheric CO<sub>2</sub> concentration is expected to limit the negative effects of stress on grassland production. The capacity to recover after drought could also be favored by elevated CO<sub>2</sub>, as it may improve plant growth through its primary effects on both leaf photosynthesis and stomatal conductance.

**The aim of this study** was to evaluate a possible mitigation effect of elevated CO<sub>2</sub> on canopy C and water fluxes, and its consequences on forage production and quality, during and after an extreme event (soil drought x heat).

## METHODS

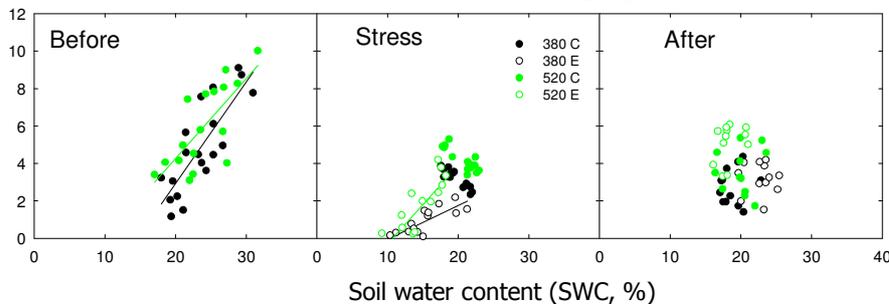


- ✓ 48 grassland monoliths (1m x 1m x 0.6 m depth, upland site: Auvergne, France) in 12 experimental units.
- ✓ **Year 1**: monoliths exposed to air temperature (T) and precipitation (P) expected for 2040-2060: **2.3 C warming combined with 10% reduction of P** by comparison to average climatic conditions
- ✓ **Year 2**: 6 of the 12 units exposed to elevated CO<sub>2</sub>, i.e. 520 μmol mol<sup>-1</sup>, compared with ambient CO<sub>2</sub>, i.e. 380 μmol mol<sup>-1</sup>.
  - In Summer, **P reduction from end of June during 1 month**, then **no watering** combined with a **heat wave (+3 C) during 17 days**, and finally progressive **rehydration until fall**.
  - Treatments: 380 C and 520 C: without heat wave and drought, 380 E and 520 E: with heat wave and drought
- ✓ C and water fluxes: gross primary production (GPP), evapotranspiration (ET) and soil water content (SWC, 0-60cm) were continuously measured. Water-use efficiency was calculated as WUE = GPP / ET.
- ✓ Above and below-ground (ingrowth-core method, picture) biomasses, forage quality (N, NDF: total cell wall) were measured before stress and after rehydration at cut date.

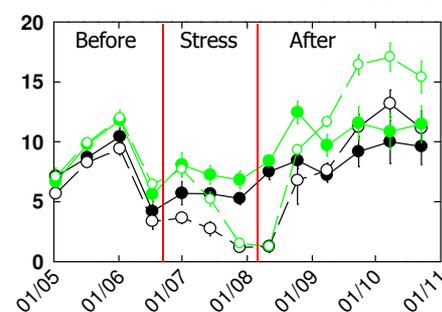


## RESULTS

Gross primary production (GPP, gCO<sub>2</sub> m<sup>-2</sup> d<sup>-1</sup>)



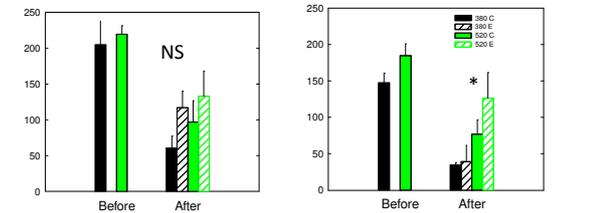
Water-use efficiency (WUE, mgCO<sub>2</sub> g<sup>-1</sup>H<sub>2</sub>O)



### Higher GPP and WUE under elevated CO<sub>2</sub>

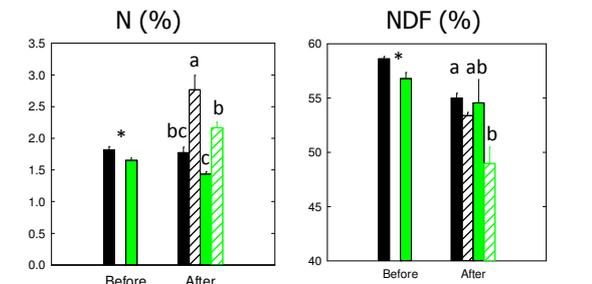
- ✓ Before stress due to slightly higher SWC (+5%)
- ✓ During stress for similar SWC and evapotranspiration
- ✓ After rehydration at similar evapotranspiration but lower SWC

Green biomass (g DM m<sup>-2</sup>) Root biomass (g DM m<sup>-2</sup>)



### Under elevated CO<sub>2</sub>

- ✓ Before stress: above and below-ground biomasses were unchanged, and lower N and NDF
- ✓ After stress: higher root biomass and lower N and NDF



## CONCLUSIONS

Under future climatic conditions (warmer and drier) forecasted for 2040-2060

- **Elevated CO<sub>2</sub> mitigated the negative effect of drought x heat** by increasing GPP and WUE, and **promoted recovery** of this permanent grassland
- These changes led to **higher root biomass** with **no effect on above-ground production**
- **Forage quality** was affected: **more digestible** forage but containing **less N**
- This study confirmed the **short-term recovery capacity of permanent grassland after severe drought and heat**