Summer extreme climatic event in the future: impact on net CO2 and water fluxes of an upland grassland and buffering impact of elevated atmospheric CO2.


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Summer extreme climatic event in the future: impact on net CO$_2$ and water fluxes of an upland grassland and buffering impact of elevated atmospheric CO$_2$

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3 platforms:

- 12 macrocosms
- 12 (300) microcosms
- 24 mesocosms

**THE EUROPEAN MONTPELLIER ECOTRON**

A research platform to analyse the responses of ecosystems, organisms and biodiversity to environmental changes

Open to international consortia
Call in summer 2013
Intact soil monoliths
From a mid-altitude grassland

Inserted in the macrocosms of the Ecotron
Air diffusing ring

Tefzel sheet

Intact ecosystem sample

Internal mixing flux (2 vol / mn)

75 m³ / mn

Air outlet

Air inlet

Air conditioning unit

2,5 m³ / mn
On line measurements

Net CO$_2$ Exchange: every 12 mn

$$\text{NEE} = \frac{[F \times (C_{\text{out}} - C_{\text{in}})]}{S}$$

Whole system calibration every night in one macocosm by simulating known additional respiration

Evapotranspiration: continuous measured by weight loss (straingauges)
2010: preconditioning warmer and dryer scenario reproducing the 2050 forecasted climate for the sampled site

<table>
<thead>
<tr>
<th></th>
<th>Annual Precipitation</th>
<th>Annual Mean Air Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>1999</td>
<td>856 mm</td>
<td>8.6 °C</td>
</tr>
<tr>
<td>2050</td>
<td>770 mm</td>
<td>10.9 °C</td>
</tr>
<tr>
<td>Difference 2050/1999</td>
<td>- 10%</td>
<td>+ 2.3 °C</td>
</tr>
</tbody>
</table>

2011: full experiment
T°C and rainfall = 2050
6 macrocosms ambiant CO₂: 390 ppm
6 macrocosms 2050 CO₂: 520 ppm
Summer drought: - 50% rainfall
Drought (0 %) + heat wave + 3.5 °C
Gradual rewatering
Averaged environmental conditions achieved in the 4 treatments

<table>
<thead>
<tr>
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<th>Ctrl 390</th>
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<th>Extr 390</th>
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<th>Ctrl 520</th>
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<tr>
<td>CO2</td>
<td>391,0</td>
<td>1,6</td>
<td>392,3</td>
<td>1,1</td>
<td>520,9</td>
<td>1,6</td>
<td>518,9</td>
<td>2,5</td>
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<tr>
<td>T °C</td>
<td>15,46</td>
<td>0,03</td>
<td>16,03</td>
<td>0,09</td>
<td>15,48</td>
<td>0,05</td>
<td>16,09</td>
<td>0,04</td>
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<tr>
<td>VPD</td>
<td>0,71</td>
<td>0,03</td>
<td>0,91</td>
<td>0,02</td>
<td>0,76</td>
<td>0,03</td>
<td>0,90</td>
<td>0,01</td>
</tr>
</tbody>
</table>
Soil moisture at 7cm depth

- Control 2050: cold colors
- Elevated CO2: lighter colors
- Extreme 2050: warm colors

- Time (Year/month)

- SWC (%)

- C-380
- E-380
- C-520
- E-520

- T°C: 2050 Rain: 2050
- T°C: 2050 Rain: 50%
- T°C: 2050 Rain: 0%
- T°C: 2050 Rain Gradient

- Cut 1
- Cut 2
- Cut 3
- Cut 4

- Cold colors: blue
- Warm colors: red
- Lighter colors: orange
Net Ecosystem Exchange (24h)

Climate: -181% p=0.000

CO₂: +29% p=0.020

Time (Year/month)

2010 2011
Net Ecosystem Exchange (24h)

T°C: 2050  Rain: 2050

Climate: - 181 % p=0,000

CO₂: + 29% p=0,020

Climate: + 152 % p=0,005

CO₂: + 143 % p= 0,006

Period Post Stress
Effet CO₂ : F(1, 8)=14,00   p=,006   Vertical Bars IC = 0,95
Effect Climate: F(1,8)=14,89  p=,005  Vertical Bars IC à,95

Time (Year/month)

NEE (g CO₂.m².day⁻¹)
CO₂  ACO₂
CO₂  ECO₂

Evapotranspiration (24h)

- **Climate**: - 49 %  \( p=0.000 \)
- **\( \text{CO}_2 \)**: - 3 %  \( p=0.021 \)

**ETR (\text{kg.day}^{-1}/\text{4m}^2)**

- **T°C: 2050  Rain: 2050**
- **T°C: 2050  Rain: -50%**
- **T°C: 2050  Rain: 40%**
- **T°C: 2050  Rain: Gradual**

**Cut 1**, **Cut 2**, **Cut 3**, **Cut 4**

**Time (Year/month)**

2010  2011
Evapotranspiration (24h)

T°C: 2050  Rain: 2050

Climate: -49%  p=0.000

CO₂: -3%  p=0.021

CO₂ * Climate:  p=0.006

Period Post Stress

CO₂ * Climate : F(1, 8)=8.3402, p=.020
Ecosystem Water Use Efficiency (diurnal)

- Climate: -150% p=0.000
- CO₂: +31% p=0.007
- CO₂: +44% p=0.011
- Climate: +51% p=0.012

Period Post Stress
Effect CO₂: F(1, 8)=10.87 p=0.011
Effect Climate: F(1, 8)=10.51 p=0.012
ETR 11 months

NEE 11 months

Root Growth Rate

Above ground biomass

Sum all cuts

Root growth at different periods
Conclusions:

Significant impact of extreme drought-Temperature on NEE

Significant positive impact of CO2, overcompensate the negative effect of extremes

More impact on roots and soil than on above ground biomass

Hope to welcome you in the Ecotron
ExpeER funds Transnational Acess to more than 30 European experimental sites

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