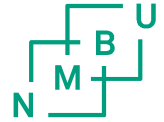


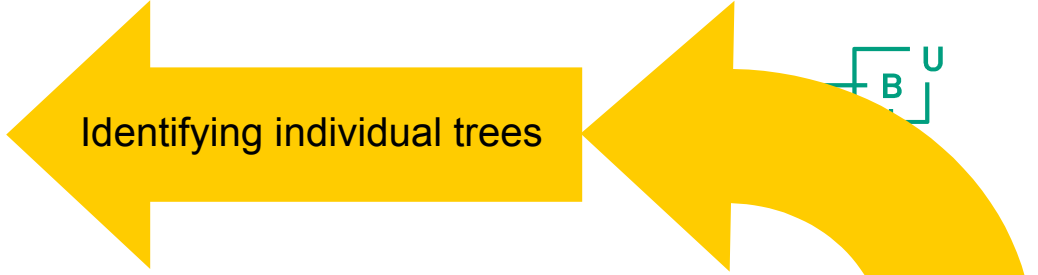
# Estimation of changes in the tree line using airborne laser scanning (ALS)

*Marius Hauglin*

Lysaker - November 12, 2015



- 1** Detection of small trees in ALS data
  - 2** Estimating single-tree height-change using multitemporal ALS
  - 3** Detecting large changes in the treeline – a brief example
-



**1**

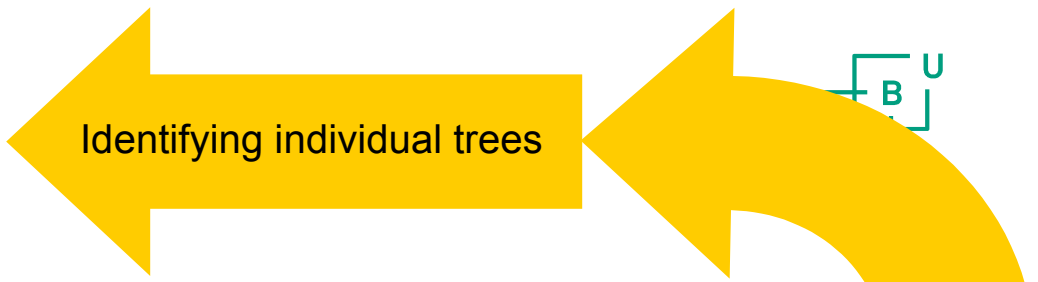
Detection of small trees

**2**

Estimating single-tree height-change using multitemporal ALS

**3**

Detecting large changes in the treeline – a brief example



**1**

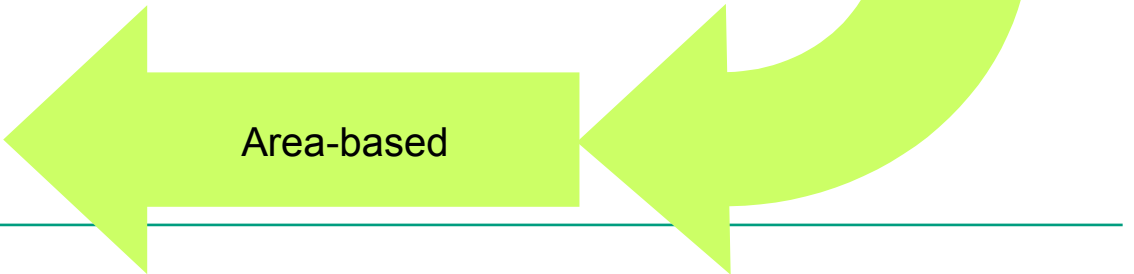
Detection of small trees

**2**

Estimating single-tree height-change using multitemporal ALS

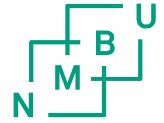
**3**

Detecting large changes in the treeline – a brief example



A novel algorithm for segmentation of small trees  
in the forest-tundra ecotone



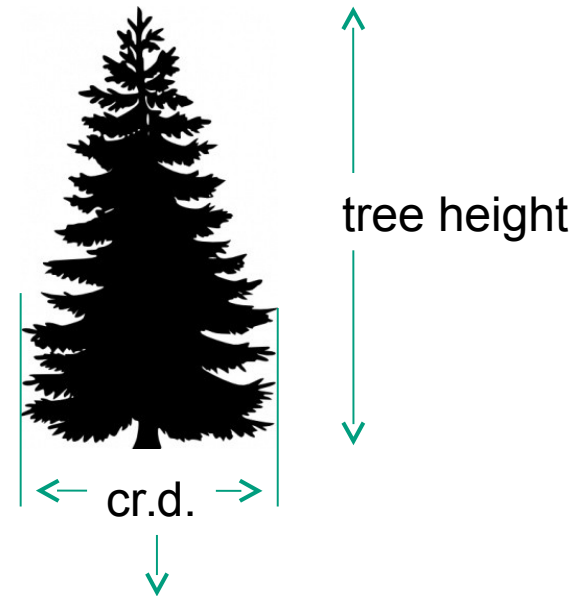


## ALS data:

Average point density on the ground: 7-8 points / m<sup>2</sup>

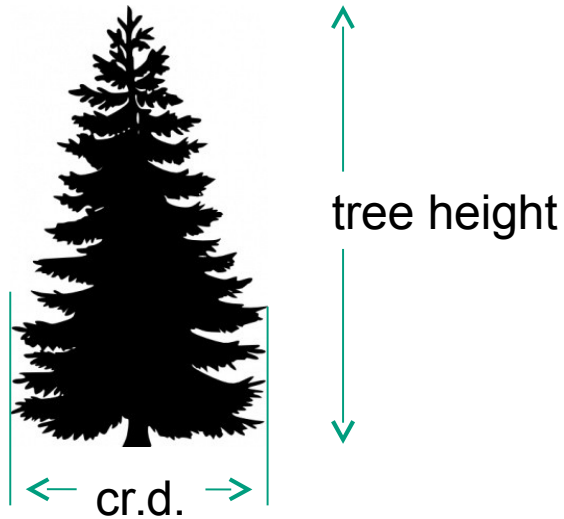
## Field data:

- 432 trees
- Position
- Height
- Crown dimensions (E-W, S-N)



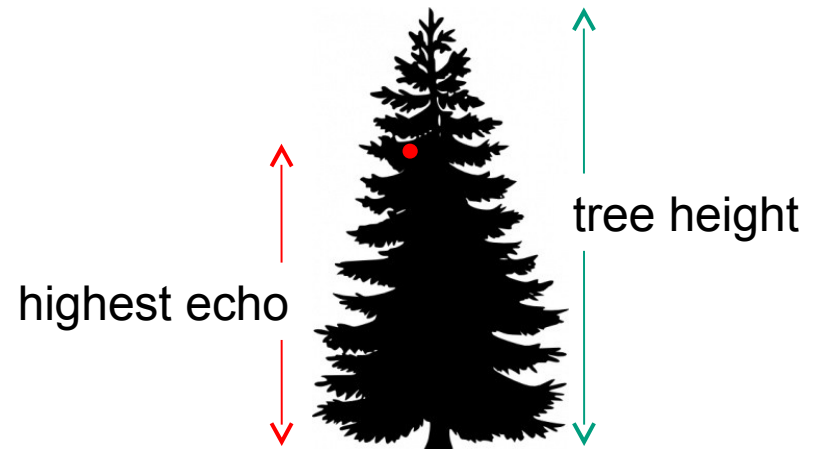
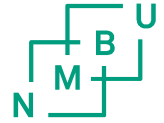


1



A model relating tree height to crown diameter.

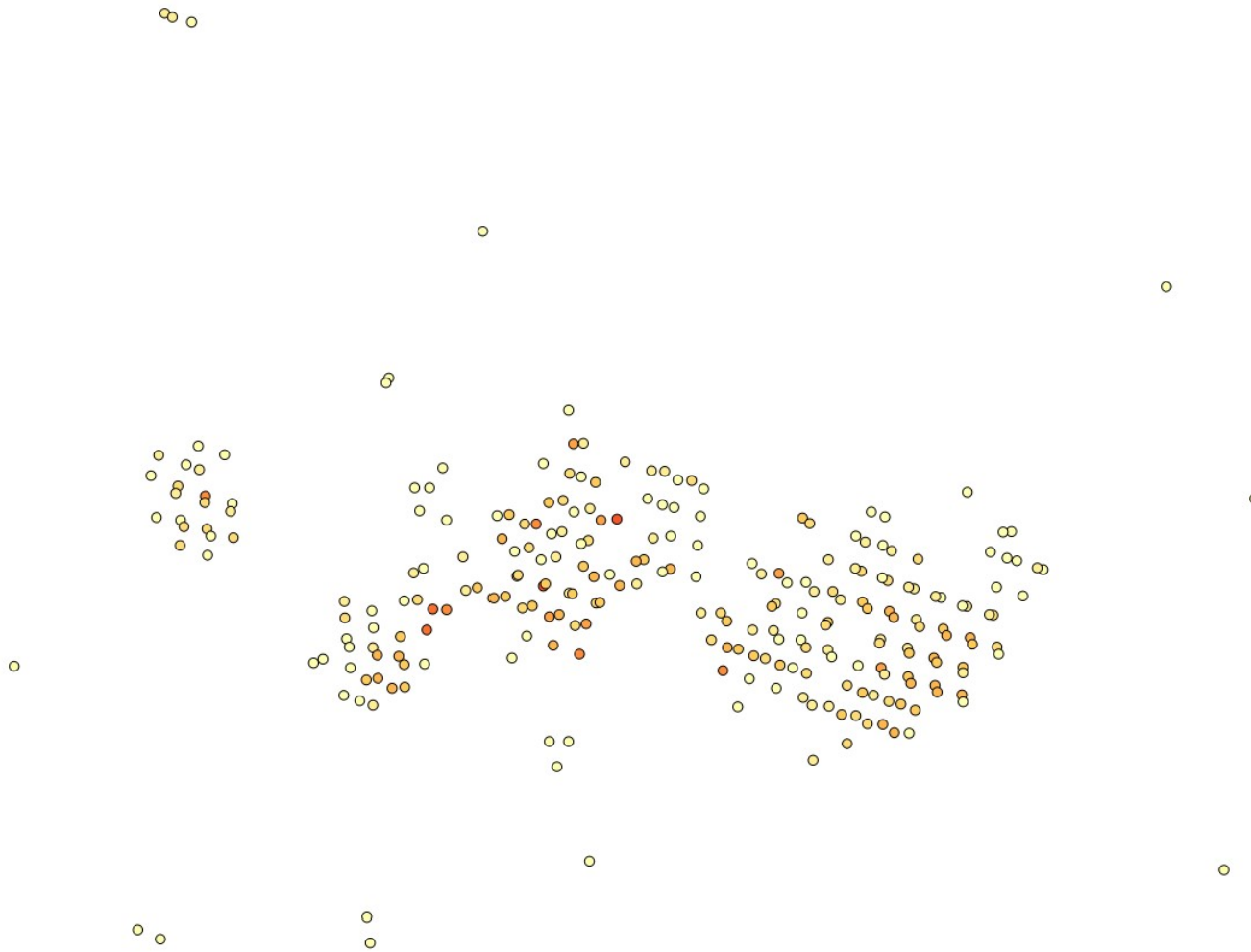
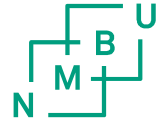
2



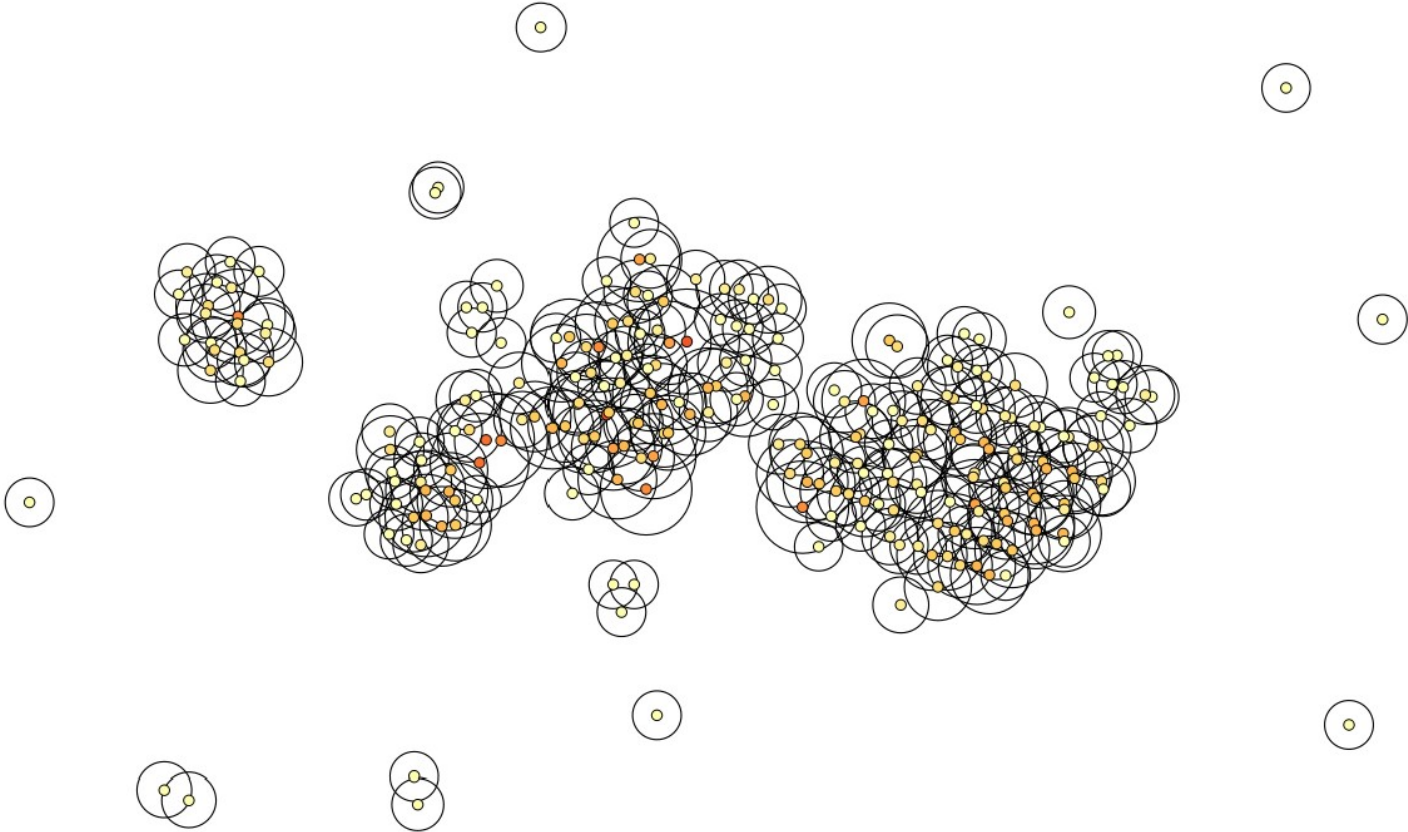
A model relating height of the highest laser echo to field measured tree height.



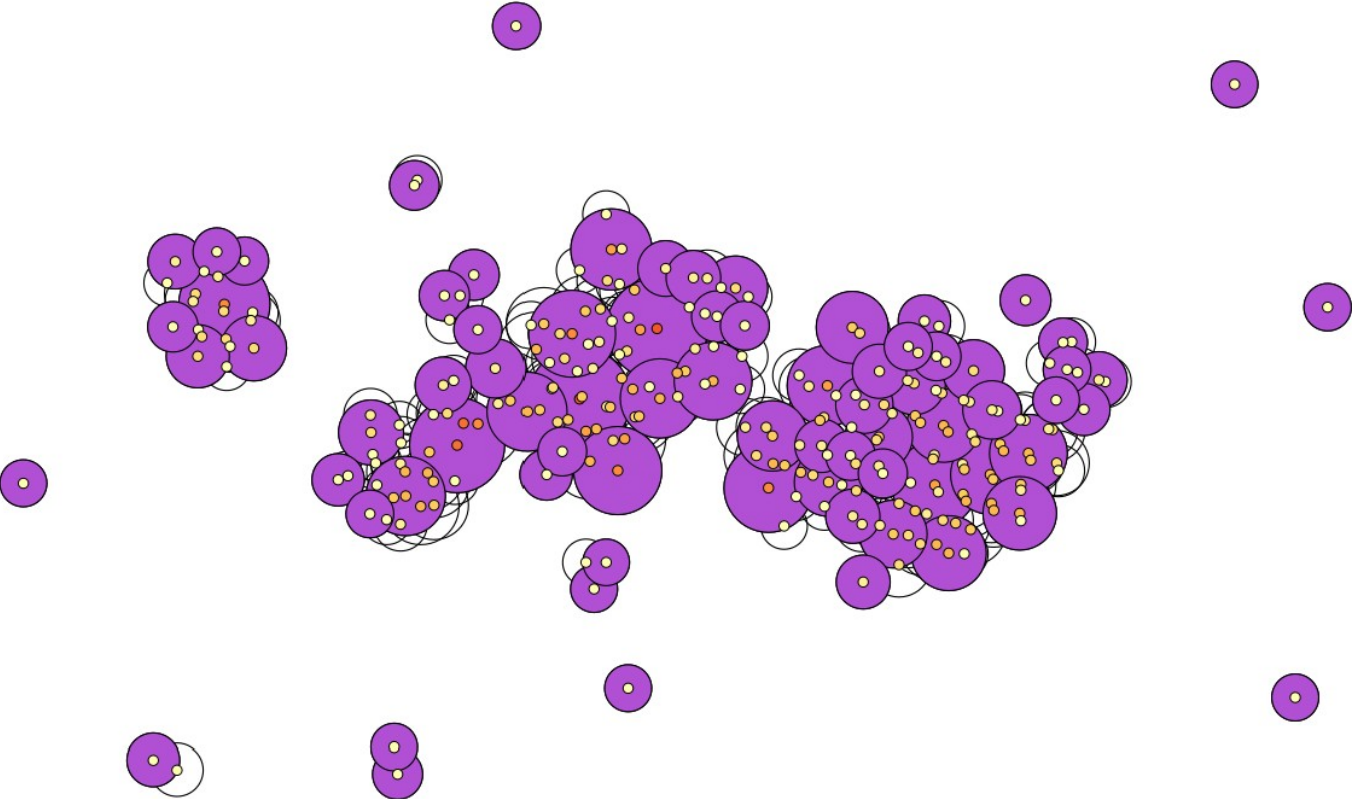
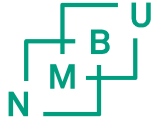
# Above-ground laser echoes



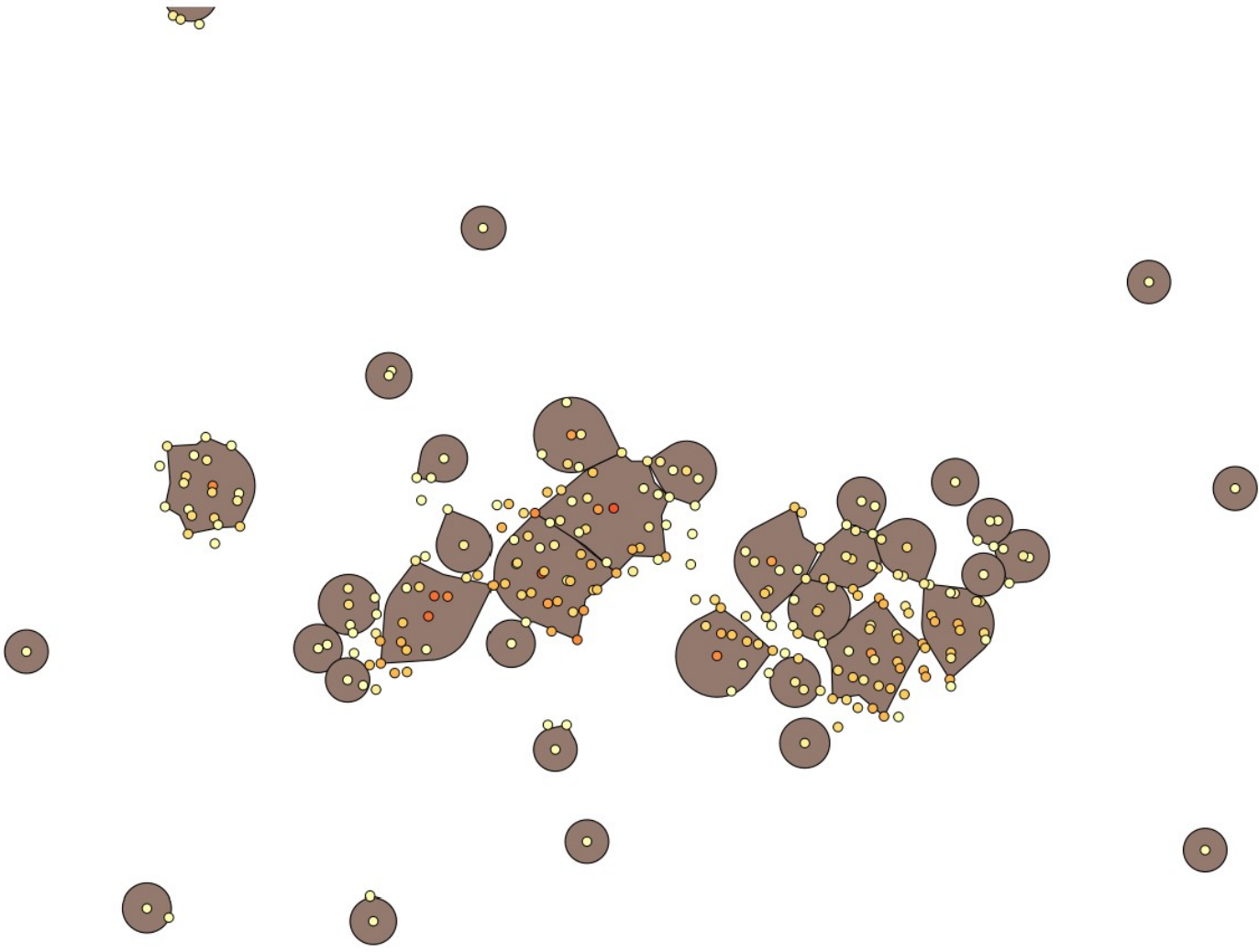
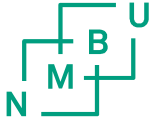
Each echo was associated with a crown diameter and thus a circular crown segment

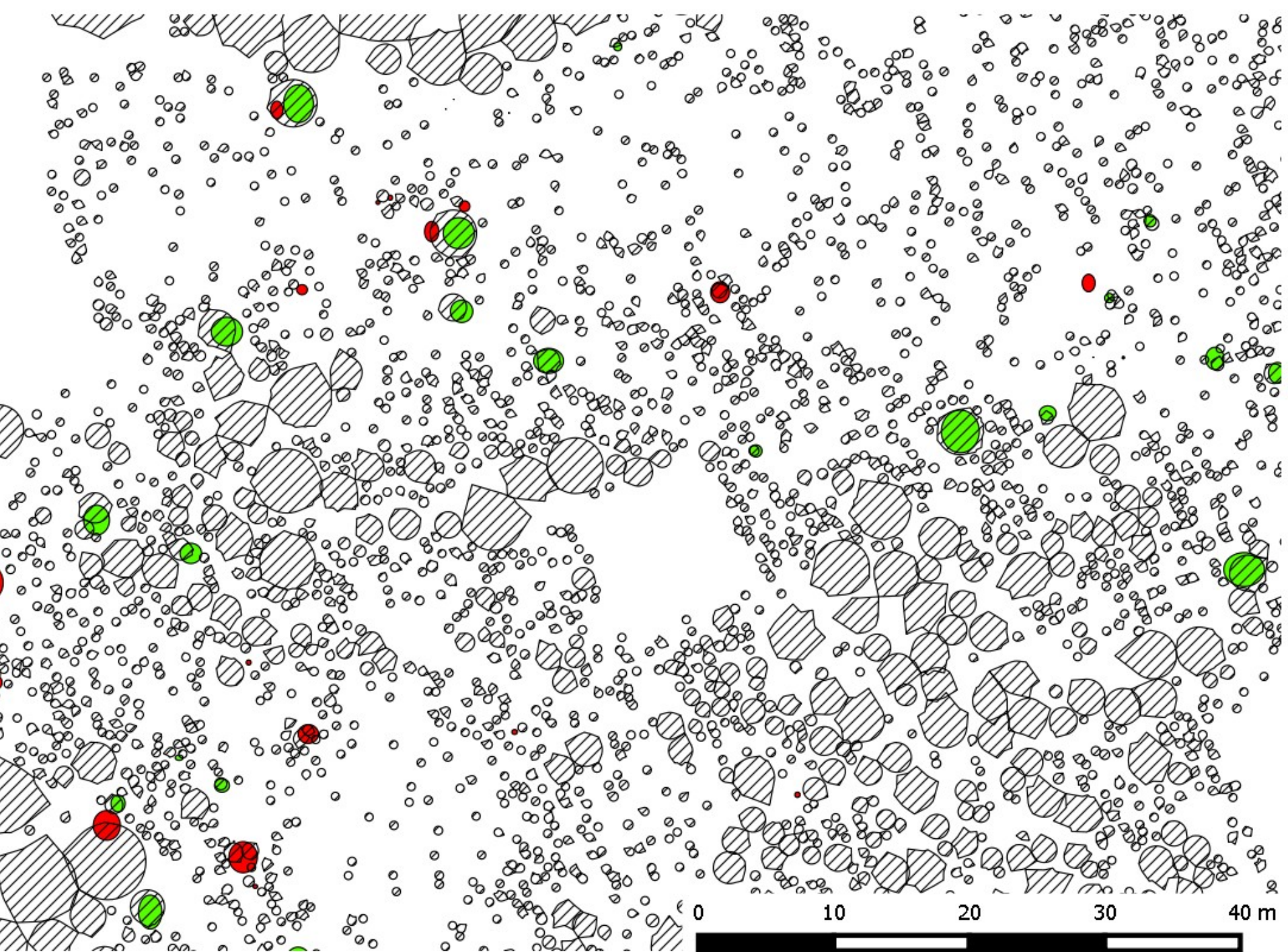


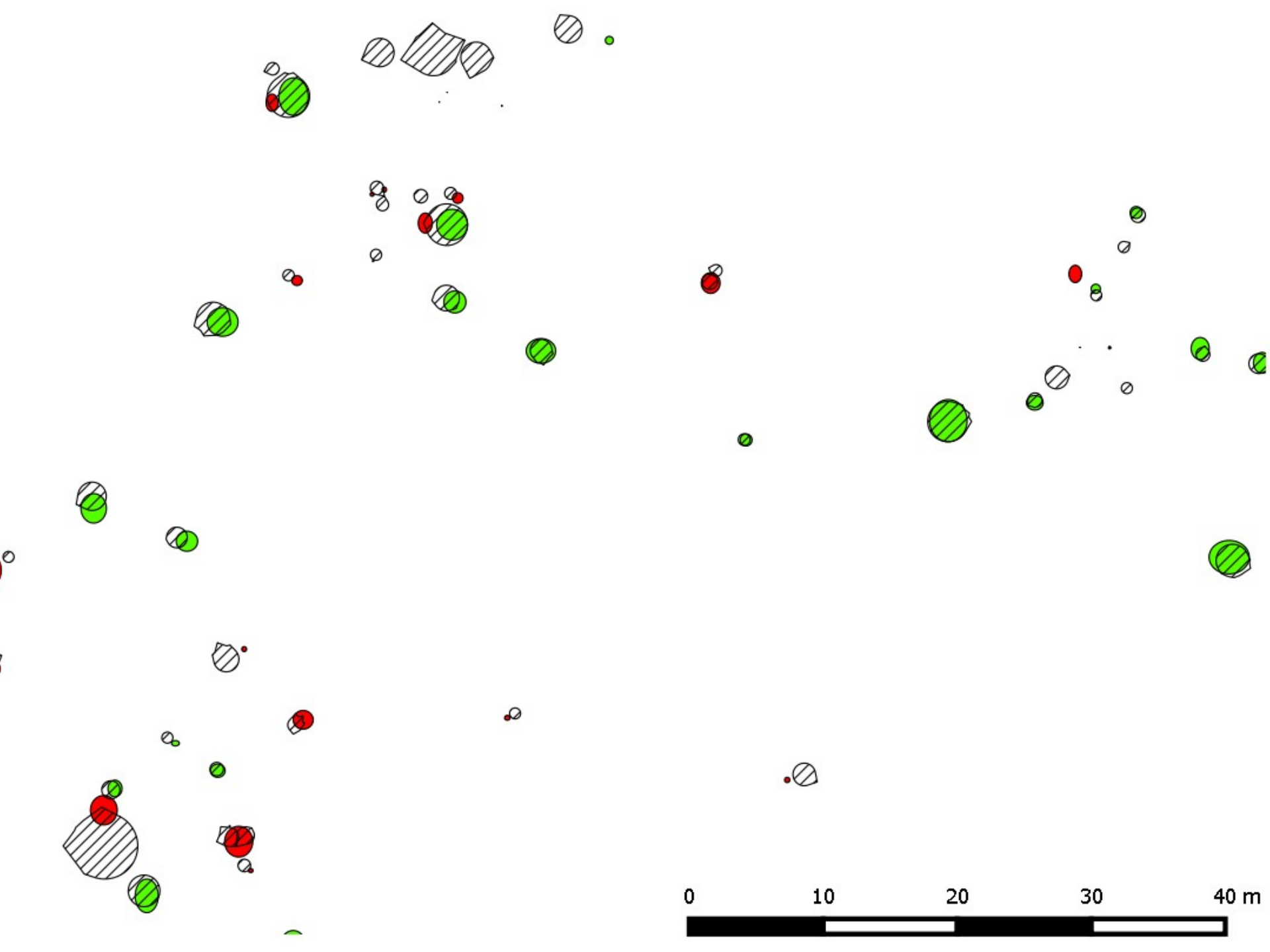
Crown segments formed from echoes inside a larger segment was removed



Overlapping crown segments were either merged or kept separate, by a set of simple rules.

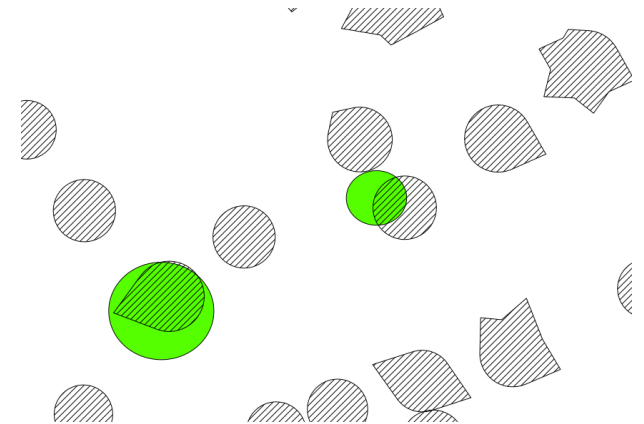




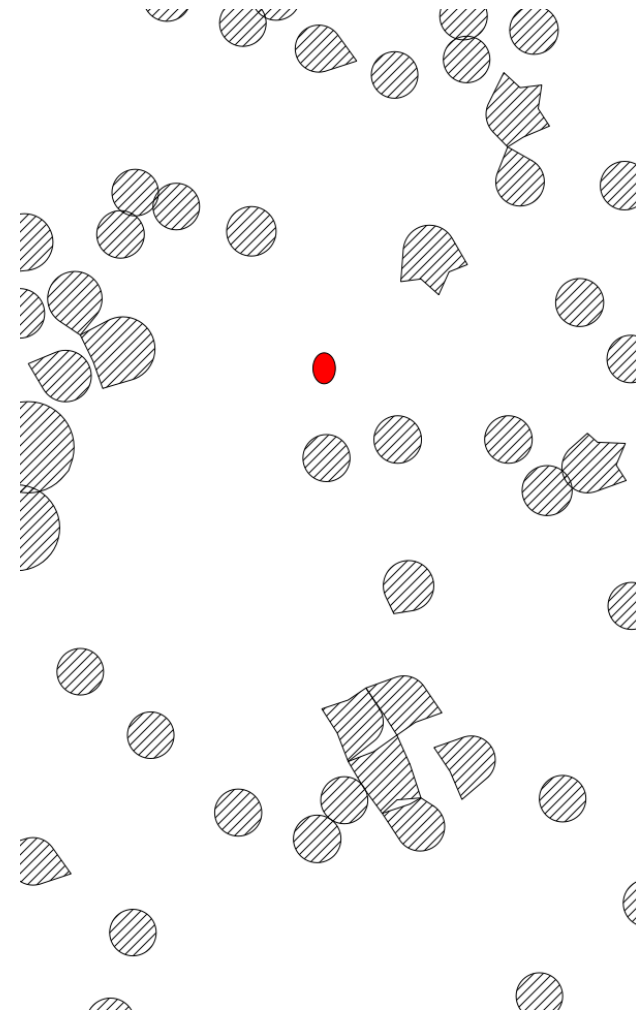




tree # 209

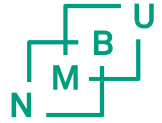


tree # 153

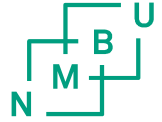




# Results

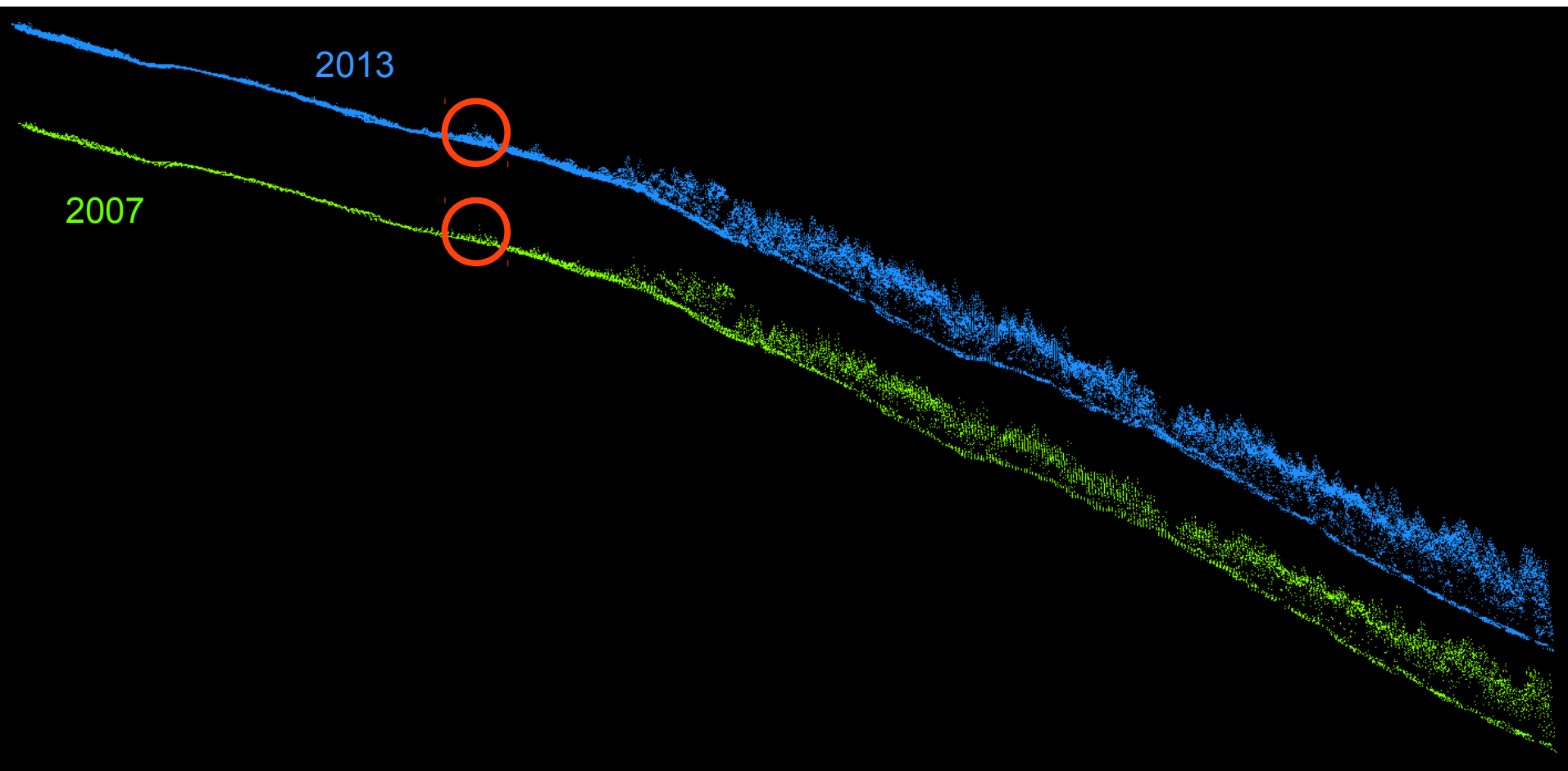


	< 1 m	1-1.99 m	2-2.99 m	> 3 m
Correctly segmented trees	18 %	43 %	66 %	75 %
Omission errors	82 %	57 %	34 %	25 %
Commission errors	109 %	54 %	31 %	9 %



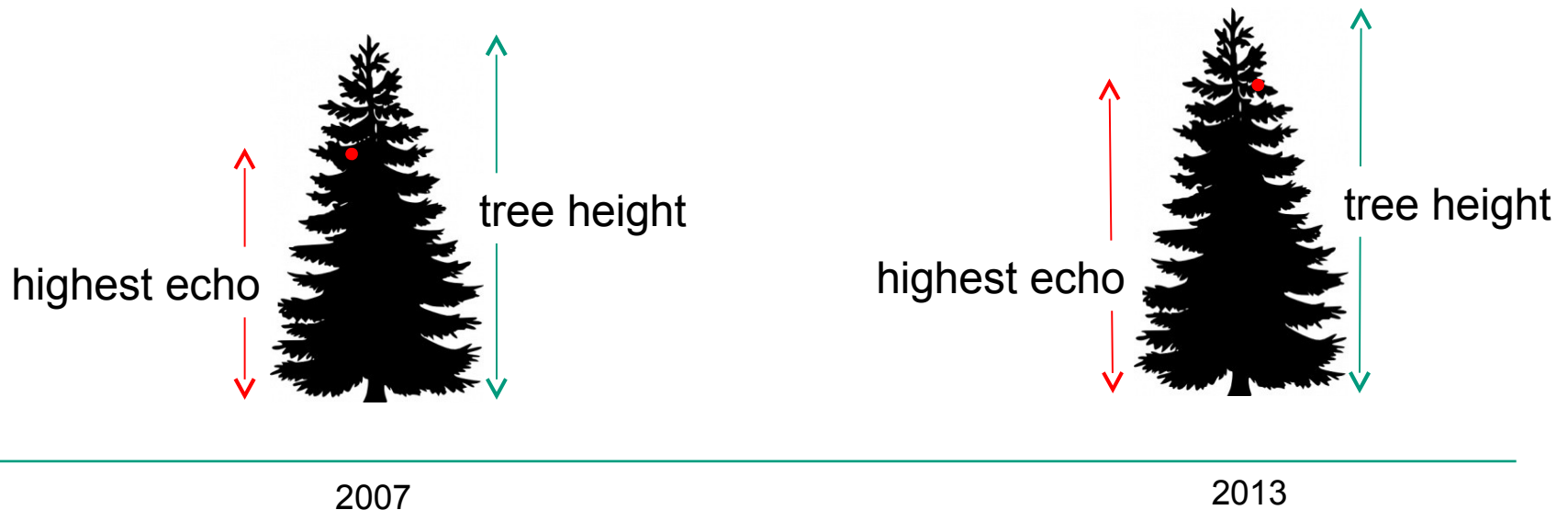
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# Estimating single-tree height-change using multitemporal ALS



# Estimating single-tree height change using multitemporal airborne laser scanning data

- Field measurements and ALS data from 2007 and 2013.
  - 611 field measured trees (mean height: 1.5 m)
  - Change: difference between two measurements
  - Regression models



# Estimating single-tree height change using multitemporal airborne laser scanning data

## Results

Field measured changes

Mean: 0.12 m

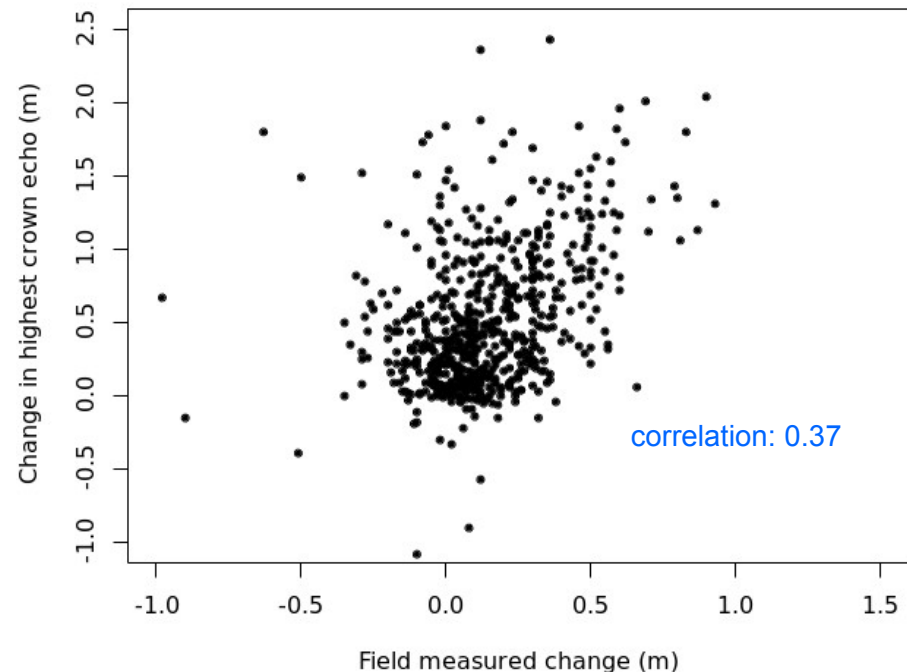
Leave-on-out cross-validation

RMSE: 145 %

The relationship between field measured height change and ALS data were found to be relatively weak at the single tree level, at least with this point density.

This might be attributed to several factors, first of all that the actual changes are small in relation to other sources of differences between the two ALS datasets

Change: single-tree heights



# Estimating single-tree height change using multitemporal airborne laser scanning data

## Results

Field measured changes

Mean: 0.12 m

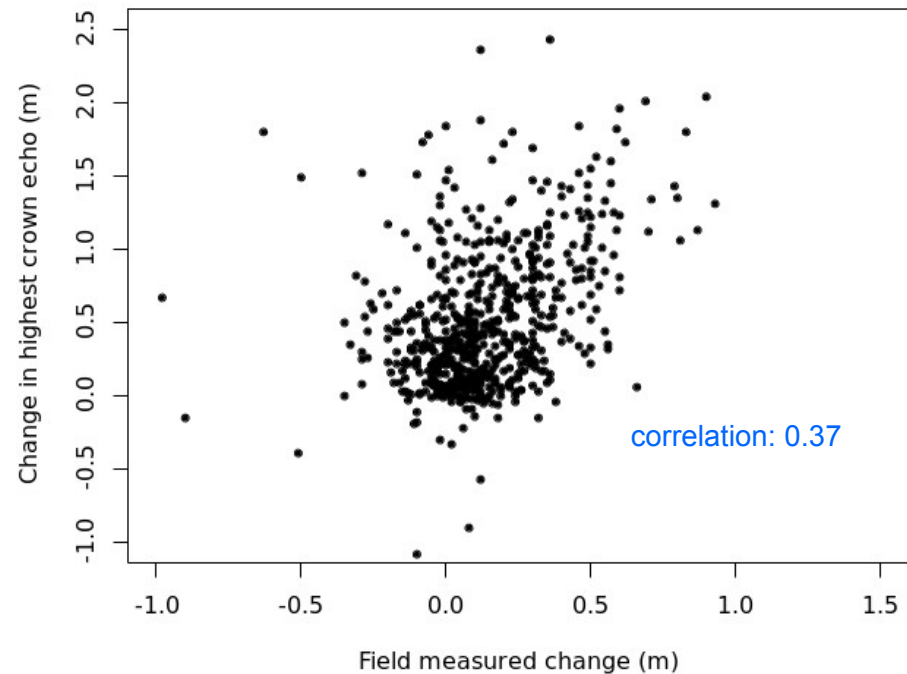
Leave-on-out cross-validation

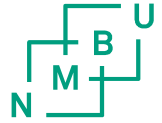
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Change: single-tree heights





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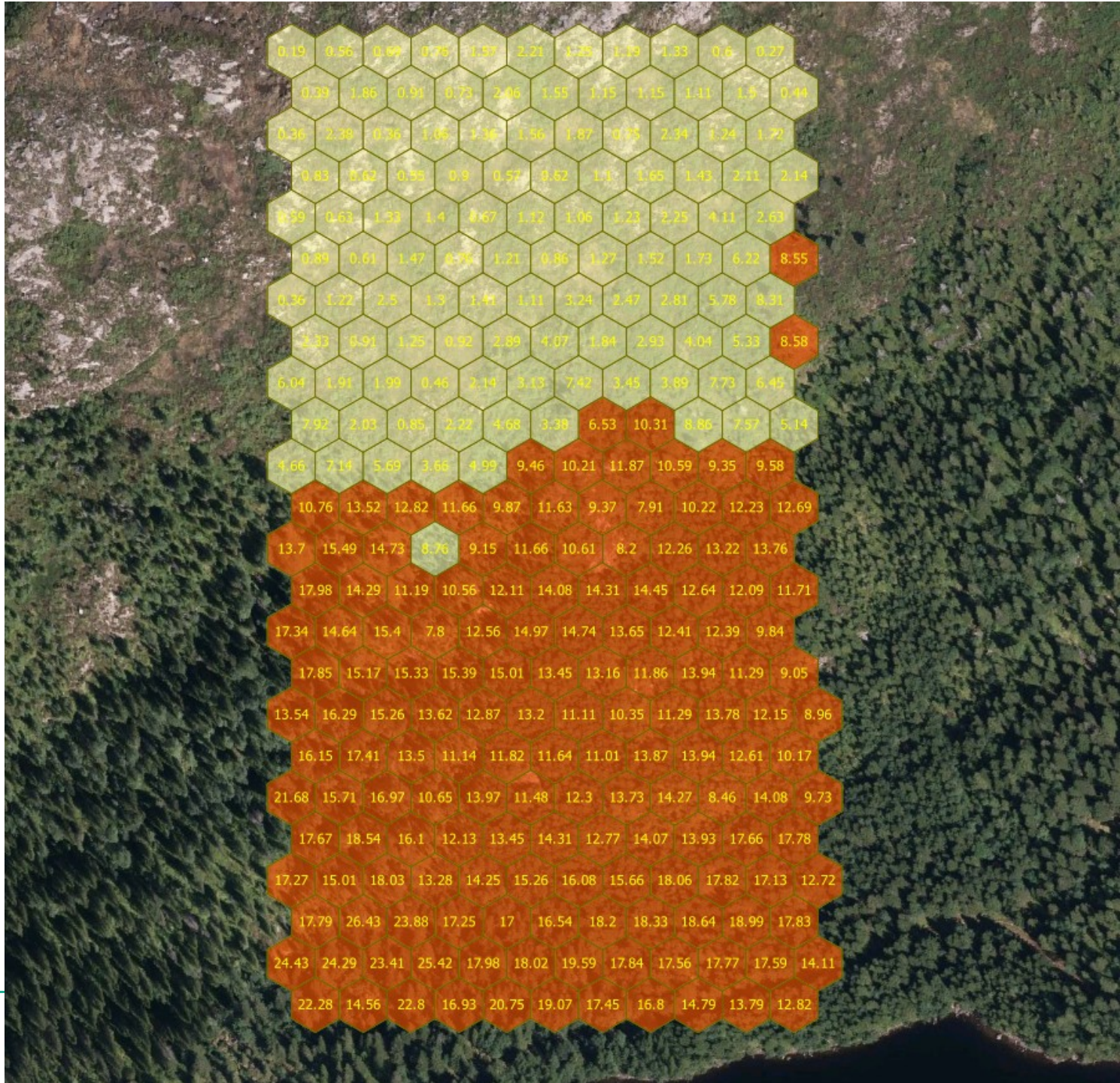
A classification into two classes based on vegetation heights.

**Forest:**

max above-ground echo height > 4 m

and

mean above-ground echo height > 2 m



Thank you!

