Forest Knowledge Know-how METLA Well-being

Above and belowground carbon stocks in coniferous boreal forests in Finland

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Introduction

Controls of storage and release of carbon in boreal forests:

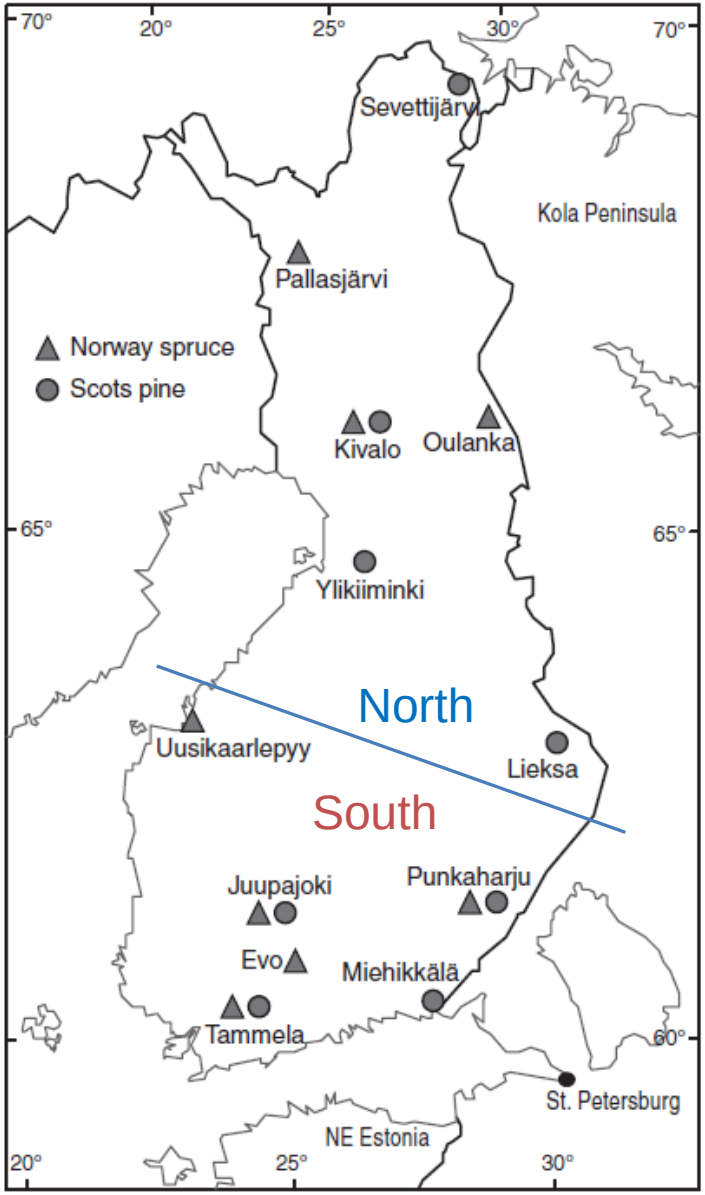
1. The rate of plant **growth**
2. The rate of **decomposition** of dead org. matter
3. Leaching
4. (The rate of formation of frozen soil, permafrost)
5. (The frequency and severity of fires, well protected in Finland)

Introduction

- These processes are determined by:
  - **Climate**: Biomass production and decomposition
  - **Nutrient status**: Productivity
  - **Dominating tree species**: C allocation, litter quality
  - **Stand age:** total C stock
  - **Anthropogenic factors**: forest management and deposition

Aim of the study

- To evaluate the amount and distribution of C stocks in forest ecosystem compartments in relation to
  - climate
    - S boreal vs. middle and N boreal
  - dominant tree species
    - **Scots pine**: xeric – sub-xeric; 3N, 4 S plots
    - **Norway spruce**: mesic – herb-rich; 3N, 5 S plots



The studied compartments:

- Aboveground:
  - Trees:
    - Needles
    - Branches (dead and living)
    - Stems
    - Bark
  - Understorey vegetation
- Belowground:
  - Course roots
  - Fine and small roots
  - Litter layer
  - Humus layer
  - Mineral soil (0-40 cm)

C fluxes

- **Litterfall**
- **Deposition DOC flux**
- **Percolation water C fluxes**

- Sampling and analysis as part of Level II monitoring

Estimation of biomasses

- **Biomass of tree compartments**: equations of Repola (2007, 2009)
  - **Predictors**: Tree dbh and height

    →Estimates for biomass of **bark, stem, wood, roots, dead branches**
  - **Predictors**: Tree dbh, height, crown length

    → Estimates for biomass of **needles and living branches**

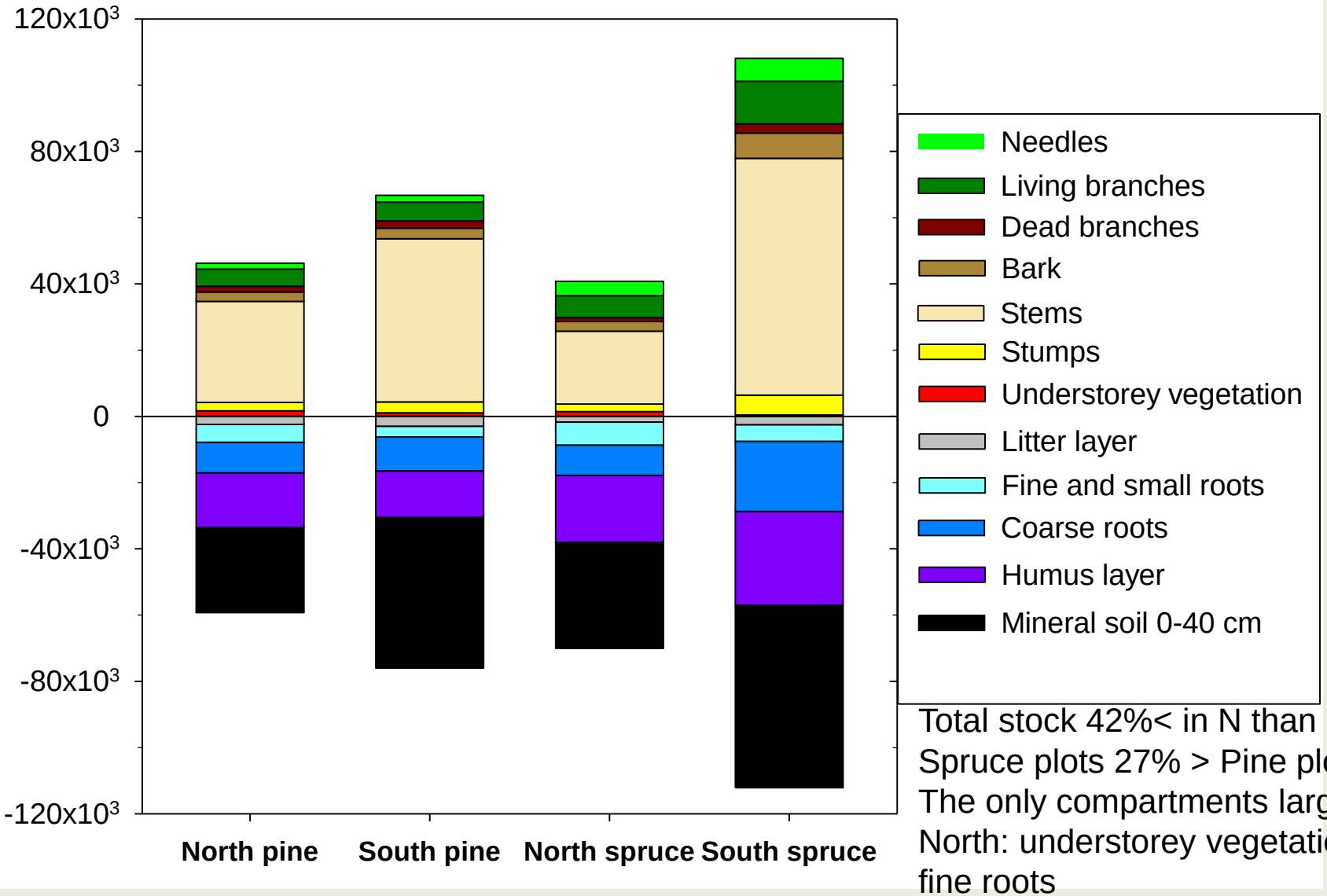
Sampling for measurement of biomass and N concentration

- **C in stem wood, bark, living and dead branches**: samples from 5 sample trees/site
- **C in needles:** method applied in Level II monitoring, all present needle year classes
- **C in aboveground understorey vegetation, organic layer (L, F, H):** 28 squares per plot (30*30 cm), sorting
- **C in fine roots:** 12 root cores per plot, understorey and tree roots separated by washing
- **C in mineral soil layers (0-40 cm):** Biosoil data

Calculation of C pools

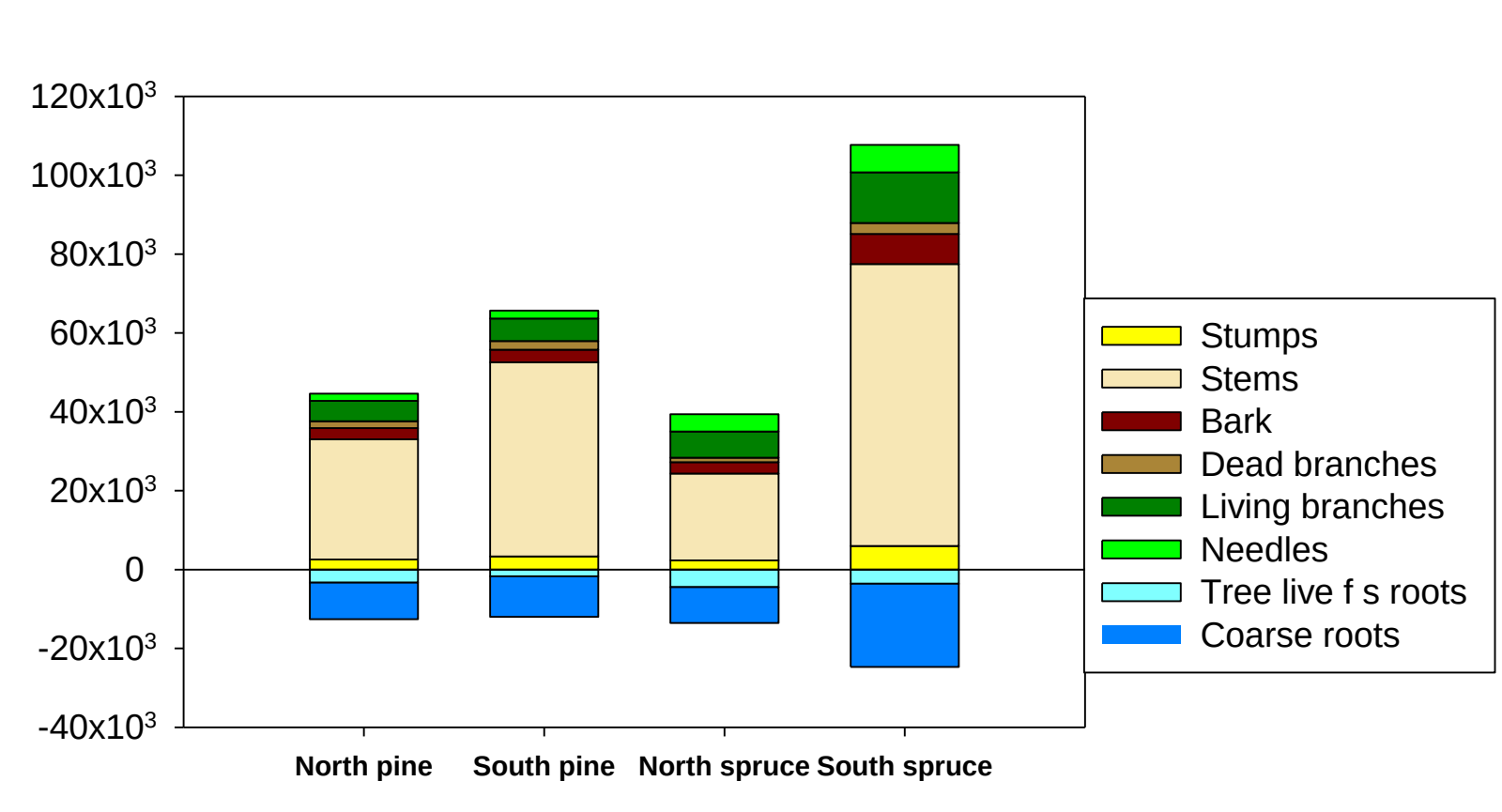
- Mass kg ha^{-1}* C concentration
- Differences between tree species and location calculated by linear mixed models

Carbon stocks, kg/ha



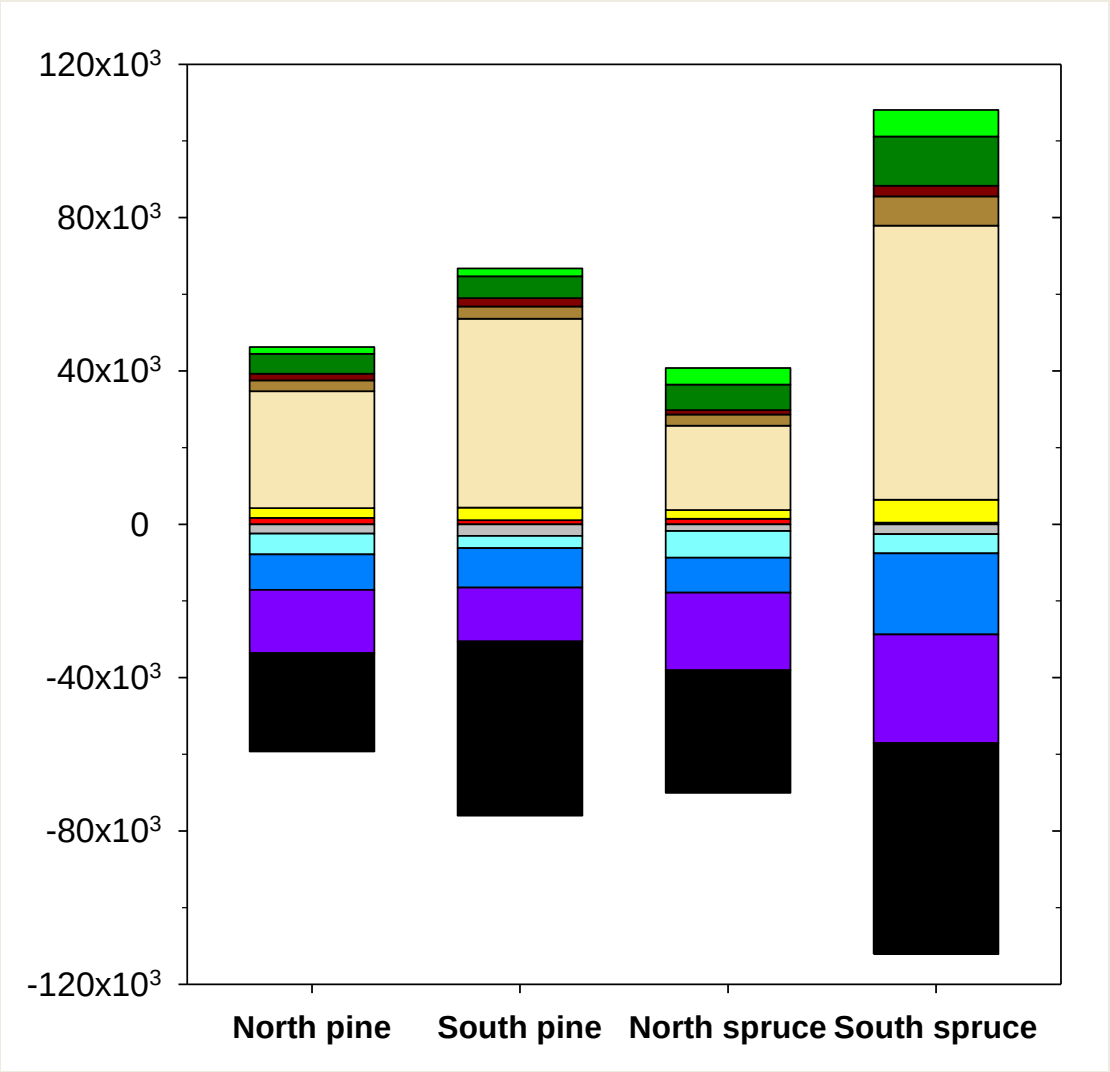
Total stock 42%< in N than in S
Spruce plots 27% > Pine plots
The only compartments larger in North: understorey vegetation and fine roots

Tree above:belowground ratios



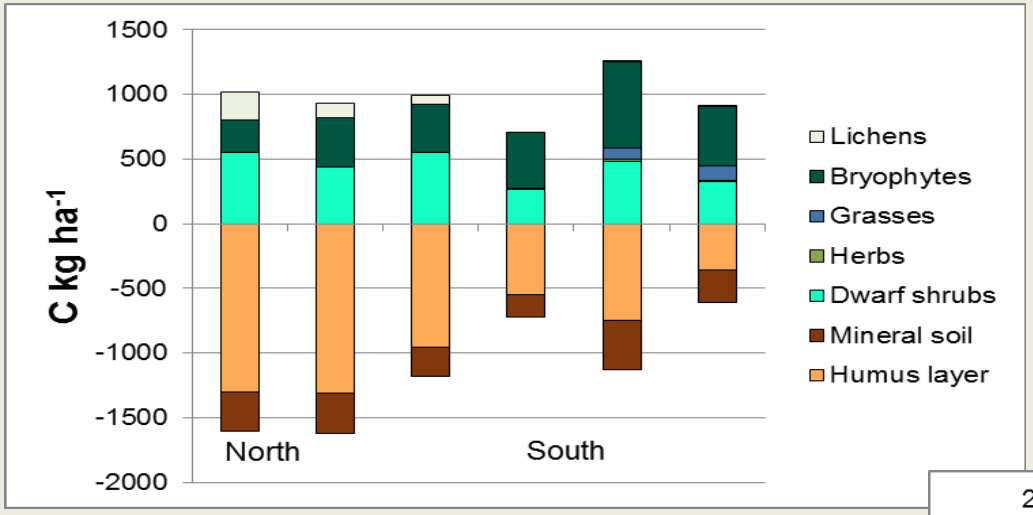
Proportionally, trees allocate more C belowground in the north

Ecosystem above: belowground ratio



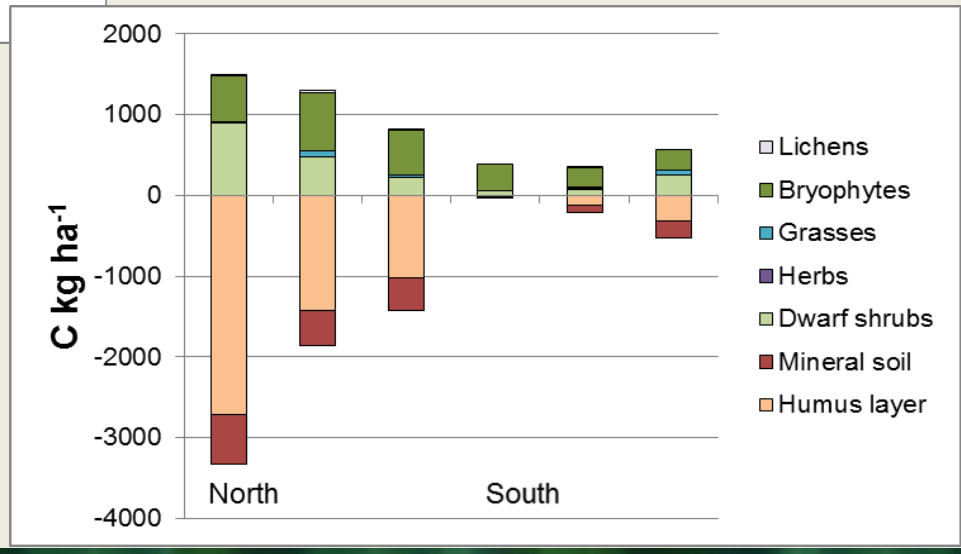
Proportionally, the ecosystem allocates more C belowground in the north

Understorey C stocks

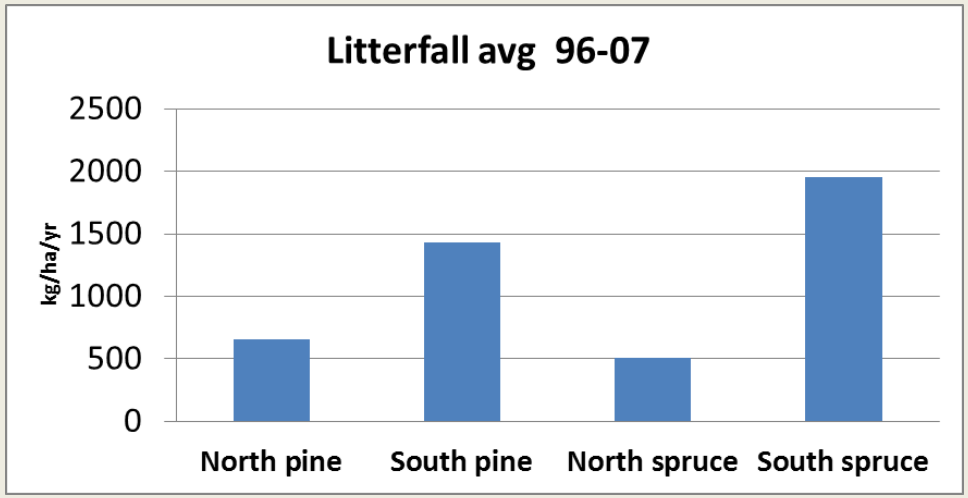


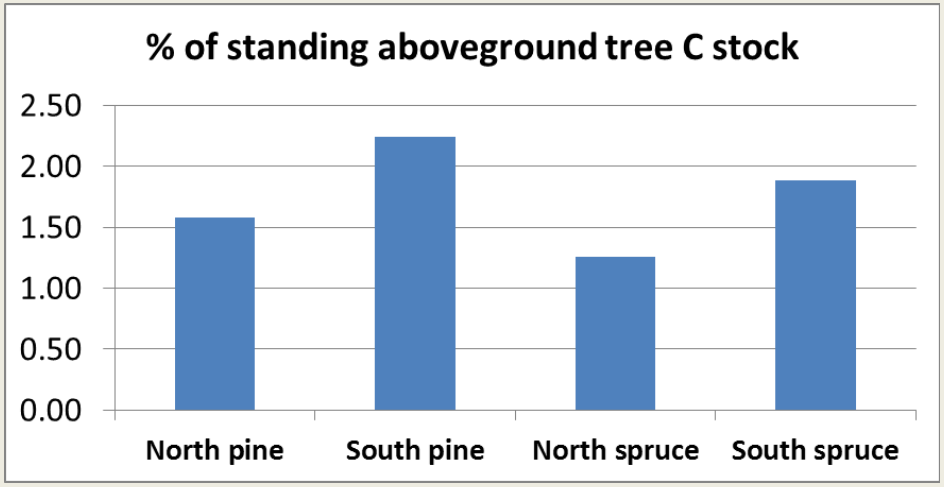
Pine plots

Spruce plots

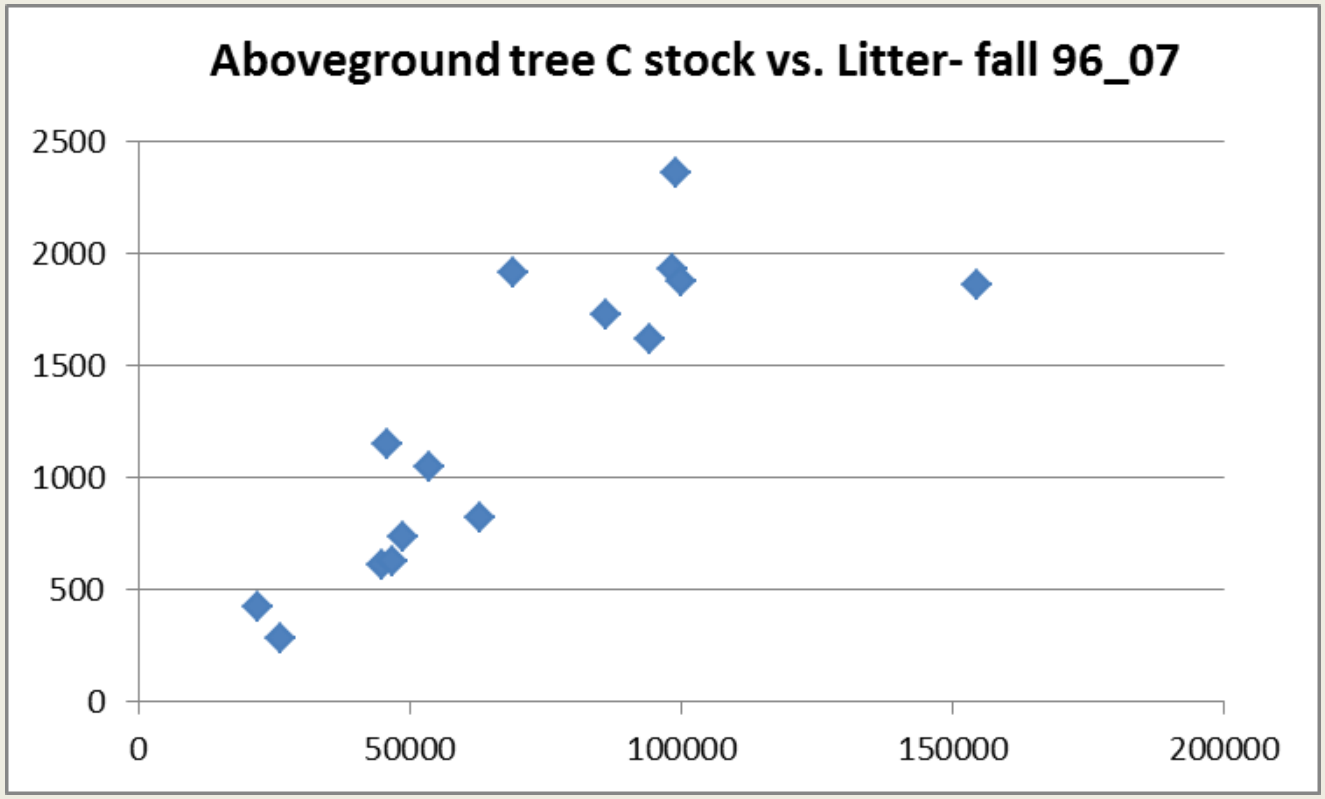


Annual litterfall flux



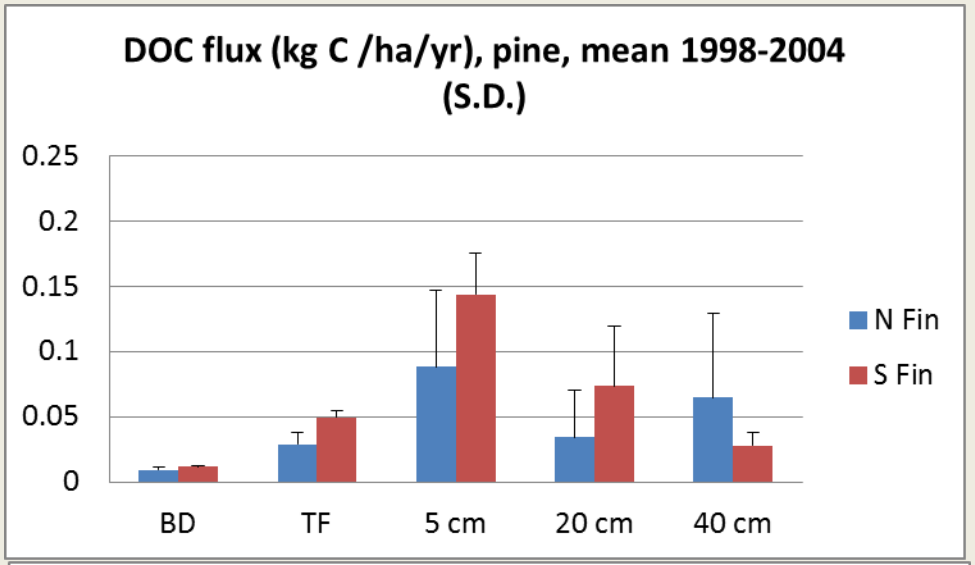


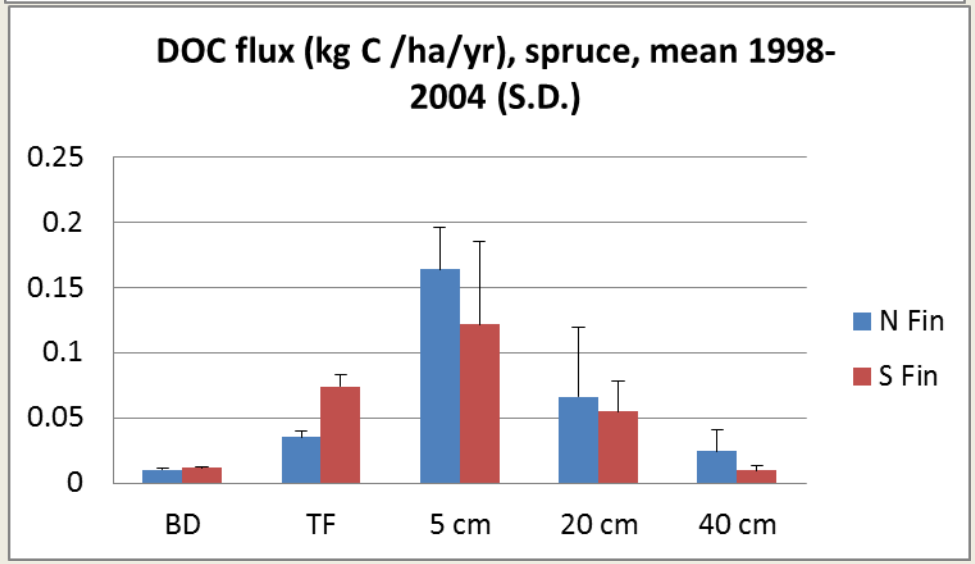
Aboveground Tree C stock vs. Litterfall C (long-term annual mean)



$R^2 = 0.55$

Annual DOC flux





Conclusions

- Major ecosystem C pools are tree stems (29%), mineral soil (28%), humus layer (14%)
- Both above and belowground C stocks > in the south than in the north
- C stock distribution pattern is different between N and S:
  - In the north higher proportion of C is located belowground
  - The importance of understorey vegetation > northwards, especially in spruce
- C pool in stems 29%, in ”logging residues” 9%, in stumps 2-3% of **ecosystem C** stock
- Stems represent 53%, ”logging residues”17%, stumps 4%, of **tree** C stock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KNOWLEDGE
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Thank you