Acclimation of northern forest trees to rapidly changing environment - Insights from the *Betula* studies

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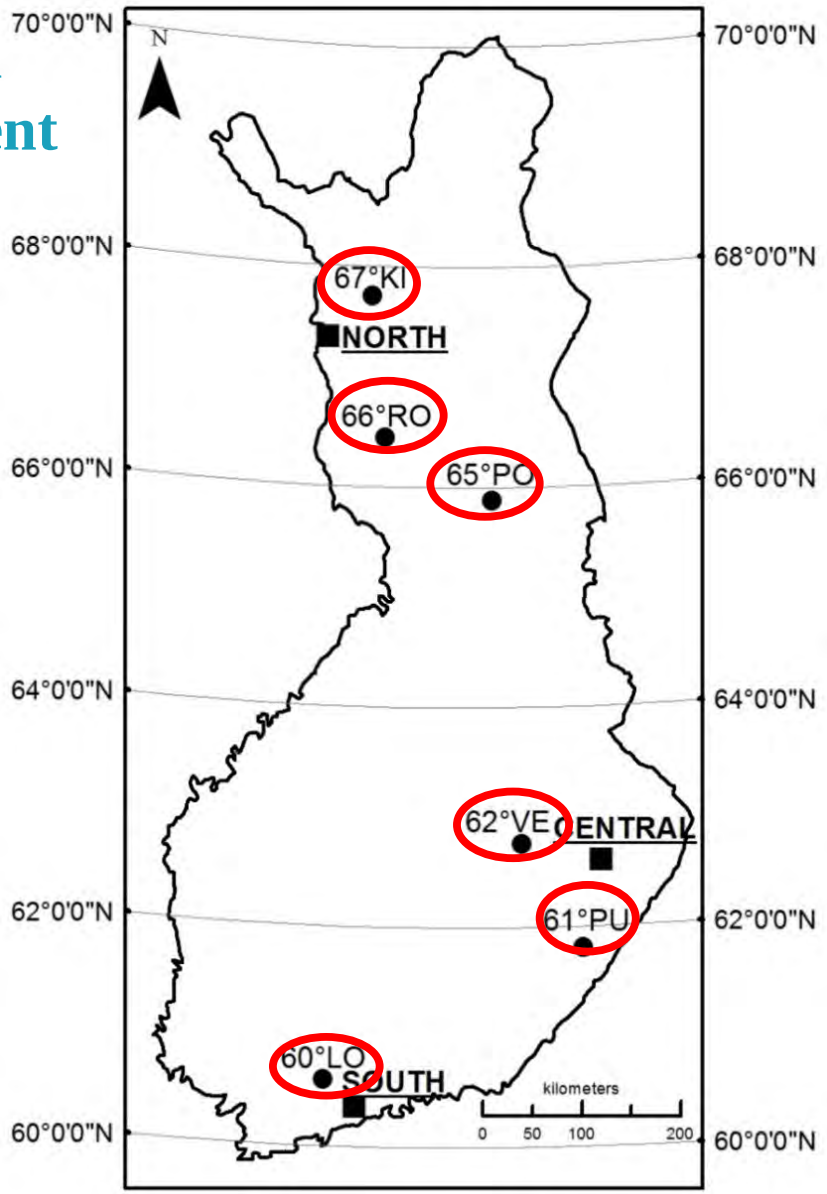
Forests need to acclimate to warming climate and rapid environmental change

- Temperature will increase by 2-5°C by the year 2100
- The thermal growing season will lengthen by 30-40 days and the effective heat sum will doubled in this area
- Increasing pests/pathogens
- Changes in precipitation, more frequent extreme weather conditions

Teams

- **University of Eastern Finland (UEF, Joensuu)**
  - Prof Elina Oksanen, Prof Markku Keinänen, Dr Sari Kontunen-Soppela, Dr Sarita Keski-Saari, Dr Kaisa Heimonen, Jenna Lihavainen, Antti Tenkanen, Maya Deepak, Lars Granlund – field and laboratory experiments, ecophysiology, spectral imaging
- **University of Helsinki**
  - Dr Juha Mikola, Dr Tarja Silfver – field experiments, ecology, soil
- **Natural Resources Institute Finland** (Luke, Vantaa)
  - Dr Kaisa Nieminen, Dr Matti Rousi – birch materials, genomics, field sites
- **National Research Council, CNR,** Florence, Italy
  - Dr Alberto Santini, Dr Luisa Ghelardini,– field studies: warming climate, marginal populations

Common garden study 2010-present

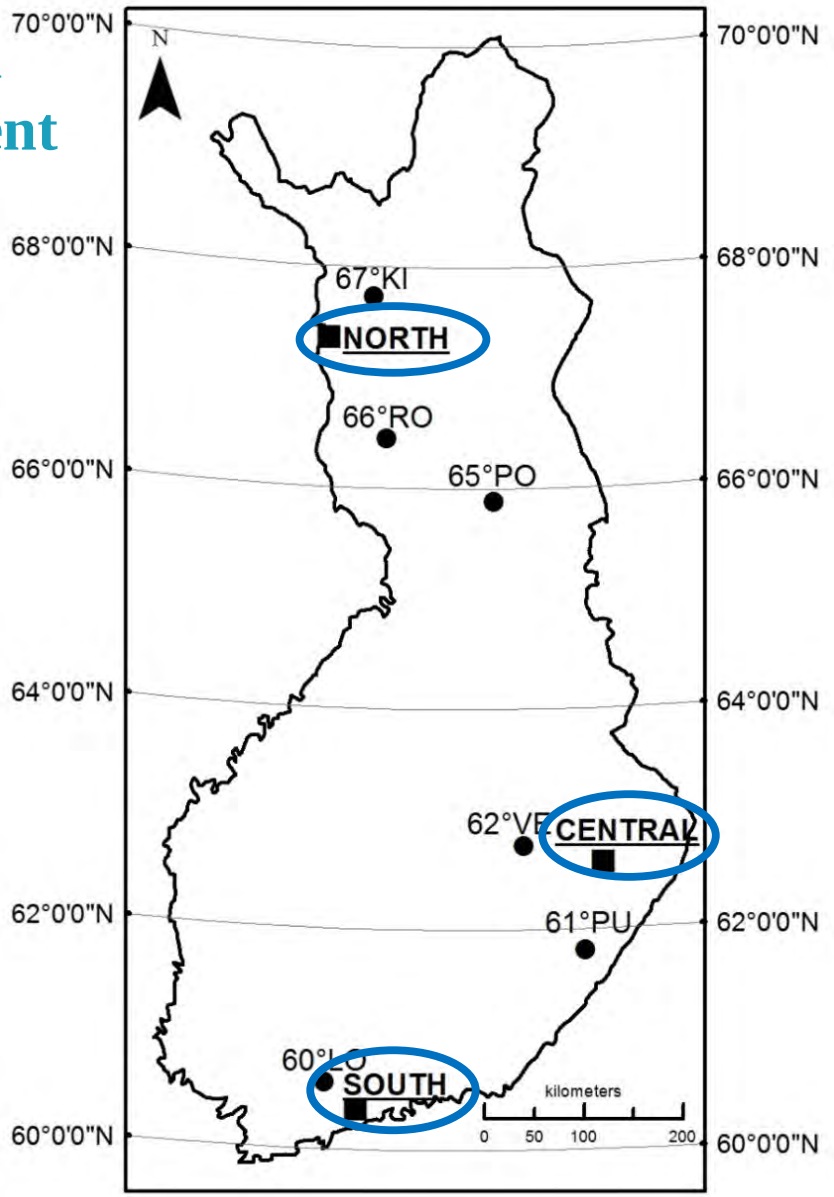


6 provenances

26 genotypes

260 birches/site =780 total

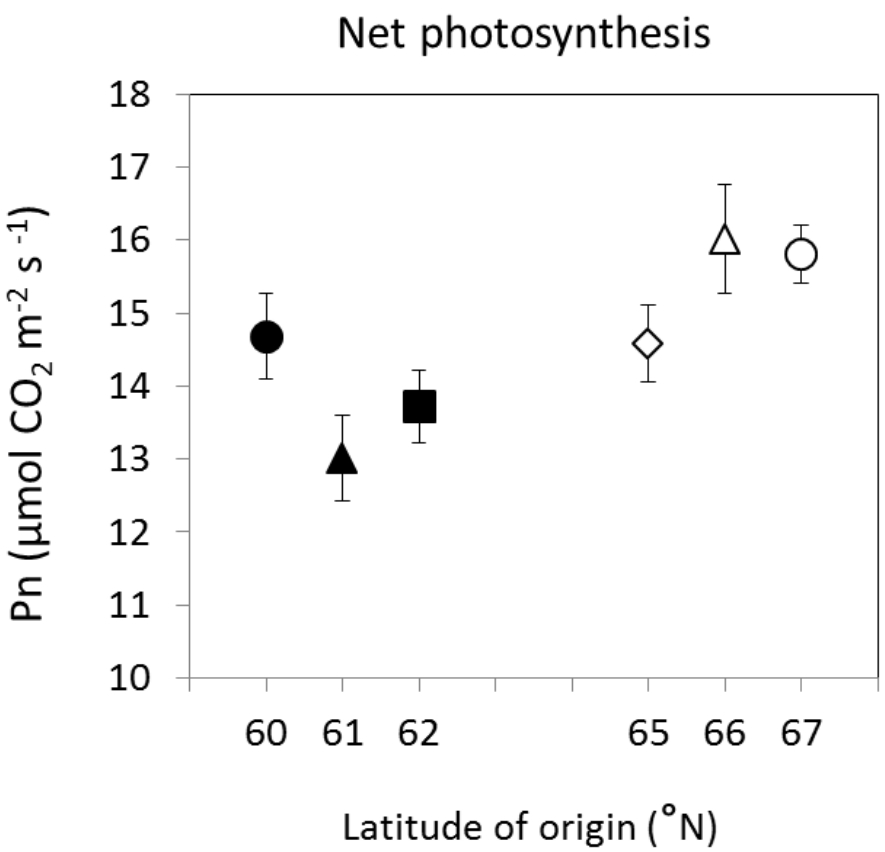
Common garden study 2010-present

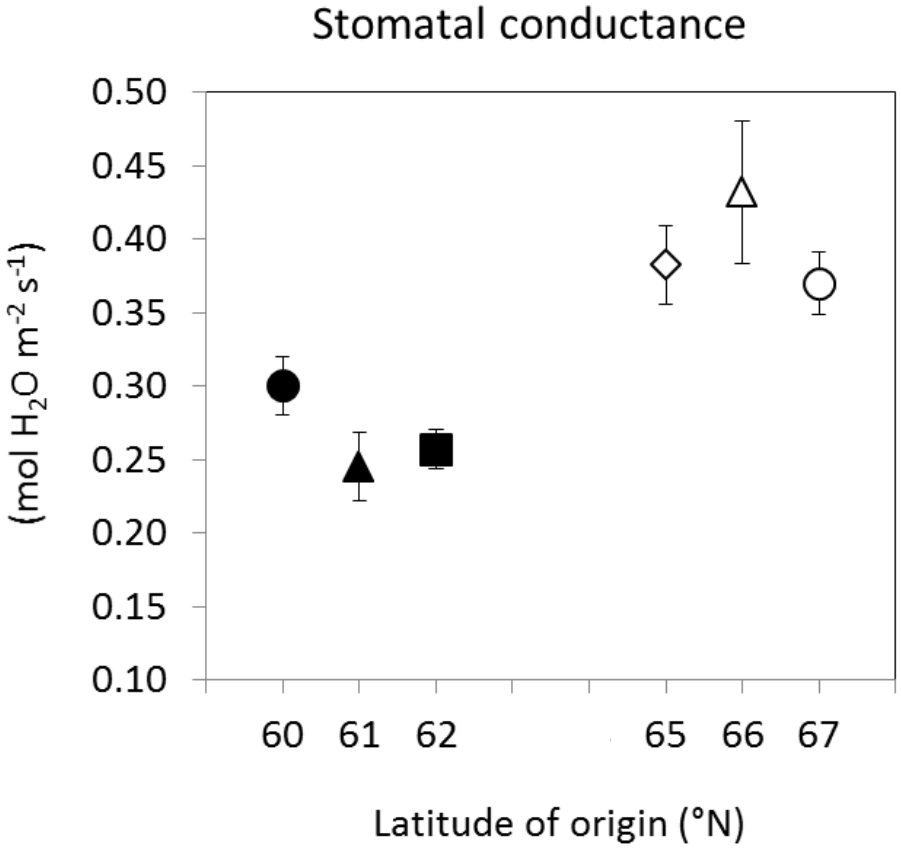


3 study sites

Translocation study simulating warming climate using 'natural laboratory' and common gardens: 1°C drop/150 km polewards

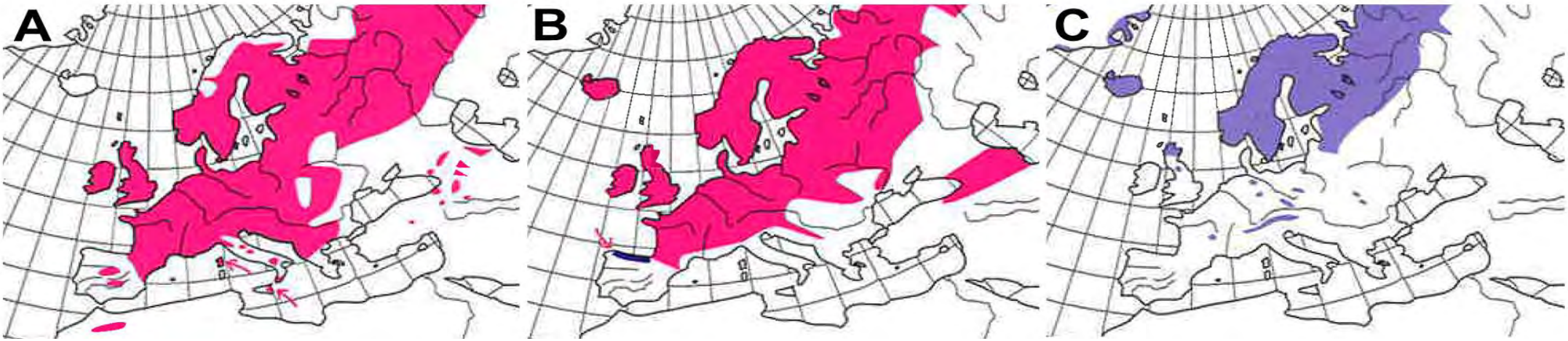
The northern provenances had higher photosynthetic rates and stomatal conductance than the southern ones





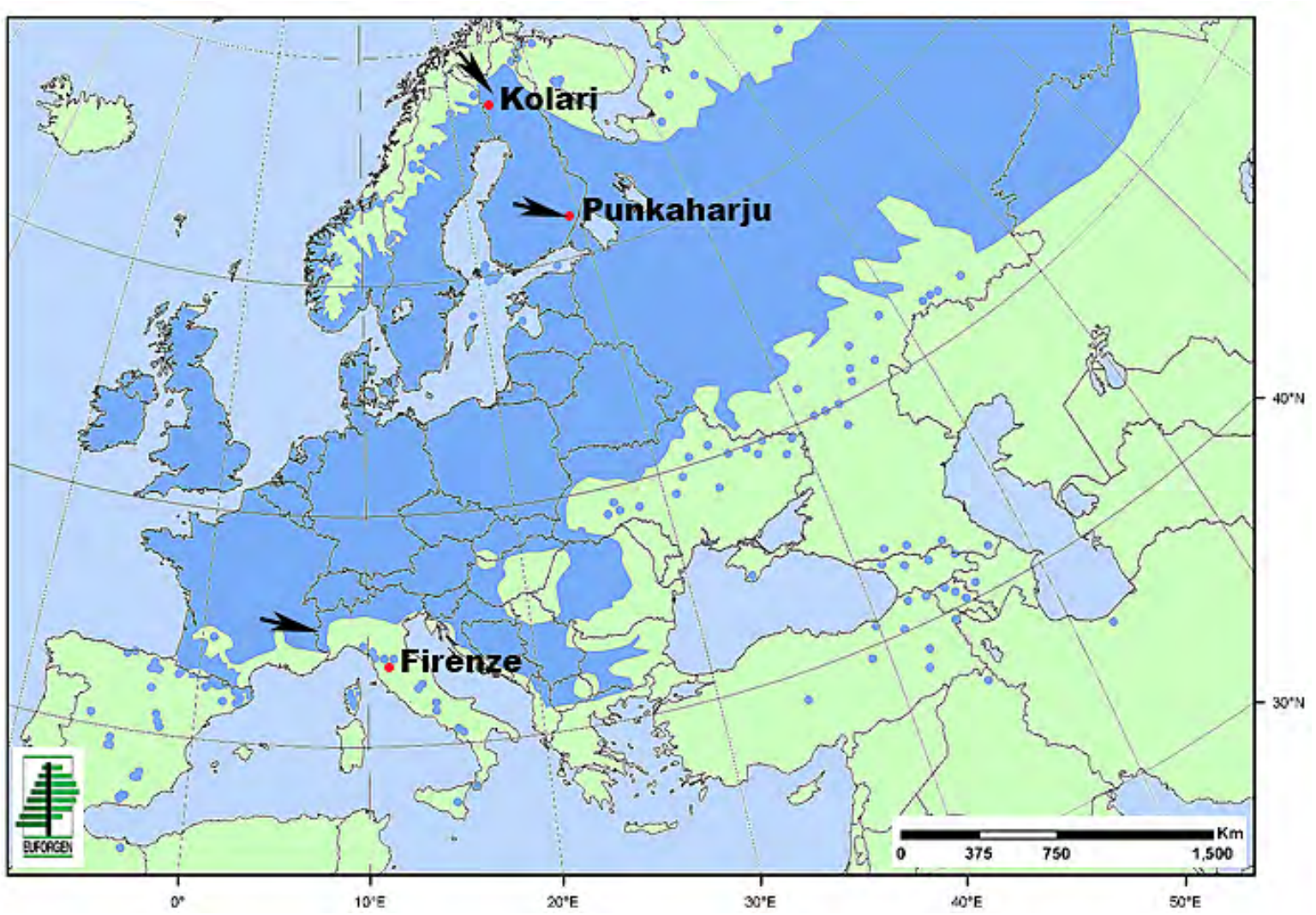
Summer 2013, Joensuu site, A. Tenkanen

BETUMICS-project (Academy of Finland) Adaptation and acclimation of birch (*Betula* species) to warming climate



Distribution maps of A) *Betula pendula*, B) *B. pubescens* (including the northern sp. *czerepanovii*) and C) *B. nana* overlap. This enables their hybridization and eventual introgression. Modified from Ashburner K and McAllister HA, 2013 (*Kew Publishing, Royal Botanic Gardens, Kew, UK. 431 p.*)

Preparation of new common garden sites (2016-)

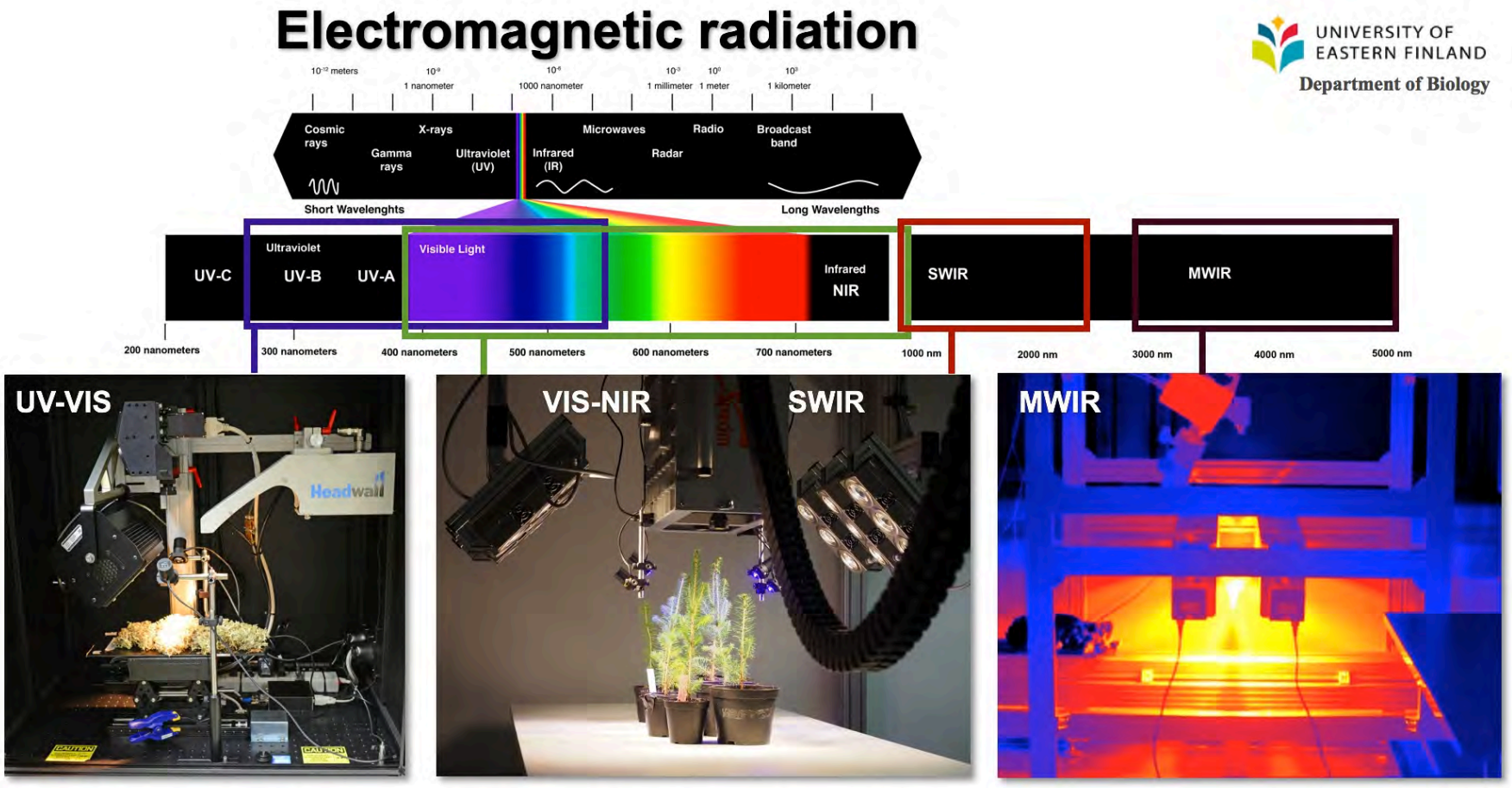


Kevo experiment: Monitoring the effects of warming on a subarctic treeline ecosystem (four *Betula* species)

Figure 1. The warming experiment will be established near the Kevo Subarctic Research Station, located in Utsjoki at the northernmost tip of Finland (69°45' N, 27°01' E) right next to the Kevo Strict Nature Reserve.

A prototype for heating system - to be set up in Kevo in June 2016

Hyperspectral imaging - spectromics

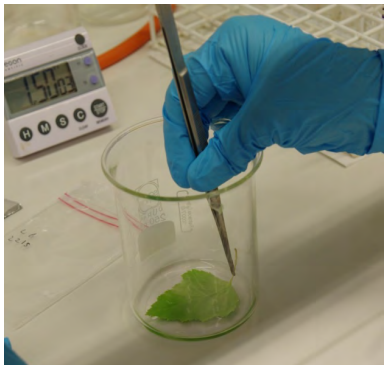


UNIVERSITY OF EASTERN FINLAND
Department of Biology

Imaging spectrographs of the UEF Spectromics Lab (www.spectromics.org)

Fluorescent stress compounds | Chl fluorescence | Water, nutrient status

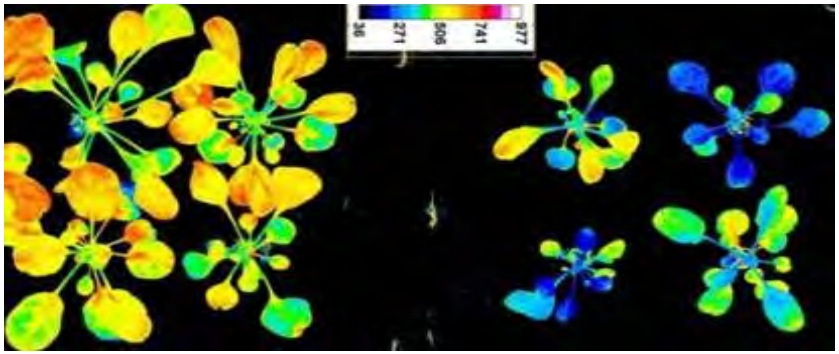
Plant biology, field and laboratory experiments, environmental research



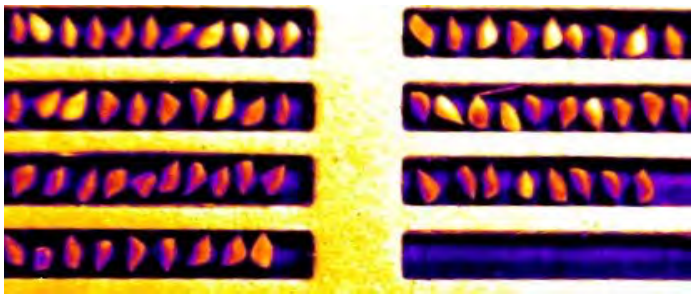
Plant stress treatments, acclimation to environmental change

Imaging applications

Mapping photosynthesis

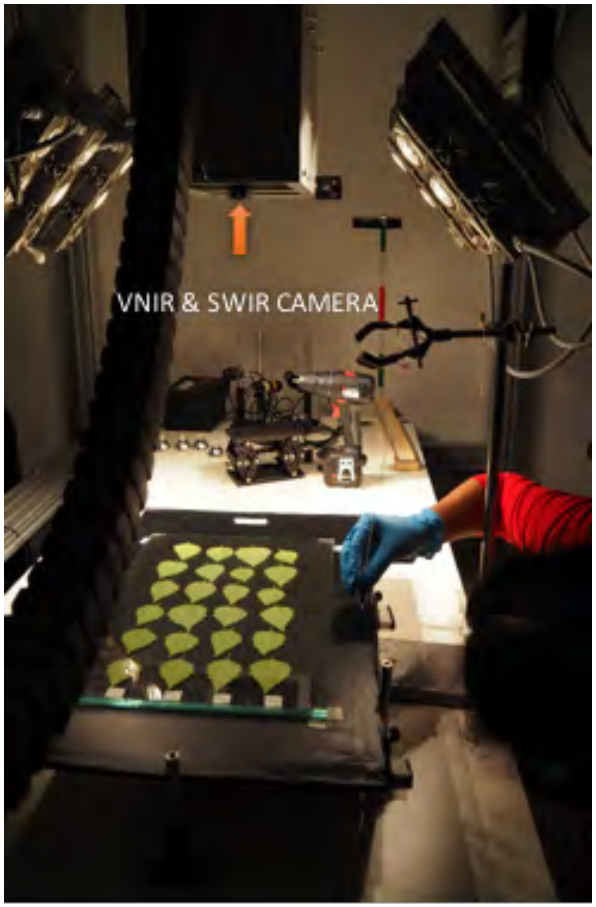


Heavy metal (Cd) accumulation, plant chemistry



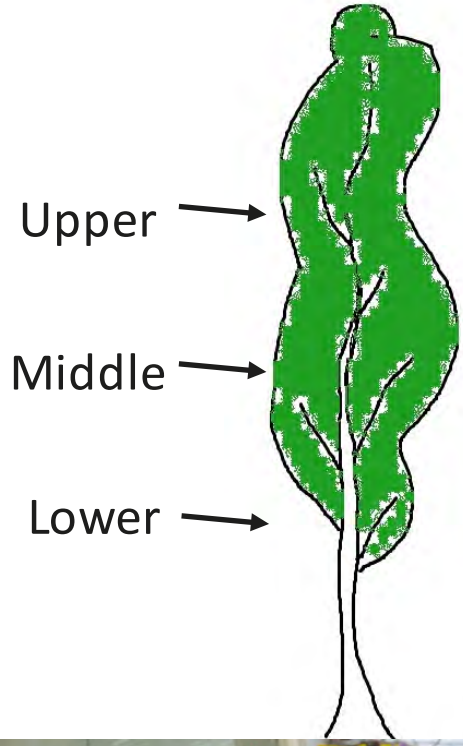
Seed quality screening

Hyperspectral and fluorescence imaging techniques (Doctoral theses by Maya Deepak and Lars Granlund)



Spectromics laboratory

- Variation in reflectance spectra within one birch tree and among the leaves
- Connections to chemical and structural composition of the leaves
  - nitrogen
  - starch
  - water content
  - polymers
- Applications: mapping the leaf traits, photosynthesis, selecting leaf samples, environmental monitoring, seed quality etc.



FAHM (Free Air Humidity Manipulation)

Figure 1. *A) Location of the Free Air Humidity Manipulation (FAHM) experimental site in Tartu, Estonia. B) Layout of the experimental area (empty circles represent control plots and filled circles represent humidified plots). C) Layout of the humidified plot. D) Humidification in progress in one of the experimental plots in summer 2012.*

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RESEARCH PAPER

Artificially decreased vapour pressure deficit in field conditions modifies foliar metabolite profiles of birch and aspen

Jenna Lihavainen[1,*], Markku Keinänen[1], Sarita Keski-Saari[1], Sari Kontunen-Soppela[1], Anu Sõber[2] and Elina Oksanen[1]

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RESEARCH PAPER

Low vapour pressure deficit affects nitrogen nutrition and foliar metabolites of silver birch

Jenna Lihavainen[1,*], Viivi Ahonen[2], Sarita Keski-Saari[1], Sari Kontunen-Soppela[1], Elina Oksanen[1] and Markku Keinänen[1]

Key messages

- Southern and northern silver birch provenances form two distinct groups that reflect the proposed colonisation patterns (east and west) after the last ice age
  - different acclimation capacity for southern vs. northern provenances
- Silver birch is sensitive to increasing air humidity (precipitation)
  - negative impact on nutrient homeostasis, gas exchange and biomass production
  - shift in metabolism towards carbohydrates, antioxidants and specific secondary metabolites (e.g. phenolic glycosides)