



# Effects of large natural soil warming gradients on potential decomposition rate and nutrient availability in a mature spruce forest

Bjarni D. Sigurdsson, Niki Leblans, Edda S.  
Oddsdottir, Marja Maljanen & Ivan Janssens

[www.forhot.is](http://www.forhot.is)



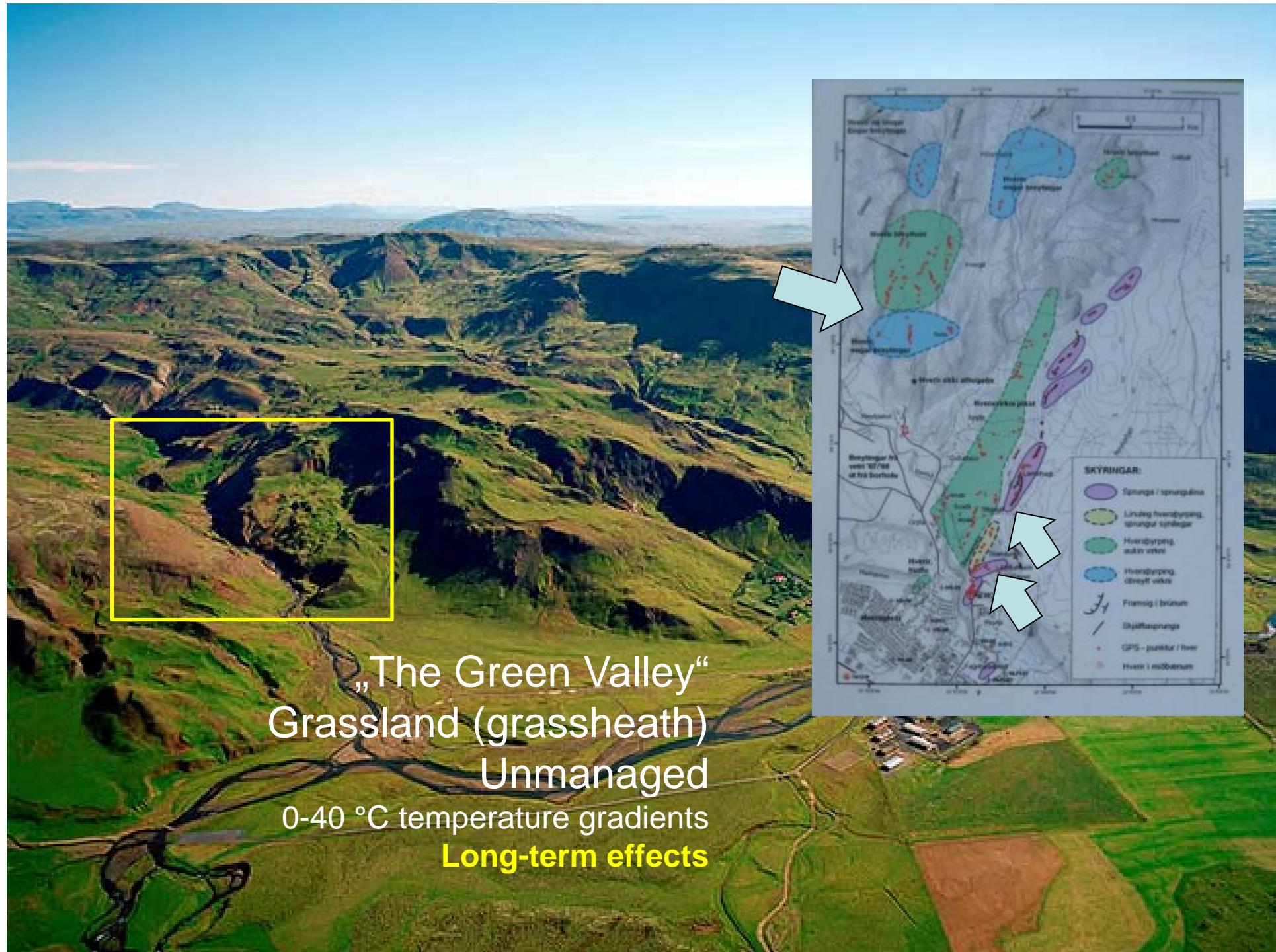
# FORHOT

*Natural soil warming in natural grasslands and a  
Sitka spruce forest in Iceland ([www.forhot.is](http://www.forhot.is))*



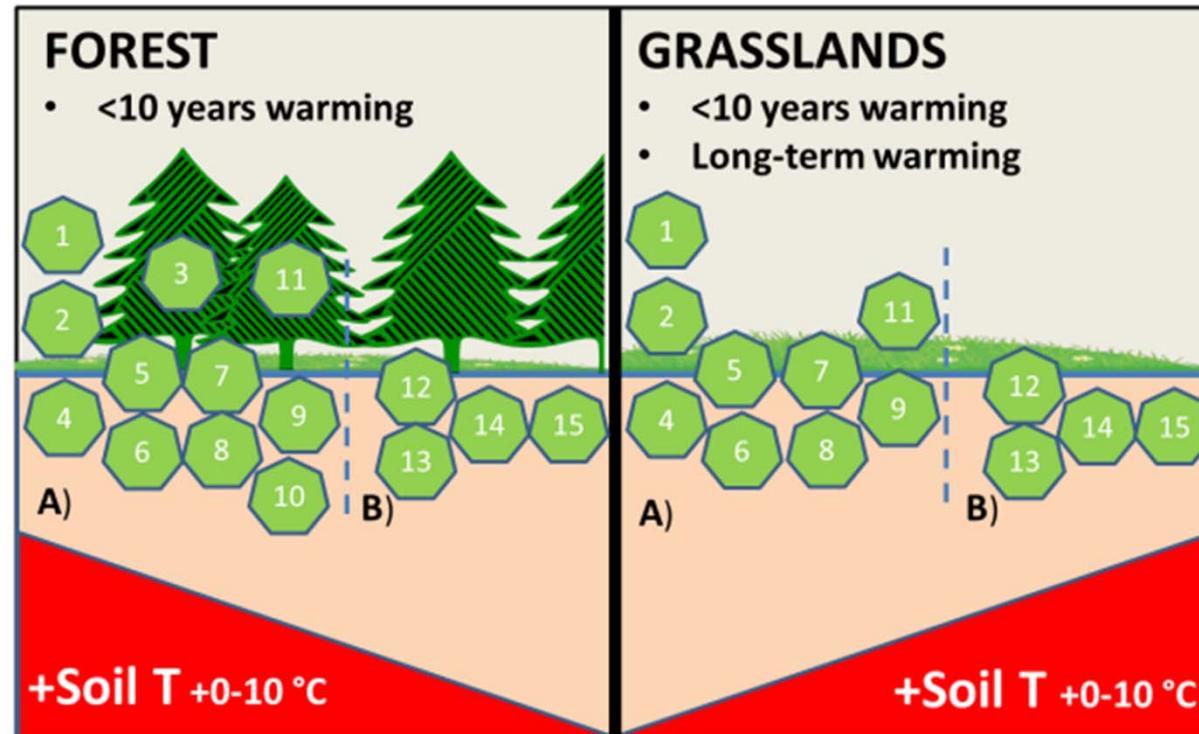


Grassland (grassheath)  
Unmanaged  
0-40 °C temperature gradients  
5 years effect





# Now: 15 WPs in 3 Ecosystems



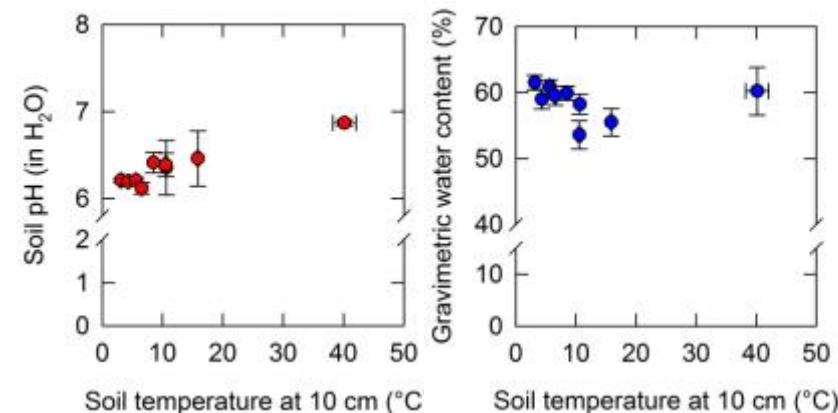
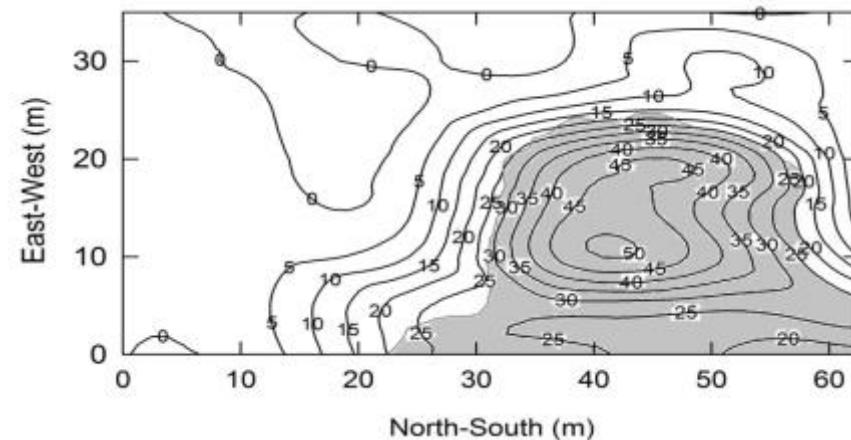
Main work packages within FORHOT. **A)** Ecosystem structure and C-dynamics: 1) Monitoring of soil and air T and soil water status; 2) Ground vegetation growth, composition, phenology; 3) Tree growth and phenology; 4) Fine-root production 5) Litter production aboveground and belowground; 6) Litter-bag study on decomposition; 7) Soil and litter organic matter; 8) Soil fauna composition and amounts; 9) Soil microbe composition and amount; 10) Ectomycorrhiza on tree roots; 11) Carbon fluxes (CO<sub>2</sub>, CH<sub>4</sub>). **B)** Nutrient cycle interactions and other issues: 12) Plant and soil N stocks and nutrient uptake rates 13) NH<sub>3</sub> mineralization and Archaeabacteria; 14) N<sub>2</sub>O fluxes; 15) C and N-isotope studies.



# Experimental setup (FN)

- 5 transects ( $n=5$ )
- Permanent plots at 6 soil warming levels:  
 $+0, +1, +3, +5, +10$   
(and  $+20^{\circ}\text{C}$ )
- 30 plots per ecosystem
- 3 Ecosystems

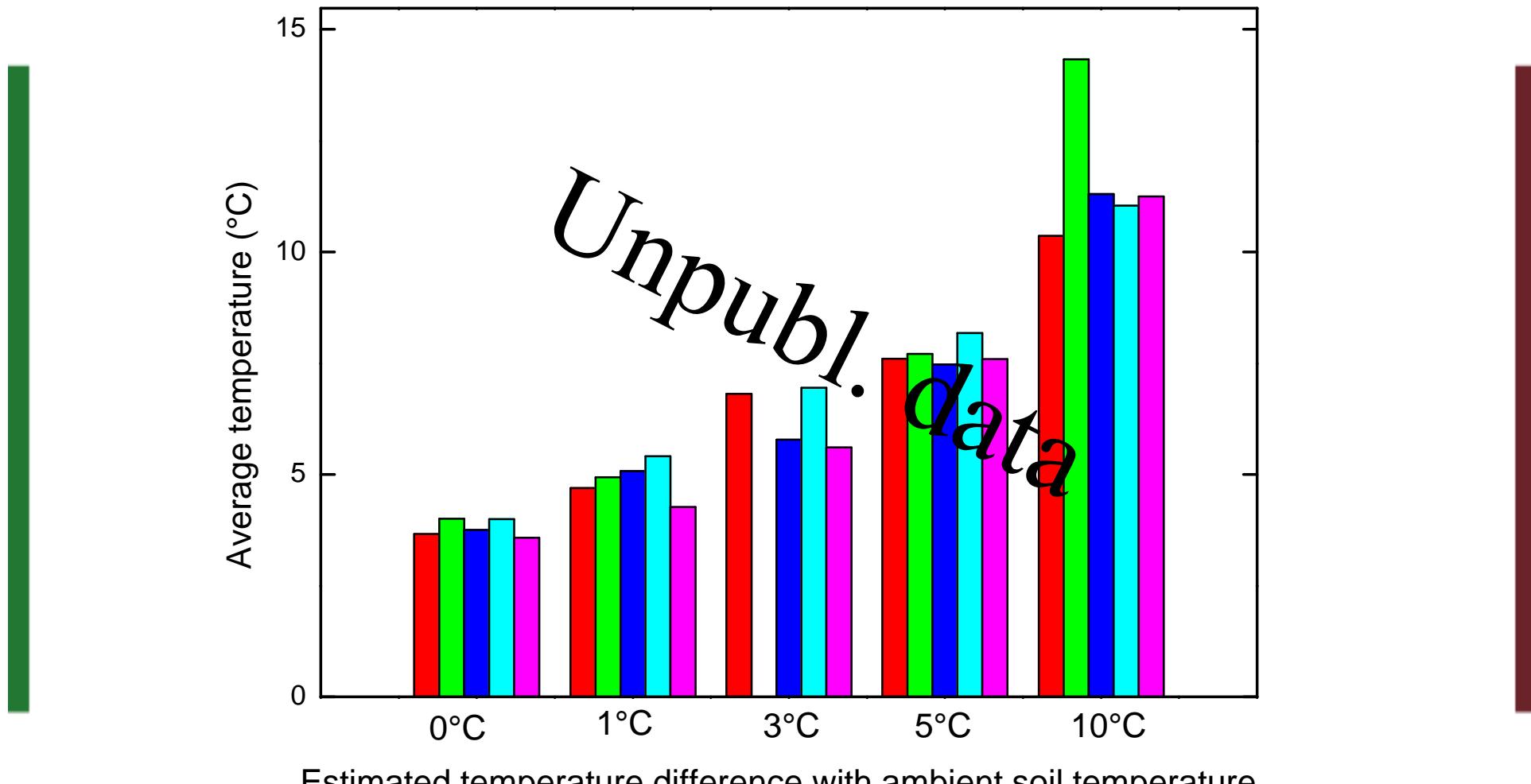
O'Gorman et al. (2014). Climate change and geothermal ecosystems: natural laboratories, sentinel systems, and future refugia. **Global Change Biology** (Accept.)



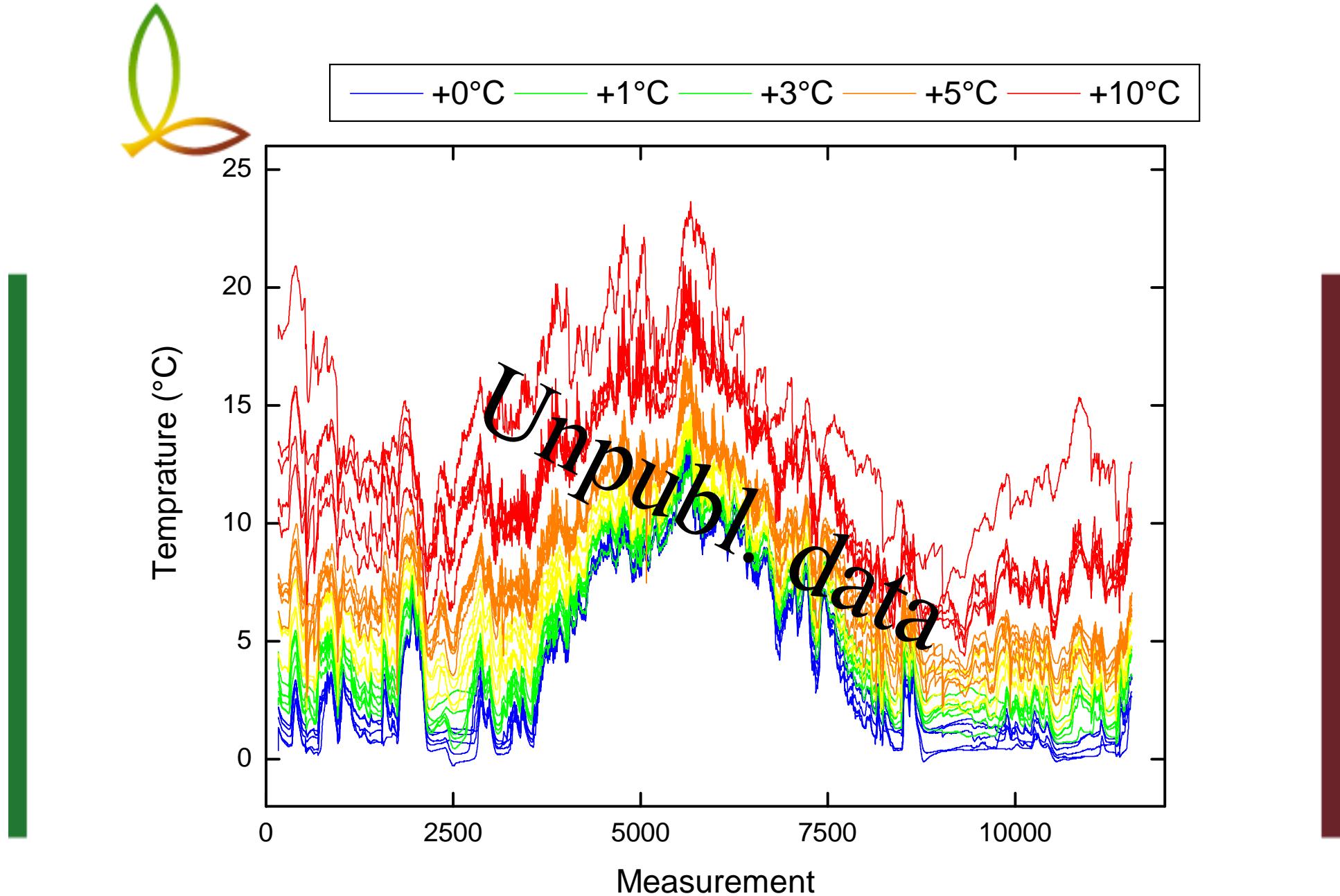


## MAT<sub>s10</sub> April 2013 – April 2014 (24 x per day)

Transect 1 Transect 2 Transect 3 Transect 4 Transect 5



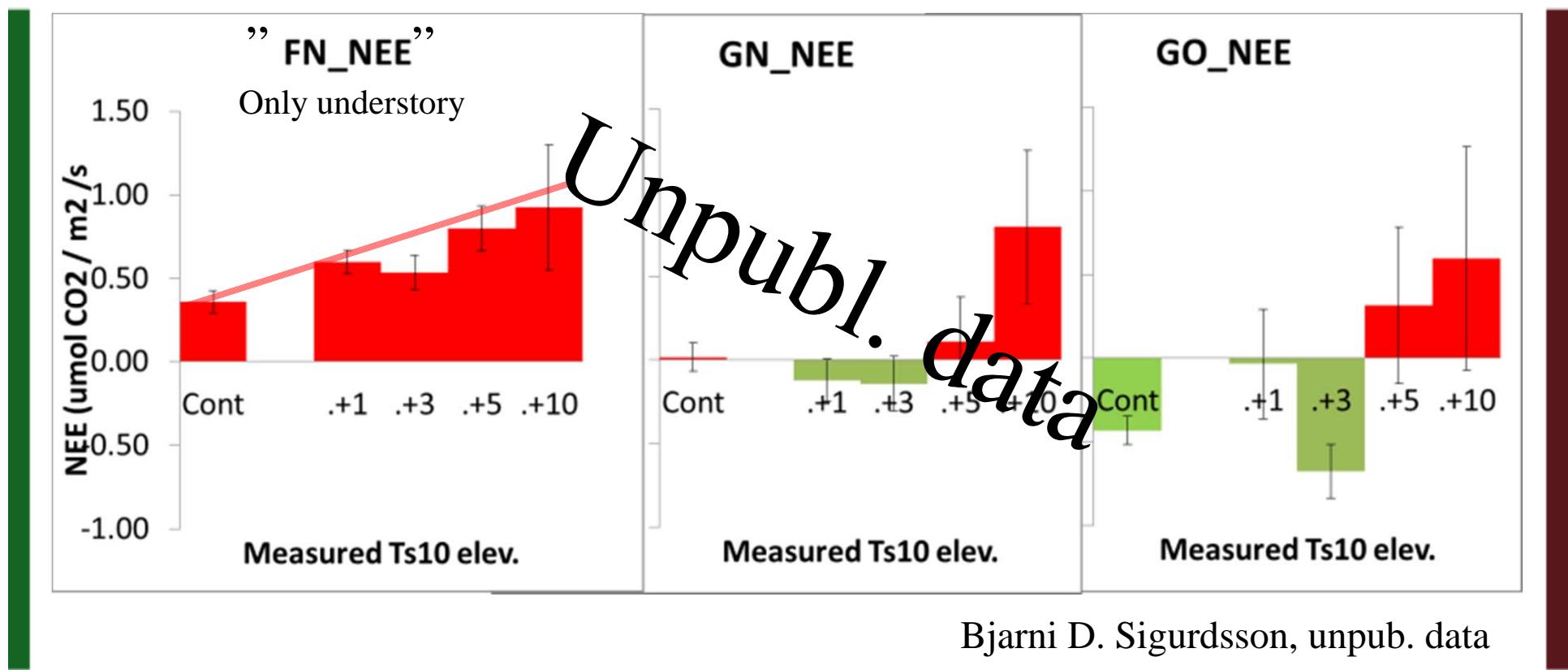
Niki Leblans, unpub. data



Niki Leblans, unpub. data



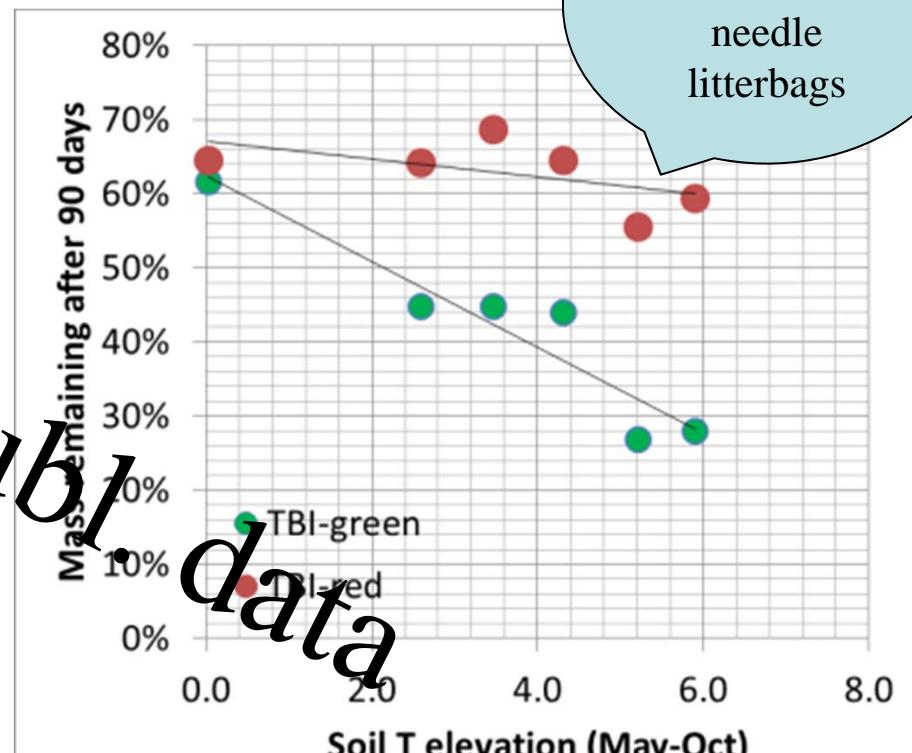
# „NEE“ all ecosystems in June/July





# TBI (pot. decompositon rate)

easily decomposable / recalcitrant litter



Similar rates  
as for Edda's  
needle  
litterbags

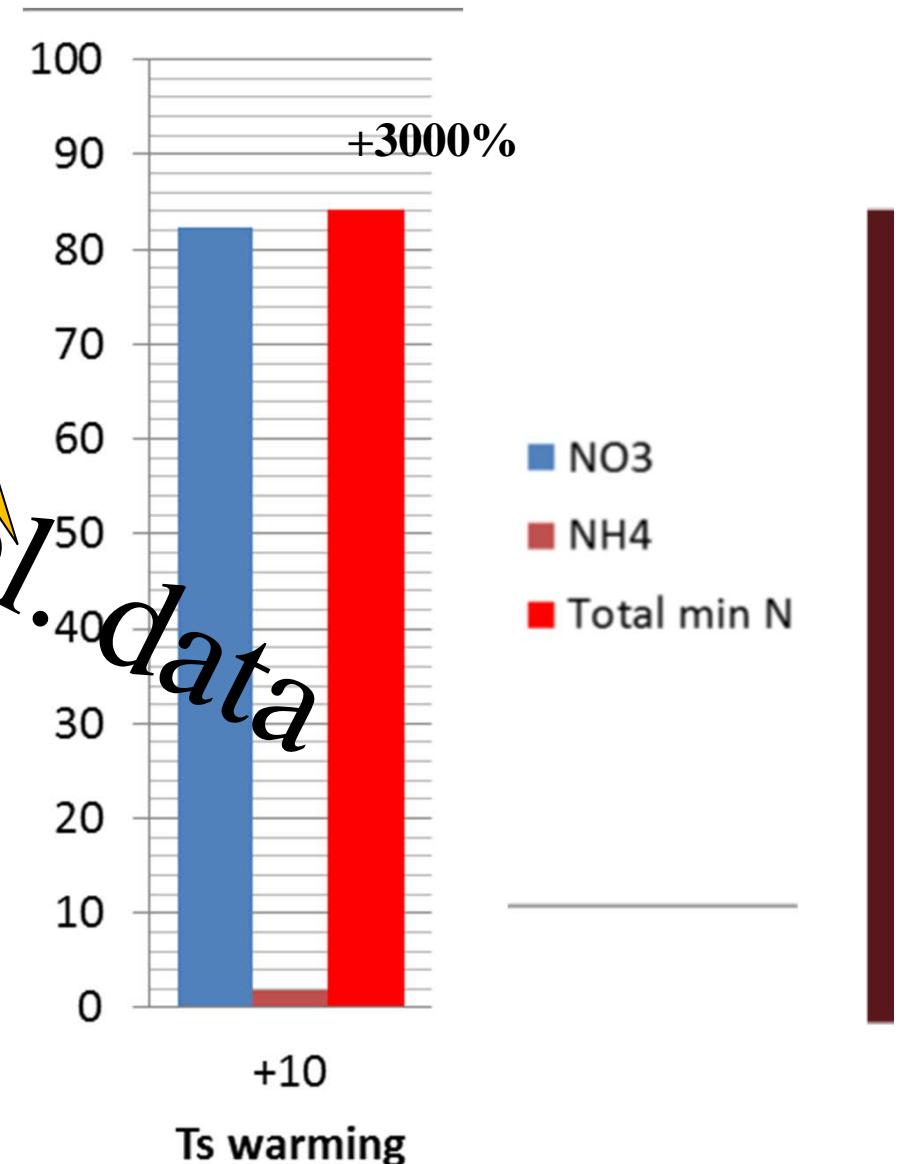
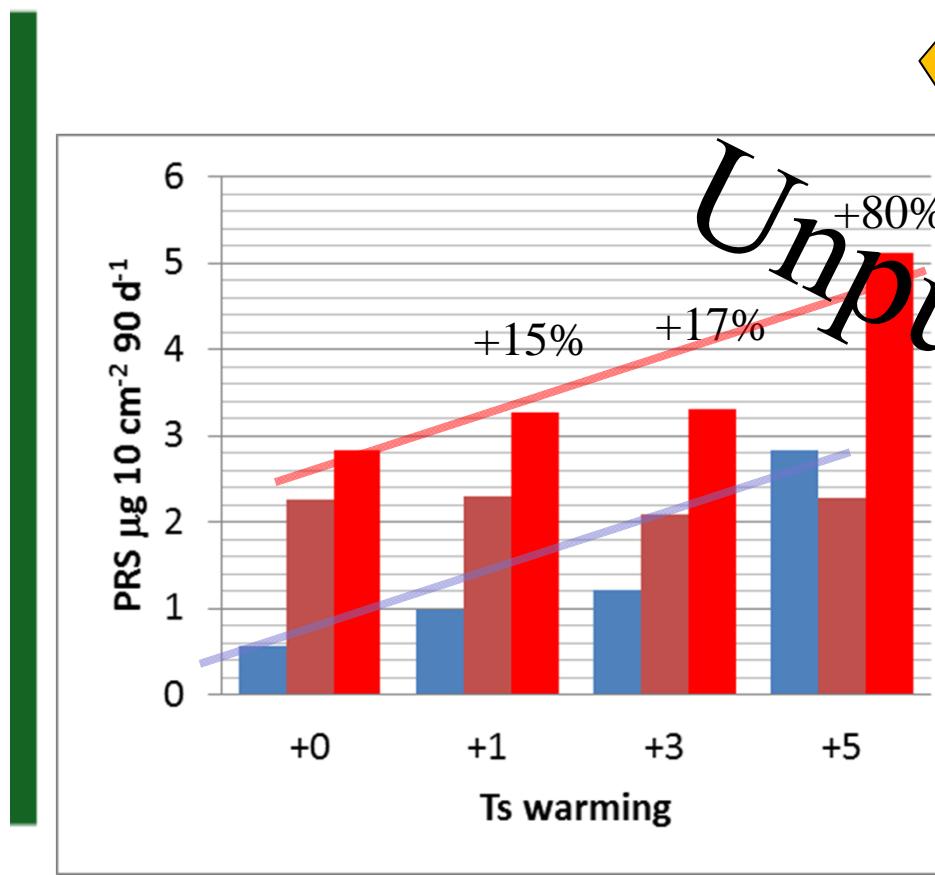


Bjarni D. Sigurdsson, unpub. data



# „Nitrogen availability“

Ecosystem  
threshold



Niki Leblans, unpub. data



# Diameter growth in 2013

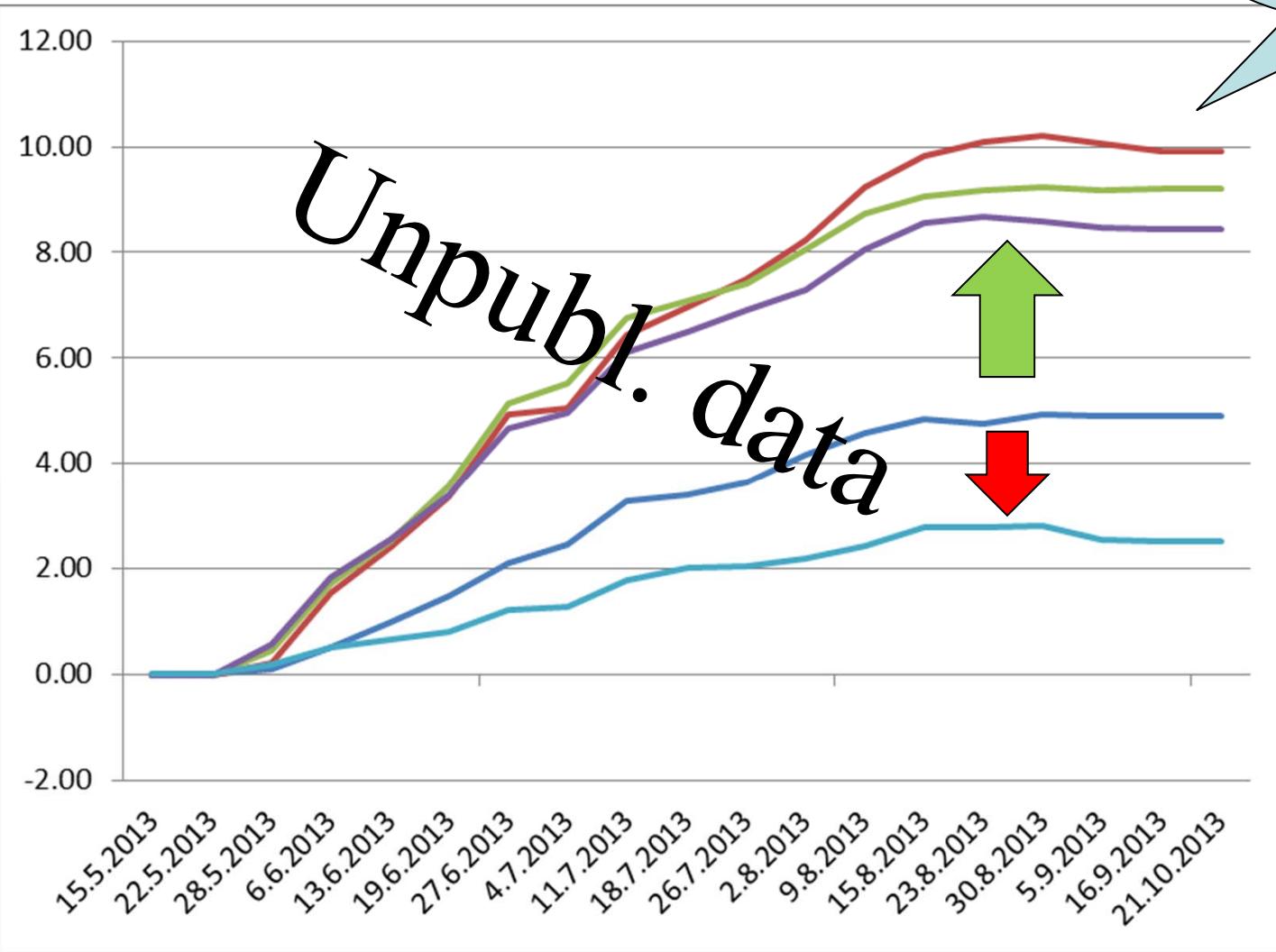
## 50 dendrometers

Bjarni D. Sigurdsson, unpub. data

Topt = +1 °C  
2013 was cold!

B = +1 °C  
C = +3 °C  
D = +5 °C

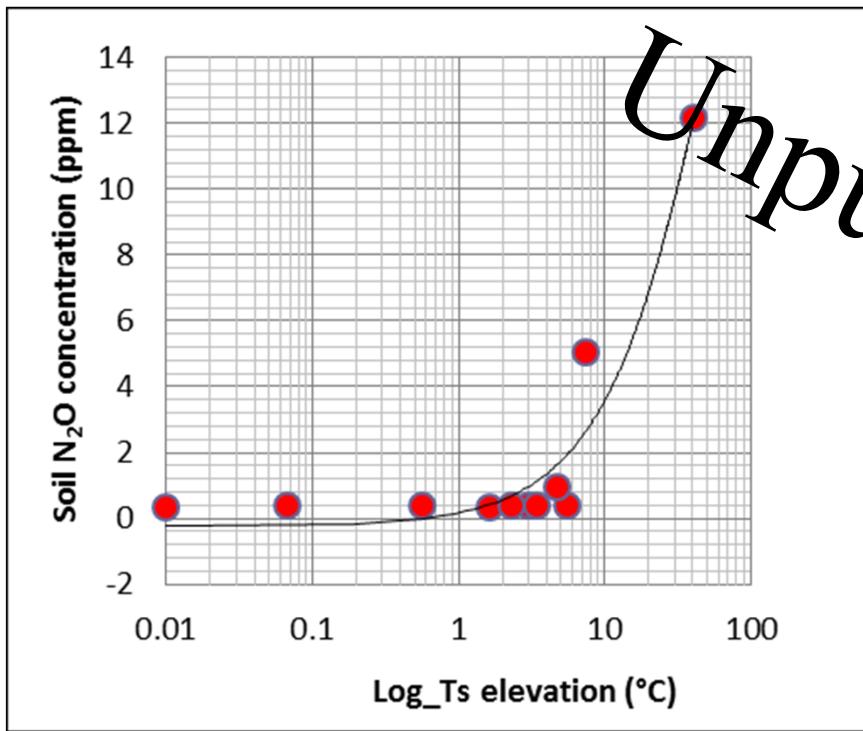
A = control  
E = +10 °C





# Does the N stay in the ecosystem when mineralization increases by warming?

Up?



Marja Maljanen, unpub. data

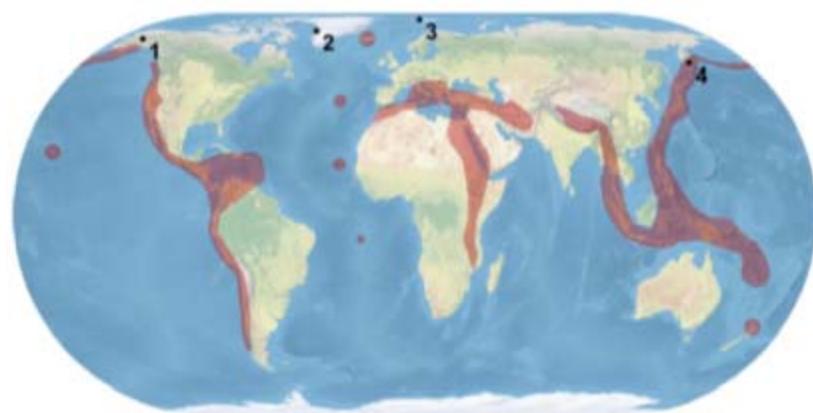
Down??

- FSC-Sink additional funding to start measuring leaching!
  - Per Gundersen
- Unpubl. data*



# Conclusions... [www.forhot.is](http://www.forhot.is)

- Geothermal areas can be utilized for studying (soil) warming → O'Gorman..., Bjarni D. Sigurdsson.... (2014) Climate change and geothermal ecosystems: natural laboratories, sentinel systems, and future refugia. *Global Change Biology* (accepted).



- **FSC-Sink** network was instrumental in starting the ForHot project.

- Large gradients enable us to study ecosystem thresholds!
- MATs10 is ca. 5 °C
  - Growth increased up to +3-5 °C
  - C-flux sink (NEE) in grassland also ALMOST DOUBLING OF TODAYS Ts
- Potential decomposition increased linearly up to +5 °C
- „N-availability“ (PRS-probes) increased linearly up to +5 °C...
- Threshold in effects when warming >5 °C !!!
- When we get into species shifts – the effect is much larger! e.g. +3000% increase in NO<sub>3</sub> „availab.“



### Icel. For. Res.

Edda S. Oddsdóttir

### Agric. Univ. Icel.

Bjarni D. Sigurðsson

Úlfur Óskarsson / Ólafur Arnalds

MS Elín Guðmundsdóttir  
PhD Niki Leblans

### Univ. Icel.

Kesara Anamthawat-Jonsson

BS Ella Thoen

### Univ. Basel

Kristian Körner

PhD Armando Lenz

### VU Univ. Amsterdam

Peter van Bodegom

MS Benjamin Hearn

### Univ. Copenhagen, Denmark

Per Gundersen

### Univ. Antwerp, Belgium

Ivan Janssens

James Weedon

PhD Niki Leblans

MS Katherine Vande Velde

MS Lieven Michielsen

### Lund, Sweden

Håkan Wallander

Erland Bååth

PhD Magnus Ellström

PhD Stephanie Reischke

### Aarhus Univ, Denmark

Martin Holmstrup

### Centr. Ecol. Res. - Polish Aca. Sci.

Karssimira Ilieva-Makulec

19 researchers  
14 students

### Univ. Aureyri

Brynhildur Bjarnadóttir

### Inst. Nat. Hist.

Ásrún Elmarsdóttir

### SLU, Swed.

BS Hanna André

BS Agnes Bondesson

### Univ. East. Finland

Marja Maljanen

MS Heli Yli-Moijala

### METLA, Finland

Leena Finér

### Univ. Vienna, AU

PhD Anne Daebeler

### Tartu Univ., Estonia

Ivika Ostonen

Ph.D Kaarin Parts