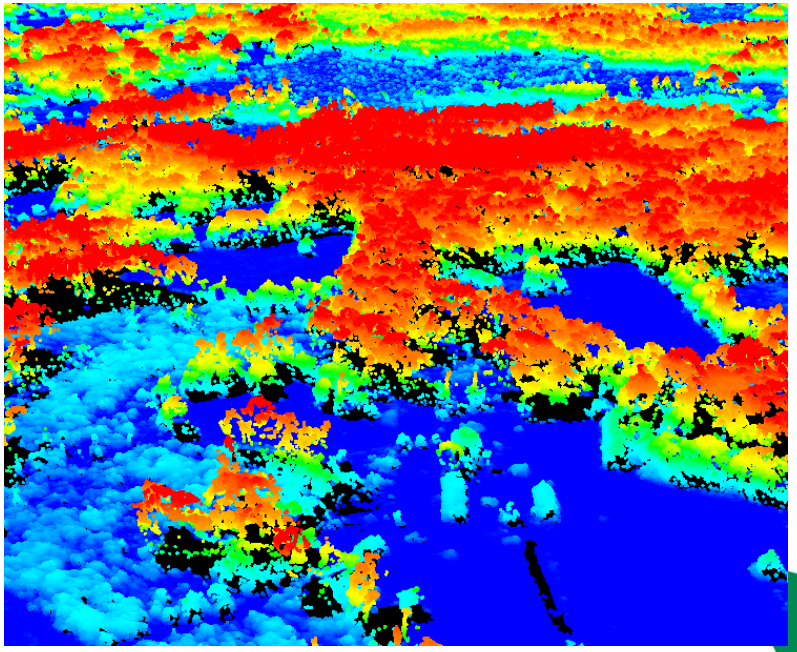
Ljungbersseminar 4.2.2016

Inka Bohlin och Mats Nilsson

Use of photogrammetric point cloud data together with field data from National Forest Inventory: possibilities and weaknesses



SKOGSSTYRELSEN
SWEDISH FOREST AGENCY

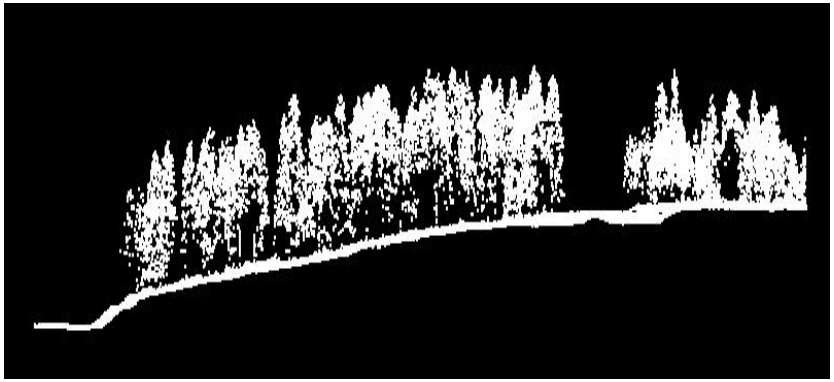
Swedish University of Agricultural Sciences
Forest Remote Sensing

SLU

National Forest Attribute Maps

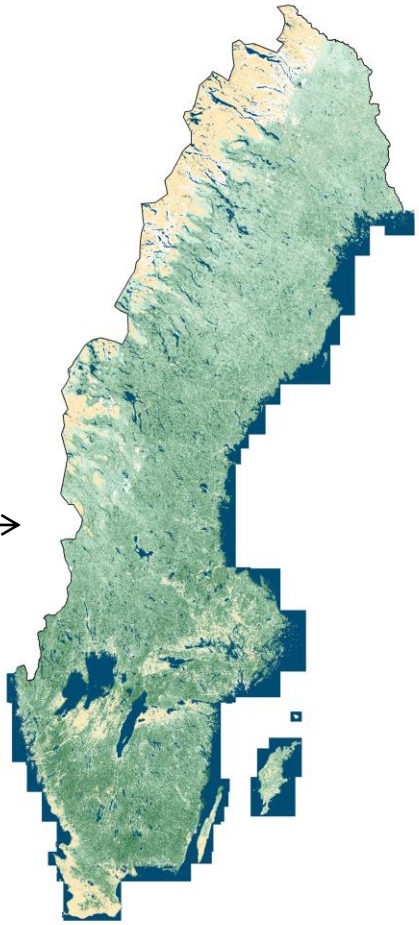
(Skogliga grunddata)

ALS data from the National Land Survey



$$Y_i = \beta_0 + \beta_1 X_i + \varepsilon_i$$

Regression models



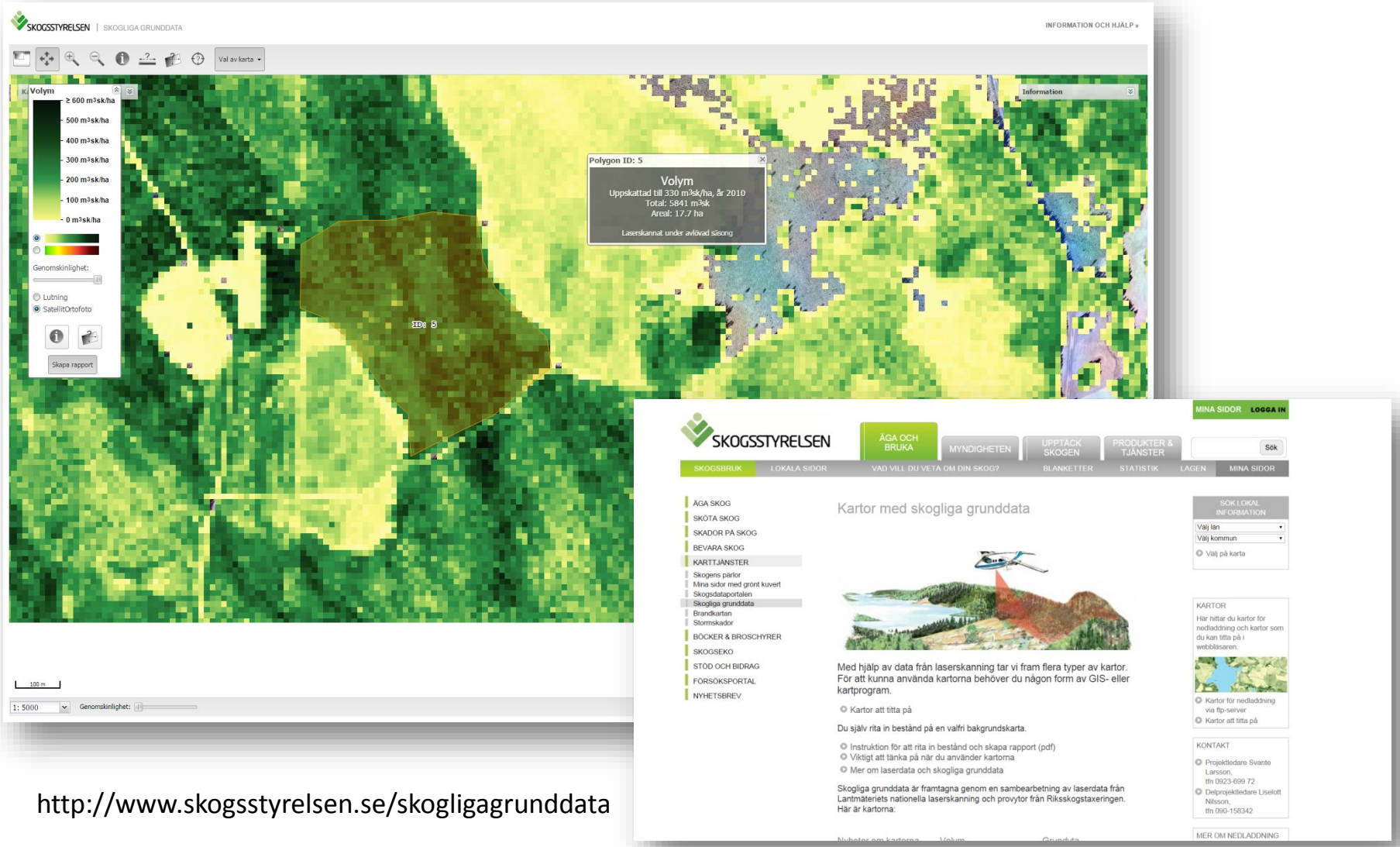
Field data from the Swedish NFI

Estimated variables

- Diameter
- Tree height
- Basal area
- Volume
- Biomass

National Forest Attribute Maps

(Skogliga grunddata)



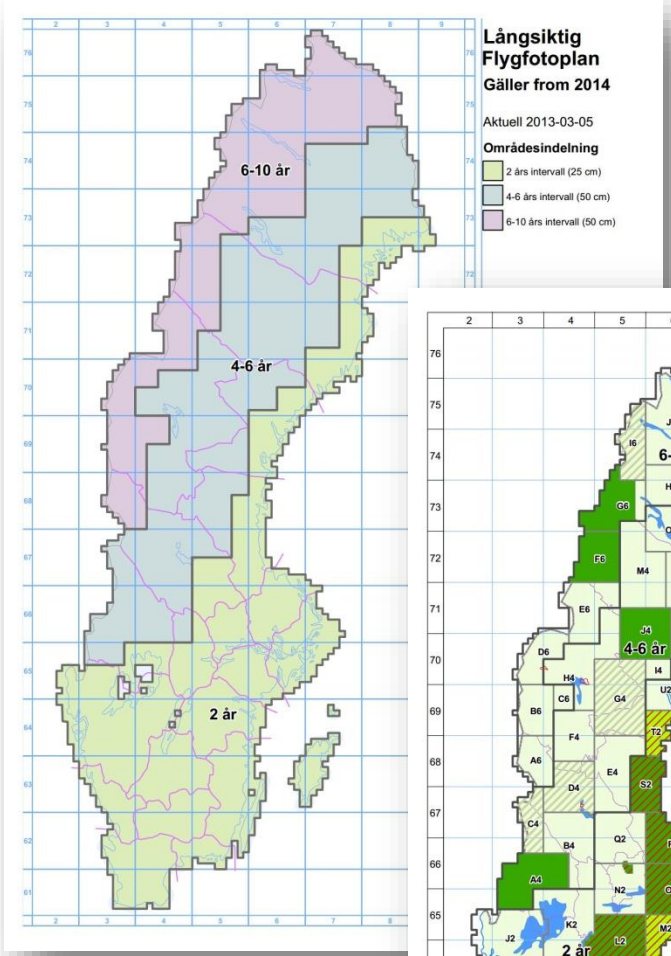
http://www.skogsstyrelsen.se/skogligagrunddata

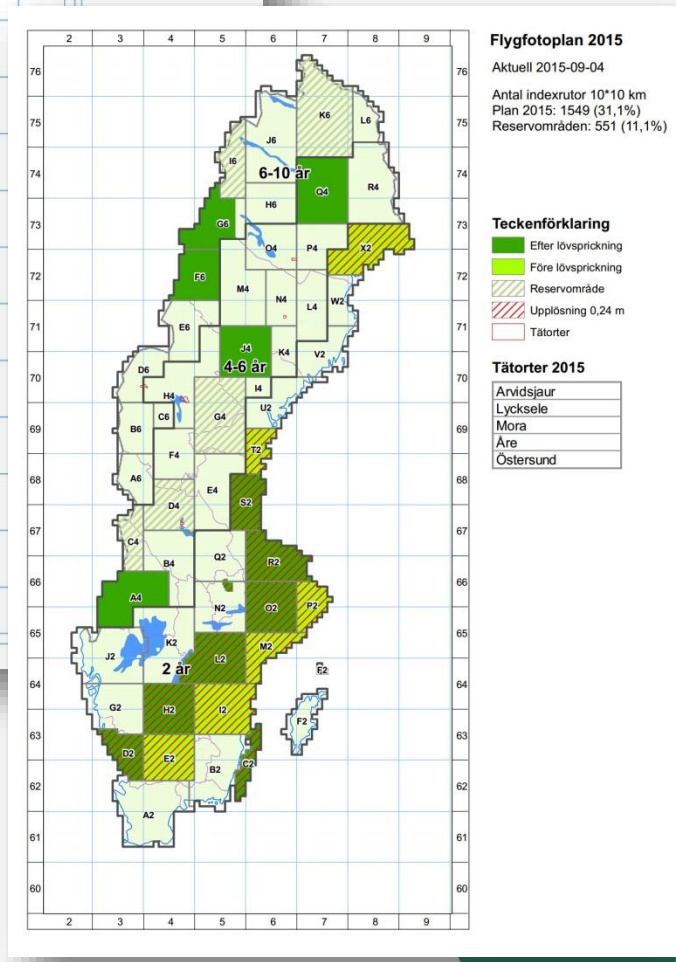
Background

- ALS mapping 2009-2016
- Every year 3.5% of the forest land is changed due to forest treatments (i.e., > 20% in some areas)
- Organisations providing information to the private forest owners (e.g., forest owner associations and the forestry agency) are now interested in possible future updates of the national forest attribute map (Photogrammetry?)
- Increasing interest towards photogrammetry also in companies

-> possibility to lower costs

- Landmätriet (Land survey) flying plan for aerial images

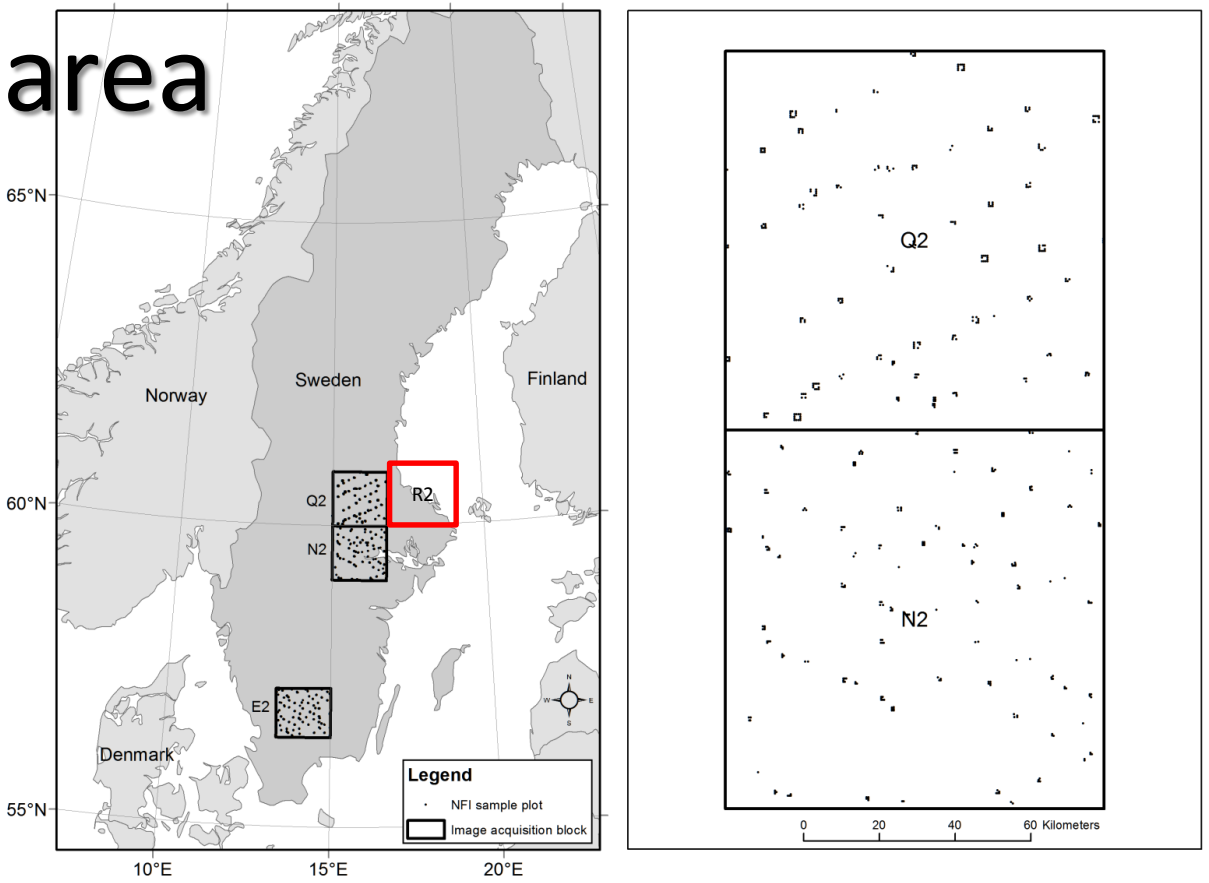




Aim of the project

- Testing the use of photogrammetry based forest inventory for updating national forest inventory maps in practice
- Test e.g.:
  - 1. SGM (Semi global matching) or FBM (Feature based matching)?
  - 2. New density metrics?
  - 3. General accuracy of photogrammetry based inventory
  - 4. Photogrammetry vs LASER?
  - 5. Accuracy in different kind of forests?
  - 6. Combining photogrammetry and LASER? (Height from photogrammetry, density from Laser)

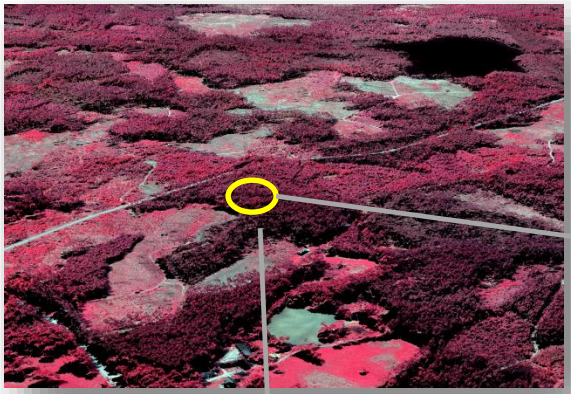
Study area

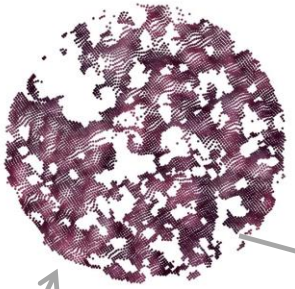


Study area	E2	N2	Q2	R2
Image data	Leaf-on, 2013	Leaf-on, 2014	Leaf-off, 2014	Leaf-on, 2015
n. NFI plots	216 (2012-2013)	167 (2012-2013)	223 (2012-2013)	233 (2013-2014)
Laser	2010-2012	2010-2012	2009-2011	2009-2012

Validation data: E2	30 company stands, 2010- 2014	11 Biotope stands 2012-2014
Q2	36 company stands, 2015	10 Biotope stands 2012-2015
R2	82 company stands, 2015	18 Biotope stands 2012-2015

ABA Modeling

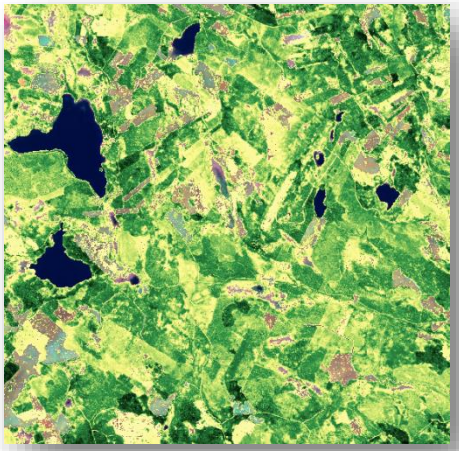




Normalizing using
DTM from LASER

Metrics
p10,…p95
MeanH
density
….

$$Y_i = \beta_0 + \beta_1 X_i + \varepsilon_i$$

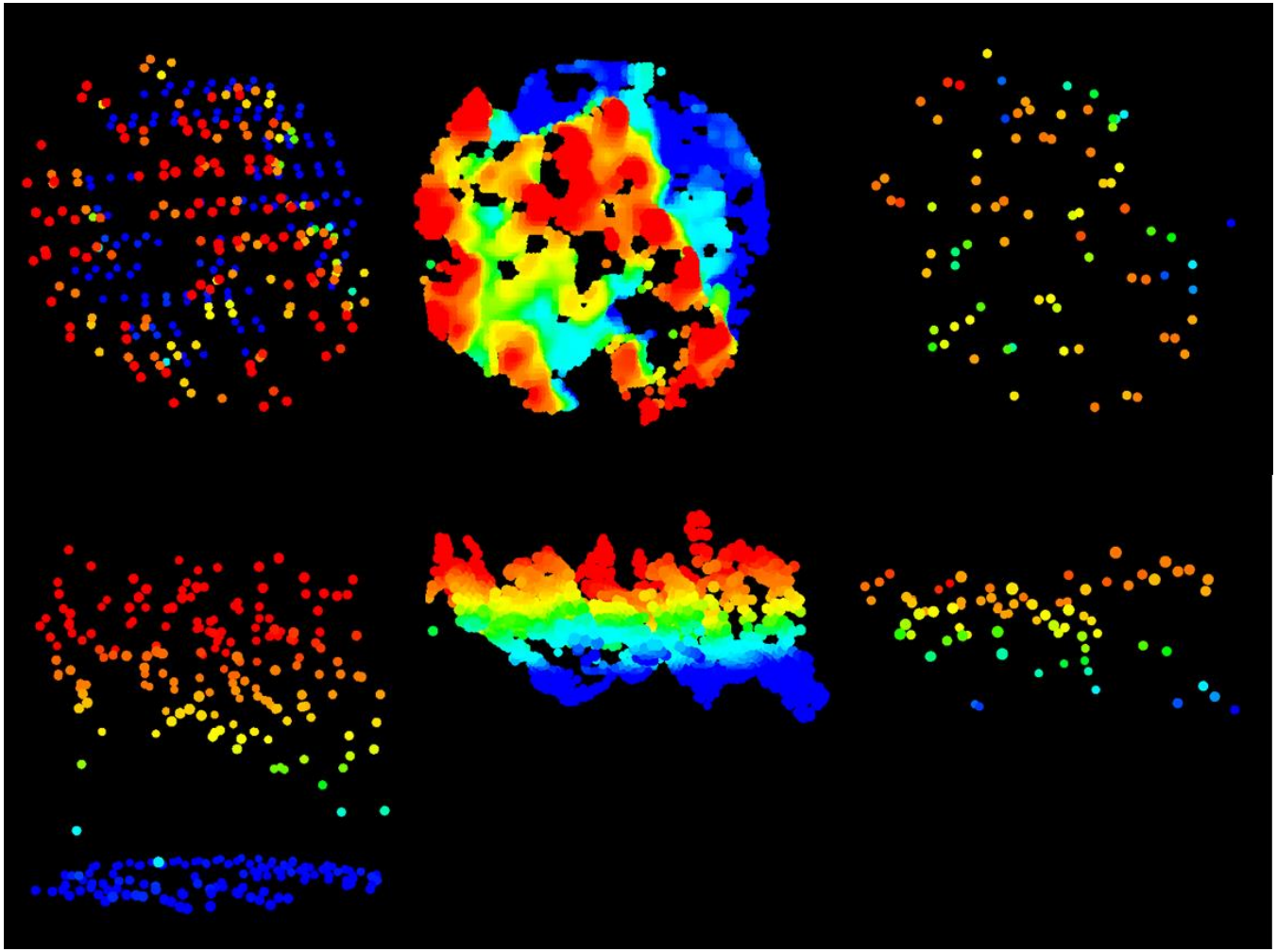


Own model for each case
(also own outlier removing):

- SGM
- FBM
- LASER
- SGM+LASER_density

- Grid-approach to wall-to-wall

1. SGM vs FBM



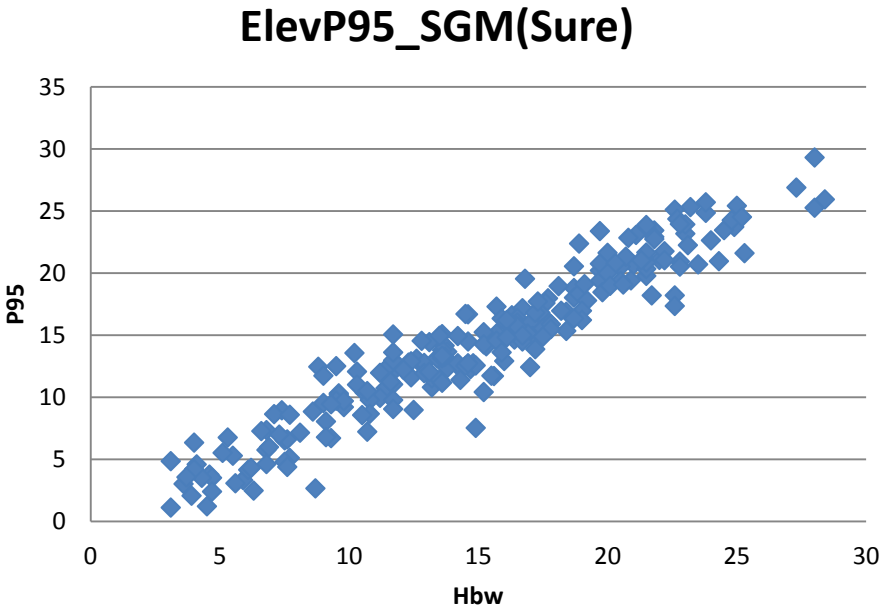
LASER
~ 0.7 p/m^2

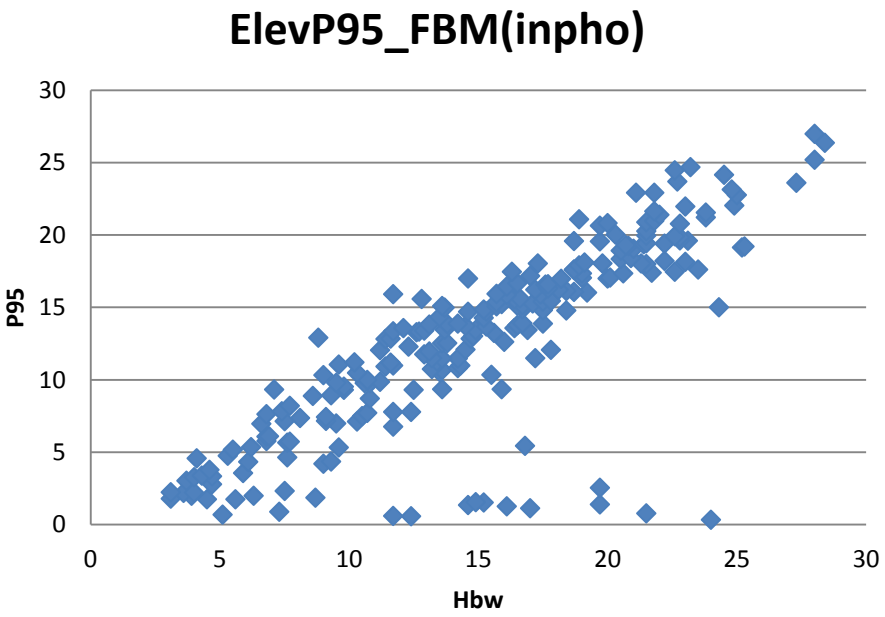
SGM (SURE)
~ 9 p/m^2

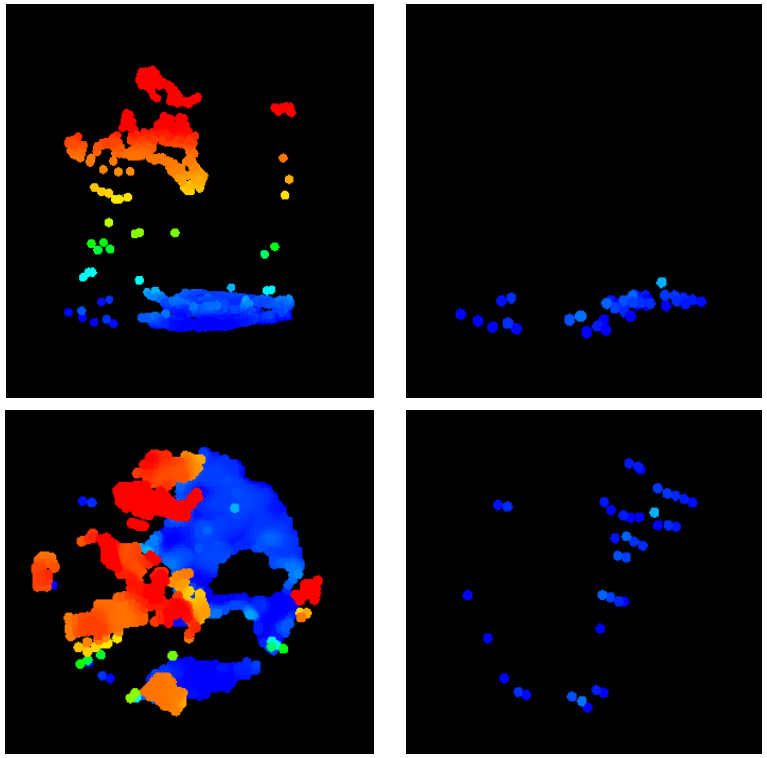
FBM (Inpho)
~ 0.18 p/m^2

Left: LASER, middle: SGM (SURE), right: FBM (Inpho)

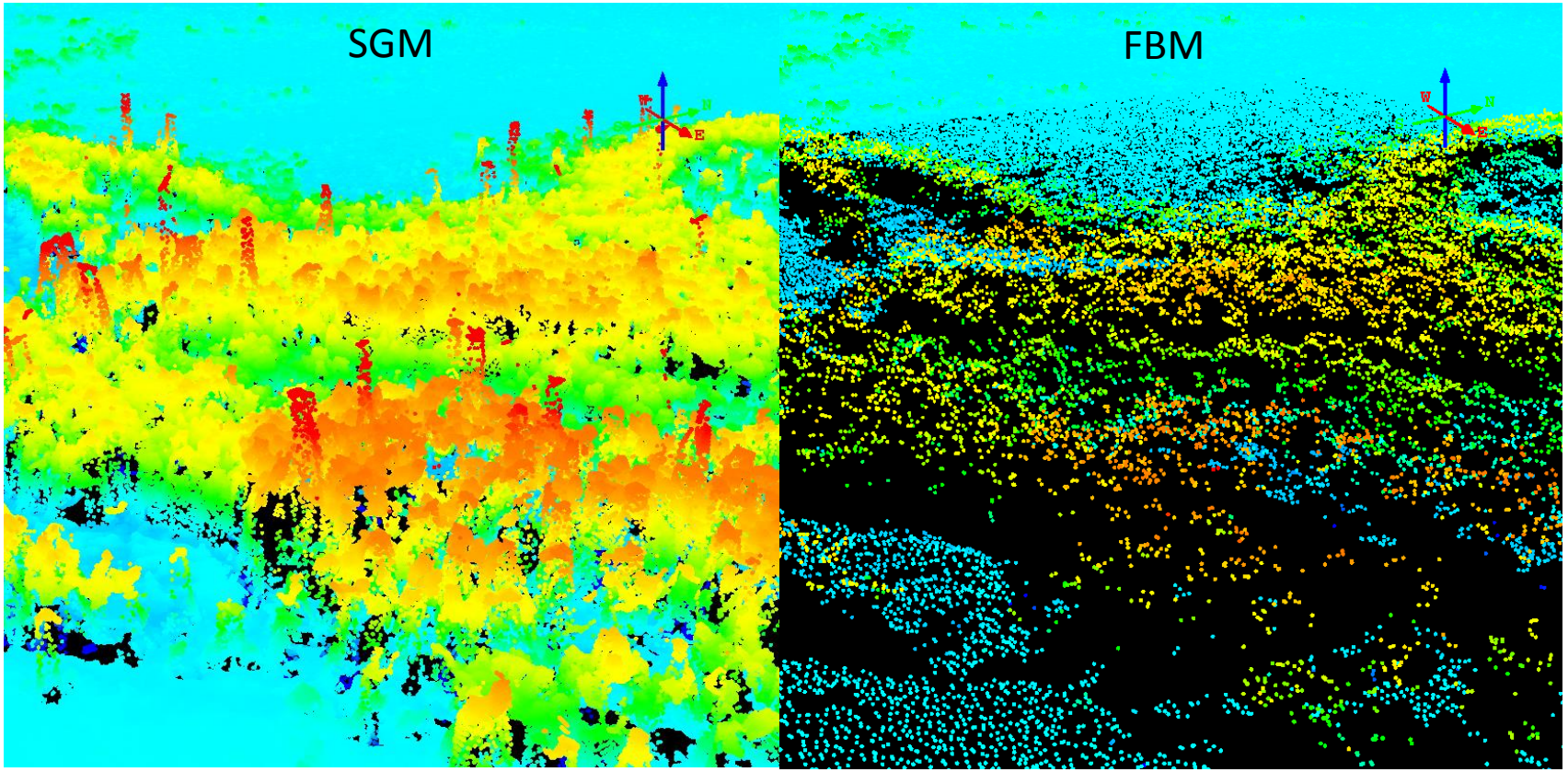
DTM is needed!







FBM problems especially in sparse forest (more outliers)



In the other hand also SGM has problems with gaps, sparse forest and borders -> “miss-matches” producing extreme low/high values

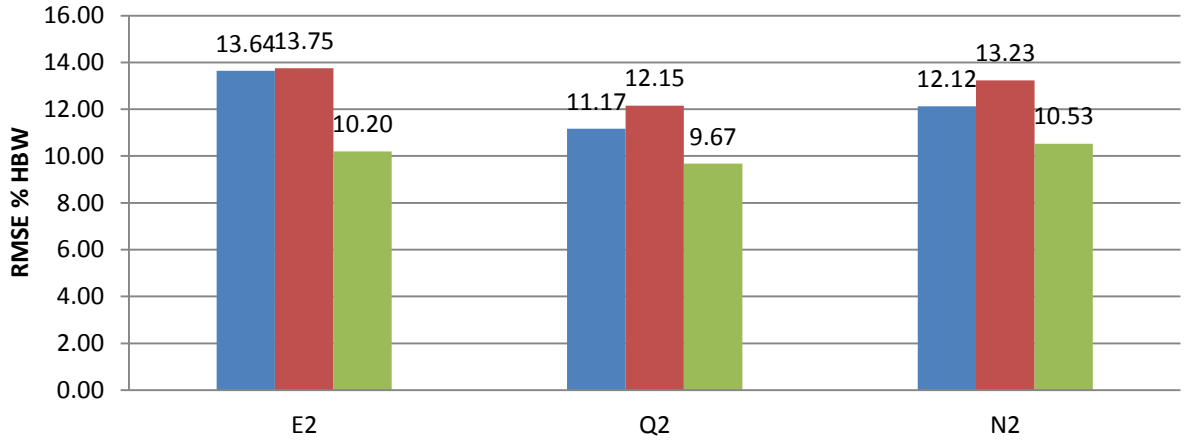
In production “miss-matches” need to be removed!

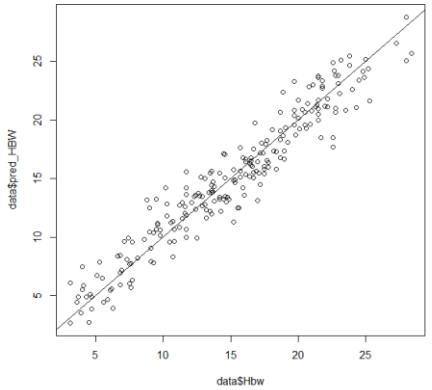
2. Valuable new metrics in volume and basal area models

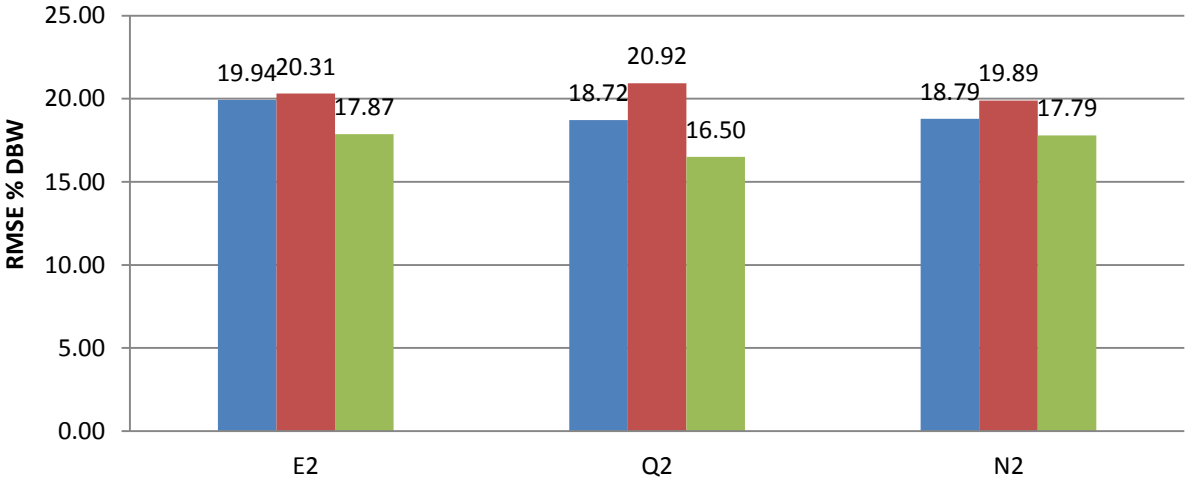
CHM_0= canopy height model (nodata filled with 0)
sumH2= sum of squared heights for local maxima in CHM
sumH2_f= same as above, but CHM is mean filtered first (smoother)
prop.points.over.70proc.of.elev.P95
prop.points.over.50proc.of.elev.P95
prop.points.over.80proc.of.maximum.elev
clarkevan= clarkeven index of spatial pattern of local maximas in CHM
slope_0 =slope from CHM (nodata filled with =0) (dbw model)

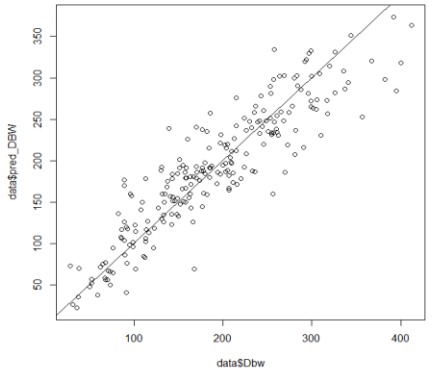
Otherwise typical FUSION height metrics

3-4. Plot level accuracies, LOO





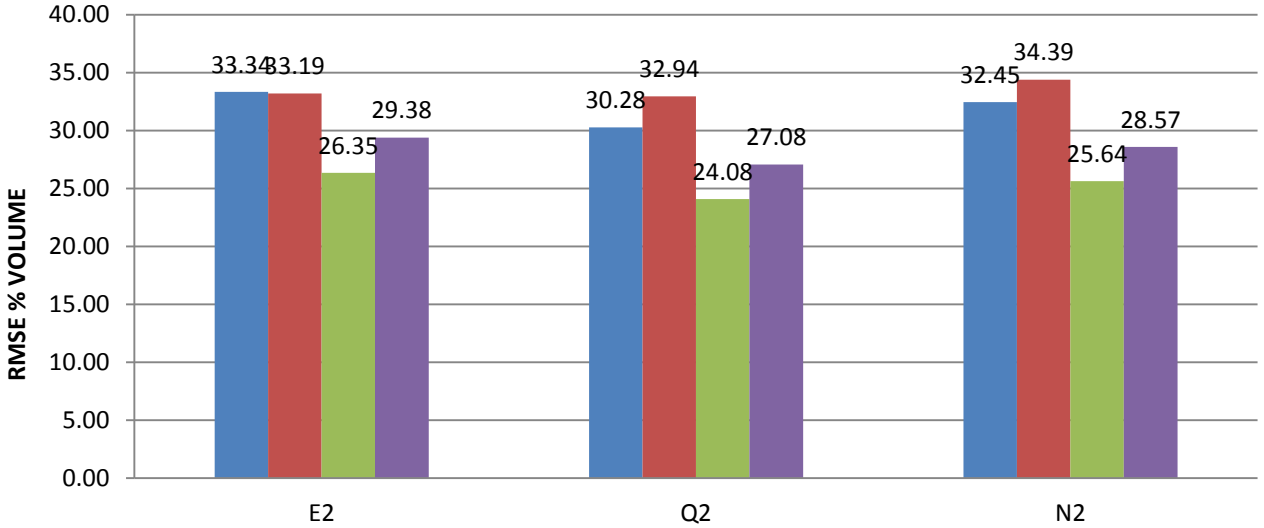


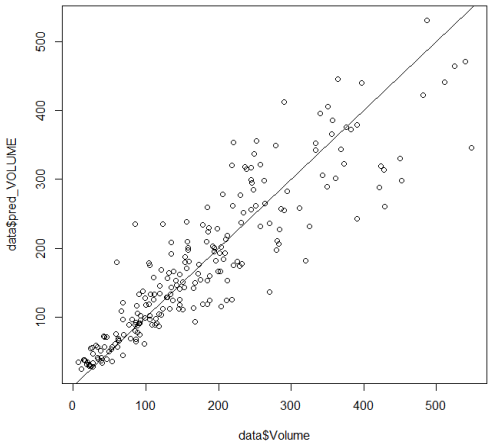


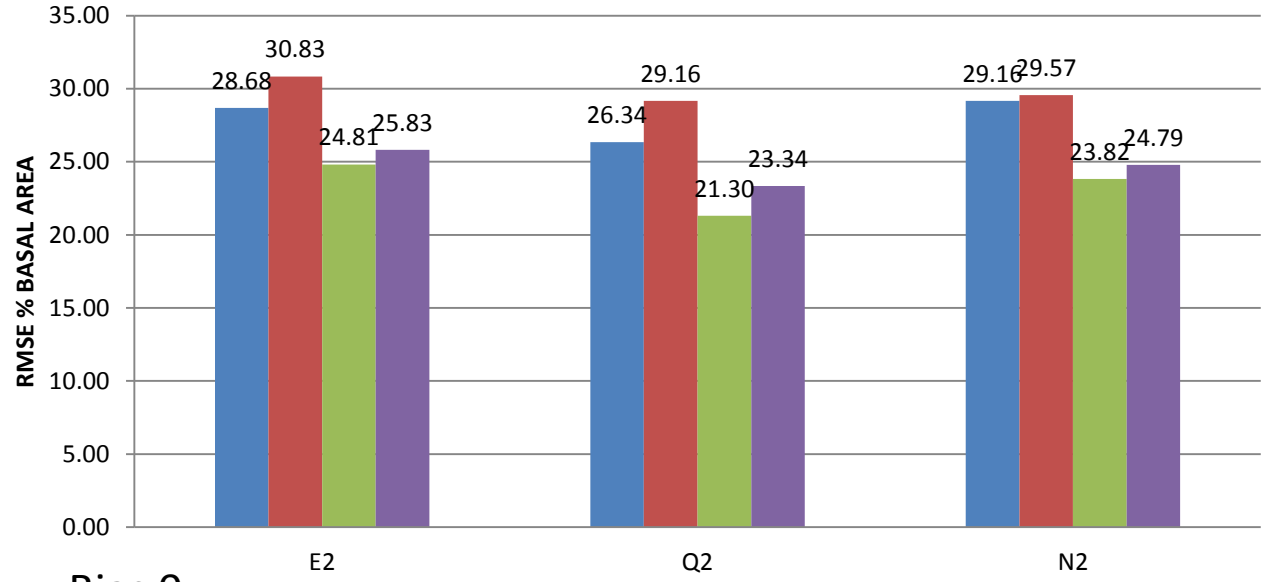
Bias 0

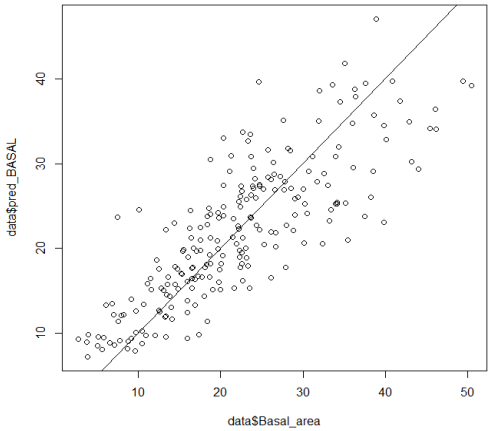
Obs old laser!

3,4,6. Plot level accuracies, LOO





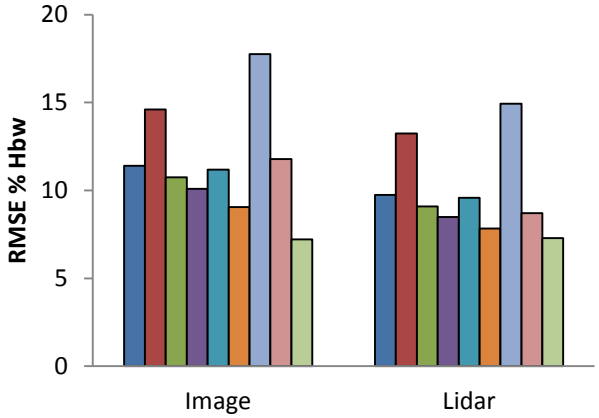


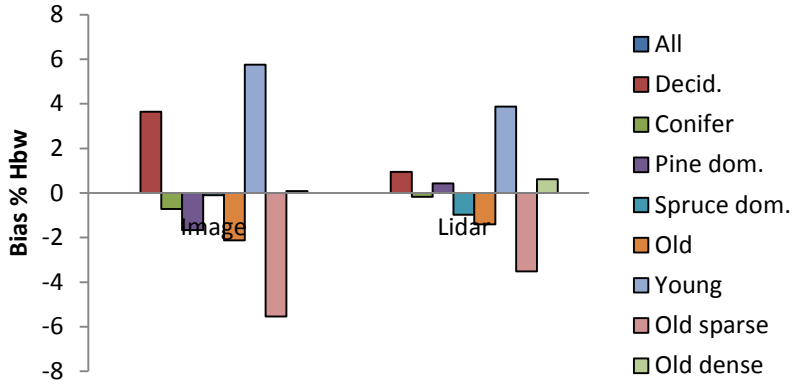


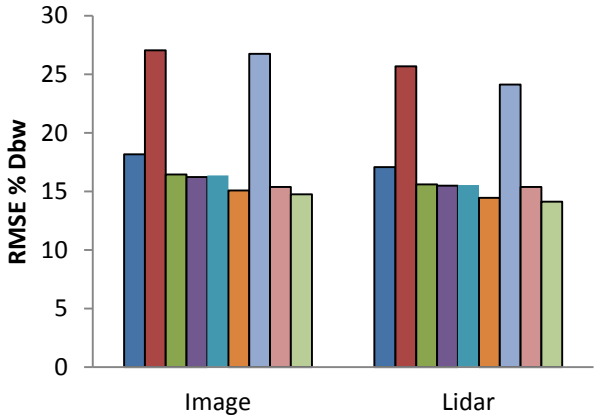
Bias 0

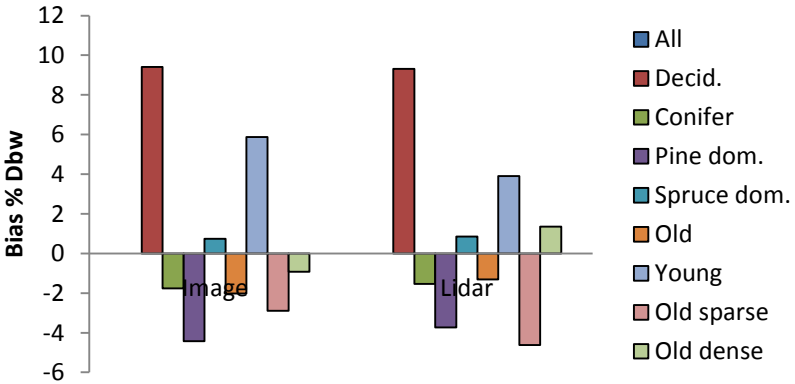
Obs old laser!

5. Accuracies in different kind of forests, plot data

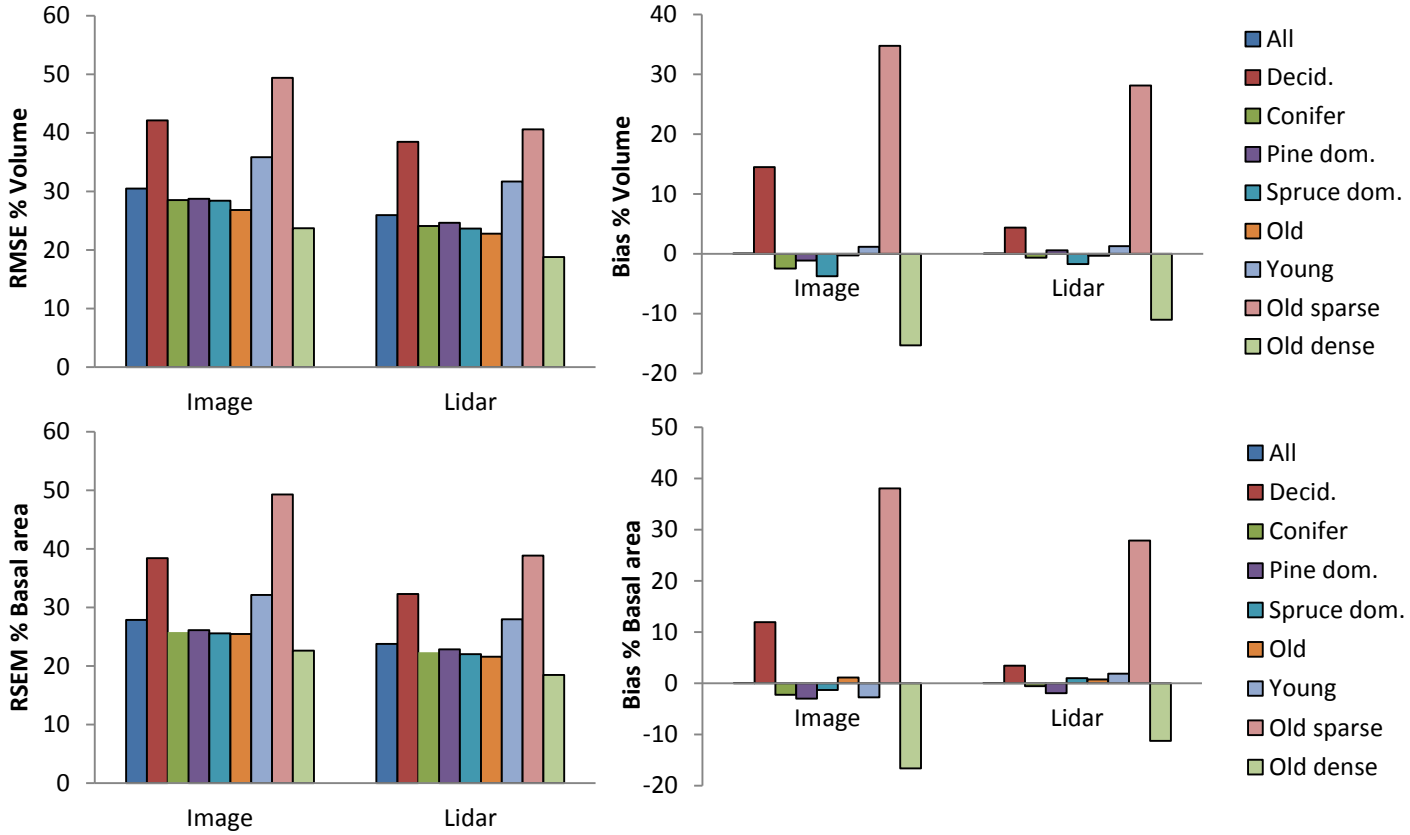




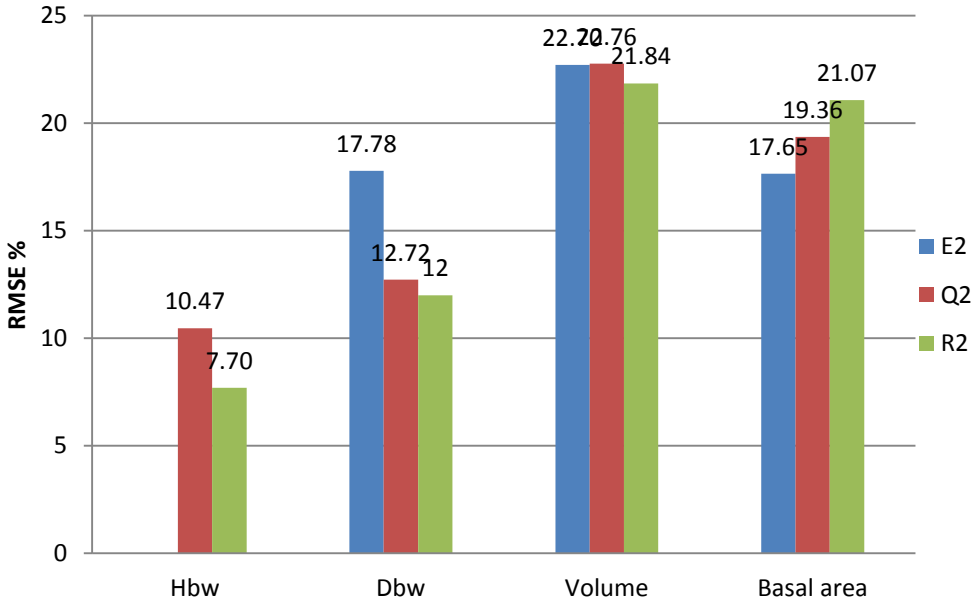


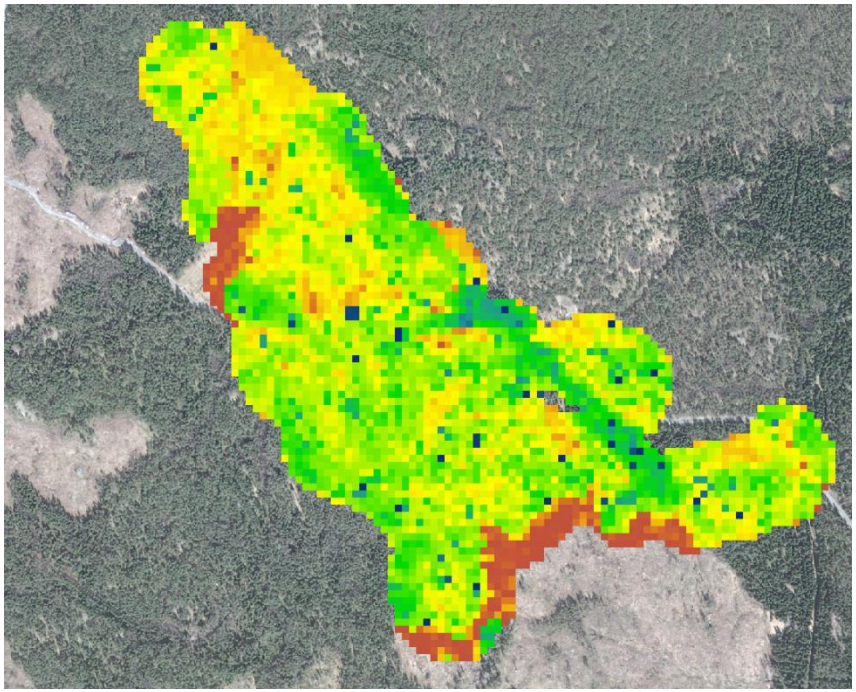


5. Accuracies in different kind of forests, plot data

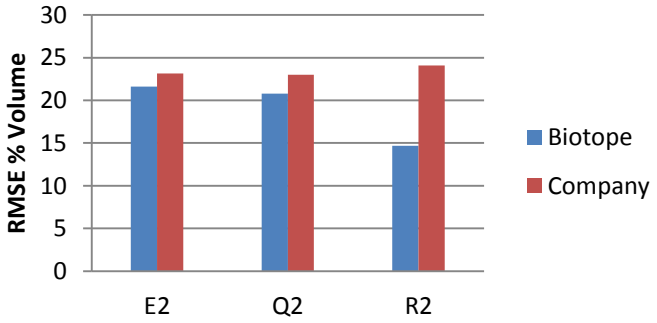


3. Accuracies in stand level





- Results close to accuracies of National forest attribute maps (skogliga grund data)
- E2 and biotope stands: lot of deciduous trees
- Accuracies affected by time difference between modelling data (2012-13), images (2014) and validation data (2015), differences between modelling and validation data and border effects of stands

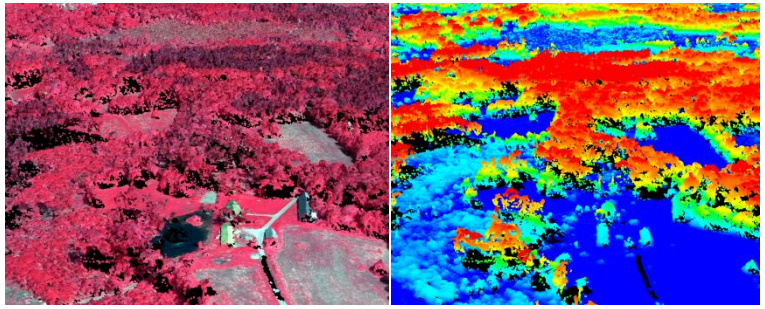


Swedish University of Agricultural Sciences
Forest Remote Sensing

Summary: Photogrammetry has high potential updating/replacing Laser based inventory

- SGM (SURE) leaded slightly better results compared to FBM (inpho) (point density), especially in sparse forest
- Lack of good density information (structure) leads slightly lower accuracy compared to LASER
- In general results similar reported in LASER inventories, also same problems (young, deciduous, sparse)
- Combining photogrammetry metrics and LASER density metrics improved accuracy->possibilities
- Important to collect comprehensive modelling data!
  - Landmäteriet planning to make image matching for all images taken 2015-2016.
  - Skogstyrellesen is ordering photogrametry based vegetation height raster over all images taken 2015
  - At the moment not yet planned continuation for national forest attribute maps

- More research needed:
  - Effect of using full-coverage over inventory area (several stereo pares), accuracy, miss-matches?
  - Leaf-on or leaf-off?
  - Combining Photogrammetry and LASER for updating?
  - How to improve prediction of density/structure?
  - How to detect thinnings, seed trees?
  - Use of stratification?
  - Adding colour information?



Thanks, Questions ?