

## **Regional XX - Sweden**

# **GlobBiomass - 1st Users Workshop**

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given on behalf of the Swedish University of Agricultural Sciences

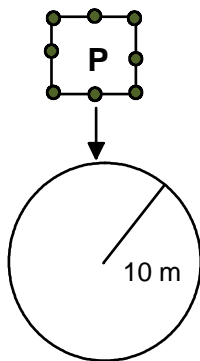
# Background

- › 55% of Sweden belongs to forest land
- › 95% of forests are intensively managed
- › On ground survey by the National Forest Inventory since 1929
- › Remote sensing used as complement to on ground measurements
- › Since decades SLU investigates and applies techniques based on airborne and spaceborne remote sensing data (optical, radar, laser scanning) to support inventory
- › For GlobBiomass , two sets of estimates of stem volume based on optical data and SAR data, respectively, are proposed.

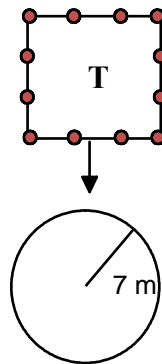
# Field data from the Swedish NFI



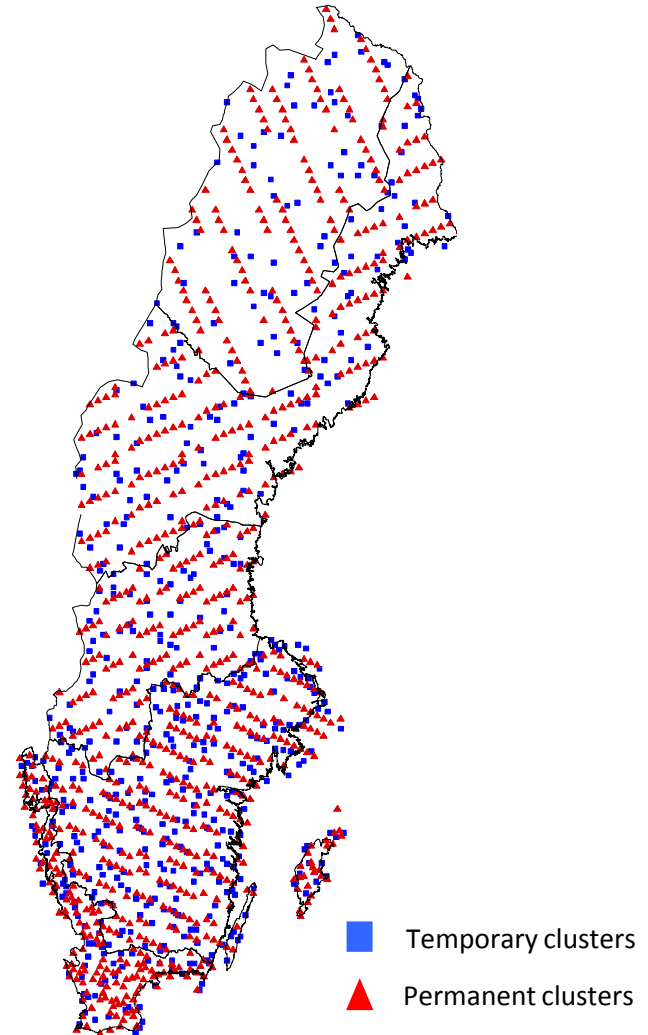
Approx. 9 500 field plots per year  
60 % permanent (P), 40 % temporary (T)



8 plots per cluster

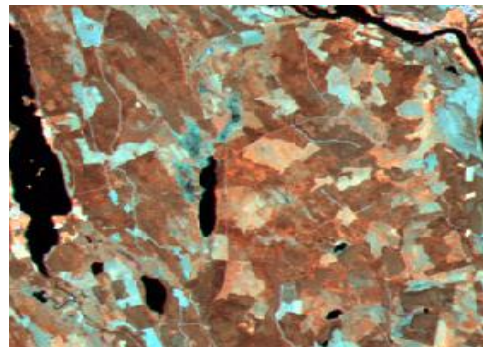


12 plots per cluster

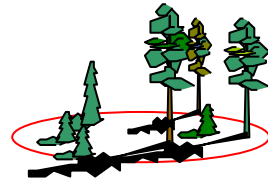


# kNN Sweden

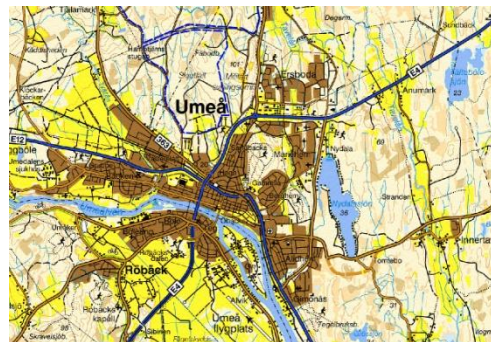
( $k$ NN =  $k$  Nearest Neighbours)



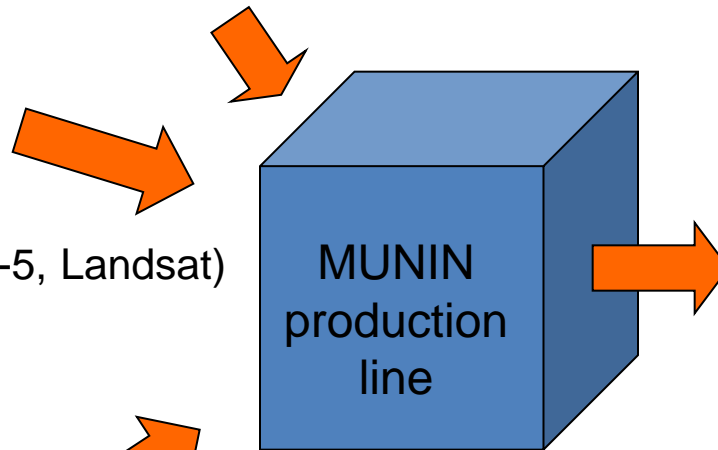
Satellite images (SPOT-4,-5, Landsat)



Field plots from the Swedish NFI

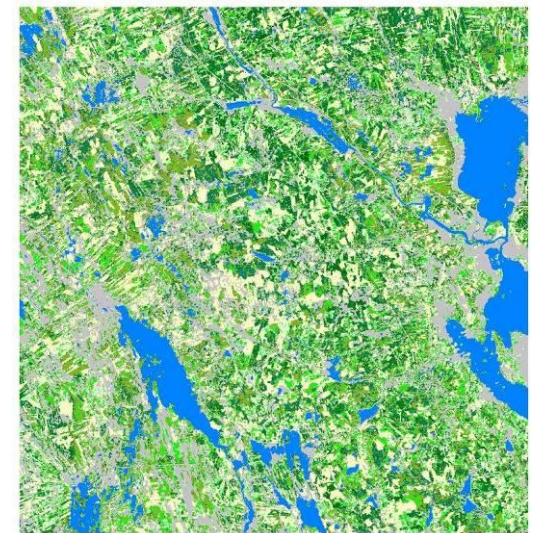


Map data



## Pre-processing

- Topographic illumination correction
- Spectral calibration



Raster maps with estimated forest variables

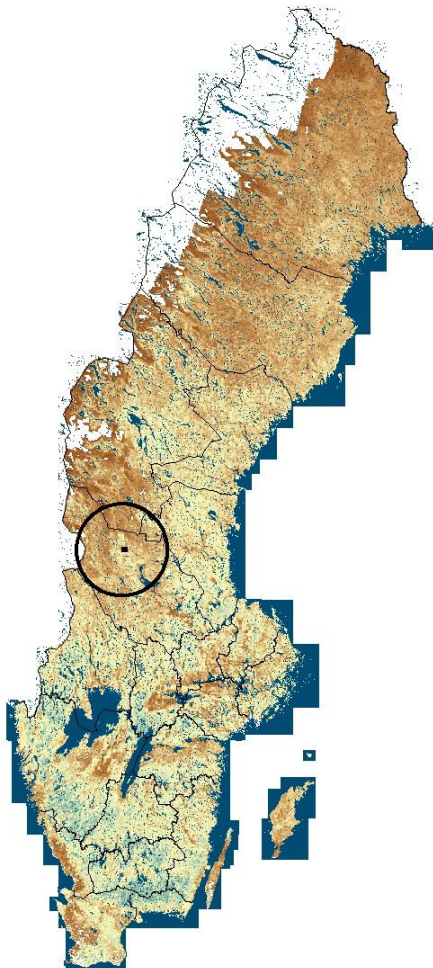


# kNN Sweden 2010

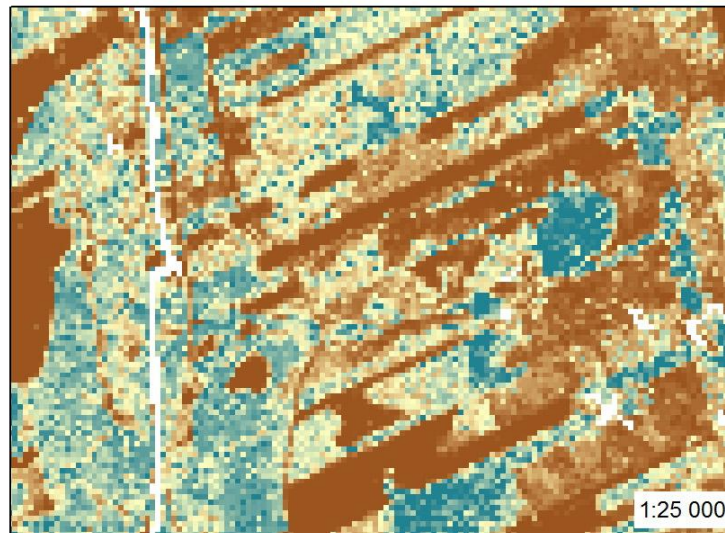
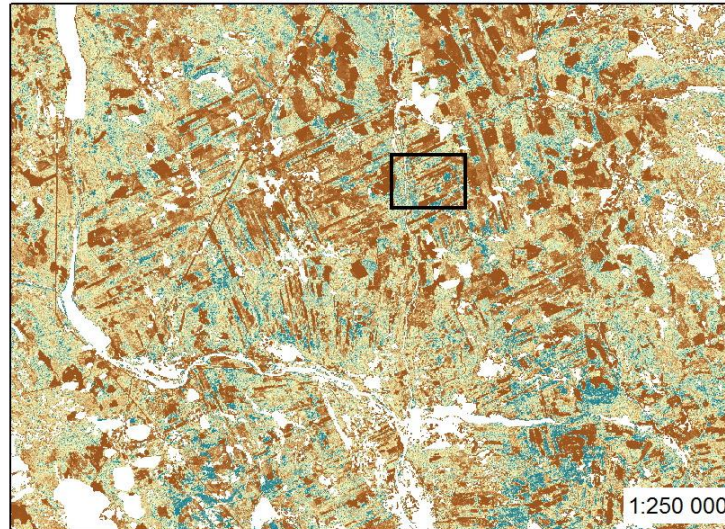
25x25 m pixels

## Variables

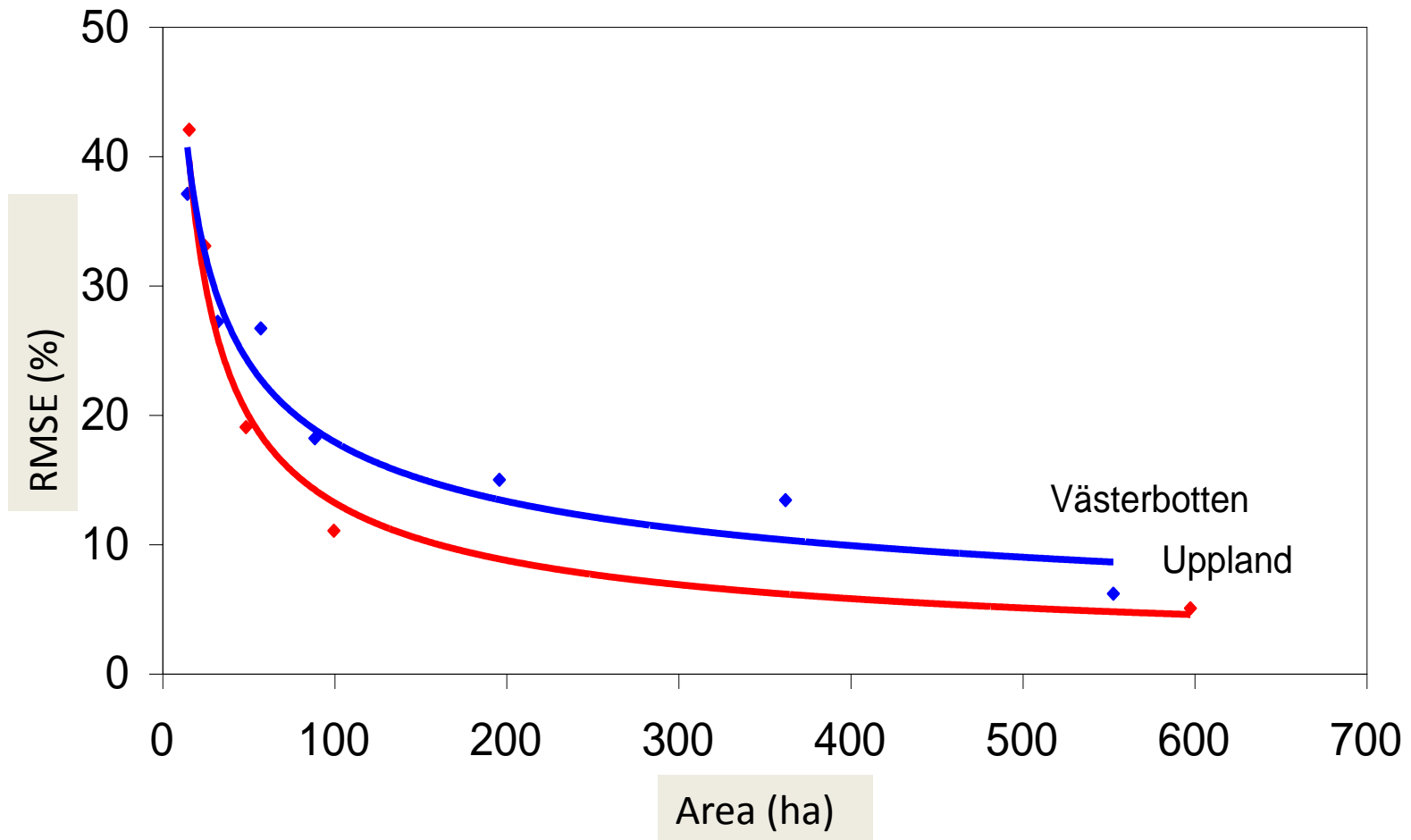
- Stand volume
- Stand volume per tree species
- Stand height
- Stand age
- Biomass



1:8 500 000



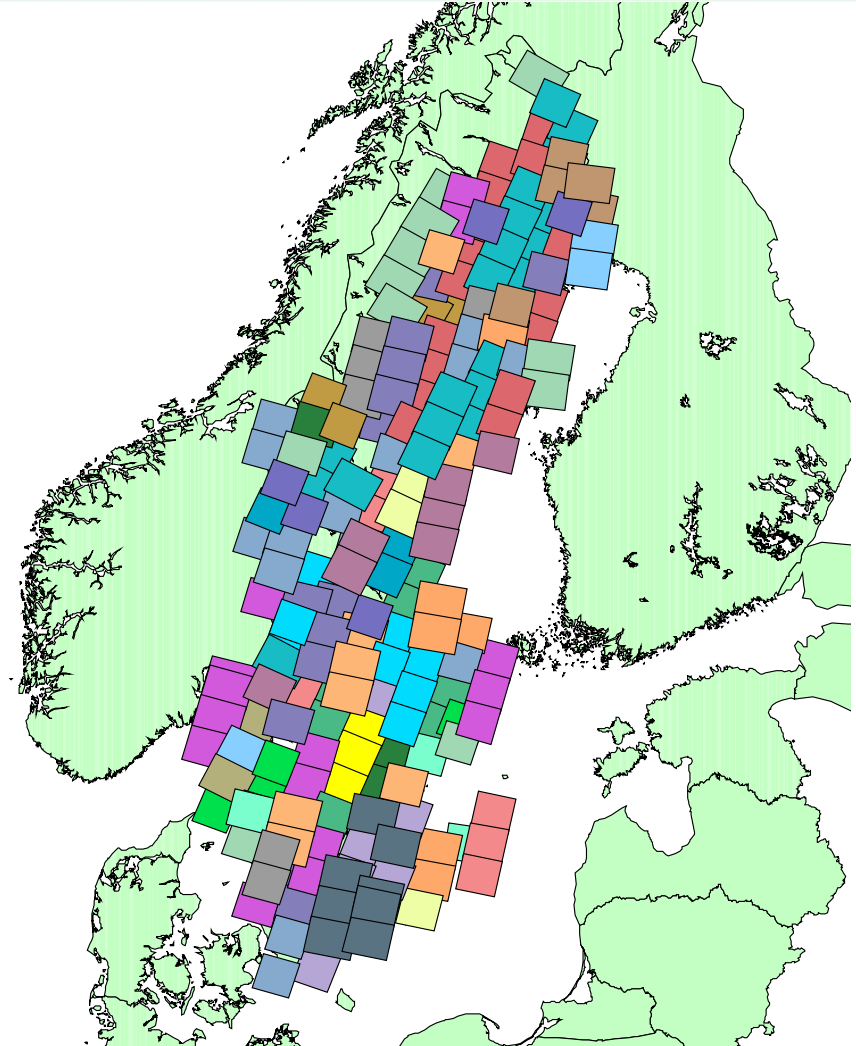
# Relative RMSE for stem volume



# kNN Sweden

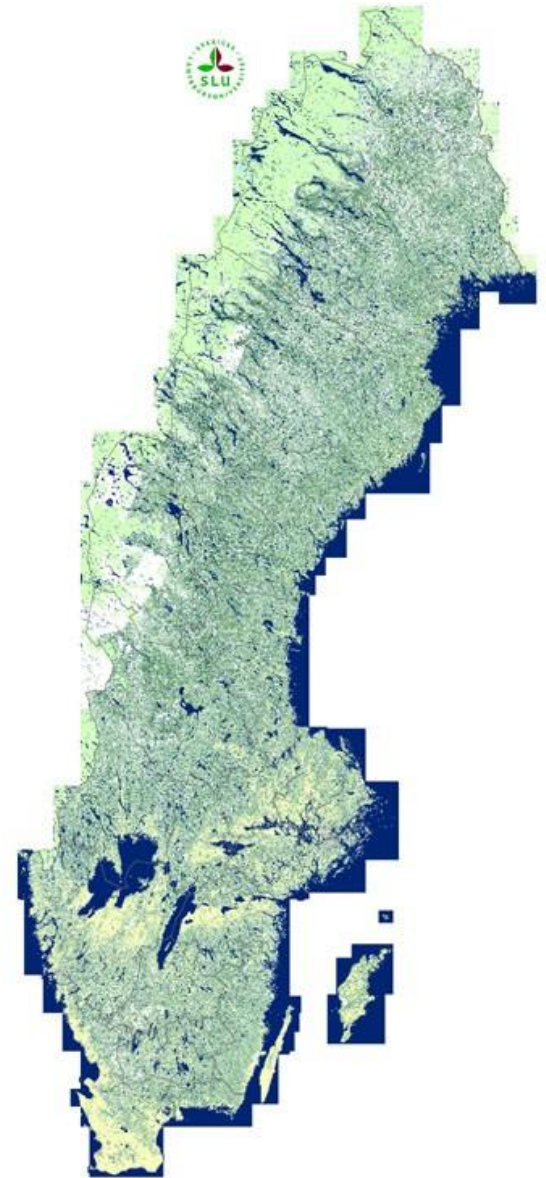
## Datasets

- › 2000
  - Landsat images from 1997-2001
- › 2005
  - SPOT images from 2005 & 2006
- › 2010
  - SPOT images from 2008-2010
- › Covers approx. 95% of the forest land area in Sweden
- › Available free of charge via internet (<http://skogskarta.slu.se/>)



# Users

- › SLU
- › Swedish Forest Agency
- › County Administration Boards
- › Swedish Environmental Agency
- › Swedish Tax Agency
- › Forest companies
- › Forest organisations
- › Universities
- › Etc.





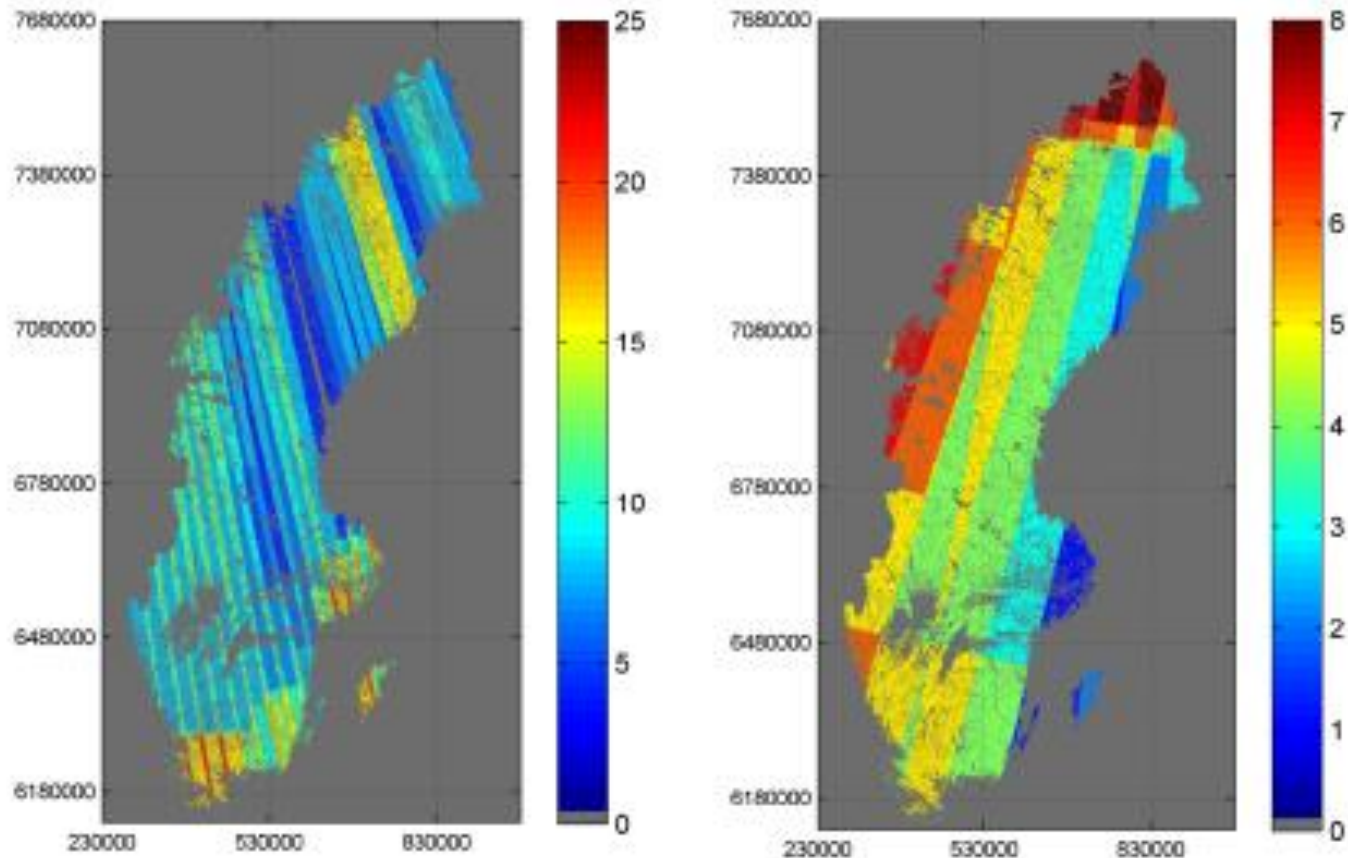
# ALOS PALSAR dataset for 2010

## ALOS PALSAR datasets 2010

PALSAR mode	Season	Pixel size (m)	# PALSAR strips
FBD	Spring / Fall	25	104
WB	Winter	75	17

- Data acquired between May and October 2010
- For each RSP, 1-4 acquisitions were available
- All data have been terrain geocoded, normalised and tiled (30 km x 30 km)

# Number of ALOS PALSAR observations



Number of ALOS PALSAR backscatter observations over Sweden in FBD mode (left) and WB mode (right) acquired during 2010

# Stem volume retrieval approach

- Based on concept of BIOMASAR algorithm developed for C-band data
- Implements the WCM + multi-temporal combination in an automated approach;
- Requires a dataset of canopy cover (e.g., MODIS VCF) for model training

• In theory dependent on dielectric properties and forest structure

• A constant value does not affect the retrieval performance  $\rightarrow 0.004 \text{ ha/m}^3$  (e.g. for boreal/temperate forest, L-band)

$$\sigma_{for}^o = \sigma_{veg}^o \left(1 - e^{-\beta V}\right) + \sigma_{gr}^o e^{-\beta V}$$

↑ 1  
↙ 3
↘ 2

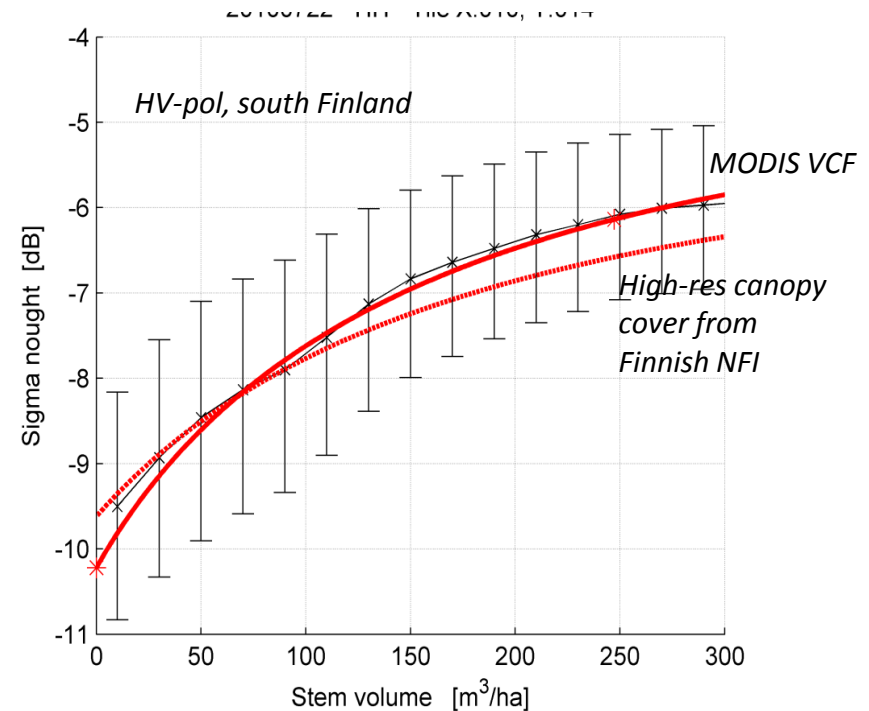
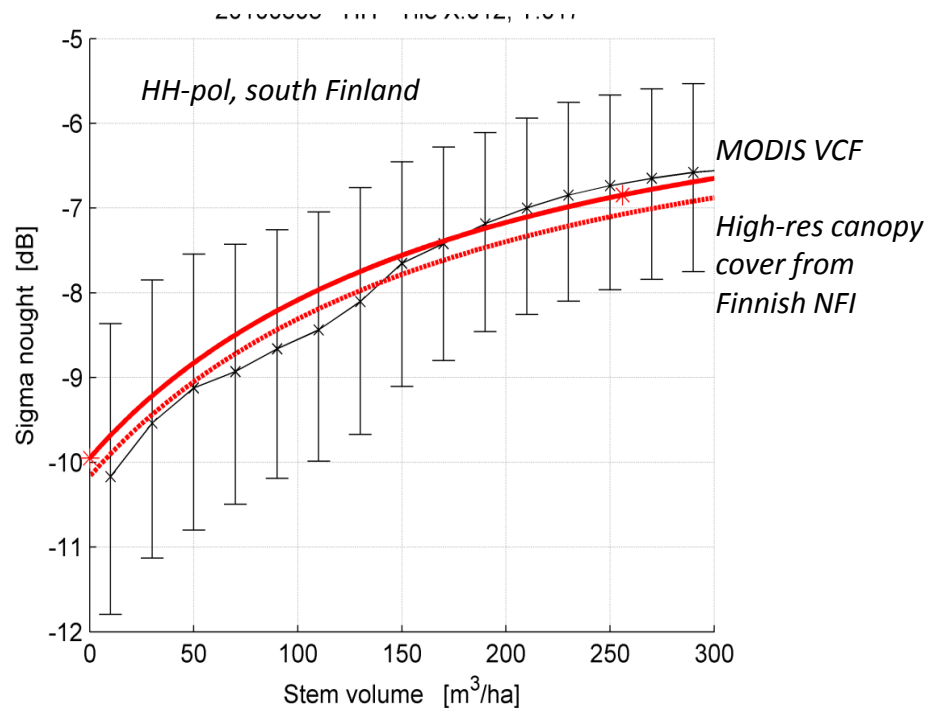
- Identify in the window „dense forest“ pixels: pixels with canopy cover > threshold (e.g. 70%)
- Median of backscatter represents the backscatter of dense forests (does not represent sigma<sub>veg</sub>)
- Compensate for residual ground backscatter, ( $V_{df}$  = GSV of dense forest, estimated from auxiliary dataset)

• Identify in the window „ground“ pixels: pixels with canopy cover < threshold (e.g. 20%)

• Parameter estimate: median of backscatter

$$\sigma_{veg}^o = \frac{\sigma_{df}^o - \sigma_{gr}^o e^{-\beta V_{df}}}{1 - e^{-\beta V_{df}}}$$

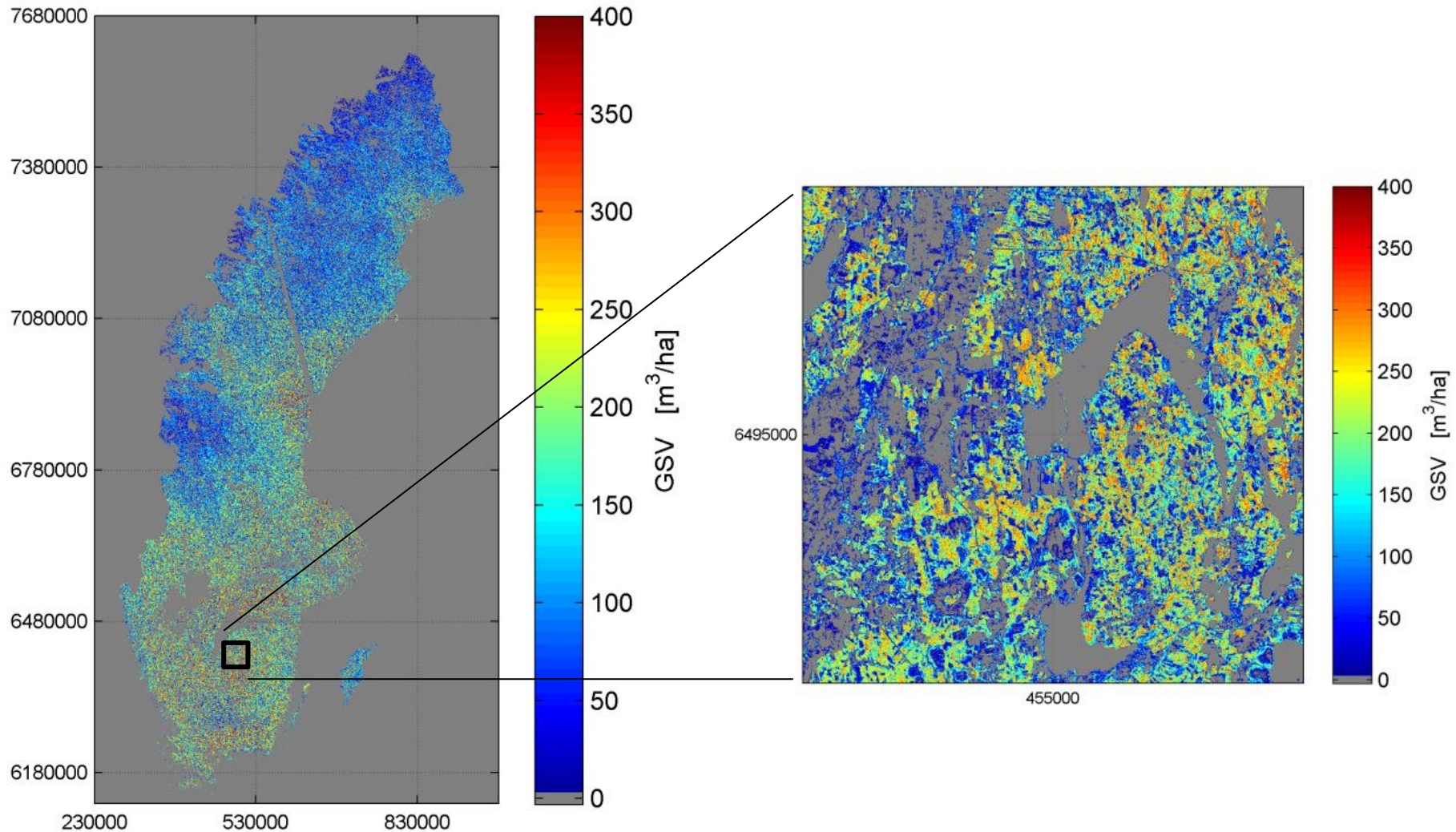
# Model training performance



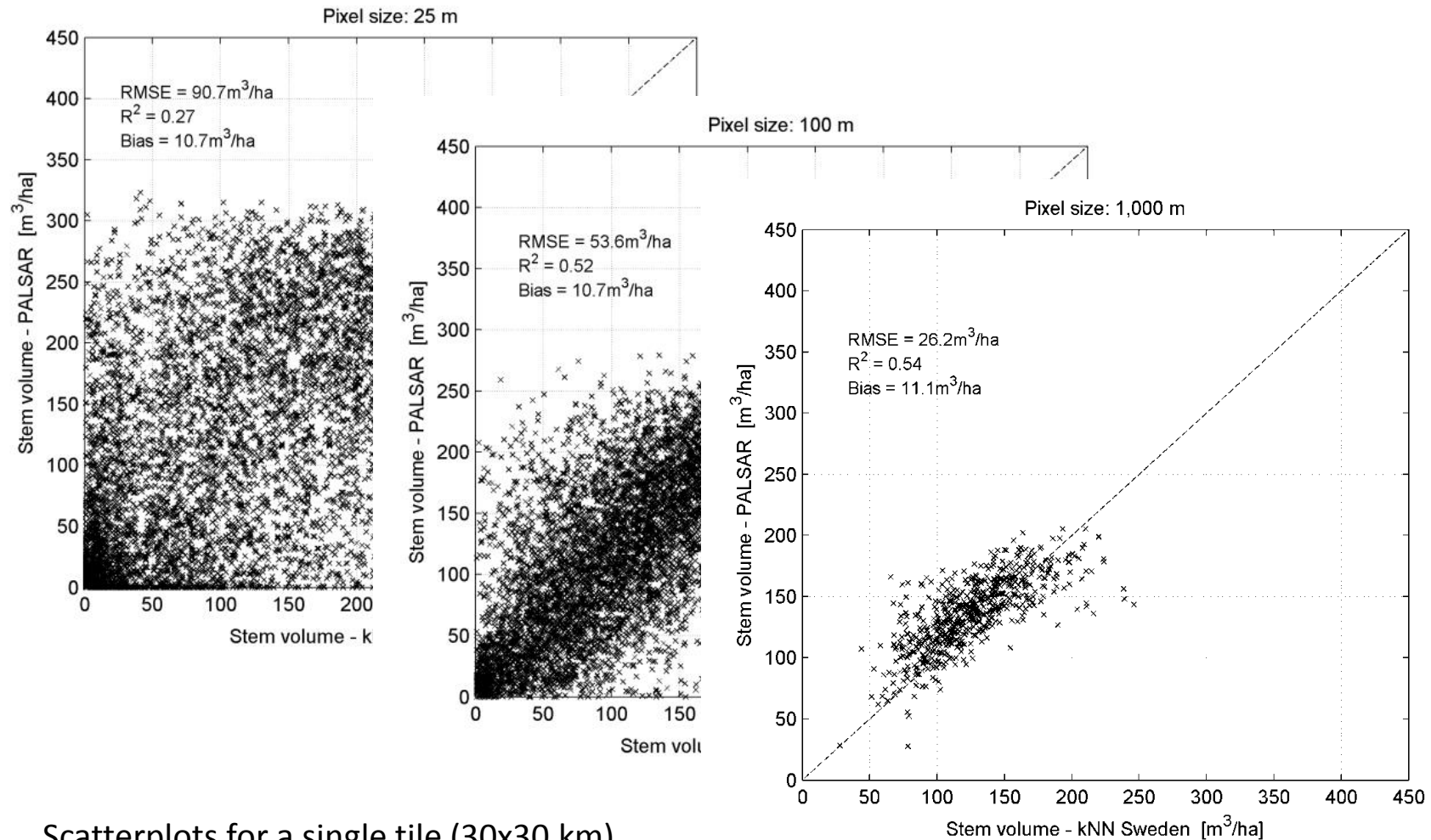
- Modelled backscatter with MODIS VCF satisfactory
- Model matches trend in observations (x = mean values, bars = interquartile range)
- Difference w.r.t. to model trained with high-res canopy cover small.



# PALSAR-based stem volume map



# Comparing *k*NN and PALSAR stem volume

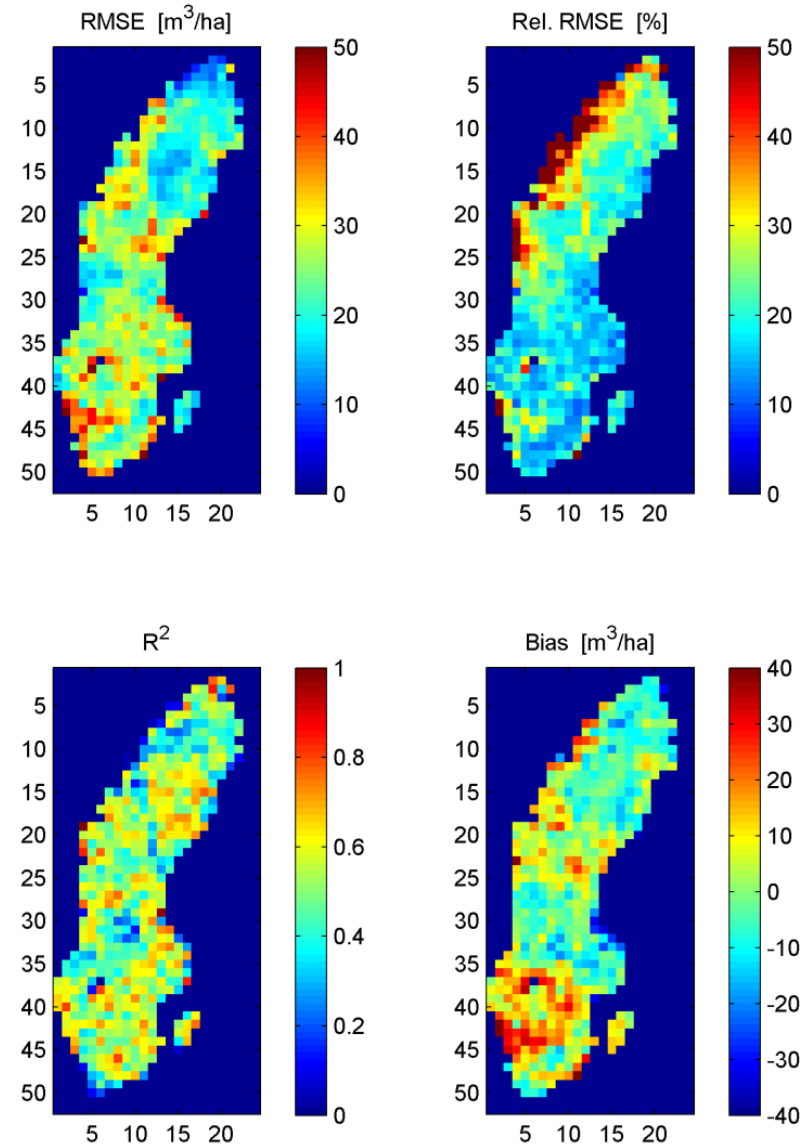


Scatterplots for a single tile (30x30 km)

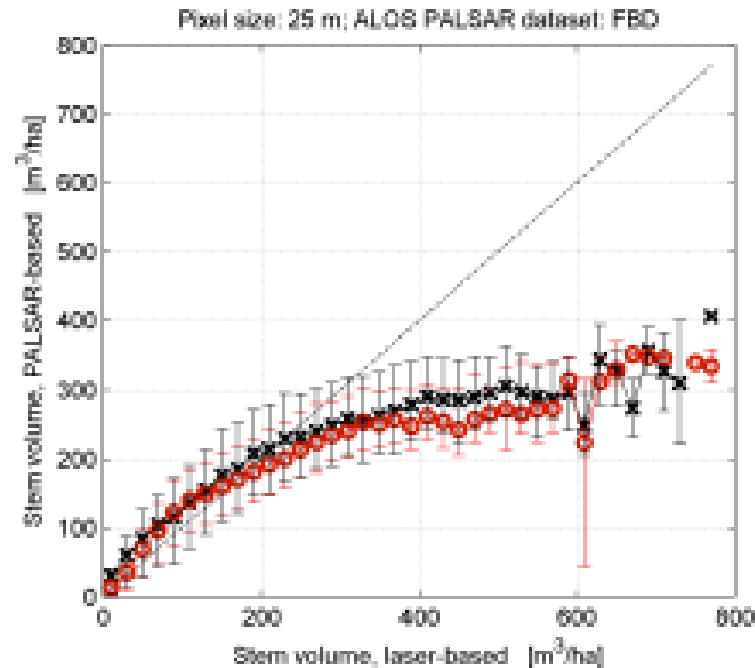
# Similarities and differences between $k$ NN and PALSAR stem volumes

## PALSAR vs. $k$ NN Sweden 2010

- Statistics relative to single 30x30 km tiles
- Relative RMSE mostly below 25%
- Larger discrepancy in sparse forest along border with Norway
- Some artifacts particularly in  $k$ NN data product
- Some underestimation in very dense forest observed when comparing again local in situ (Remningstorp)



# Assessing PALSAR stem volume with laser-based estimates of stem volume



Distribution of PALSAR-based estimates of stem volume with respect to reference laser-based estimates. Black symbols: Remningstorp; red symbols: Krycklan. Crosses and circles refer to the mean value of PALSAR-based stem volume for a given interval of laser-based stem volume. Vertical bars represent the corresponding interquartile range.