N deposition and bryophyte responses in boreal background forests

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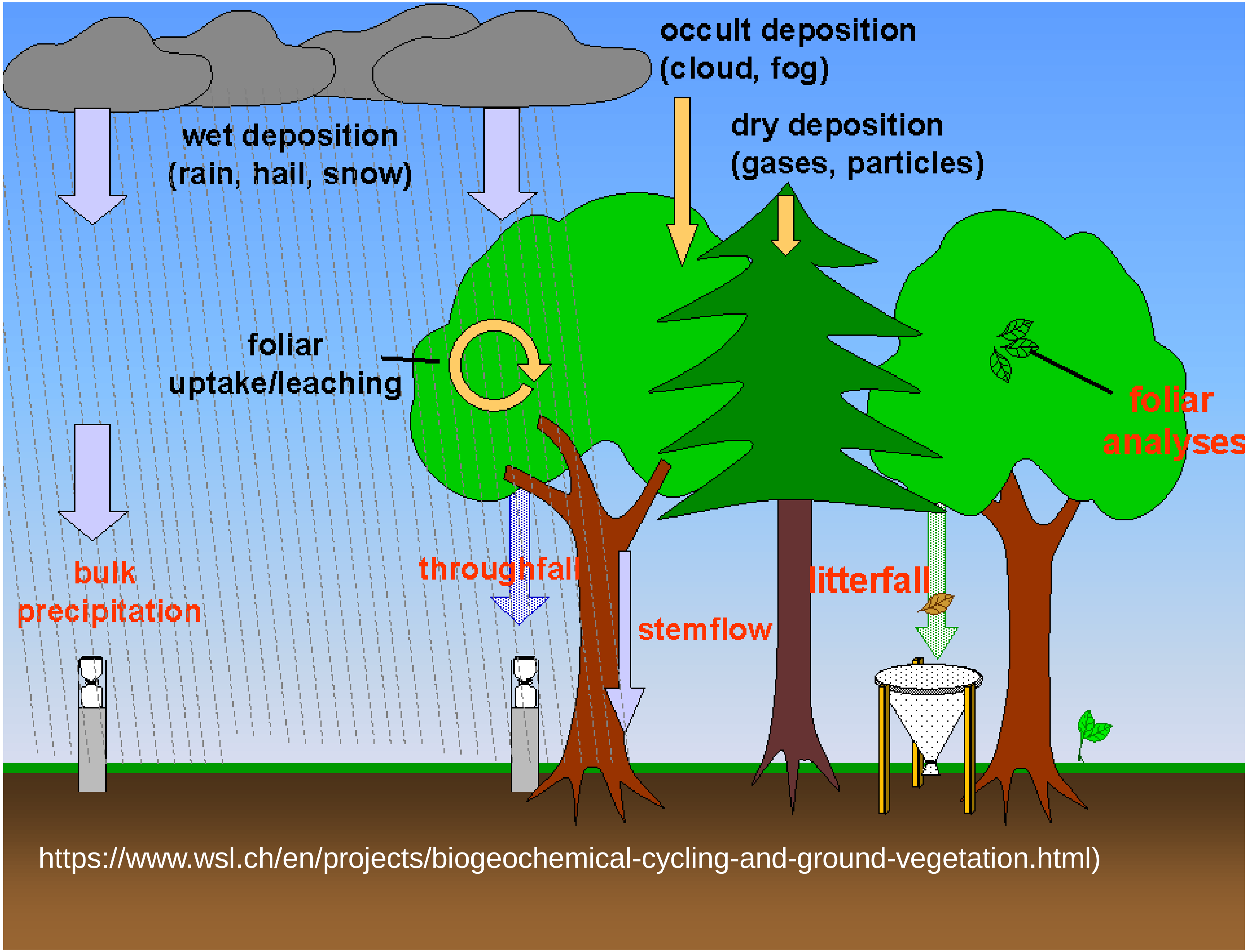
Bryophyte layer is an important component of the boreal ecosystem

Aim

- To investigate the responses of common **moss species to N deposition** in boreal background forests (< 5 kg N ha^{-1} yr^{-1})

- To compare the relationships between moss N% and N deposition both **outside** (vs. bulk deposition, BD) and **inside forests** (vs. TF) including **different N fractions** in deposition (total N, NH_4-N, NO_3-N and DON).

- To calculate equations that can be used in **predicting the total N deposition in background areas** of Finland according to N% of common forests moss species.

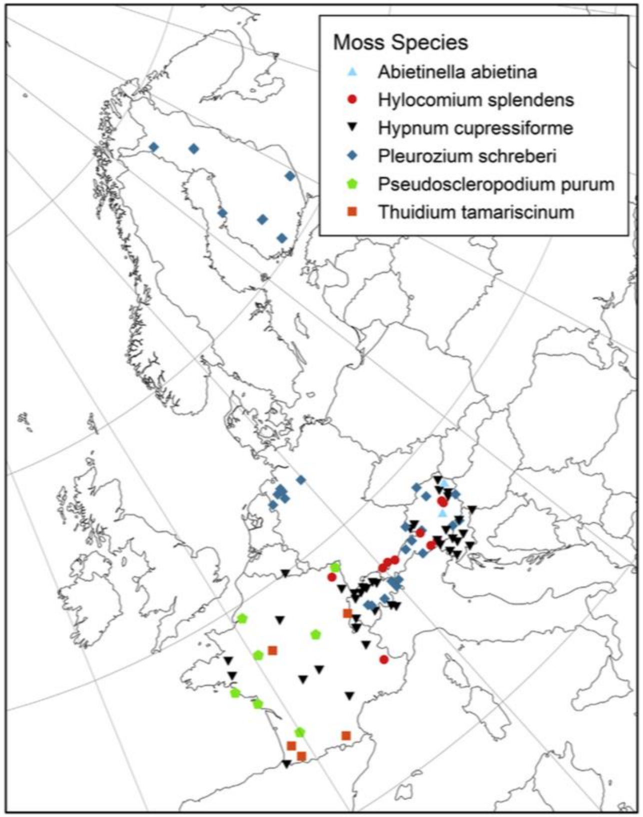

occult deposition
(cloud, fog)
wet deposition
(rain, hail, snow)
dry deposition
(gases, particles)
foliar
uptake/leaching
foliar
analyses
bulk
precipitation
throughfall
litterfall
stemflow
https://www.wsl.ch/en/projects/biogeochemical-cycling-and-ground-vegetation.html)

International connections

- European Moss Survey
- EU/Forest Focus (EC) No 2152/2003 and EU/Life+ FutMon programmes.

Harmens et al. ENPO 194 (2017), 50-59)
Meyer et al. STOTEN 538 (2015), 600-610
Kosonen et al. ENPO 239 (169-178)

Sampling sites in Europe



ICP Forests Level II plots in Finland

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Material and methods

ICP Forests Level II plots:

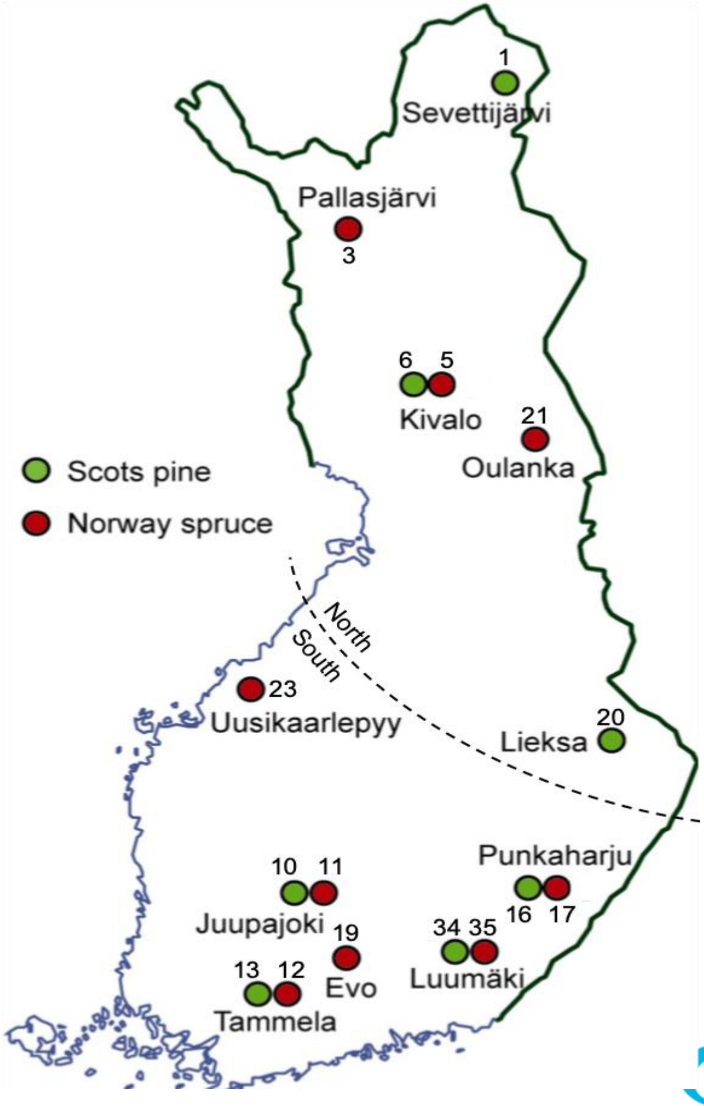
- 11 BD sites in forest openings in 2009
- 16 TF forest plots in 2009
- 10 TF plots in 2002-2003

Note: Plot Uusikaarlepyy locates near a fox farm (outlier)

Deposition and moss chemistry studied

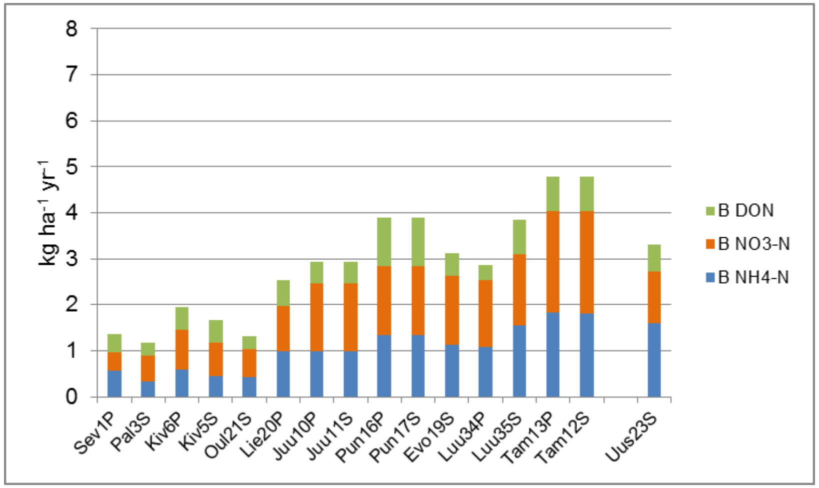
- *Hylocomium splendens*
- *Pleurozium schreberi*
- *Dicranum* spp.

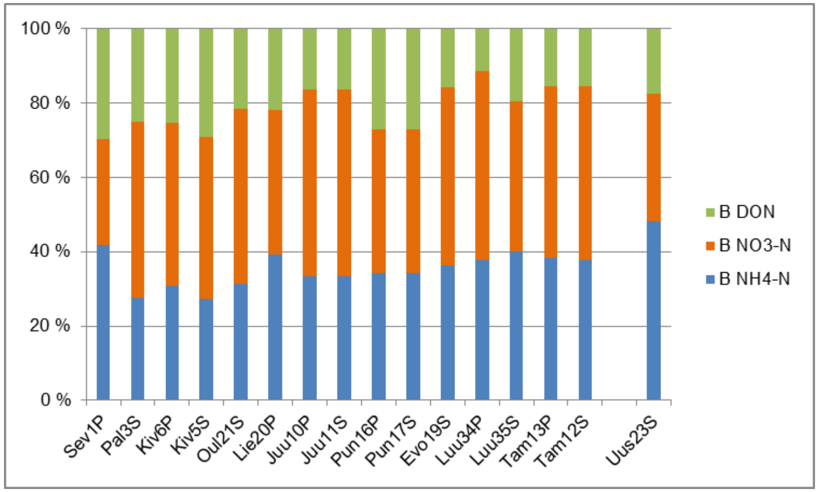
south-north climatic gradient
Scots pine (*Pinus sylvestris)* vs. Norway spruce (*Picea abies)* canopy effect



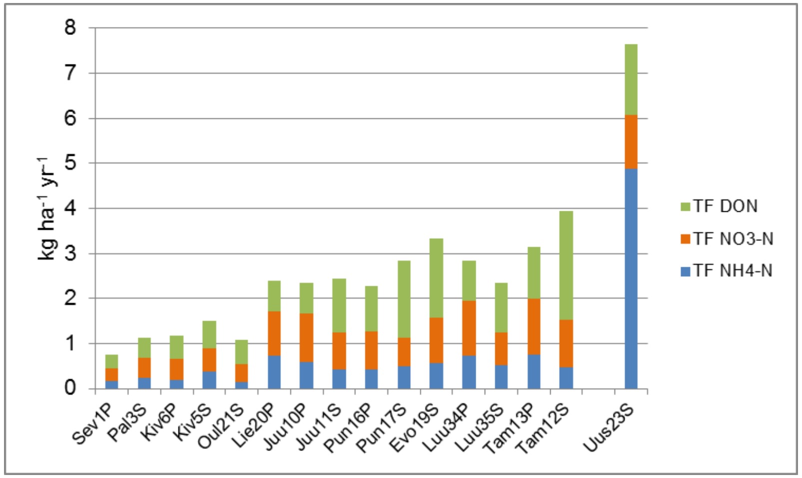
Results: Nitrogen deposition in Finland (ave 2006-09)

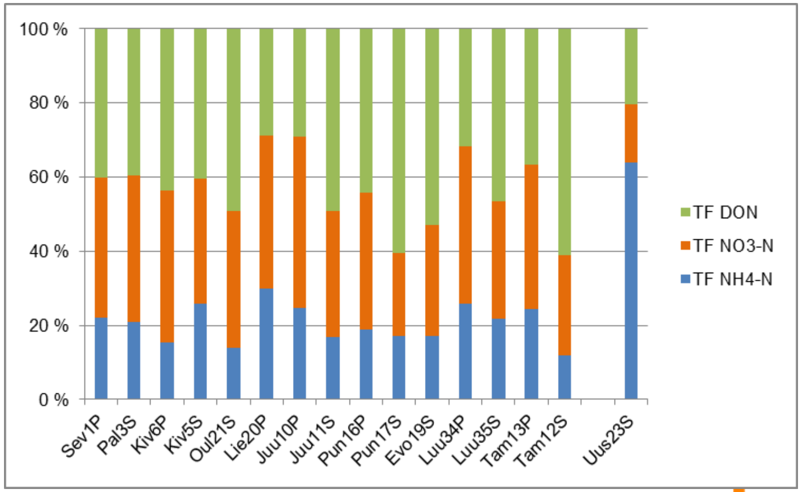
Bulk deposition



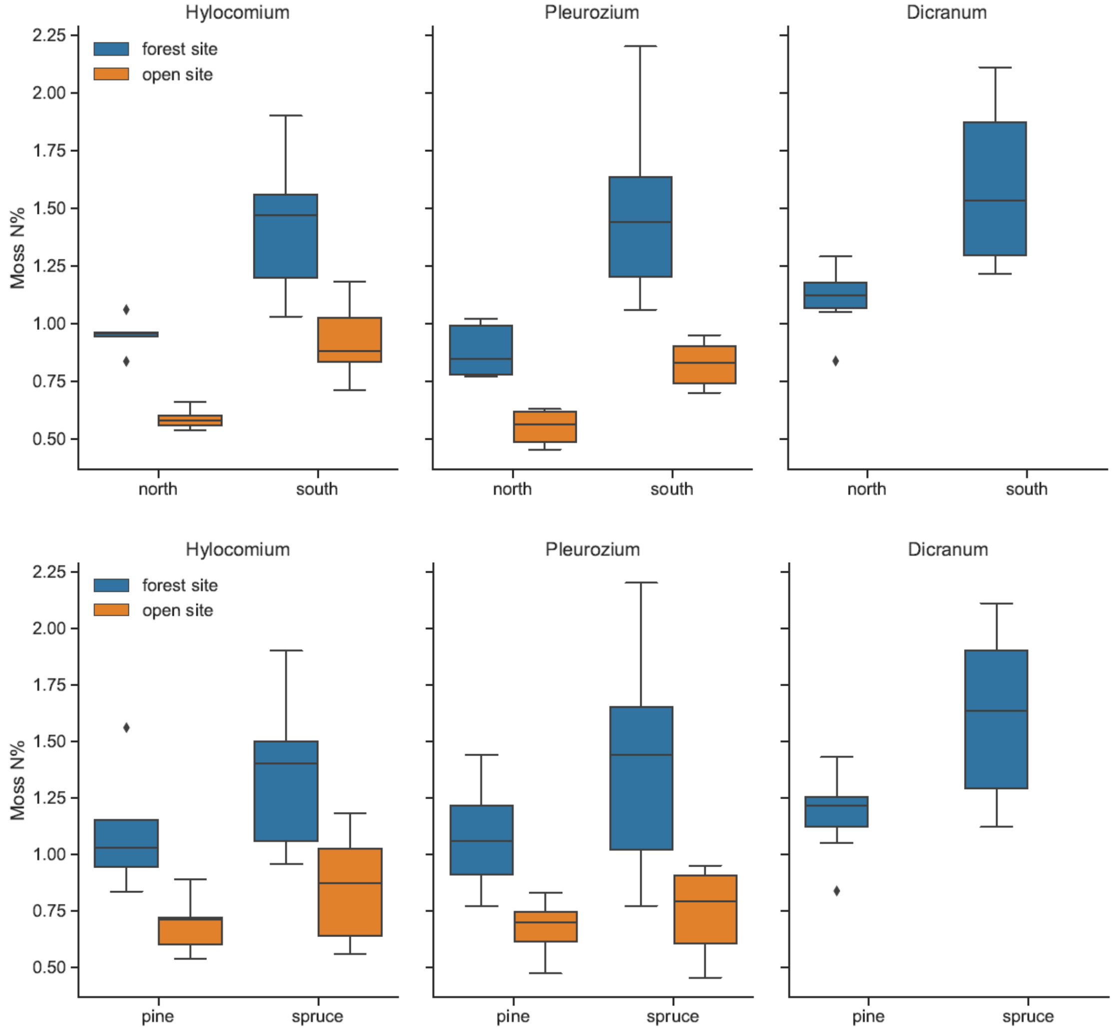


Throughfall deposition





Results: Ntot % of three moss species



South > North

Forest > Open site

Spruce > Pine stand

WHY?

Hypothesis

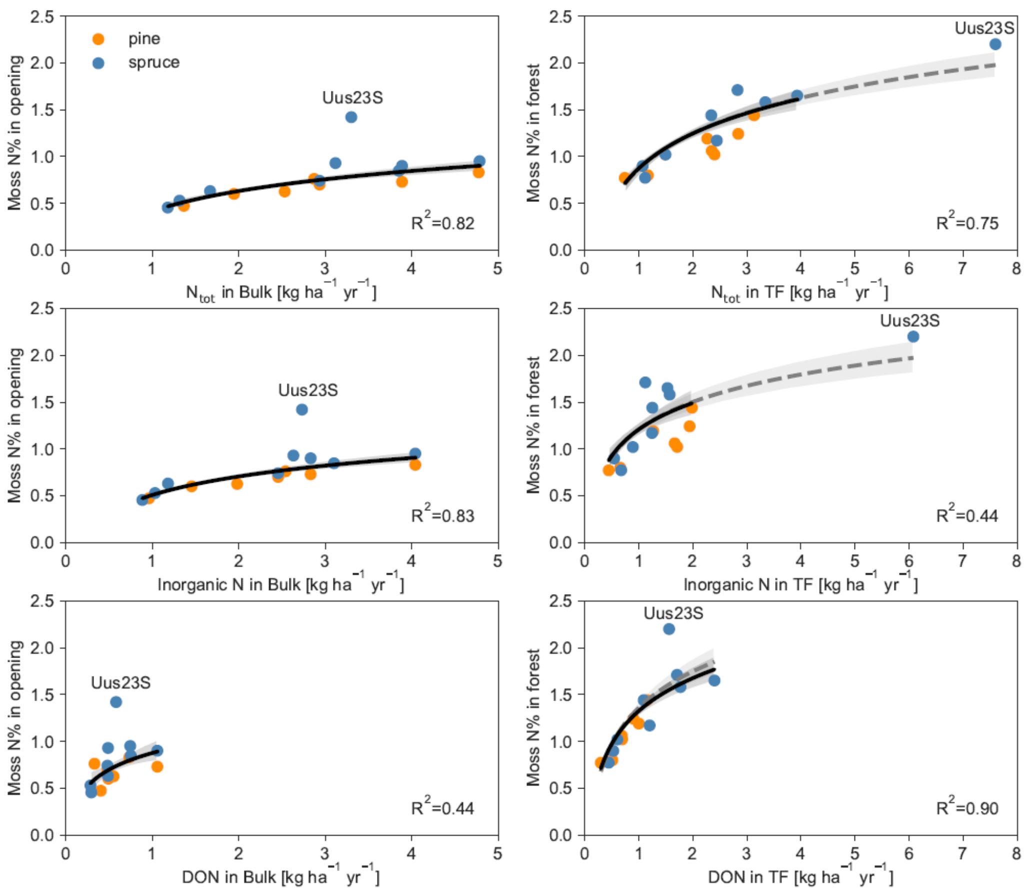
- Moss N_{tot} in forest plots > in open sites due to canopy drip of N, especially that of DON, given that the assimilation cost of organic N (amino acids) is expected to be lower than that of inorganic N

- OBS: DON deposition was calculated by subtracting the measured NH_4-N and NO_3-N from the total N

Results: Moss N% vs. different N forms

Pleurozium schreberi

Bulk deposition TF deposition



- Inorganic N forms (NH_4-N and NO_3-N) of bulk deposition explained all variation in moss N% in open sites

- Dissolved organic N (DON) leaching from tree canopies (TF) explained almost all variation in moss N% in forests.

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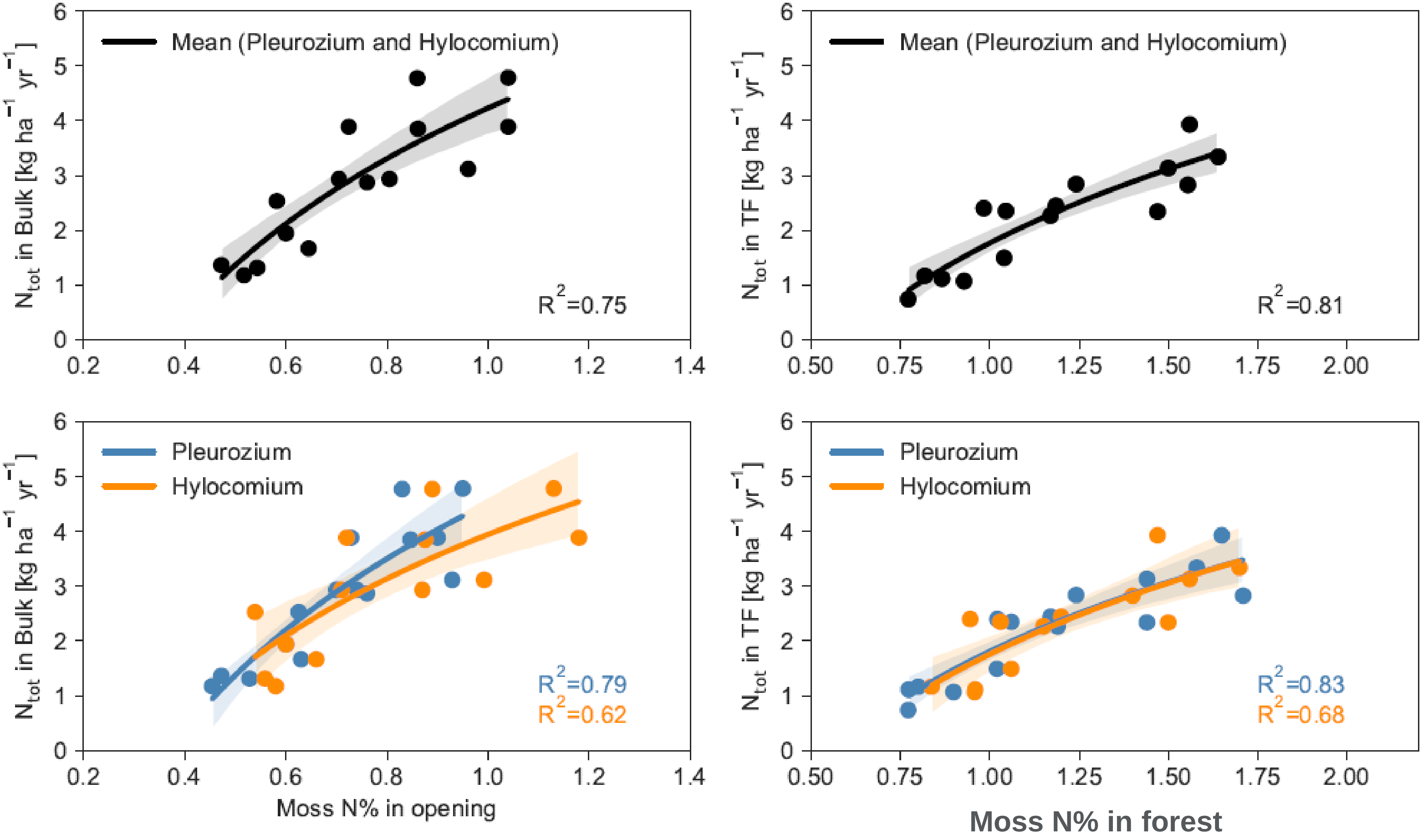
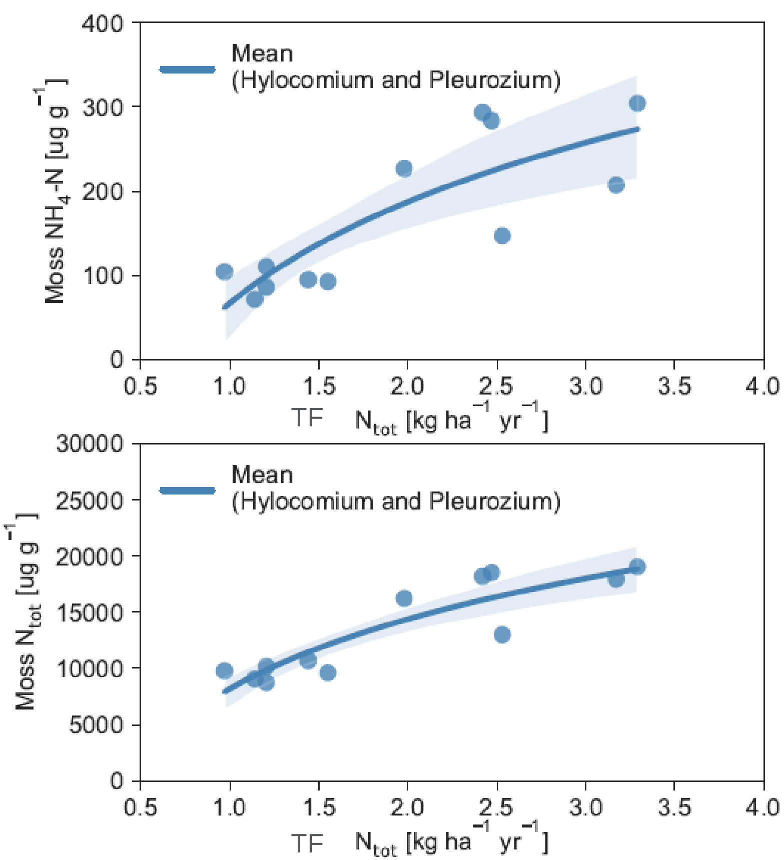
Results: Equations for predicting of Ntot deposition in background boreal forests



10.6.2019

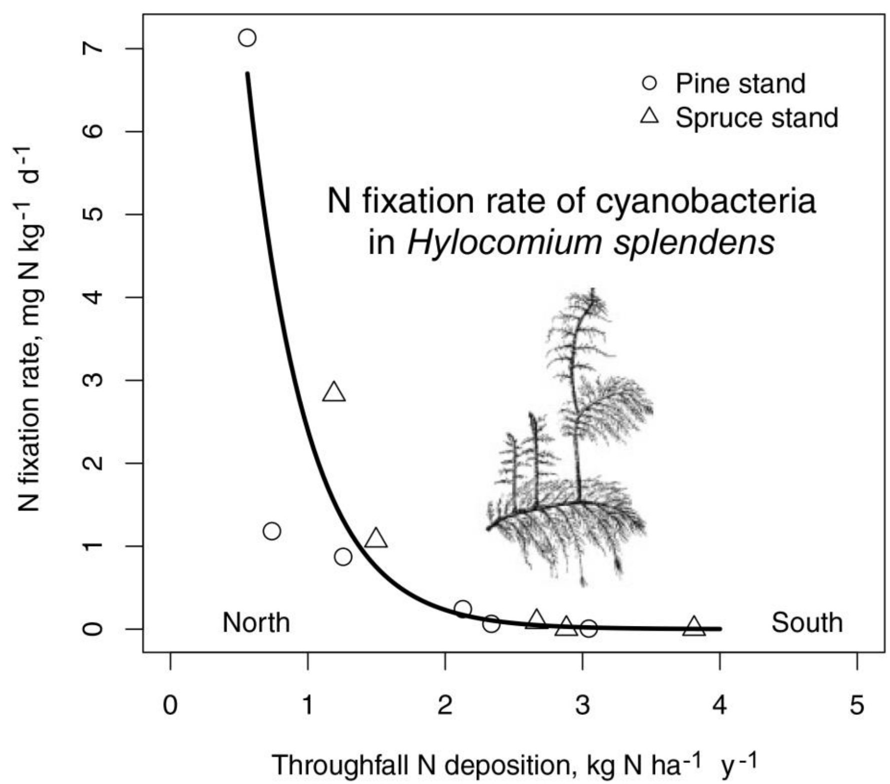
Results: Accumulation curves for NH_4-N and total N in moss tissues



Data from years 2002, 2003

Cyanobacteria activity turns off at 3-4 kg N ha^{-1} yr^{-1}

Salemaa et al. 2019, STOTEN 653:995-1004)



Conclusions and discussion

- TF DON explained moss N_{tot} % in forest plots as predicted by our hypothesis. Tree canopies, litter fall and herb layer leach DON.
- Forest mosses were near saturated level at the deposition level 3–4 kg N $ha^{-1}yr^{-1}$ as seen as asymptotic form of the moss N% response curves and as accumulation of free NH4-N in tissues. Cyanobacteria activity on mosses was inhibited at this level, too.
- Should 3–4 kg N $ha^{-1}yr^{-1}$ deposition level be incorporated in the critical load concept for most sensitive organisms in boreal forests?