PLANT-SOIL-MICROBE RESPONSES TO EXPERIMENTAL CLIMATE CHANGE

OR: WHY PLANT ROOTS AND MICROBES MATTER FOR SOIL CARBON

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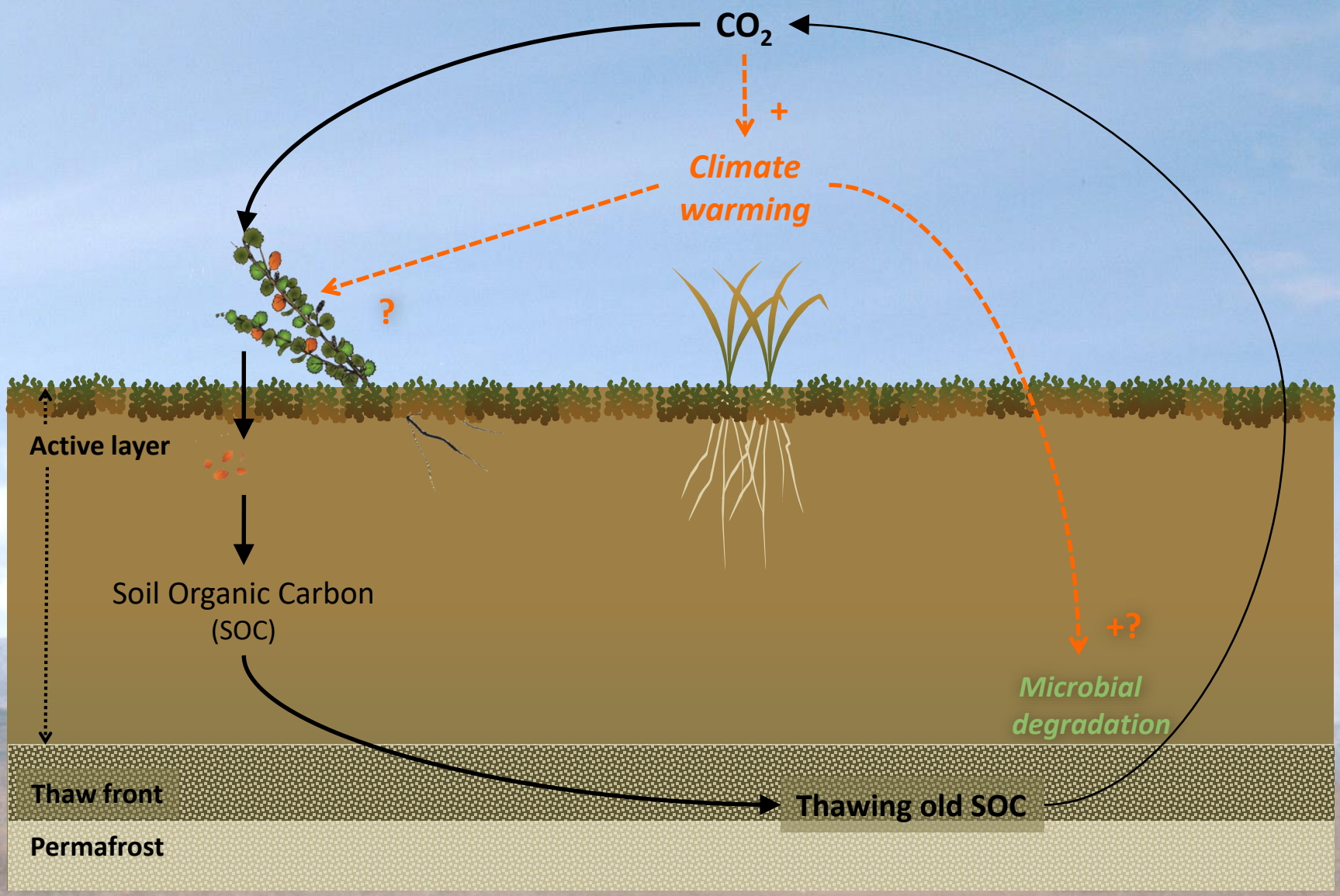
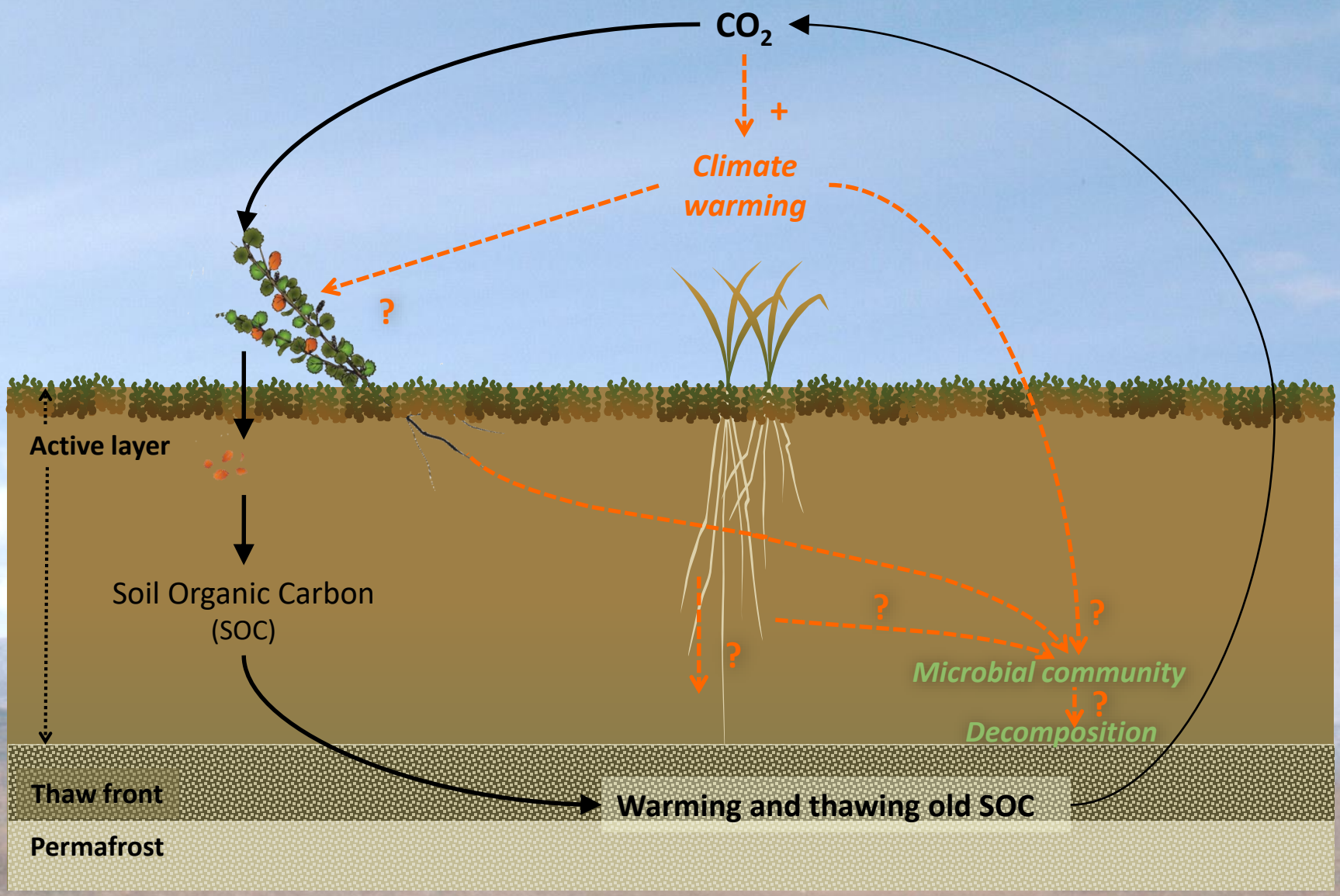
Arctic ecosystem carbon feedbacks to our climate

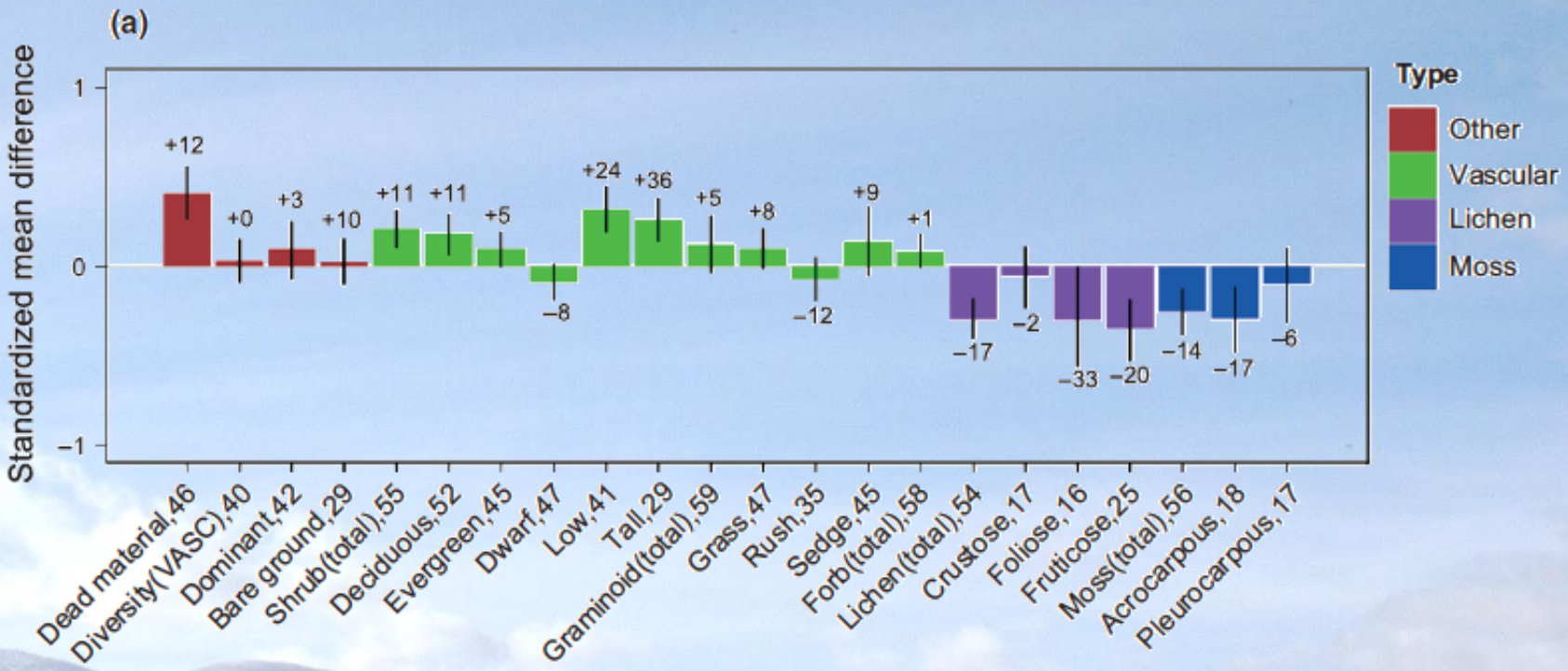


Interacting controls on arctic soil carbon losses



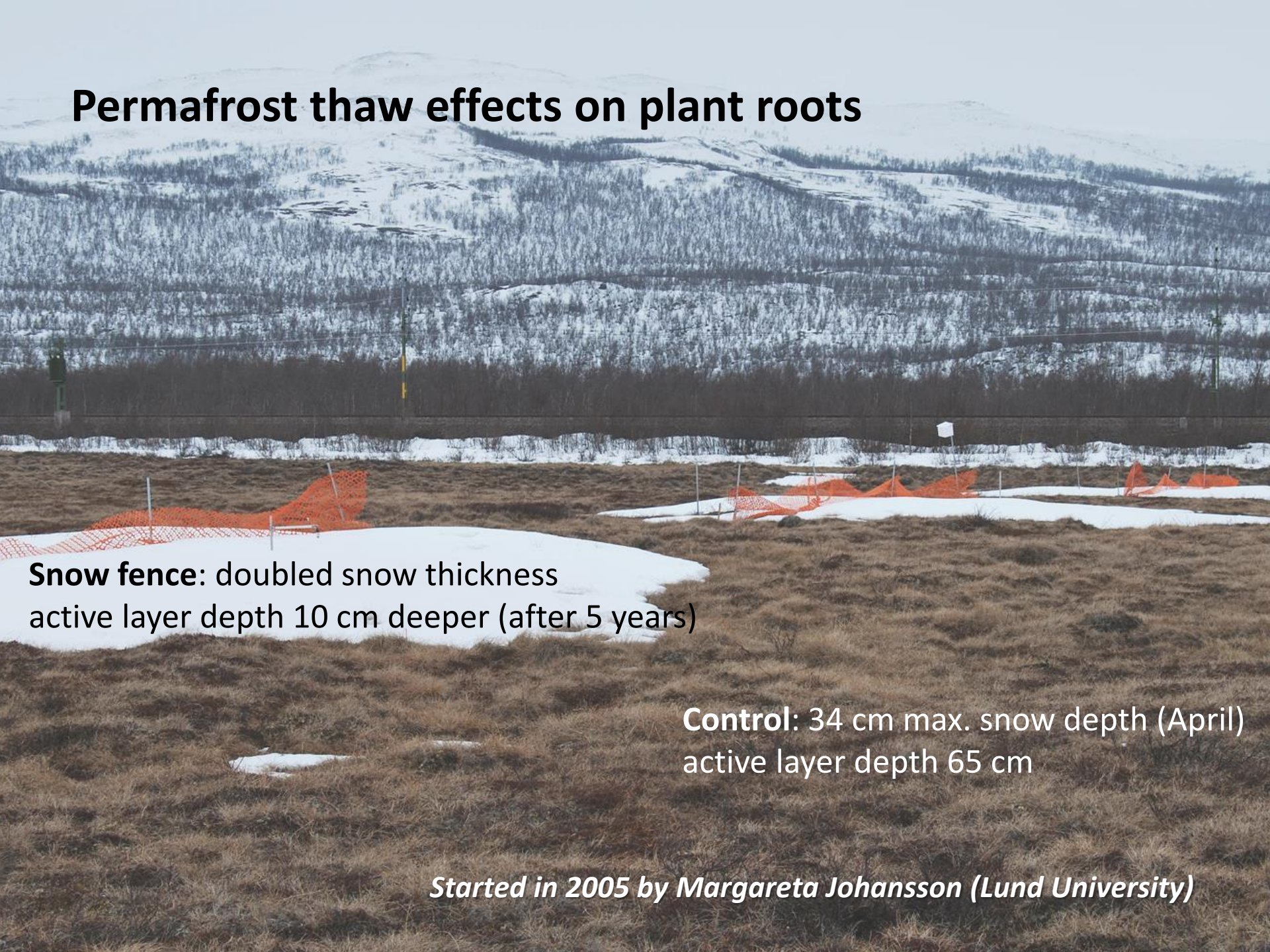
Plant shoot responses to warming

Elmendorf et al. (2011) Ecol. Lett.



But vascular tundra plants are mostly roots, with some leaves…

Permafrost thaw effects on plant roots



Snow fence: doubled snow thickness
active layer depth 10 cm deeper (after 5 years)

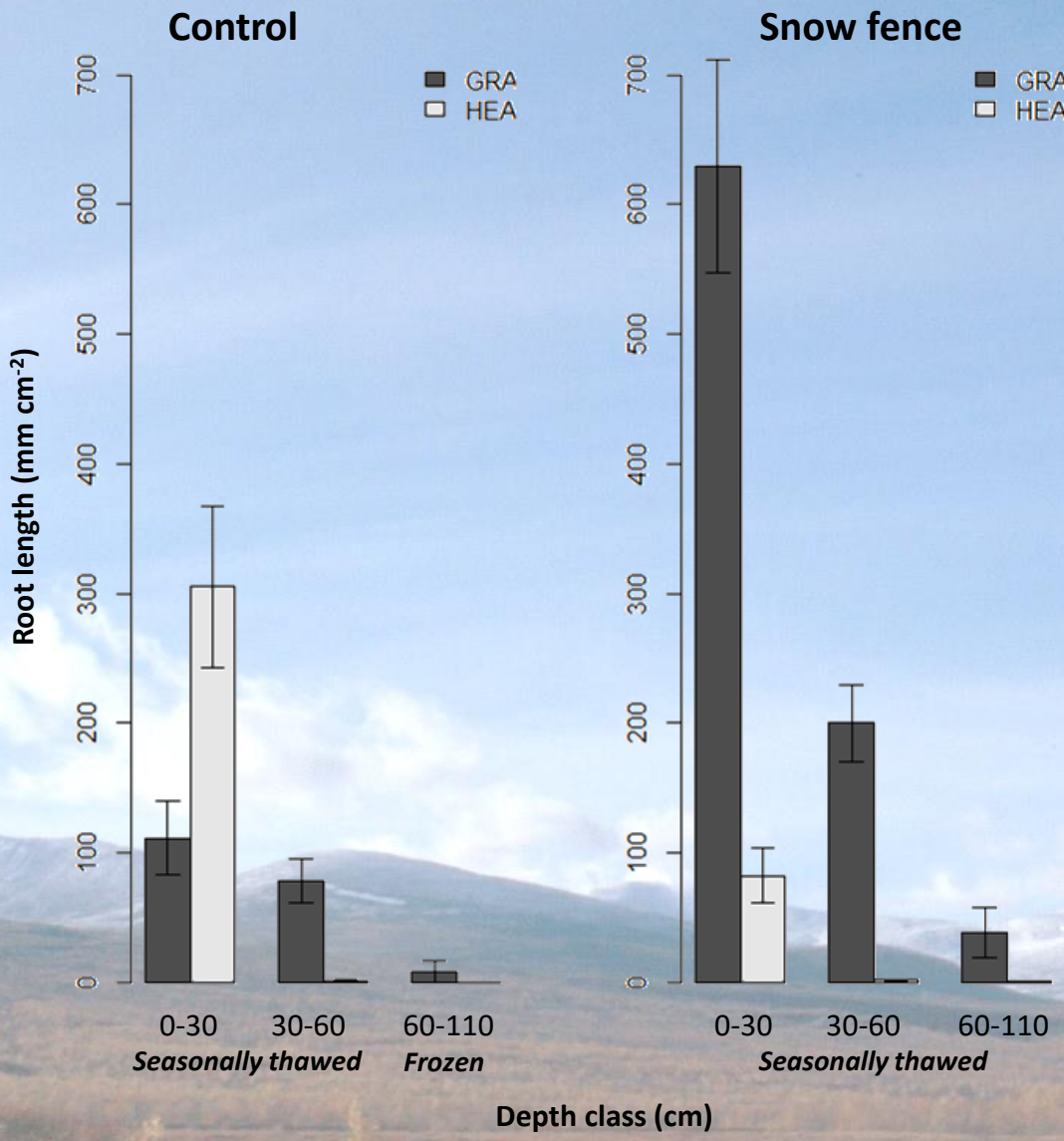
Control: 34 cm max. snow depth (April)
active layer depth 65 cm

Started in 2005 by Margareta Johansson (Lund University)

Permafrost thaw effects on plant roots

Snow fence: Surface subsidence + wet depressions
-> doubling of *Eriophorum vaginatum* cover

Permafrost thaw effects on plant roots



Grasses/sedges (*Eriophorum*)

Heather/shrubs (e.g. *Rubus*, *Andromeda*, *Empetrum*)

Measured in 2014-2015
(after 9-10 winters)

Blume-Werry et al. 2019
New Phytol.

***Eriophorum*: 4.4 x greater root length**
Shrubs: 3.7 x smaller root length

Plant root controls on soil microbes

Empetrum nigrum

Andromeda polifolia

Betula nana

Eriophorum vaginatum

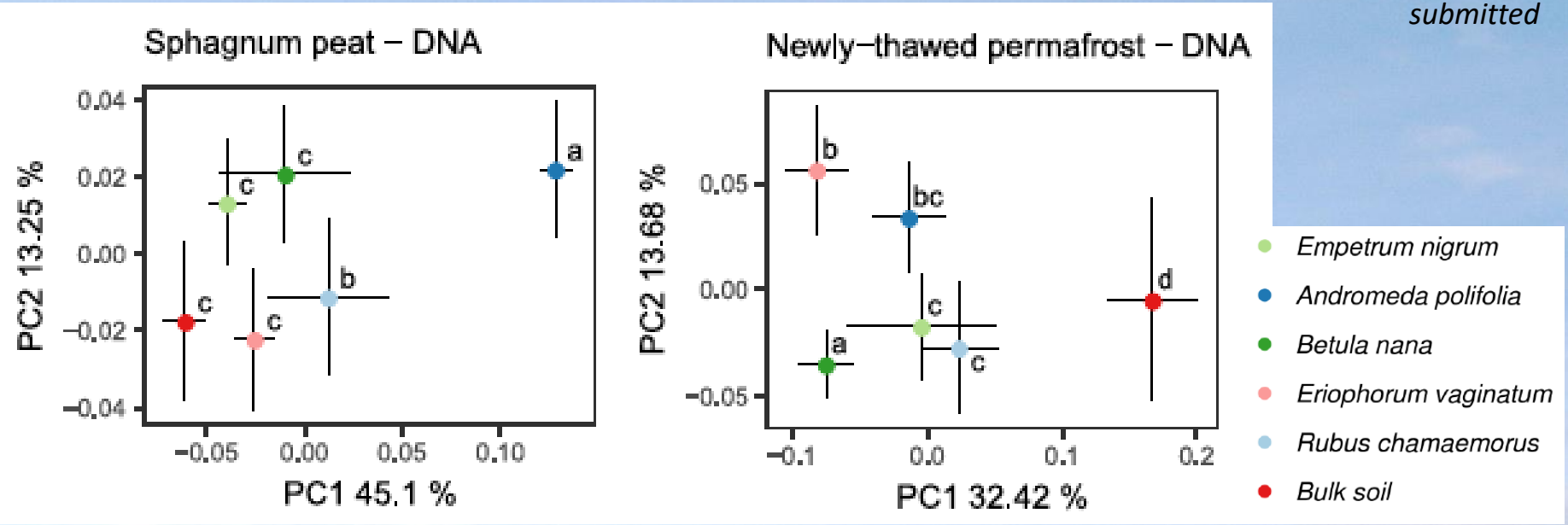
Rubus chamaemorus

Peat or permafrost


14 Months outside, N=5
Sampling: scalpel blade <2 mm
from roots
Liquid N snap-freezing
RNA and DNA co-extraction
V4 16S rRNA amplicons

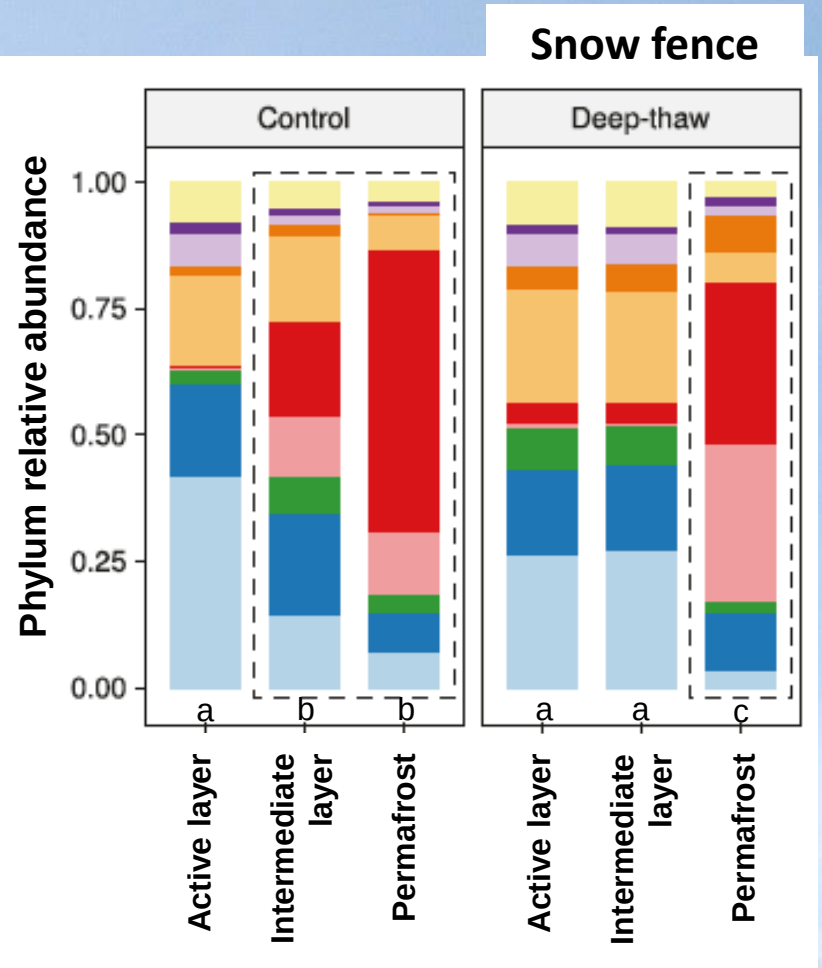
Plant root controls on soil microbes

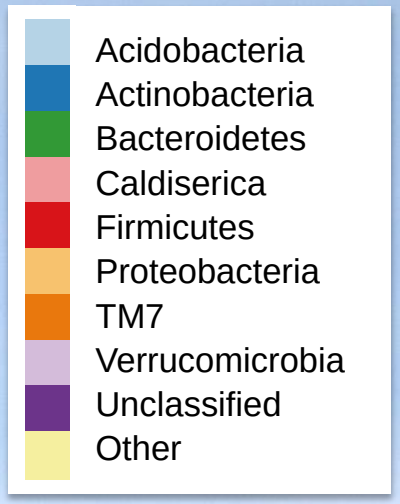
Monteux et al. (2019) submitted



Plant species differ in rhizosphere bacterial community structure in permafrost soil (but less in *Sphagnum* peat)

Permafrost thaw and plant effects on microbes



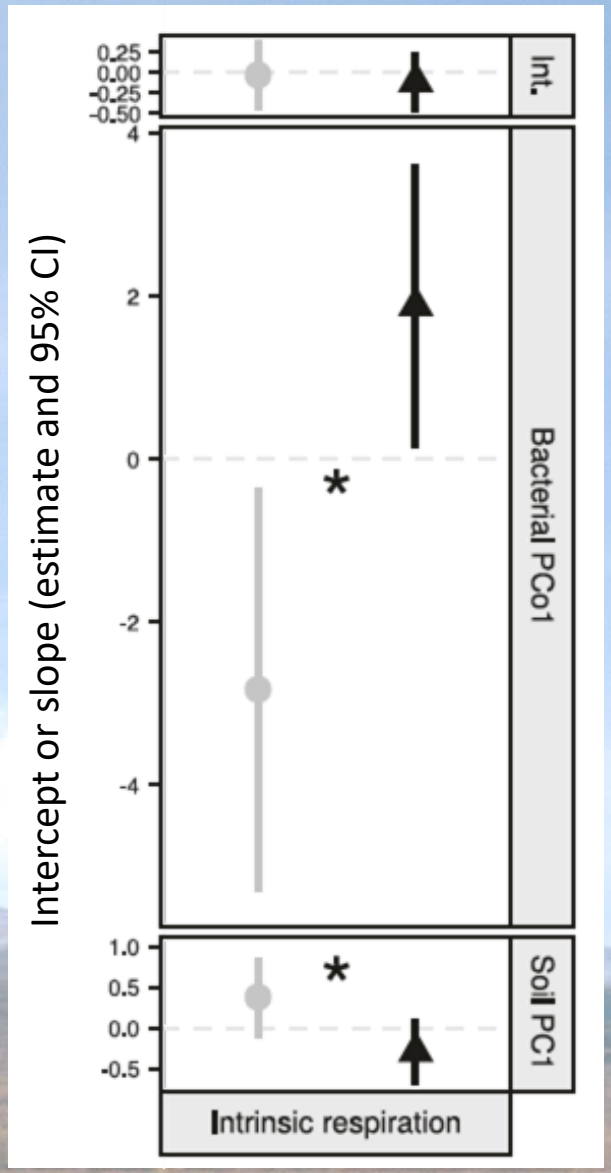


Monteux et al. (2018)
ISME Journal 12: 2129-2141

Bacterial community structure:

- Converges in intermediate layer to AL
- Shows increased aerobic abundance

Permafrost thaw, plant and microbial effects on respiration



Monteux et al. (2018)
ISME Journal 12: 2129-2141

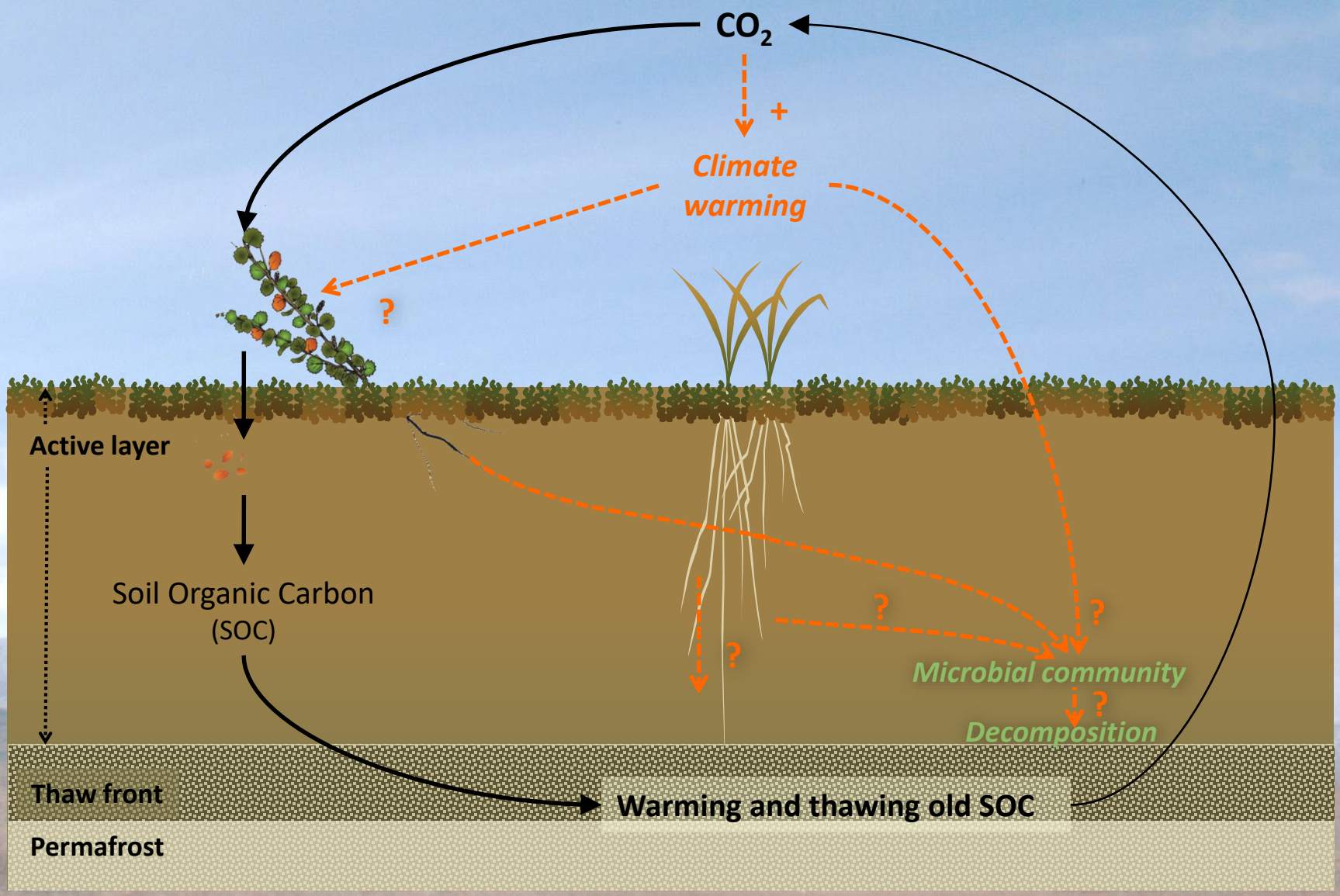
Snow fence

Control ▲ Deep-thaw

Bacterial community structure:

- Explains variation in soil respiration (but differently with deep thaw)

Interacting controls on arctic soil carbon losses



Respiration responses to warming: what do we (not) know?

Oecologia (2001) 126:543–562
DOI 10.1007/s004420000544

Ecological Monographs, 77(2), 2007, pp. 221–238
© 2007 by the Ecological Society of America

TUNDRA CO_2 FLUXES IN RESPONSE TO EXPERIMENTAL W

Ecology, 94(3), 2013, pp. 726–738
© 2013 by the Ecological Society of America

L.E. Rustad · J.L. Campbell · G

esa

Response

Biogeosciences, 11, 6969–6983, 2014
www.biogeosciences.net/
doi:10.5194/

Consequences

Focus on response size of soil carbon to warming: large *spatial* variation

Focus mostly on *abiotic* drivers of variation (C stock, temperature, precipitation, pH, soil chemistry/structure), and drivers therefore still not understood *(Van Gestel et al, Crowther et al Nature 2018)*

itrogen-addition and warming

nisms overlooked by land models

Soil Biology & Biochemistry 107 (2017) 32–40

Contents lists available at ScienceDirect

Soil Biology & Biochemistry

journal homepage: www.elsevier.com/locate/soilbio

ELSEVIER

A meta-analysis of the effects of experime
and nitrogen dynamics on the Tibetan Pla

Xian-Zhou Zhang [1], Zhen-Xi Shen [1], Gang Fu [*]

Review Paper

Soil microbes and their response to experimental warming over time: A meta-analysis of field studies

A.L. Romero-Olivares [a, *], S.D. Allison [b], K.K. Treseder [a]

ITEX network: a unique opportunity to fill a gap

- Standardized warming method (+ snow manipulations), long-term, realistic field conditions
- Data on respiration responses
- Data on long-term vegetation/trait changes
- Data on microbial community responses
- New synthesis: *How does climate warming affect carbon losses from tundra, and what is the role of direct and indirect drivers?* (i.e., linking the above)

  (-> 2-yrs postdoc position in my group (recruitment this autumn))

Workshop 3 on Thursday

Things to take home

- Climate warming (thawing) strongly alters belowground plant communities (roots)
- Plant species in permafrost soil harbour different rhizosphere microbial communities
- Microbial community matters for decomposition of thawing permafrost soil
- Climate warming (thawing) can thus affect C-losses via alterations in bacterial communities, partly via changes in plant community/rooting patterns

Plant-soil responses to experimental permafrost thaw

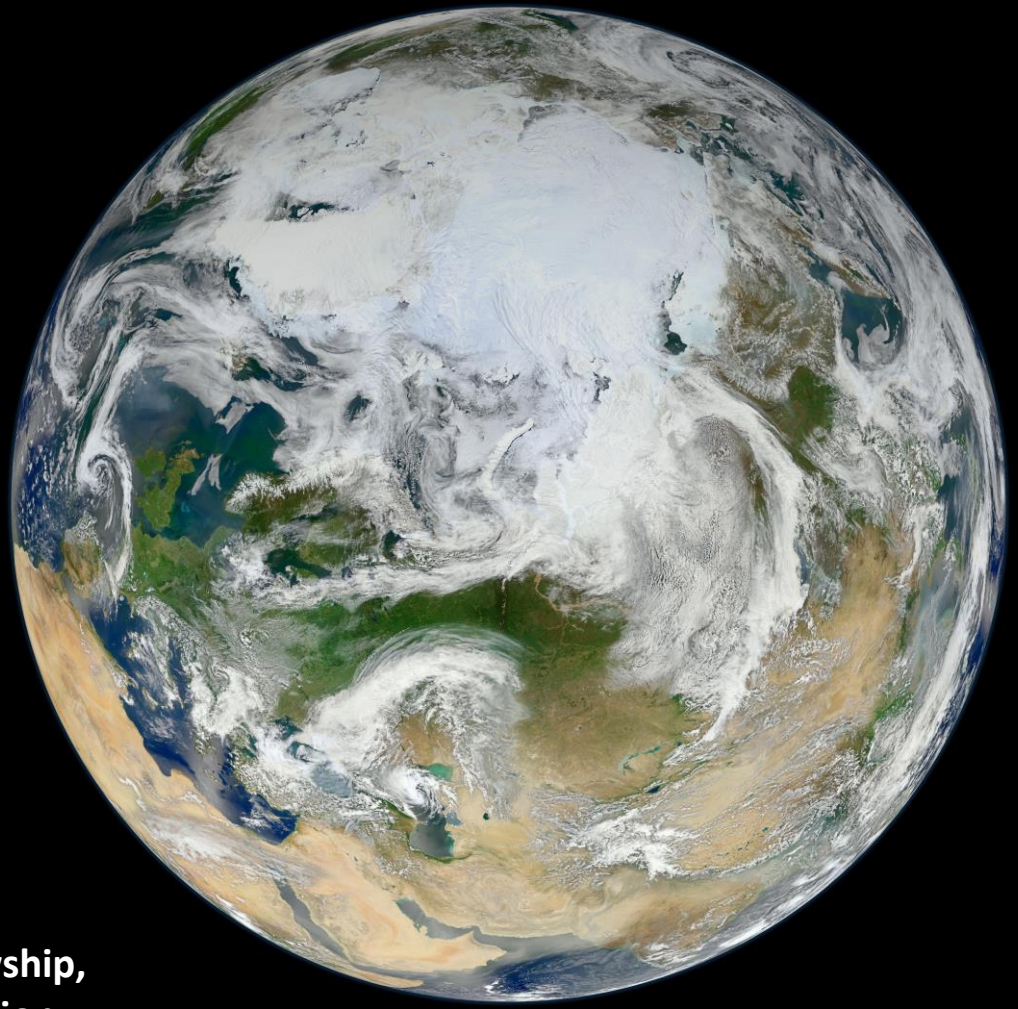
Many thanks to:

James Weedon, Frida Keuper,

Laurenz Teuber, Margareta Johansson

FIELD-ASSISTANTS / STUDENTS!

***A*ll current and former colleagues and students at Umeå University, Abisko Scientific Research Station**



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Permafrost thaw effects on plant roots

Snow fence: Surface subsidence
-> wet depressions (strongest in spring)

Photo: Maja Wressel