Long-term effects of climate change drivers (temperature, drought and elevated CO2) on an upland grassland ecosystem

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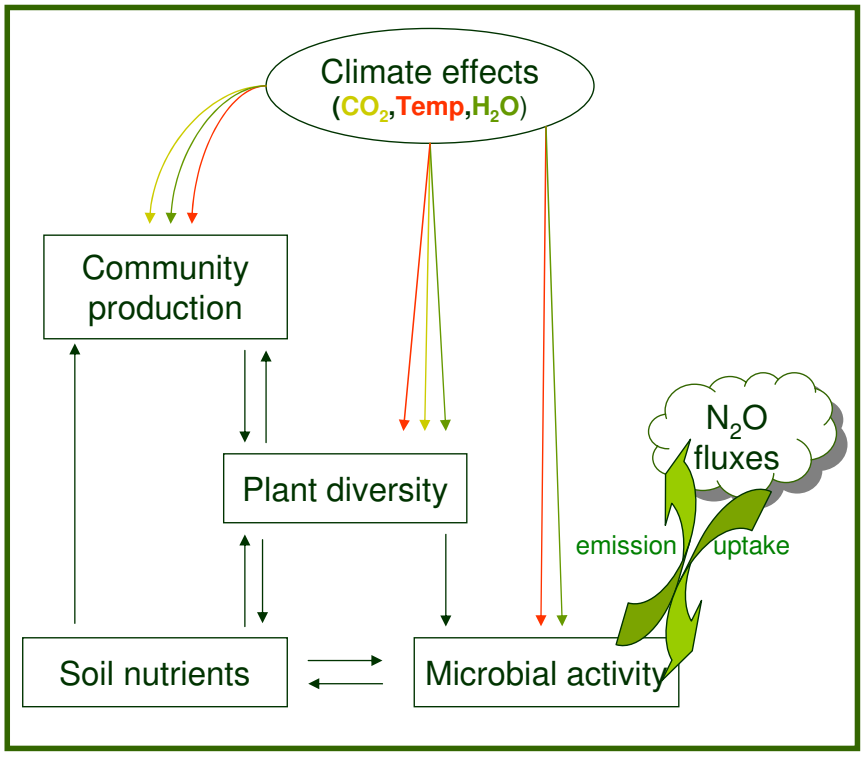
Introduction

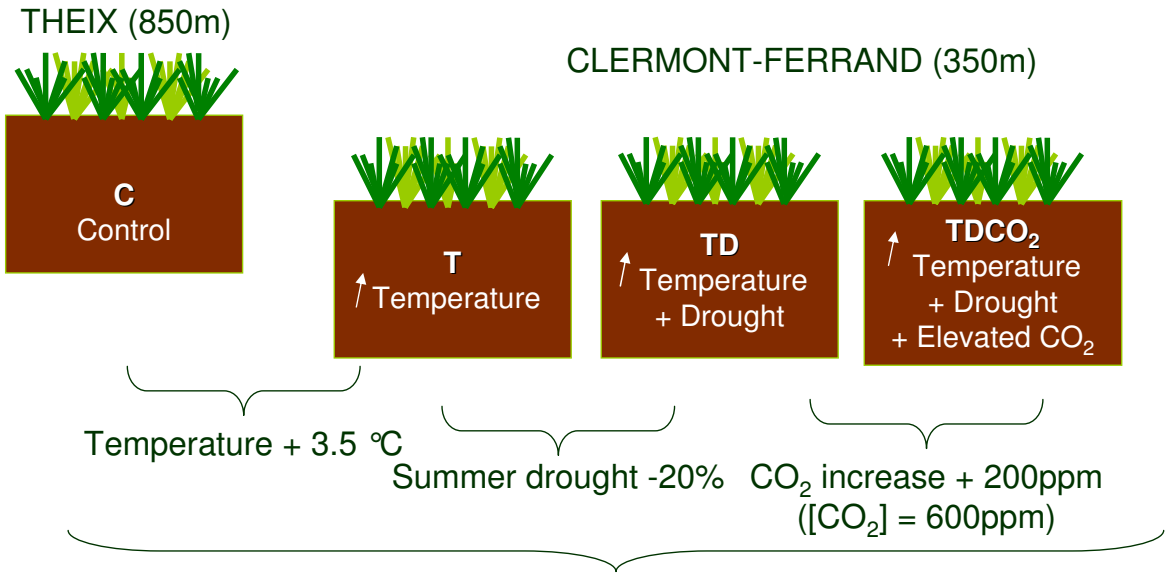


- Current climate models predict
  - ↗ global temperatures
  - Changes in regional patterns of rainfall
  - ↗ greenhouse gases production
- Climate change has direct and indirect effects on
  - Plant community production
  - Plant community diversity
  - GES emissions
- Long term effects of climate change remain unclear

Study aims

- How do climate change drivers affect grassland production (short and long term effects)?
- Do plant biomass patterns match changes in species diversity or/and functional diversity?
- How are trace greenhouse gases (N_2O fluxes) impacted by climate change drivers?

Experimental design

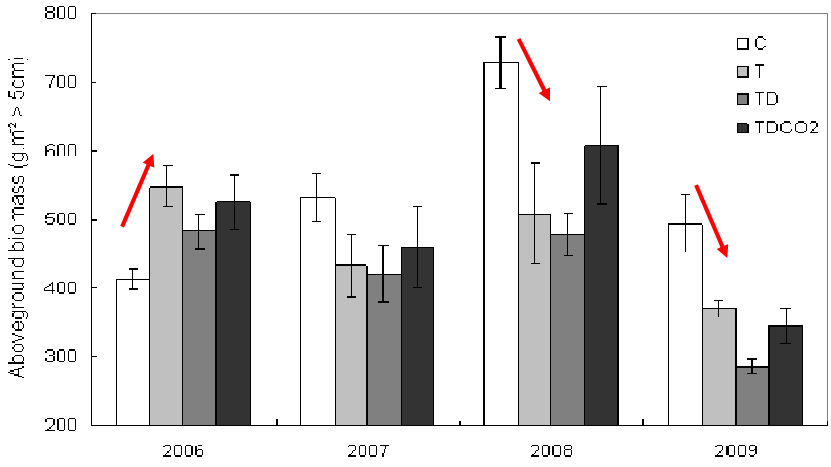


A2 scenario predicted for Massif-Central in 2080 (IPCC)

- Ecosystem: upland grassland, light sheep grazing, no fertilizers
- 5 experimental units per climate treatment

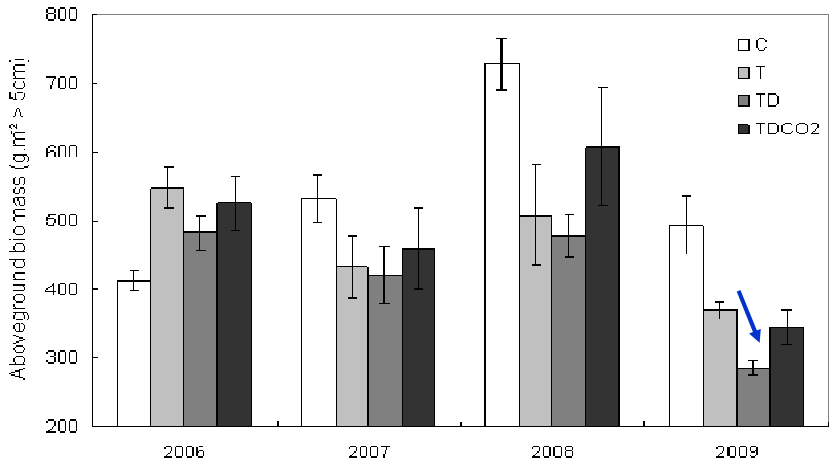
- Annual biomass production: sum of the April and October biomass per experimental unit
- Species diversity: Shannon-Weaver, Equitability indices based on April cut
- Functional diversity: proportion of grasses, legumes and forbs on annual biomass
- N_2O measurement with closed static chambers and a photoacoustic gas analyser (INNOVA)

Aboveground biomass production



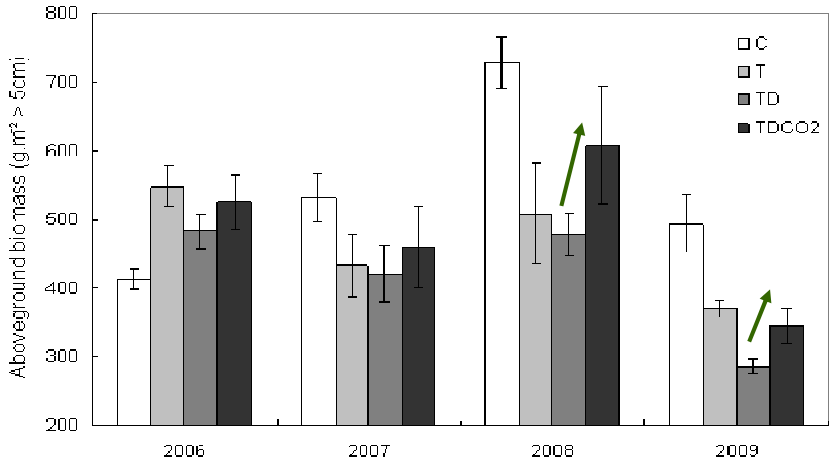
- Effects of warming varied over time: positive effects in 2006 but negative effects in 2008 and 2009

Aboveground biomass production



- Biomass tended to decrease in response to summer drought (but only significant in 2009)

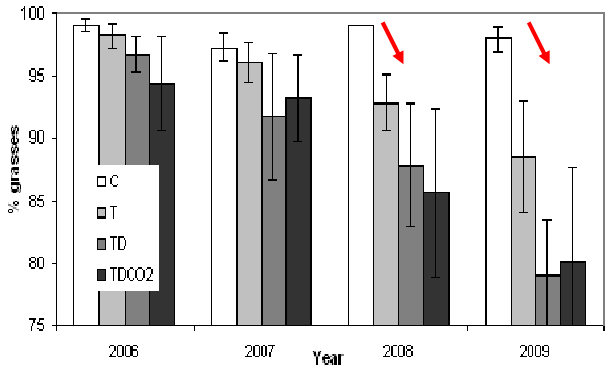
Aboveground biomass production

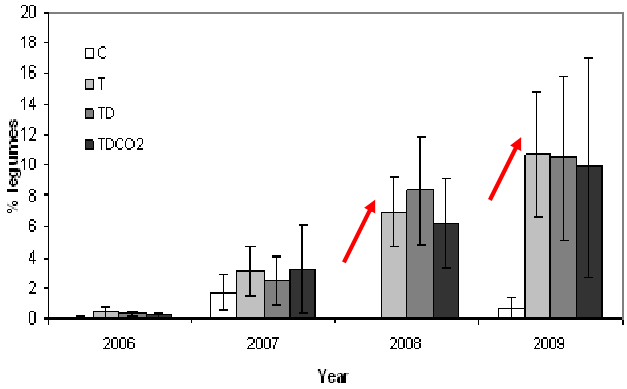


- Positive effect of elevated [CO_2] after three years of climate change

Plant diversity

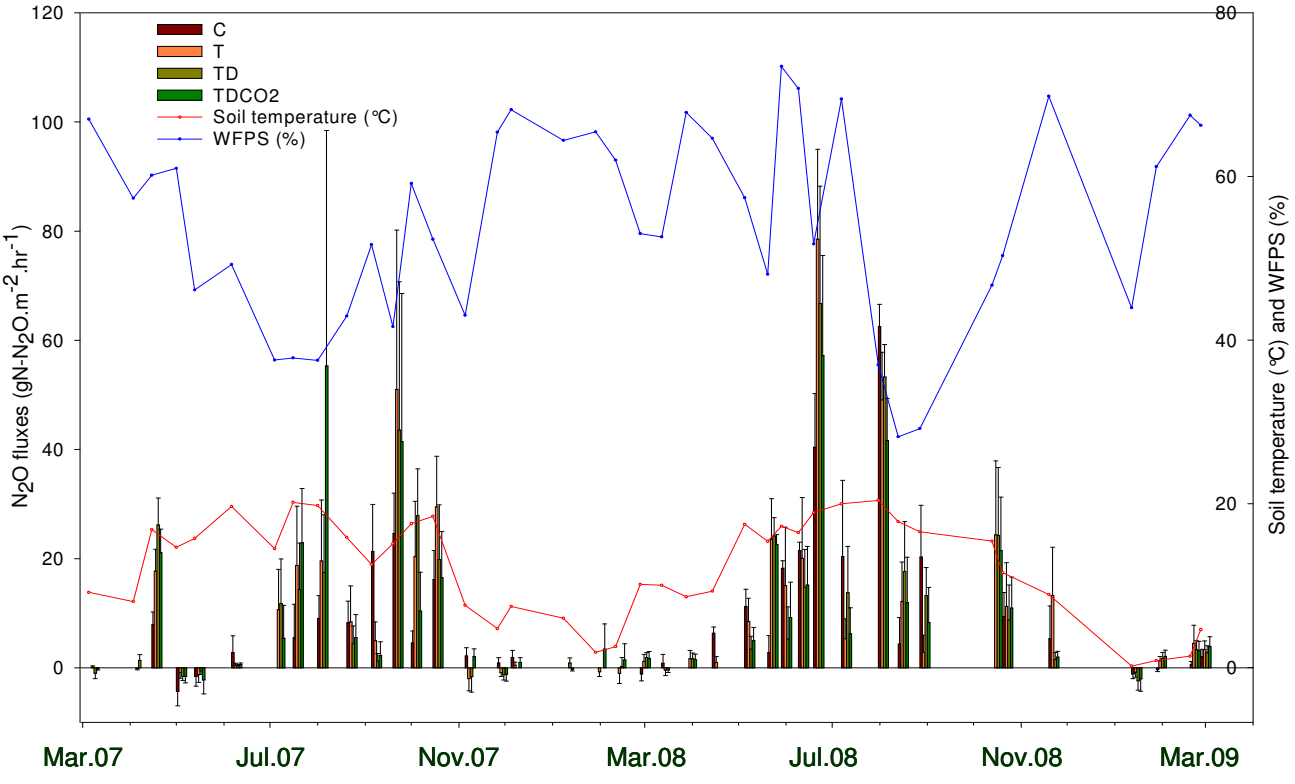
- No effect of climate drivers on Shannon-Weaver and equitability indices
- Significant effect of warming on functional diversity after 3 years of climate change



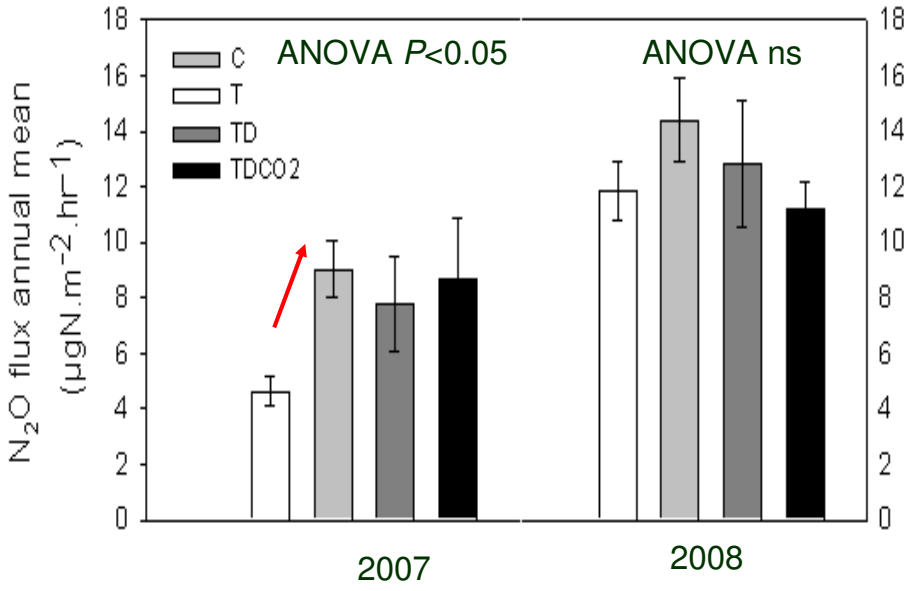


- negative impact on grasses
- positive impact on legumes

Variation in N_2O fluxes



N_2O fluxes and climate change treatments



- Warming had a positive effect on annual N_2O fluxes in 2007 (same tendency in 2008)

Abiotic factors and N_2O fluxes

- Positive effect of soil temperature (*Spearman R*: 0.643) and rainfall (*Spearman R*: 0.563) on N_2O fluxes
- Negative correlation between WFPS and N_2O fluxes (R: -0.250)
- Climatic treatments seem to modify relations between N_2O fluxes and abiotic factors.
  - Multiple regression analysis:

$$Ln(N_2O) = a + b*ln(Soil\ temperature) + c*ln(WFPS) + d*ln(Rainfall)$$

Treatments	R^2	Soil temperature	WFPS	Rainfall
C	18.65**	**	ns	ns
T	45.55**	ns	**	***
TD	37.77**	*	*	*
TDCO2	30.30**	***	*	ns

Conclusions – Part 1

- Climate change drivers have different effects on plant biomass production
  - Warming appears to be the most important climate change driver for this cool upland system
  - Elevated [CO_2] effects are progressive in time
  - Limited summer drought may be related to ambient weather conditions
- No change in species diversity but changes in functional diversity after 3 years of climate change
  - Decrease in grass abundance under warming mirrors patterns in plant biomass

Conclusions – Part 2

- N_2O fluxes showed limited responses to climate change drivers in our study system.
  - Greater responses might be expected in more productive grasslands.
- N_2O fluxes were correlated with soil temperature, WFPS and rainfall
  - Climate treatments appear to modify the relationship between N_2O fluxes and abiotic factors
- Long term studies are critical for detecting progressive effects of climate change on ecosystems





Thank you for your attention!

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