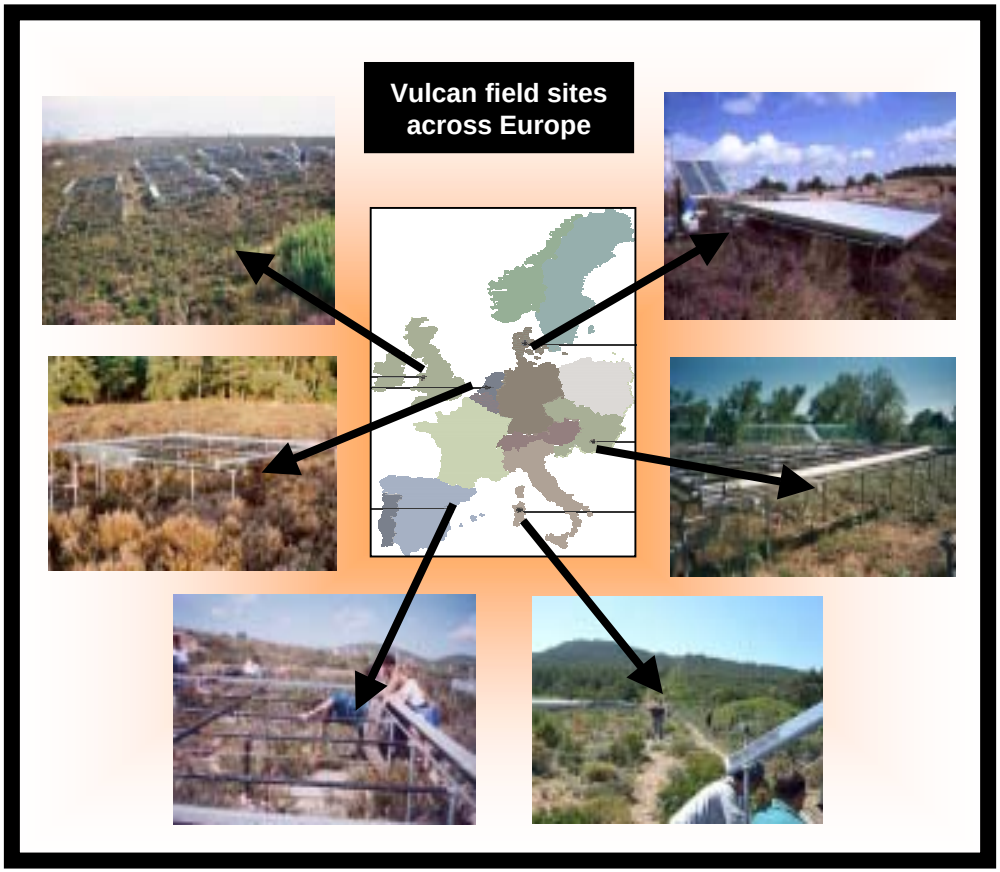
Experimental rationale

- To quantify key shrubland ecosystem functions
  - Nutrient cycling, C sink, water quality, GHG emissions….
- And determine how they are modified by climate change

•www.vulcanproject.com



Ecosystem services

Vulcan

Climate

Ecosystem & soil CO_2

Canopy Reflectance

N mineralisation

Phosphotase activity

Litterfall

Litter decomposition

Plant species change

^{14}C allocation

Plant chemistry

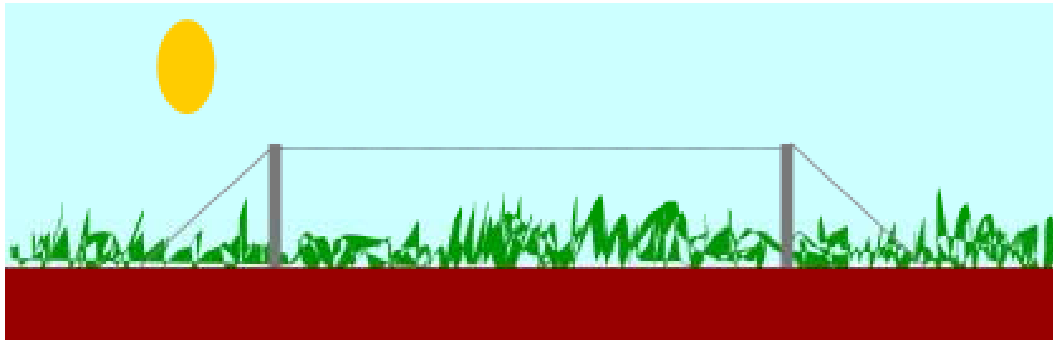
Phenology

Root ingrowth

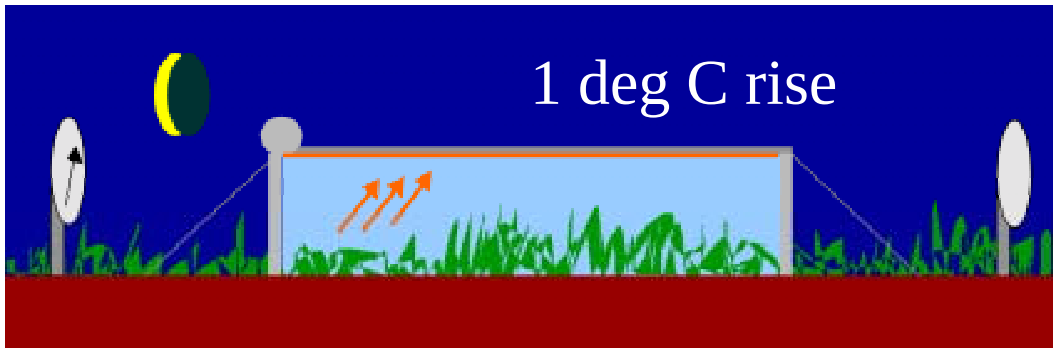
Above- and below-ground invertebrates

Water quality

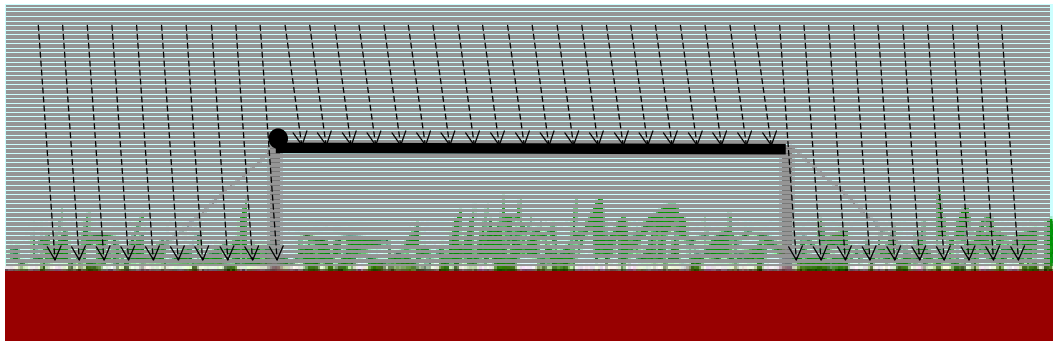
We use retractable roofs to minimise artefacts



Roofs open during daytime



Roofs closed during nightime "Warming"



Roofs closed during summer rain "Drought"

3 levels of information

- Inter-annual variations at a site
- Response functions across sites (gradient approach)
- Experimental results

Wales

- Upland heathlands dominated by *Calluna vulgaris*
- Risk analysis indicates persistence will depend on value for conservation
  - N deposition
  - inappropriate management
  - & now climate change

Impact on ecosystem structure: Species change

- Increased dominance by *Calluna* at expense of *Empetrum*
- Not always as would be predicted from inter-annual variability
- Why?
  - Interactions and feedbacks

Impacts on ecosystem function: C storage

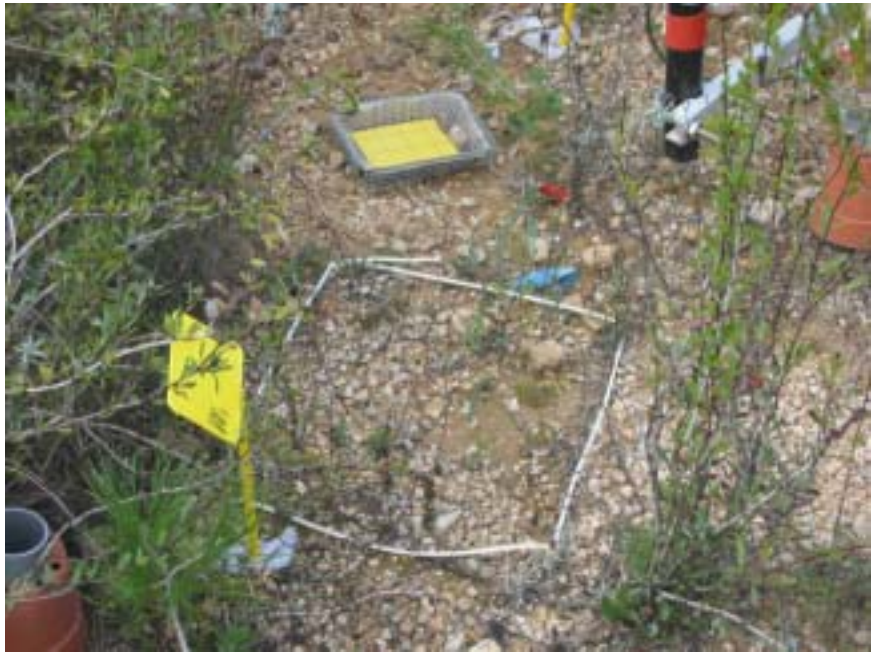
- Persistent effect of drought on soil moisture holding capacity over whole year
- Accelerated carbon loss from the soil

Spain

(J Penuelas and Marc Estiarte, CREAF)

- Risk analysis indicates major threat is urbanisation and fire
- Main climate change effect is on fire risk
- but additional effects on phenology, recruitment, competition + …….

Seedling recruitment sampling procedure



Italy

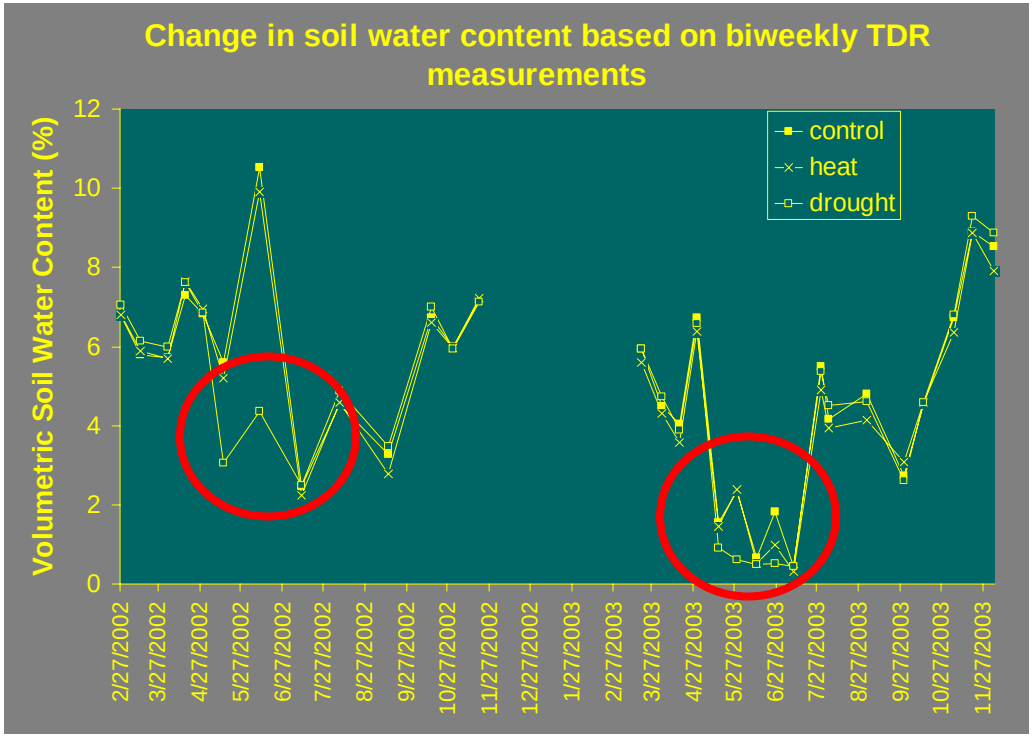
(Paolo de Angelis, DISAFARI et al.)

- We expected the drought effects in the Mediterranean but also warming effects
- Soil respiration suppression was greatest in warming plots

Hungary

(Kyorgy Kroel-Dulay &Edit Lange -BOTANIKA)

- ‘Natural’ drought in 2003 was beyond the ‘extreme’ treatment imposed in 2002
- Future may be beyond the current envelope



The Netherlands

(Albert Tietema, UoA)

- Water quality problems are enhanced with climate change
- There was a three-fold increase in nitrate leaching with warming in the NL

Conclusions

- Shrublands are expanding in some areas and declining in others
- Drivers of these changes are very specific to different regions as are the perceptions of their value
- We are just starting to understand their wider ecosystem functions and sensitivity to climate change