Long-term effects of seasonal warming on ecosystem functioning in a north Swedish blanket bog

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With contributions of:

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- Andrej Tsyganov
- James Weedon

Study site

- Blanket bog near Abisko, Sweden (68^0N)
- Dominated by *Sphagnum fuscum, Empetrum hermaphroditum, Betula nana, Rubus chamaemorus, Andromeda polifolia, Calamagrostis lapponica*
- Vegetation season of 130 days
- Experiment started in June 2000

Experimental design

Six treatments (n=5):

Seasonal climate manipulations by combinations of

summer ambient (A) or summer warming (W)

winter ambient (A) or extra winter snow (S)

spring ambient (S-) or spring warming (S+)

Take home messages:

(1) Responses of short-lived, non-sessile organism much faster than plant responses.

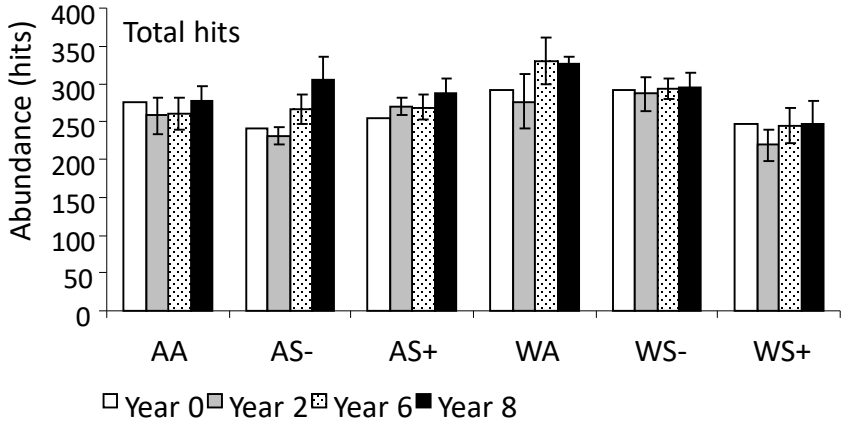
(2) Plant responses more driven by plant identity than by climate treatments;

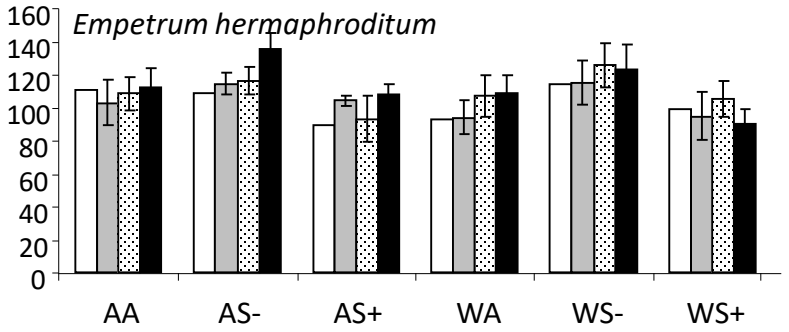
(3) Summer warming is the main driver of responses, compared to spring and winter treatments

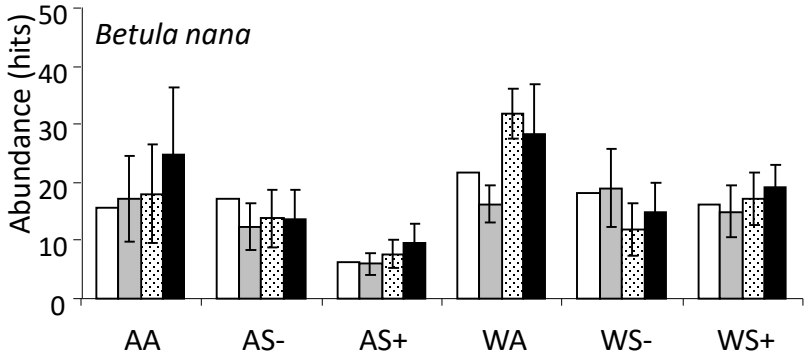
(4) Climate extremes (or interannual variability) far more important than gradual warming treatments;

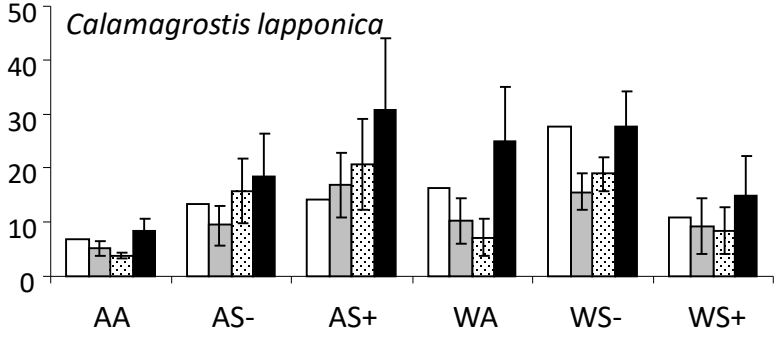
Vascular plant cover and diversity determined after 2, 4, 6 and 8 years

No treatment effects !



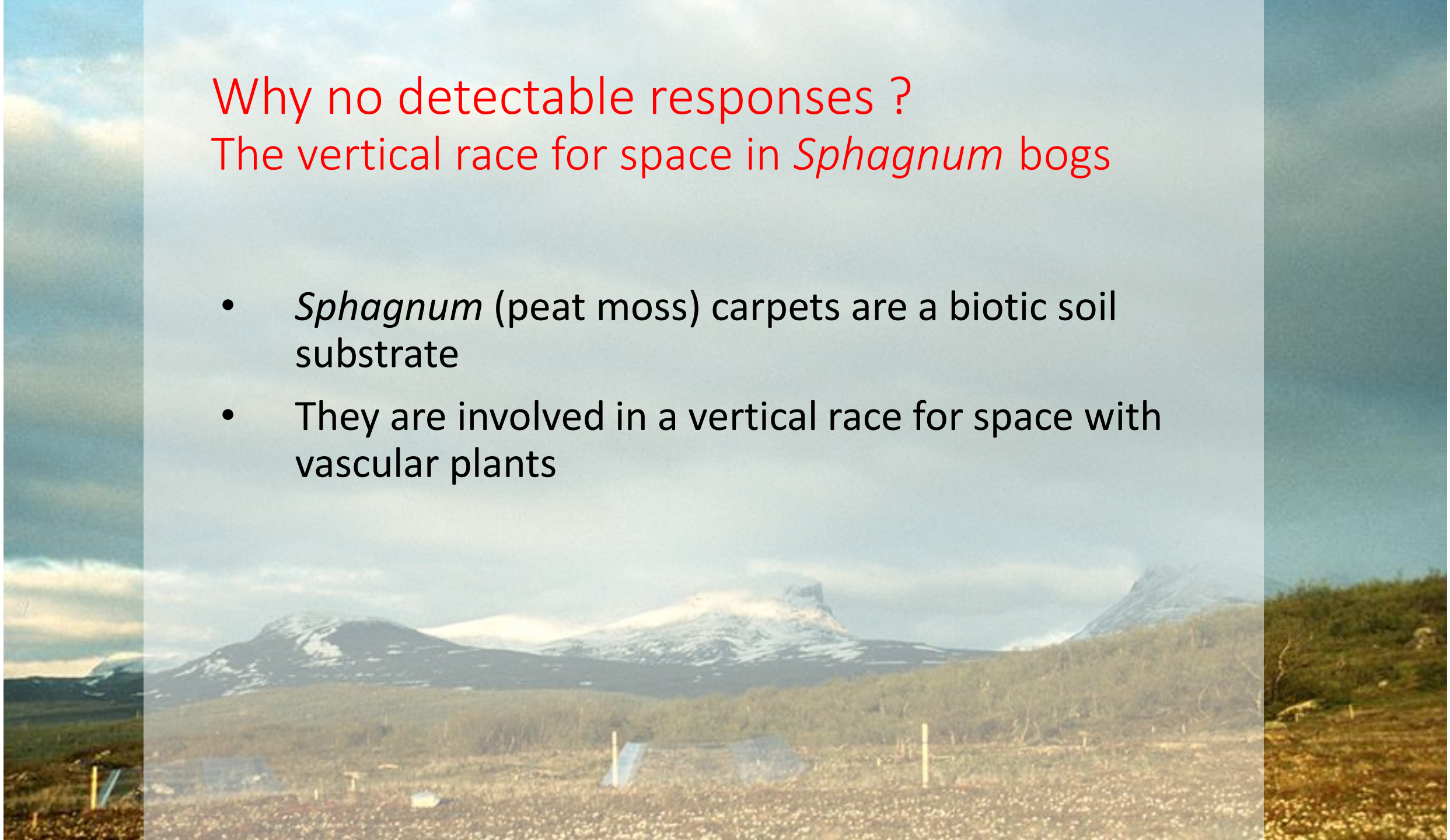




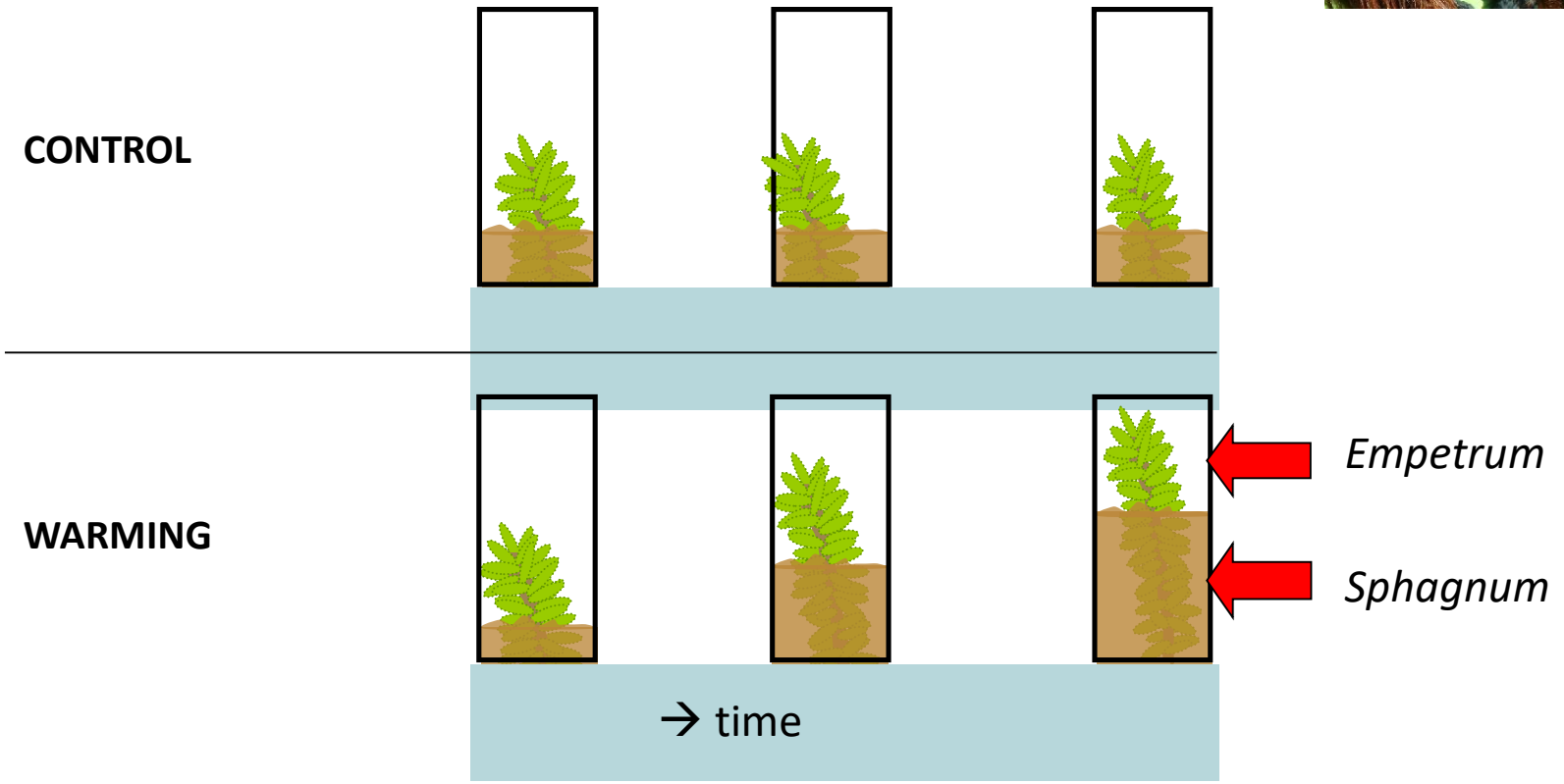


Why no detectable responses ?
The vertical race for space in *Sphagnum* bogs

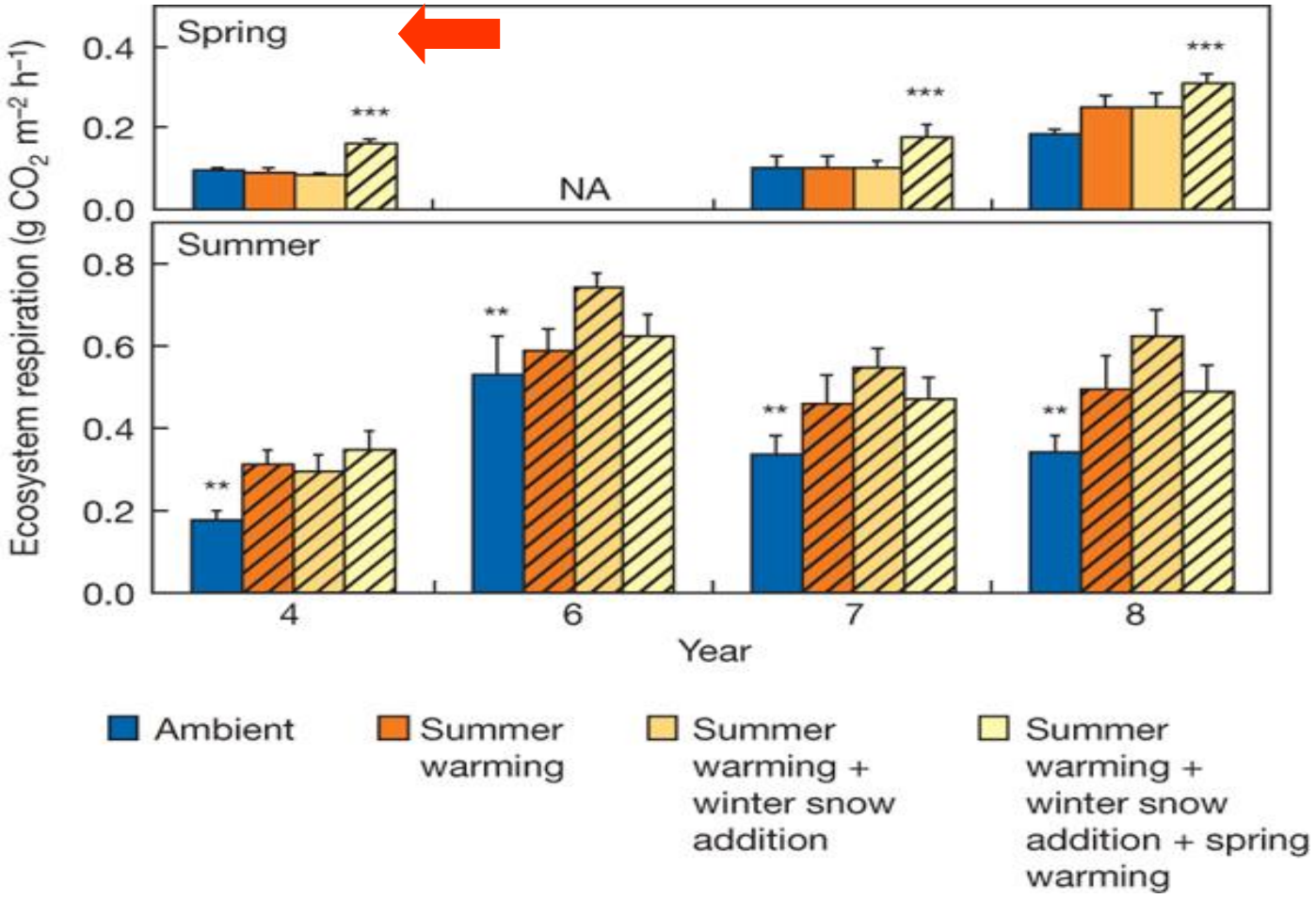
- *Sphagnum* (peat moss) carpets are a biotic soil substrate
- They are involved in a vertical race for space with vascular plants

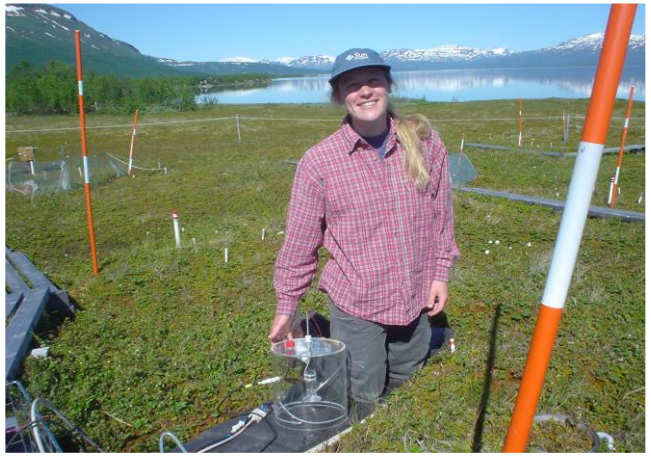


The vertical race for space



Responses of short-lived organisms: Ecosystem respiration increases quickly with summer warming





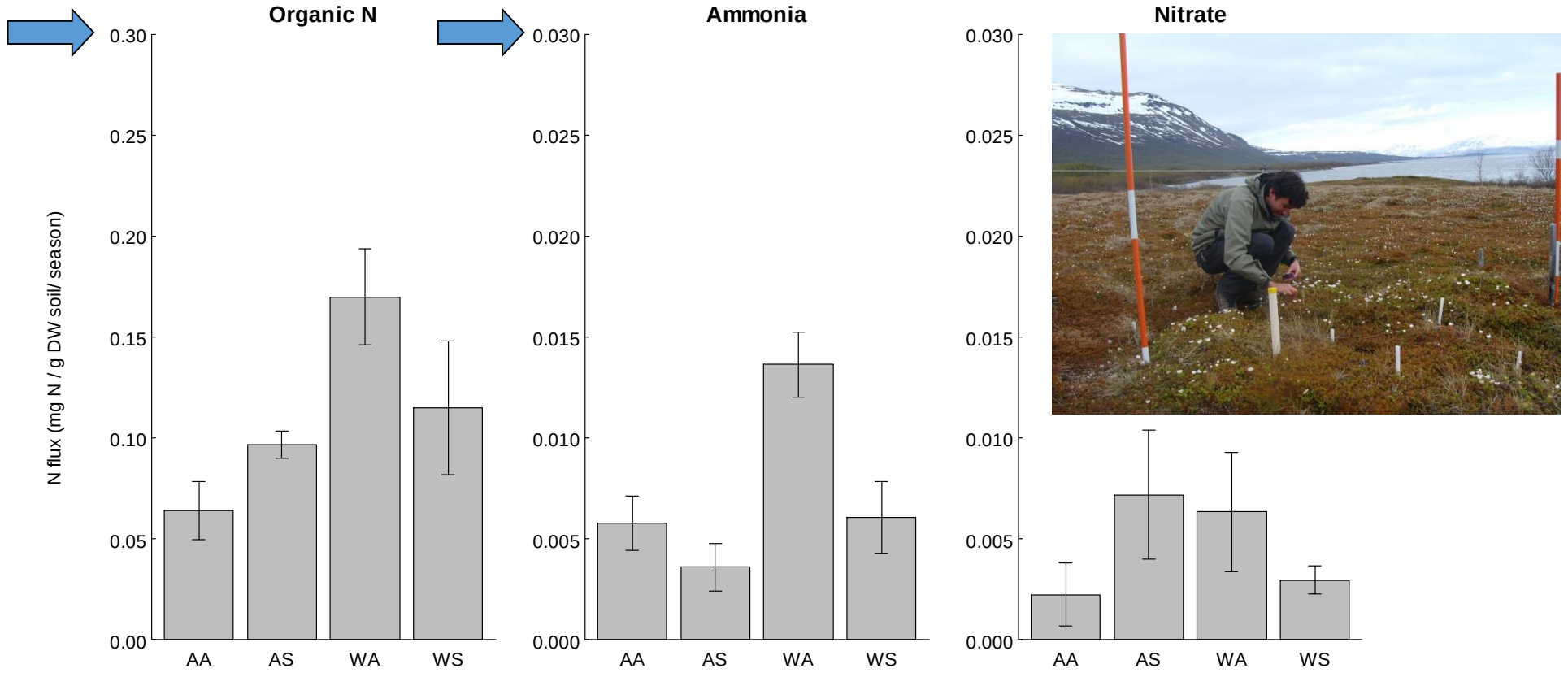
Dorrepaal *et al.* Nature

Conclusions CO_2 flux study

- Summer warming (1.5°C) increases ecosystem respiration with ±50%
- 70% of this increases originates from sub-surface peat ('old peat')

→ A positive feedback on global warming !!

Responses of N-transforming bacteria: Summer warming doubles fluxes of organic N and ammonia in SOM



Weedon et al. (GCB, 2014)

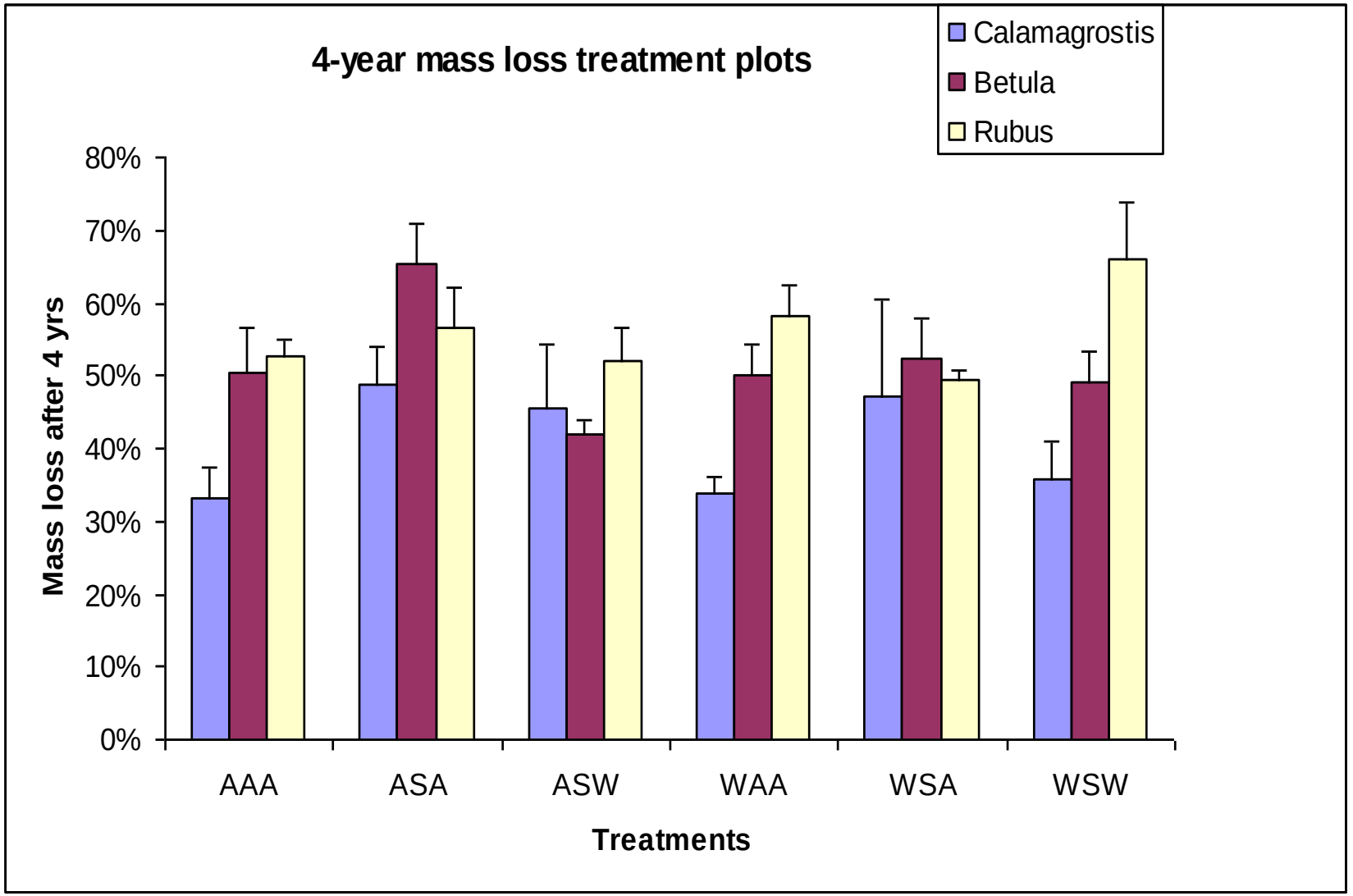
Results sub-arctic N-flux study

- Organic N-fluxes almost an order of magnitude higher than inorganic N fluxes.
- Summer warming doubles fluxes of organic N and ammonia.
- No treatment effects on potential peptidase activities, but strong seasonal decline.
- Stable microbial community structure.
- N flux driven by seasonal microbial dieback.

Plant specific responses:
Litter decomposition vascular species

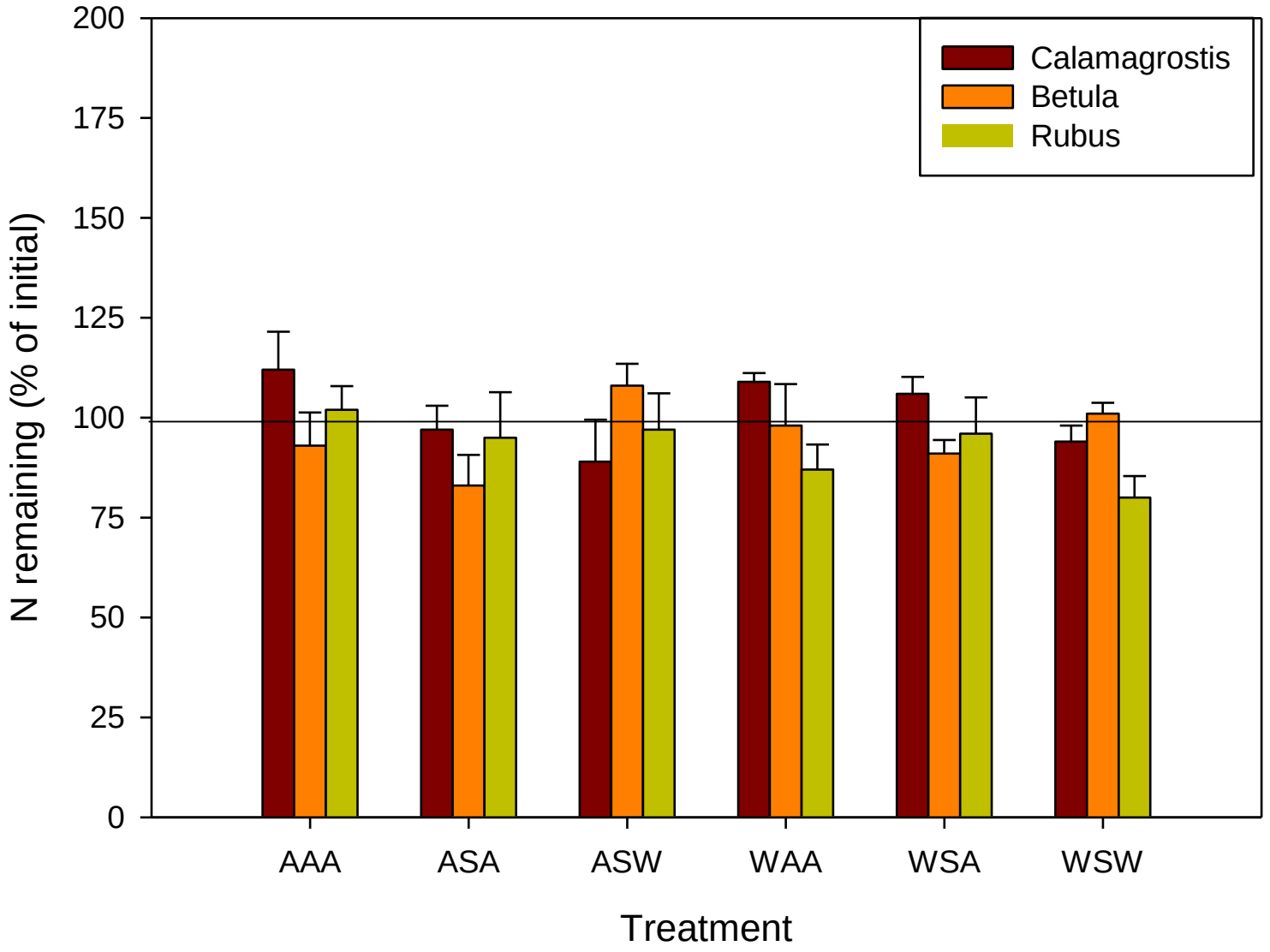
- *Calamagrostis lapponica, Betula nana, Rubus chamaemorus*
- Litter collected in the six treatments
- Incubation in the treatment plots with a temperature increase of about 1.5°C
- Harvest after 4 years

After 4 yrs hardly any treatment effects but strong interspecific differences



Aerts et al. Oecologia

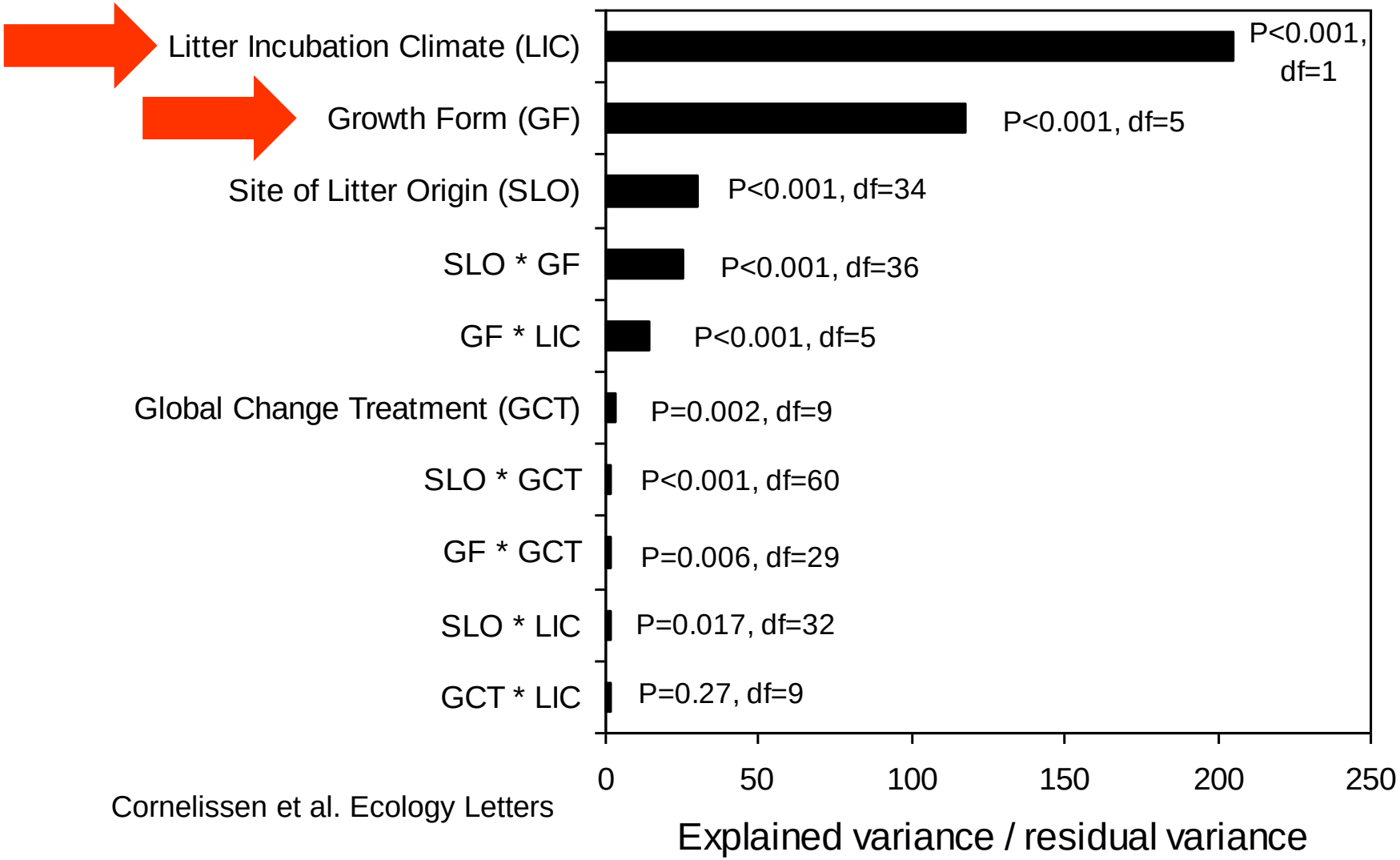
After 4 yrs no net N-release and no treatment effects, but interspecific differences



How robust is this pattern ?
What happens at temperature increases at the high end of the predicted range ?

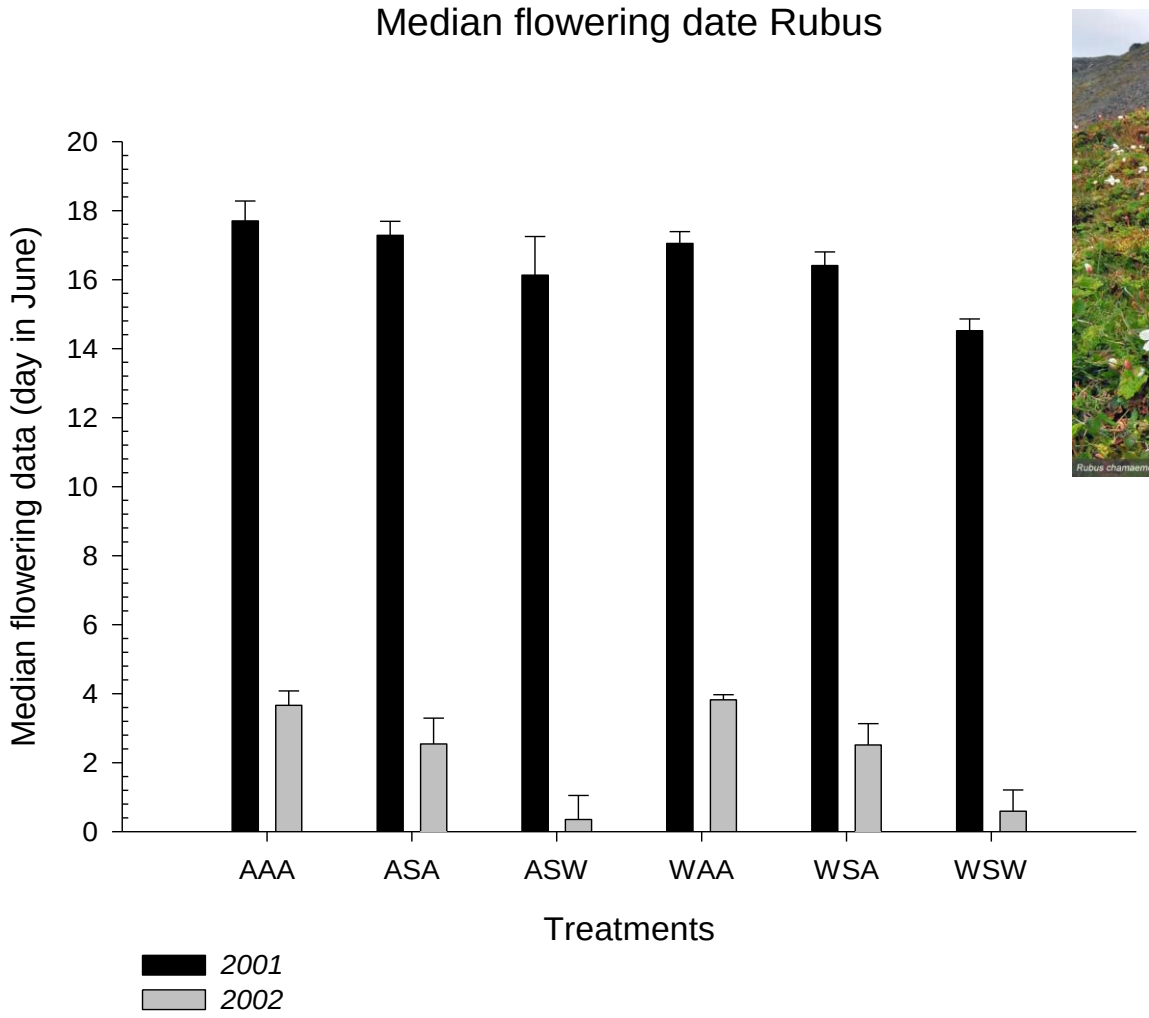
- The “Meeting of Litters”
- Litter material from 33 global change experiment incubated in Abisko in litter beds *at two altitudes* differing 6^{o}C in MAT.
- Incubation for 2 yrs.

LIC (representing a 6^0C difference) explains the largest % variation in mass loss !



Cornelissen et al. Ecology Letters

Effects of inter-annual temperature variability >> treatments



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Some considerations for the future: ITEX 2.0

(1) How to include climate extremes in standardized protocols ?;

(2) Are we warming strongly enough to mimick current and projected climate warming?;

(3) If not, what should be done ?


Thank you for your attention !