CHALMERS

FOREST PARAMETER RETRIEVAL FROM L-BAND TOMOGRAPHY

Erik Blomberg[1)], Maciej Soja[1)], Laurent Ferro-Famil[2)], Lars Ulander[1)]

[1)]Chalmers University of Technology, Sweden [2)]Université de Rennes 1, France

INTRODUCTION

L-band radio waves interact strongly with the forest canopy and L-band SAR images has shown value for retrieving above-ground biomass (AGB) estimates from boreal forest. This poster presents a study of how forest parameter retrievals from L-band synthetic-aperture radar (SAR) data can benefit from the use of tomography, including a comparison with the simulated performance of the proposed tomographic SAOCOM-CS (1.35 GHz) satellite mission.

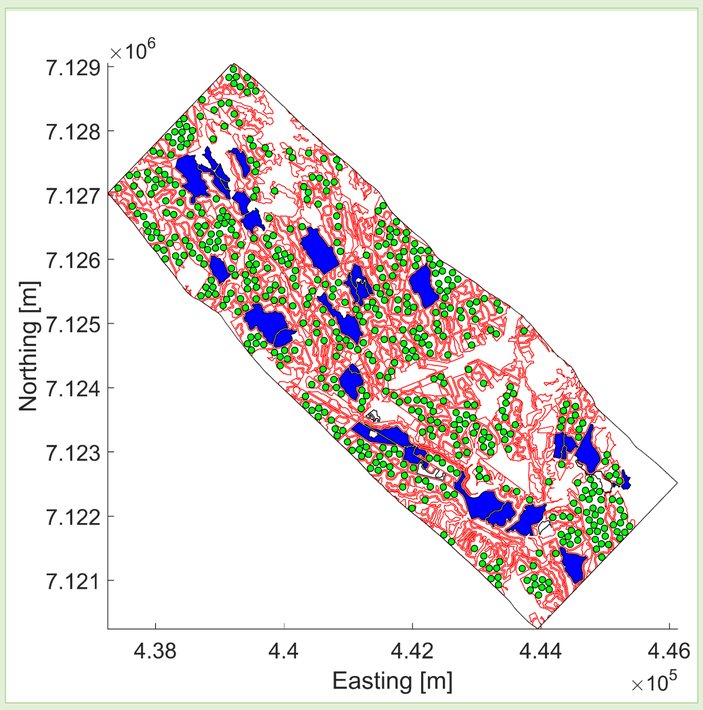


Figure 1. *The green circles are the training data plot that have been randomly distributed within the forest stands, delineated in red. Detailed in situ data is available for the stands marked in blue.*

DATA

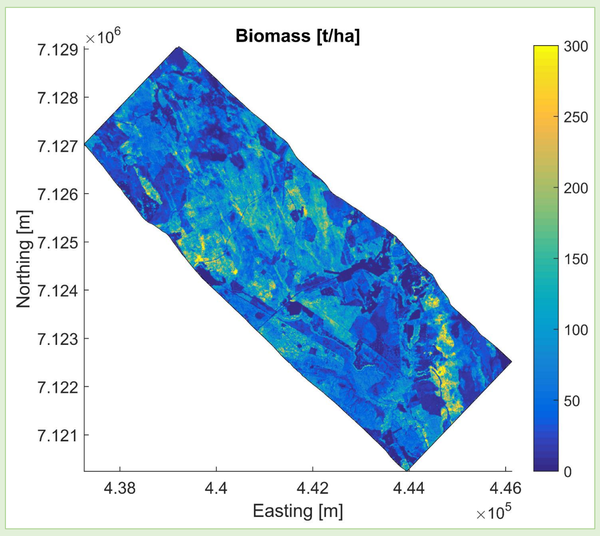
The BioSAR 2008 campaign at the Krycklan forestry test site in northern Sweden resulted in several extensive data sets used for this analysis:

12 fully polarimetric L-band SAR acquisitions provide calibrated backscatter intensity γ^0 and tomographic volumetric intensity for both the full resolution airborne E-SAR case and the simulated space mission SAOCOM-CS.

High resolution LiDAR based products including an in situ calibrated biomass map as well as LiDAR return high percentiles and Vegetation ratio (VR).

Training and validation data

A forest stand map was used to randomly select a total of 517 circular 50 m radius plots of homogenous forest over which the biomass map and radar data were averaged for use as training data for the models. Validation data was provided by detailed in situ measurements available for 27 forest stands within the area covered by the radar acquisitions.

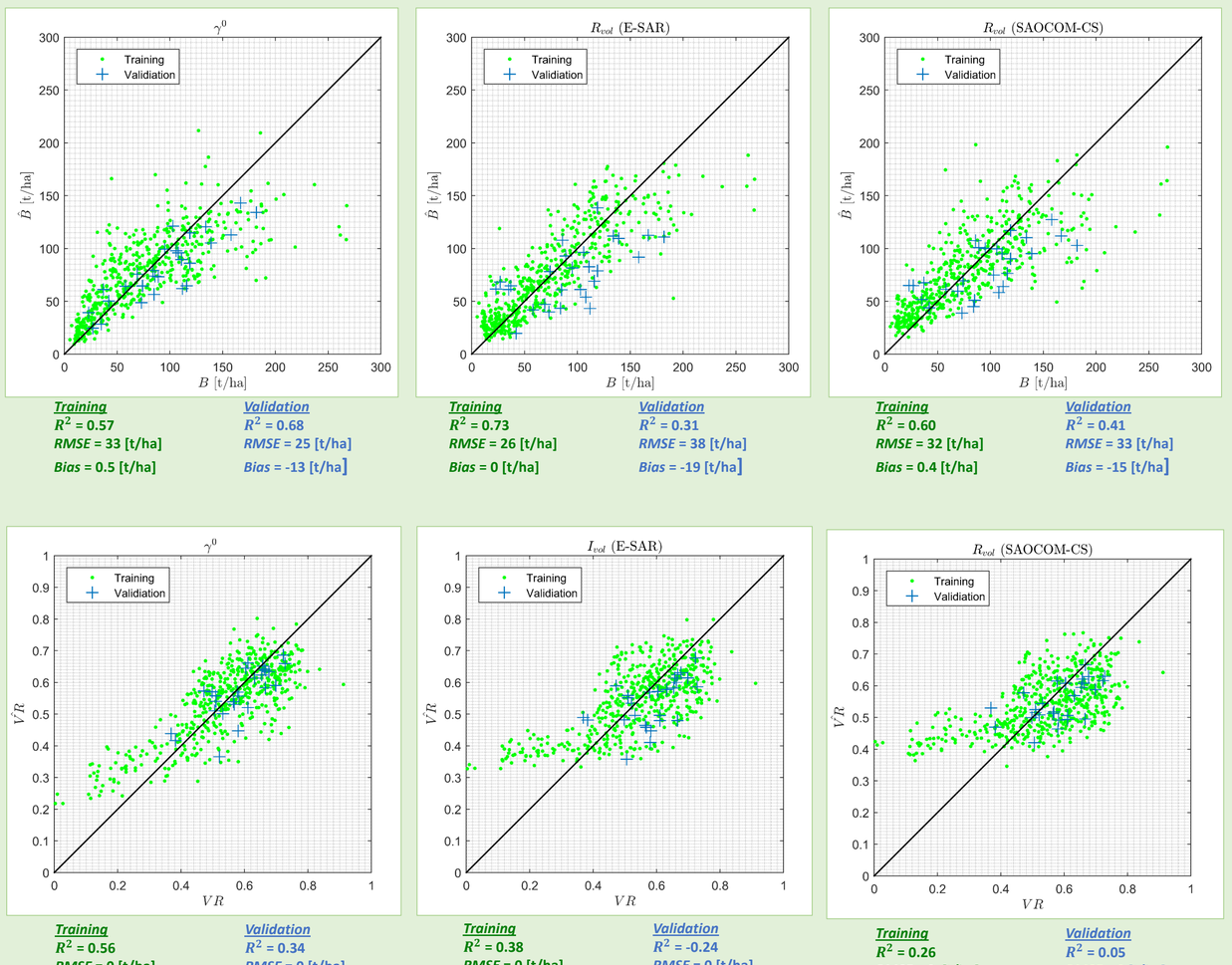


Figures 2 -3. *Biomass (left) and Vegetation Ratio (right) are the two example forest parameters for which retrieval results are included here.*

MODELS

The two models used are linear combinations of the polarimetric components of the observables after either a log or a square root transform. For the original radar data the calibrated and incidence angle corrected SAR intensity γ^0 is use, while tomographic data sets are processed into the volumetric intensity I_{vol} and the normalized volumetric intensity ratio R_{vol}:

$$I_{vol} = \int_{z=10m}^{\infty} \beta^0(z)\,dz \qquad R_{vol} = \frac{\int_{z=10m}^{\infty} \beta^0(z)\,dz}{\int_{z=-\infty}^{\infty} \beta^0(z)\,dz}$$



	Training	Validation
γ^0	R^2 = 0.57, *RMSE* = 33 [t/ha], *Bias* = 0.5 [t/ha]	R^2 = 0.68, *RMSE* = 25 [t/ha], *Bias* = -13 [t/ha]
R_{vol} (E-SAR)	R^2 = 0.73, *RMSE* = 26 [t/ha], *Bias* = 0 [t/ha]	R^2 = 0.31, *RMSE* = 38 [t/ha], *Bias* = -19 [t/ha]
R_{vol} (SAOCOM-CS)	R^2 = 0.60, *RMSE* = 32 [t/ha], *Bias* = 0.4 [t/ha]	R^2 = 0.41, *RMSE* = 33 [t/ha], *Bias* = -15 [t/ha]
γ^0	R^2 = 0.56, *RMSE* = 0 [t/ha], *Bias* = 0 [t/ha]	R^2 = 0.34, *RMSE* = 0 [t/ha], *Bias* = 0 [t/ha]
I_{vol} (E-SAR)	R^2 = 0.38, *RMSE* = 0 [t/ha], *Bias* = 0 [t/ha]	R^2 = -0.24, *RMSE* = 0 [t/ha], *Bias* = 0 [t/ha]
R_{vol} (SAOCOM-CS)	R^2 = 0.26, *RMSE* = 0 [t/ha], *Bias* = 0 [t/ha]	R^2 = 0.05, *RMSE* = 0 [t/ha], *Bias* = 0 [t/ha]

Figures 4-9. *Retrieved biomass versus reference biomass (top row) and retrieved VR versus reference VR (bottom row). The plots represent the best performing model and parameter for each data set. γ^0 with the logarithmic model (left) while both the full resolution tomographic intensity ratio or intensity (middle) and simulated SAOCOM-CS intensity ratio (right) used a square root model.*

RESULTS & DISCUSSION

L-band data performs well for biomass retrieval as can be seen for both the SAR intensity and tomographic parameters, with γ^0 outperforming the tomographic retrievals in all cases. It is however worth observing that the tomographic training data appears less representative of the validation data, as the training data fits are reversed. Results for VR demonstrate that this parameter is difficult to retrieve with the simple models and observables used, even though it might have superficial resemblance of volumetric backscatter.

CONCLUSION

Results for biomass retrievals are good while those of VR are generally poor. A slight skewing of the validation data relative to the training data is seen for tomographic biomass retrievals. Nothing suggest that the decreased performance in the spaceborne case will adversely affect retrievals.

ACKNOWLEDGEMENT

This work was funded by the Swedish National Space Board (SNSB) and the European Space Agency (ESA). All data were acquired during the ESA BioSAR 2008 campaign with Université de Rennes 1 performing the subsequent tomographic processing.

CONTACT

Department of Earth and Space Sciences
Chalmers University of Technology
SE-412 96 Gothenburg, Sweden
E-mail: blombere@chalmers.se