

Large scale estimation of biomass change

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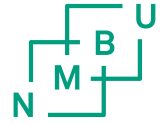
Observed changes in field data

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Project conclusions

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Objectives

- Monitoring of biomass changes in montane forest
 - Biomass estimation
 - Estimation of biomass change

The data



- Field data (ground truth):
 - 70 circular 250 m² plots in montane forest
 - Measured in 2008 and 2012

- ALS data
 - First flight: 06/07 – 7 p/m²
 - Second flight: 12/13 - 13 p/m²

Definition of the population

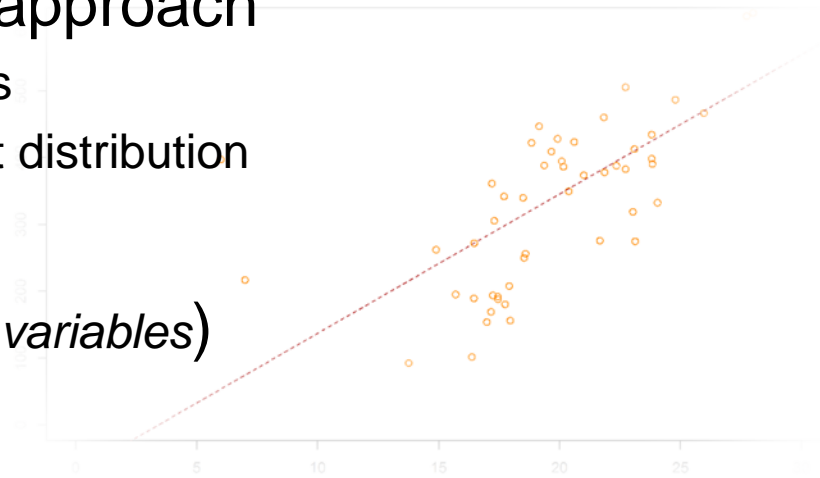


Photo: Nadja
Stumberg

- Lower altitude limit (by county)
- Excluding water bodies, glaciers, developed areas etc.
- Excluding areas with no ALS-echoes $>1.3\text{m}$
- Total area: 3020 ha

Modelling

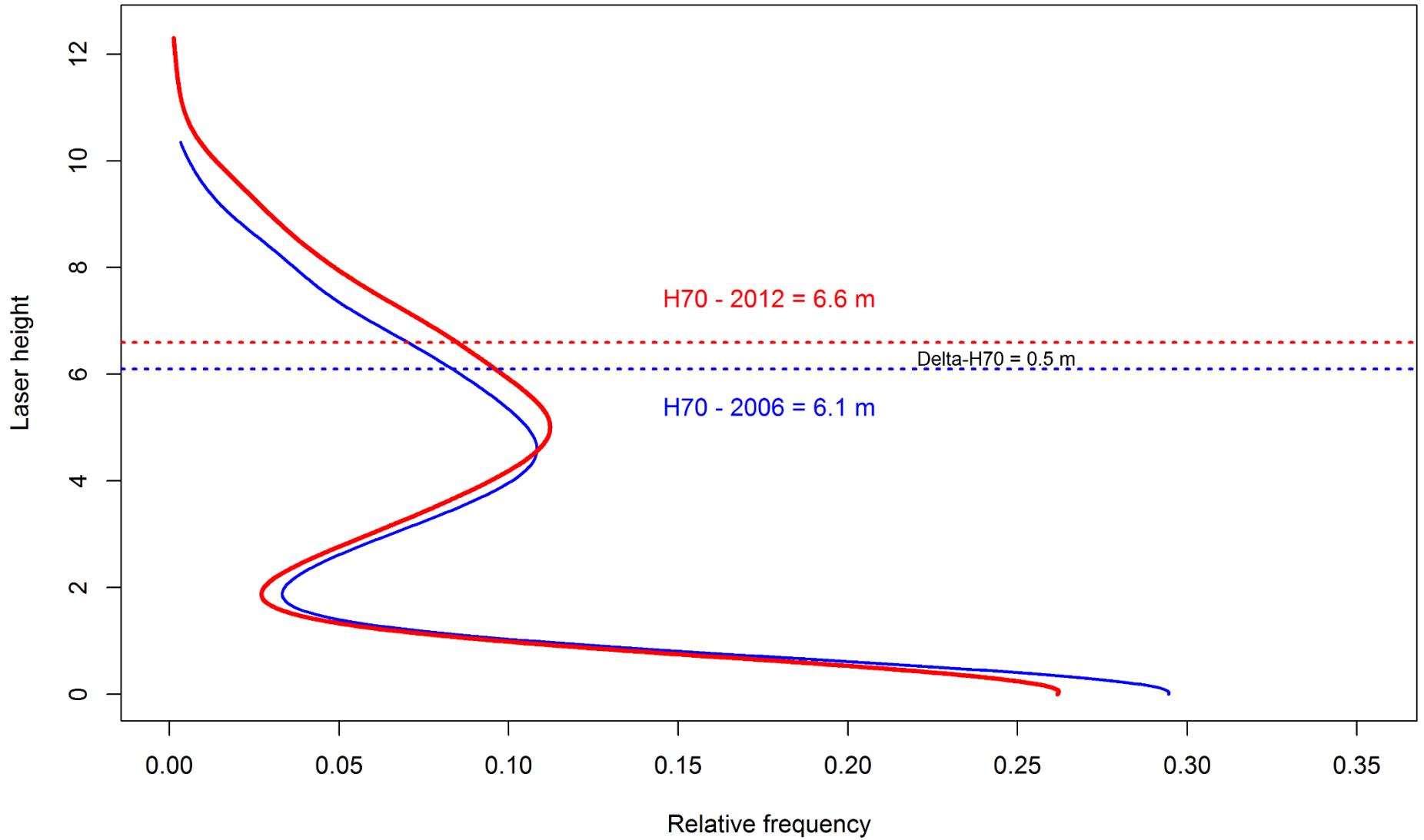
- The area based approach
 - Field observations
 - Laser echo height distribution

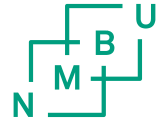


- Biomass = $f(\text{laser variables})$

- Biomass change = $f(\text{change in laser variables})$

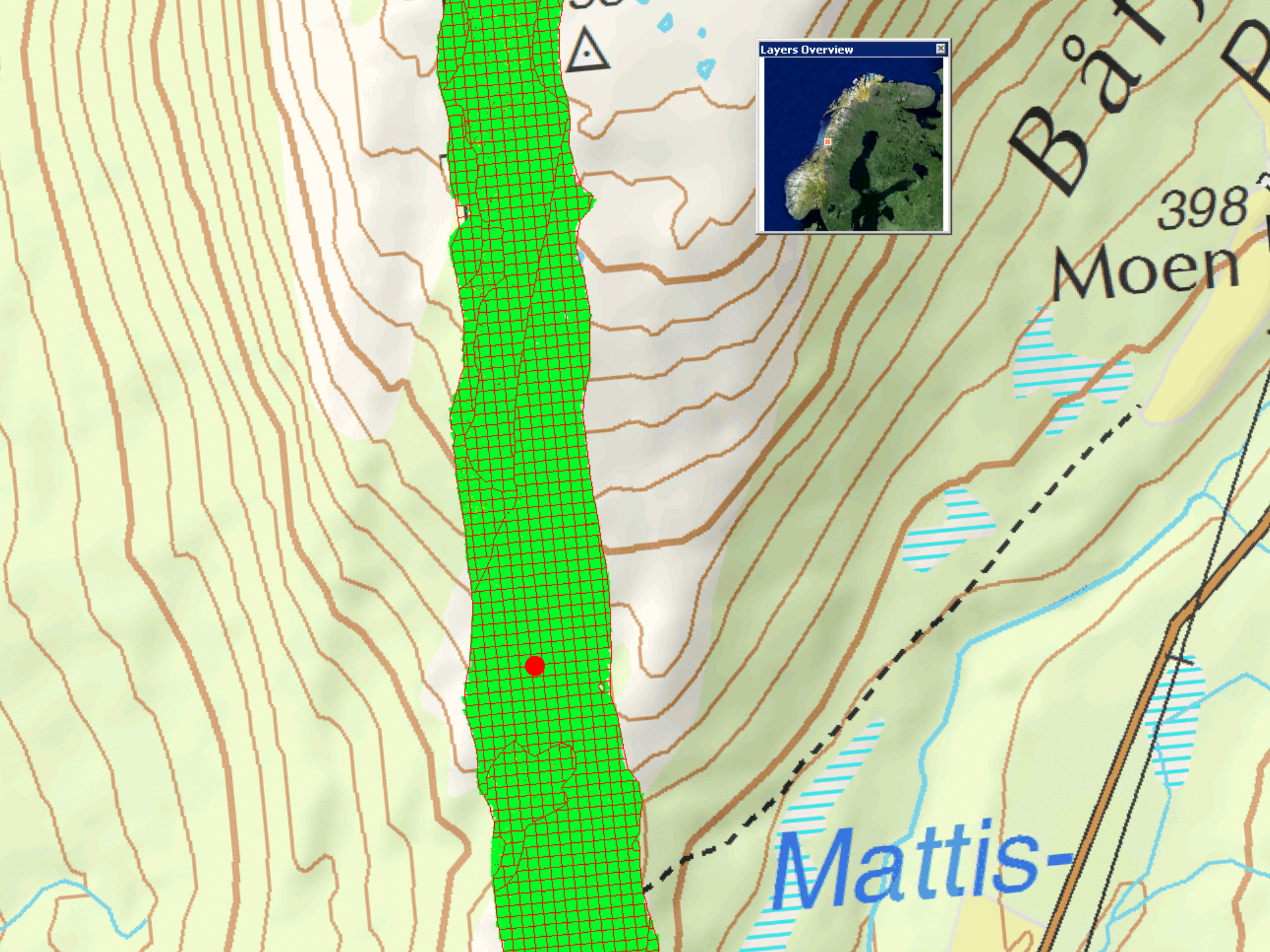
Echo-height distributions





Estimation

- Models applied to grid cells ($\sim 250 \text{ m}^2$) over the population
- Sums and means of biomass- and biomass change estimates
- Variance of the mean estimated (model based inference)
(McRoberts et al. (2014) RSE)



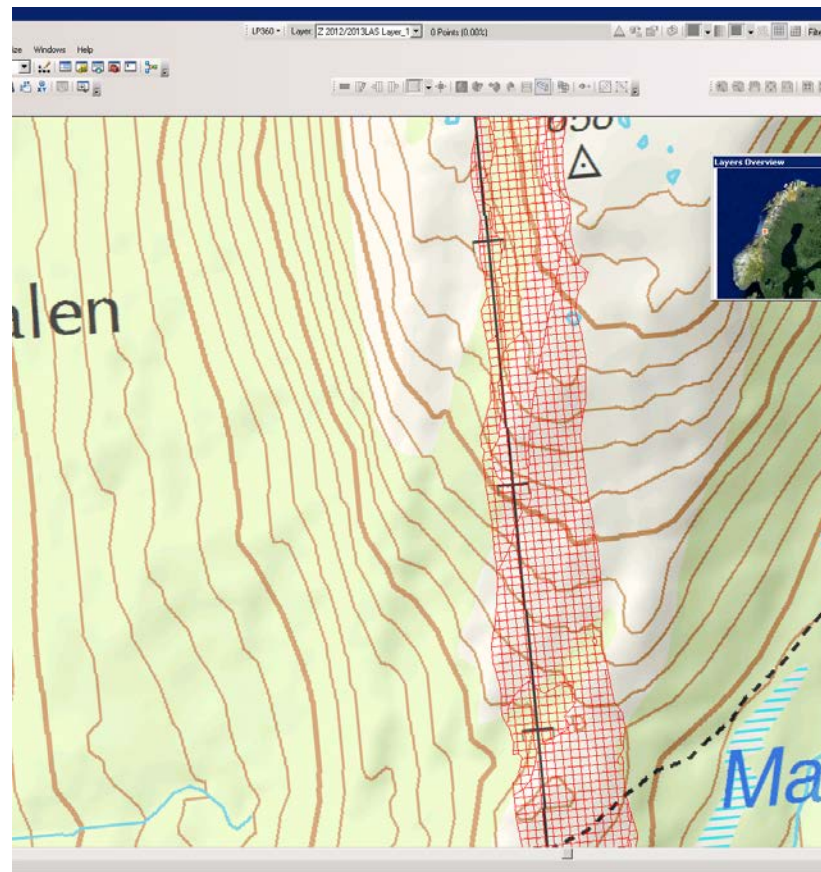


Results

	Total (tons)	95% Conf. (tons)	Per ha (tons)	95% Conf. (tons)
Biomass 2006	46,492	9,976	15.4	3.3
Biomass change	5,416	3,735	1.79	1.24

Concluding remarks

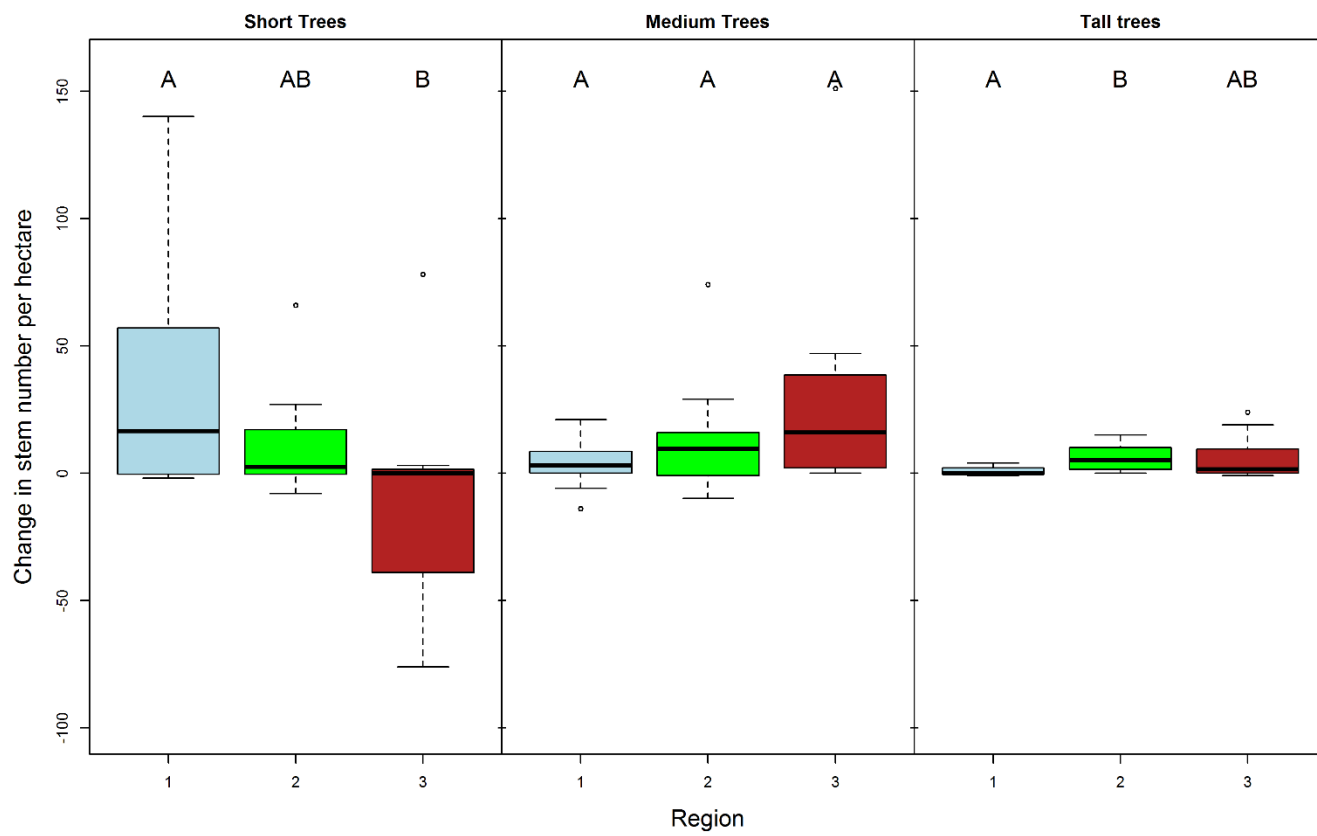
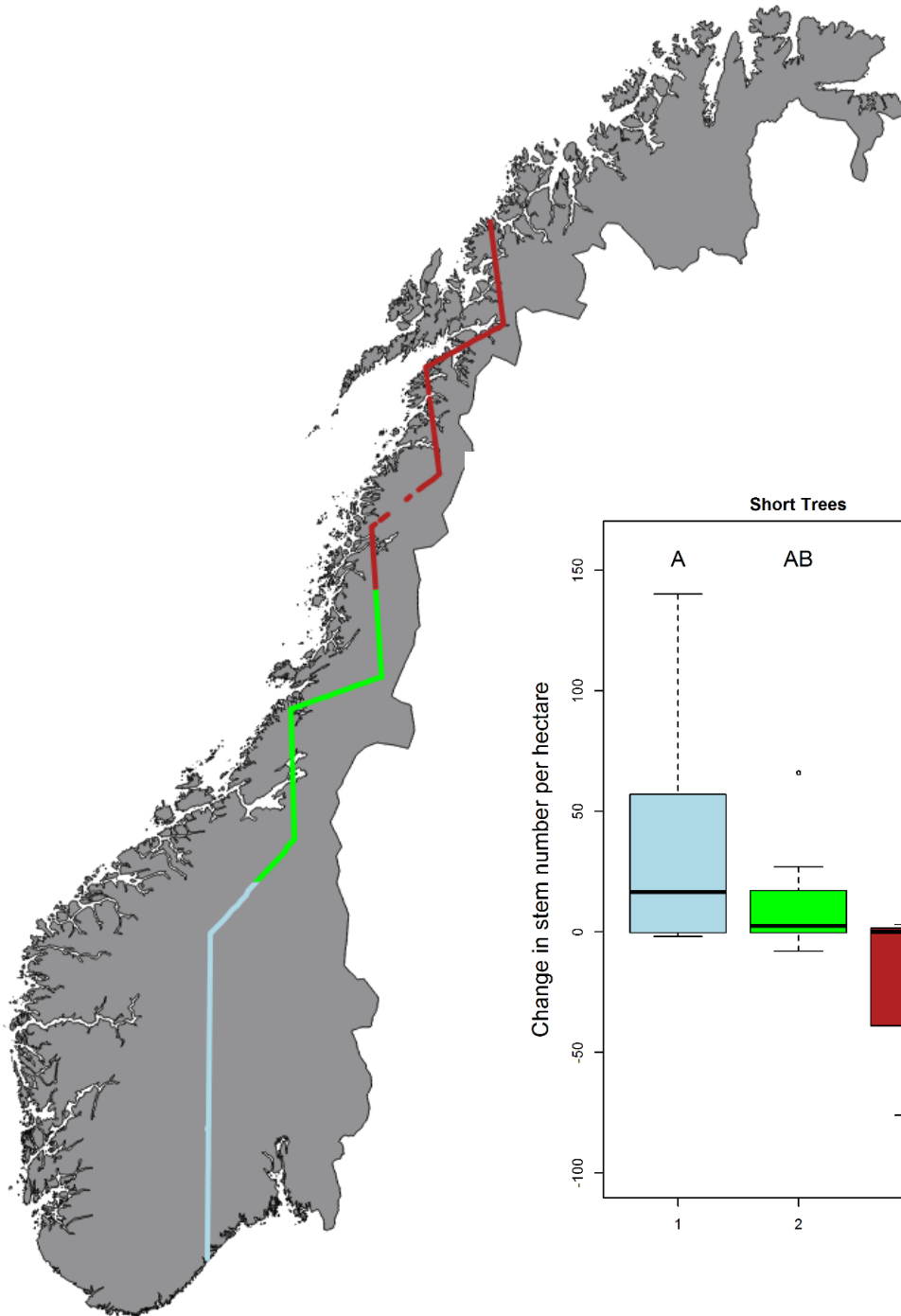
- Significant growth
- Wide confidence interval
- Short observation period
- Power lines introduced noise

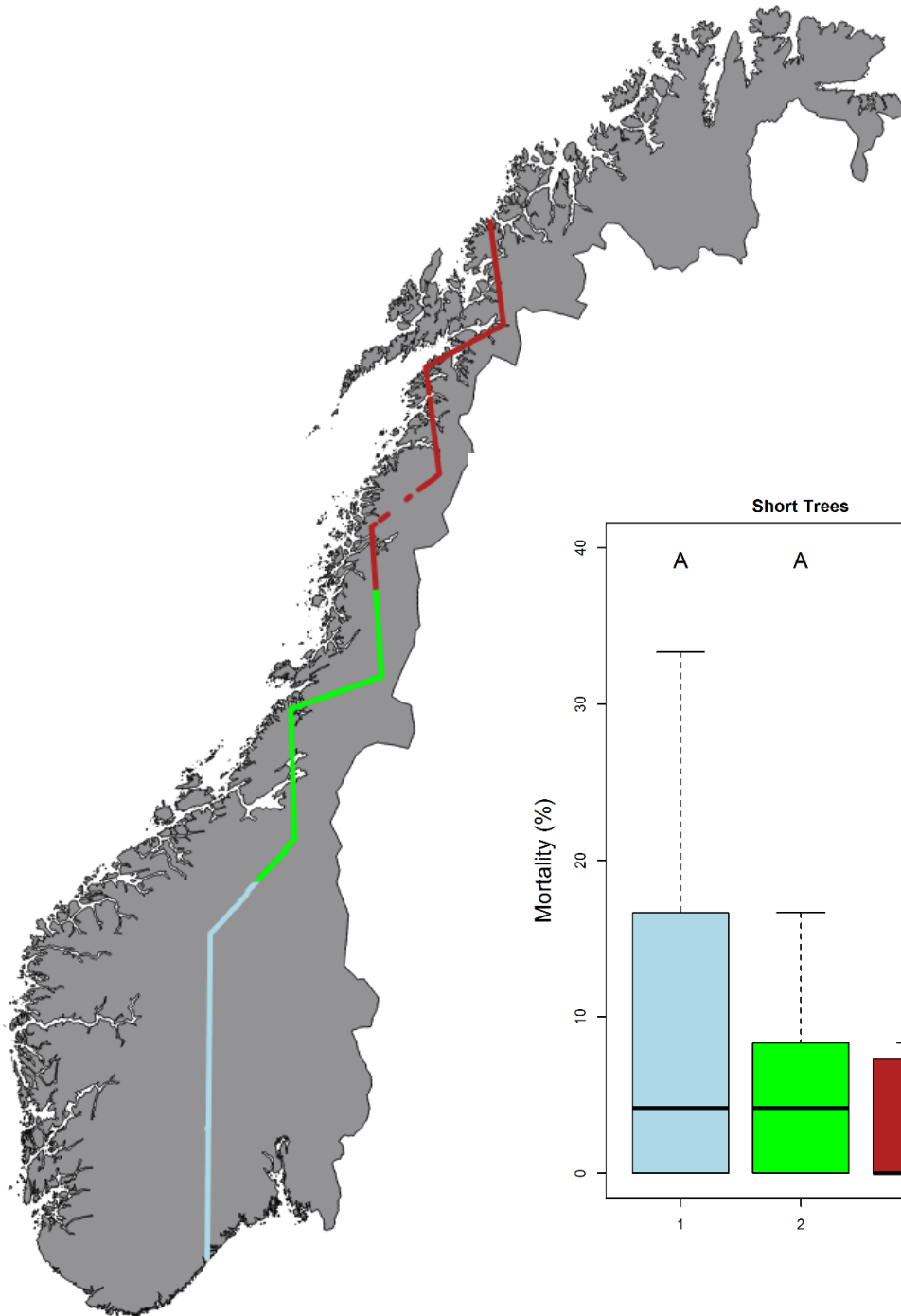


Observed changes in the small trees (PCQ-plots)

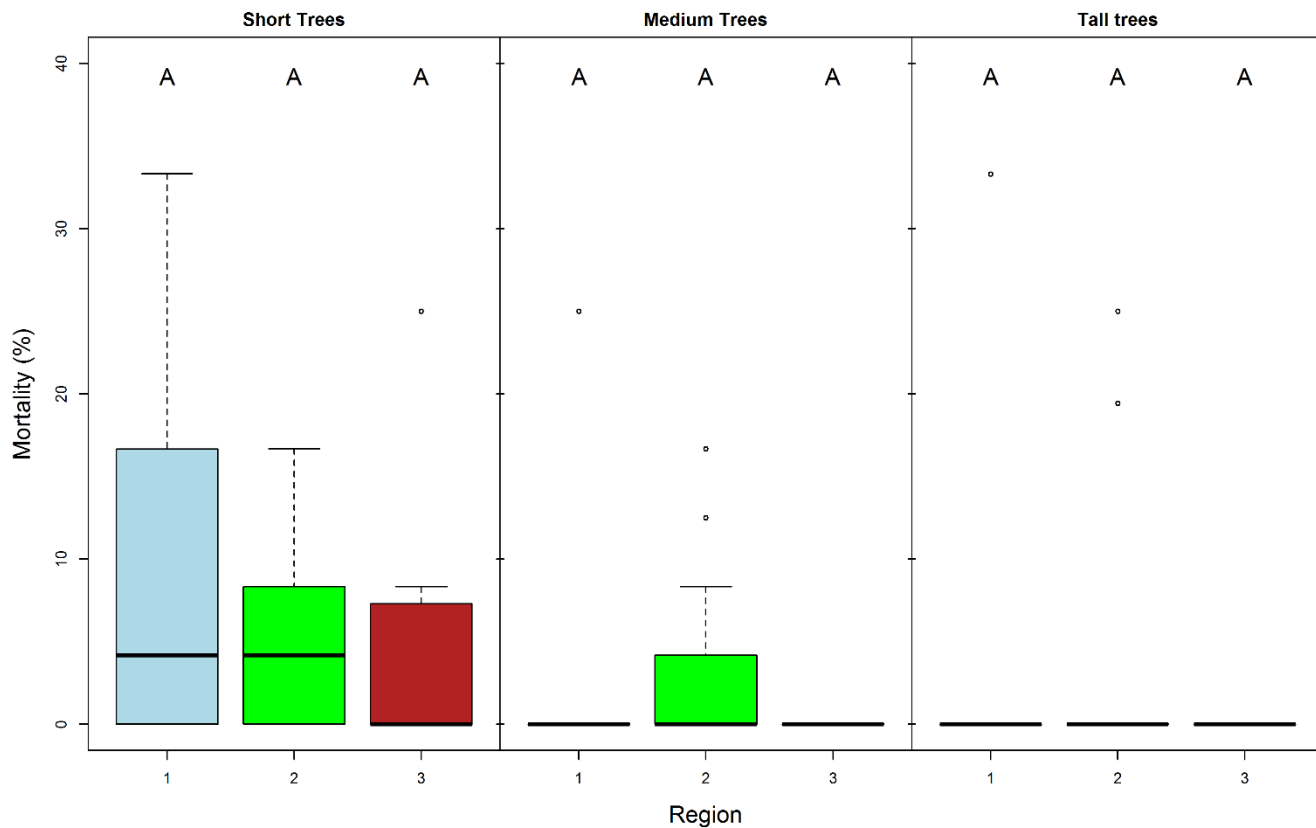


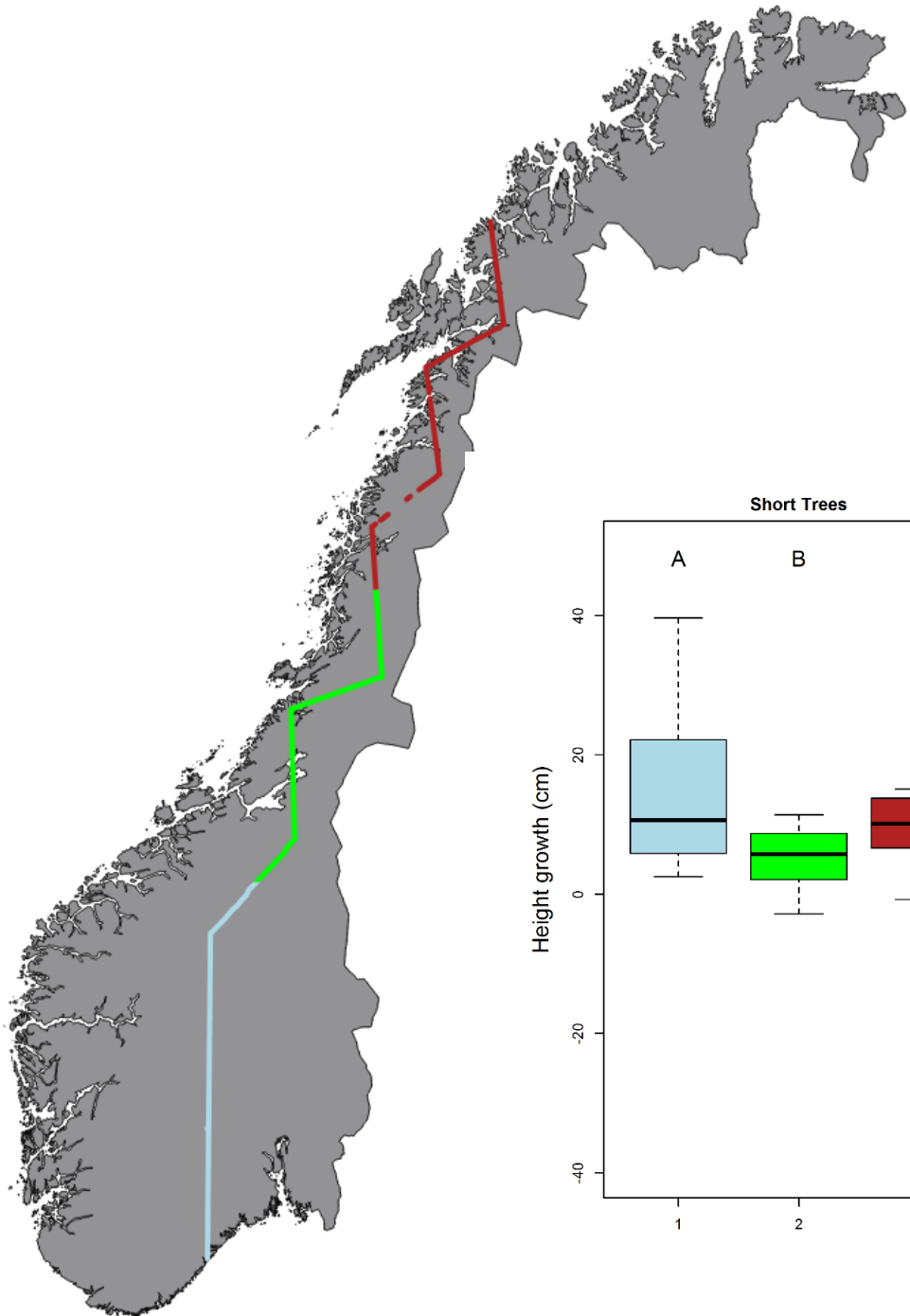
Change in stem number



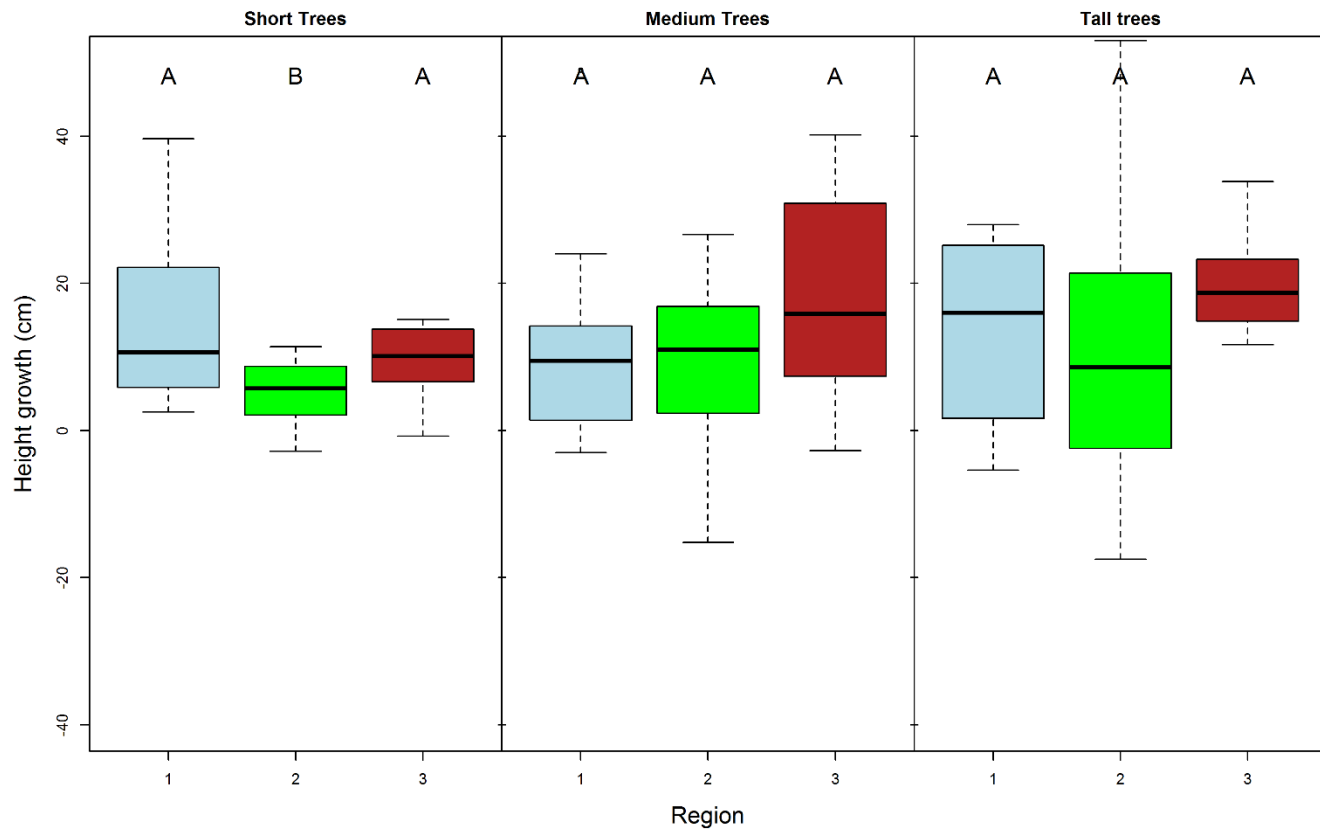


Mortality





Height growth



Project conclusions

- Field observations of small trees (PCQ-plots)
 - Increase of small trees in the south
 - Decrease in the north
 - No significant differences in mortality
 - Small differences in height growth

Project conclusions

- Flight parameters can affect detection success
 - Flying altitude, pulse repetition frequency, and evenness of echoes
 - Important in a change detection context
- Near 100% of all pioneer trees $>1\text{m}$ could be detected (7 p m^{-2})
 - Tree species, terrain properties influenced results
 - Spectral information, spatial echo pattern, and terrain information improved tree / non-tree echo classification

Project conclusions

- Biomass change could be estimated using ALS
 - Biomass increase of approx. 0.45 t/ha/yr (3%) in montane forest
 - Significant growth
- Single tree change detection is difficult for small trees
 - Change detection of short single trees is difficult
 - Area based change estimation seems to be a better alternative

Project conclusions

- We have «pushed» the current technology far
 - Small changes / short periods is challenging
 - Probability of a tree being hit by a laser pulse decreases with decreasing size
 - Probability of a tree being included in the terrain model increases with decreasing size
 - We plan to re-measure both field and ALS

Publications

Type	#
Reports	17
Popular	7
Peer review	54
Other scientific	22
In prep.	5