# Linking soil organic carbon pools and LiDAR remote sensing of above-ground biomass in boreal forest ecosystems

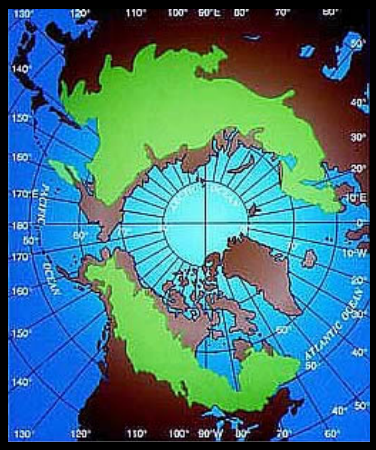

- Terje Kristensen (Norwegian University of Life Sciences)
- Erik Næsset (Norwegian University of Life Sciences)
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- Rune H. Økland (University of Oslo)


## Main structure of the presentation

- The boreal forest
- Conceptual idea (only an idea, no results yet)
- Our data and sampling approach

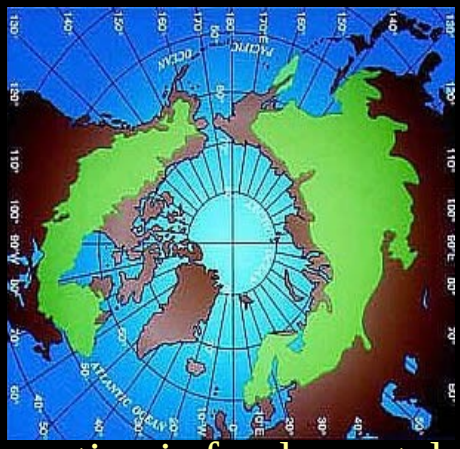
# The Boreal forest – huge areas and huge carbon stocks



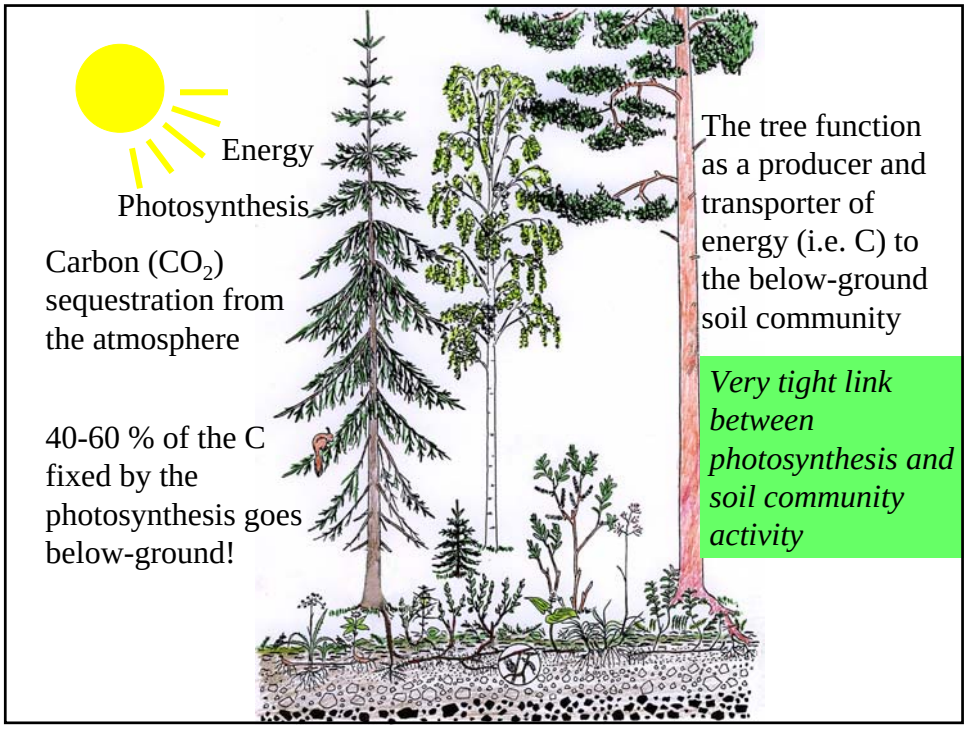


# The Boreal forest – huge areas and huge carbon stocks

- 1,37 x $10^9$ ha
- 559 PgC (1Pg = $10^{15}$g)
- 23 % of the global terrestrial C stock
- As a comparison – tropical forests represents 17 %
- *471 out of the 559 PgC are stored in the soil*



<u>A below-ground perspective is fundamental</u>




**Large-scale forest girdling shows that current photosynthesis drives soil respiration**

Peter Högberg*, Anders Nordgren*, Nina Buchmann†, Andrew F. S. Taylor‡, Alf Ekblad*§, Mona N. Högberg*, Gert Nyberg*, Mikaell Ottosson-Löfvenius* & David J. Read‖

Nature 411, 789-792
(14 Jun 2001)

Major below-ground components:

The mycorrhiza fungi community

Free living microbial heterotrophs (the decomposer community)

Soil-fauna (e.g. Colembola grazing on the fungi mycelium)







## Conceptual idea (1)

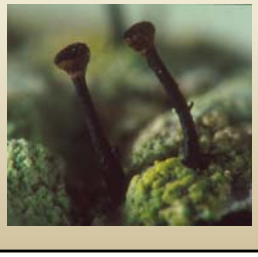
- The carbon balance is ultimately a delicate equilibrium between the fluxes of photosynthesis and respiration
- In forests, total ecosystem respiration tends to be dominated by root and microbial soil respiration
- Respiration is the main determinant of carbon balance in European forests (Valentini et al. 2000 – Nature 404)
- There is a tight link between tree photosynthesis and soil respiration (Högberg et al. 2000 – Nature 411)

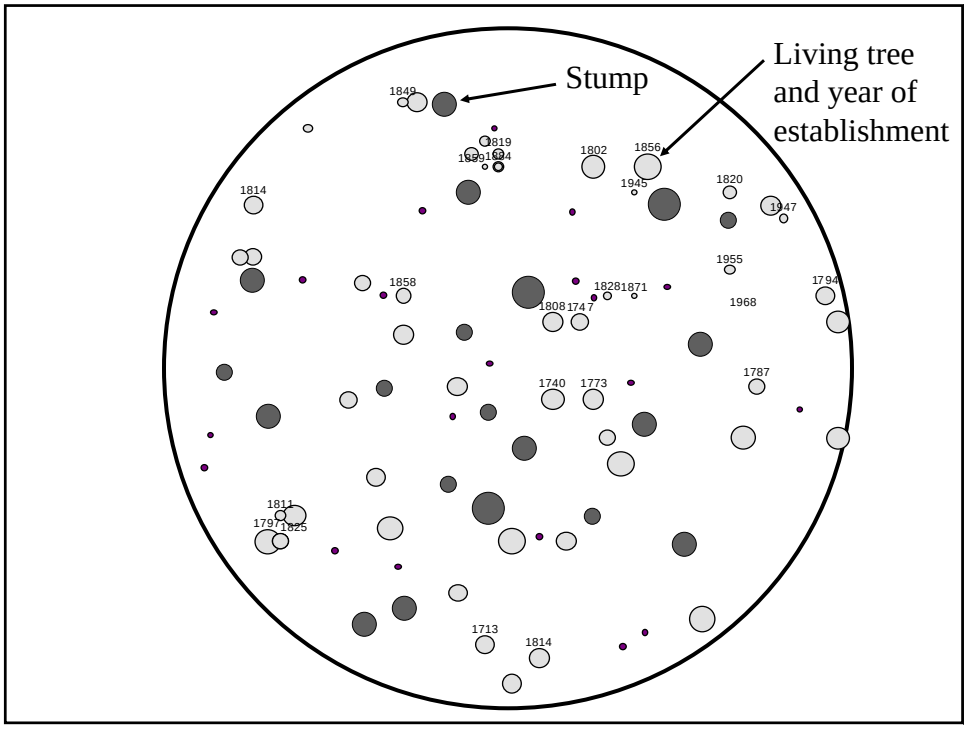
## Conceptual idea (2)

- The spatial arrangement of forest trees has a very significant impact on the size and composition of the forest soil microbial community (Sætre 1999 – Ecography 22; Sætre & Bååth 2000 – Soil Biology & Biochemistry 32)
- LiDAR can recognize and characterize the spatial arrangement of forest trees
- Thus, LiDAR ought to be able to detect patterns as regard the forest soil microbial community, which in turn is the main determinant of below ground carbon stocks in boreal forests

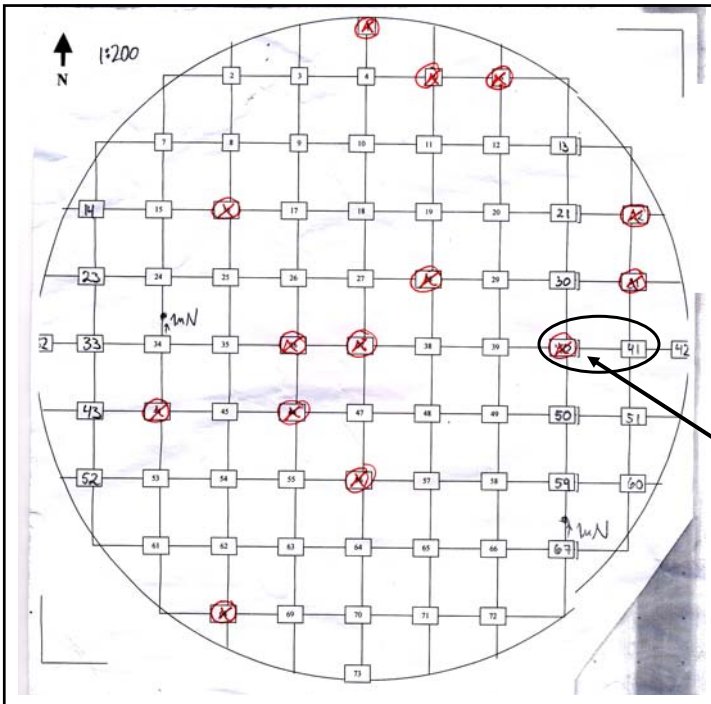
## Our data and sampling approach

- Two forest landscapes – Siljan in south east Norway
- Eight circular 2000 $m^2$ plots – four in each landscape
- Age, size and position of all trees
- Detailed biodiversity data (lichens, bryophytes, fungi and vascular plants
- Forest history
- LiDAR






OK, but what about biomass and carbon pools?

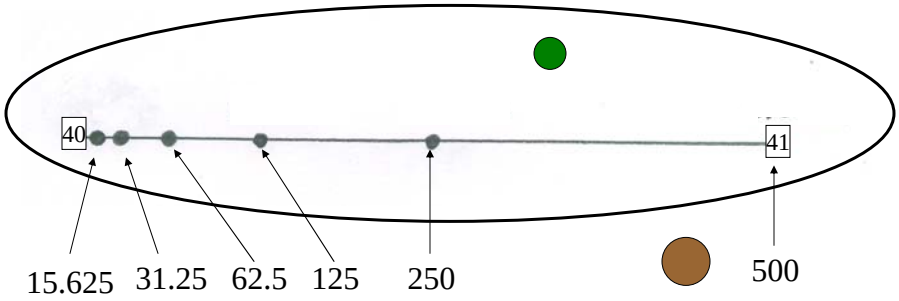



Systematic sampling of biomass and **s**oil **o**rganic **m**atter (SOM) from 73 positions in each plot.

Randomly selected positions (*n*=14) for geostatistical analysis.

## Biomass and carbon pools – scales of spatial variation

Lag classes in the geostatistical approach (cm)




Species, size, position and age of all trees are known



## Our data set for biomass and carbon estimation

- 1144 samples of above ground vascular plant biomass
- 1144 samples of bryophyte biomass
- 1144 organic soil profiles
- Tree biomass – both above- and below ground is estimated from allometric relationships



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ORIGINAL ARTICLE

**Functions for below-ground biomass of *Pinus sylvestris*, *Picea abies*, *Betula pendula* and *Betula pubescens* in Sweden**

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## Finally some thoughts

- Ecology + LiDAR = True
  (there is a great potential in the collaboration between ecology and LiDAR)
- It will be an important break-through if we are able to estimate below ground carbon pools in boreal forest ecosystems by remote sensing from above

# Thanks to:


- The Research Council of Norway
- Monica Slåttum and Malin Pilstrøm who have done an excellent job in the field