living planet symposium | BONN 23–27 May 2022

TAKING THE PULSE OF OUR PLANET FROM SPACE

TomoSense P/L-band sensitivity to forest above-ground biomass

Patrik Bennet, Lars Ulander, Albert Monteith, Chalmers University of Technology
StefanoTebaldini, Mauro Mariotti d'Alessandro, Politecnico di Milano

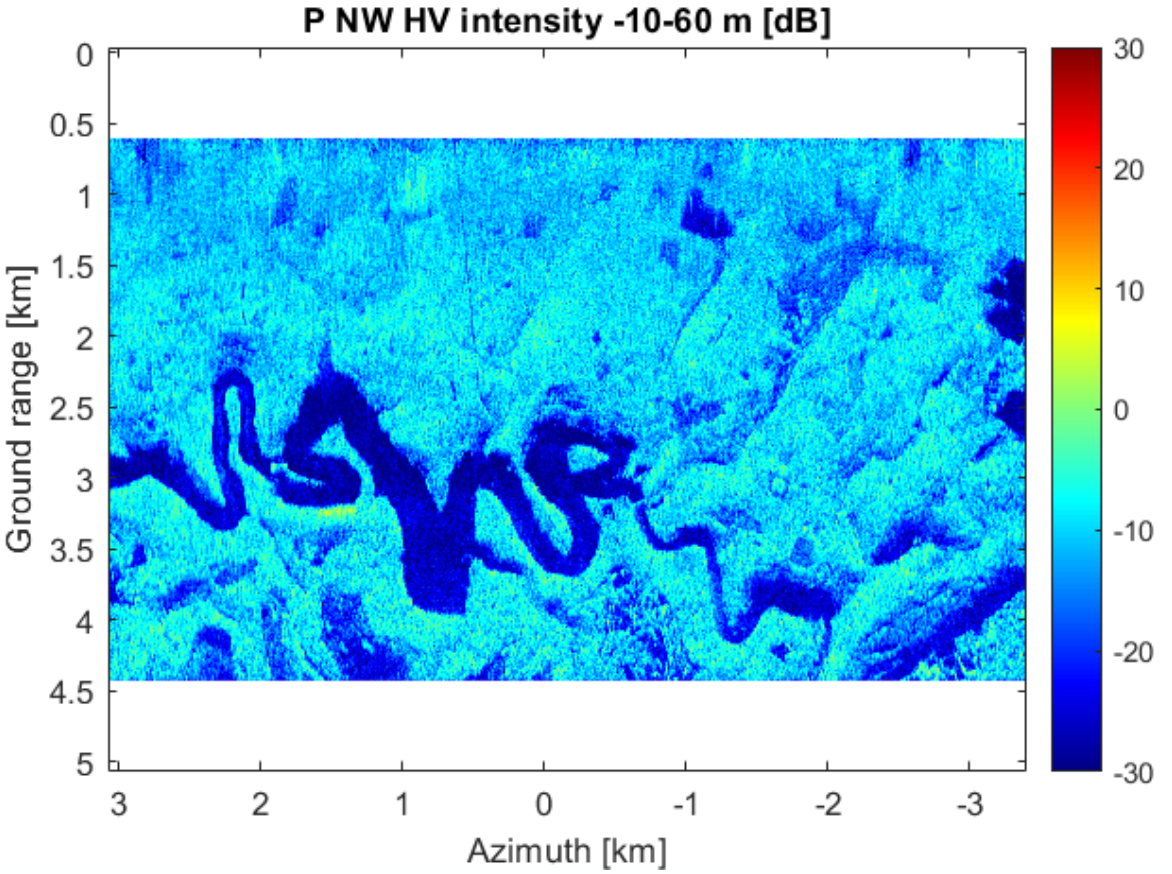
2022-05-26

Tomographic SAR experiment in National Park Eifel

TomoSAR

- Data from 20/30 (P/L) airborne radar acquisitions is combined to construct 3-D image of scene reflectivity.
- Reflectivity is resolved in height layers.
- P and L-band are important for forest applications since signal penetrates canopy and scatters off tree stems and larger branches.

Example SAR image acquired in 2020 over Kermeter site



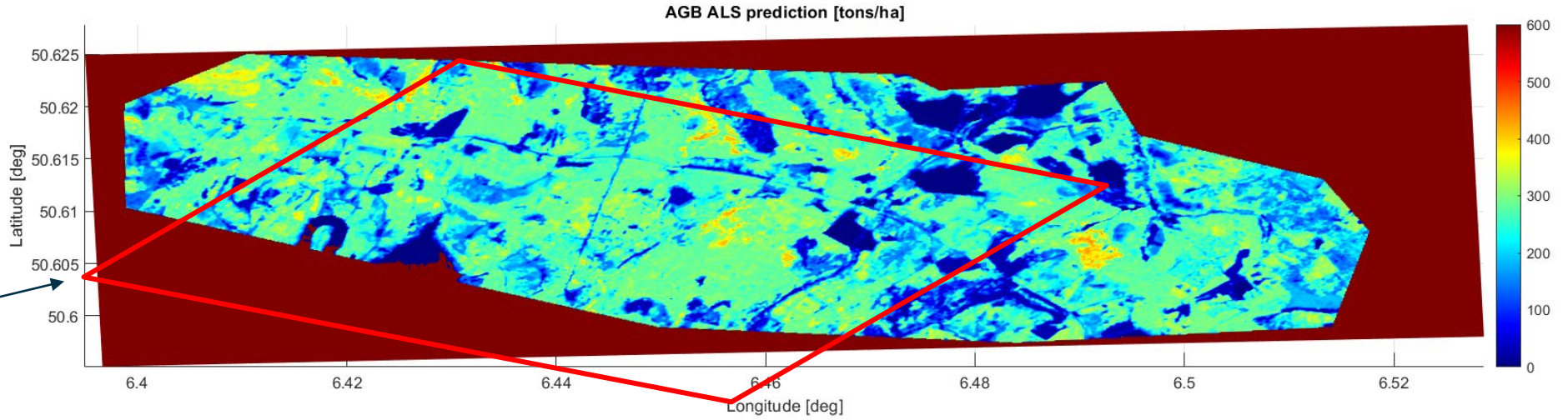
Kermeter forest site in National Park Eifel

Forest biotype map

Biotypes marked on Google Earth image

- Brown - beech forest
- Blue – spruce forest
- … additional forest types but limited coverage

ALS (airborne lidar scan) AGB estimation map

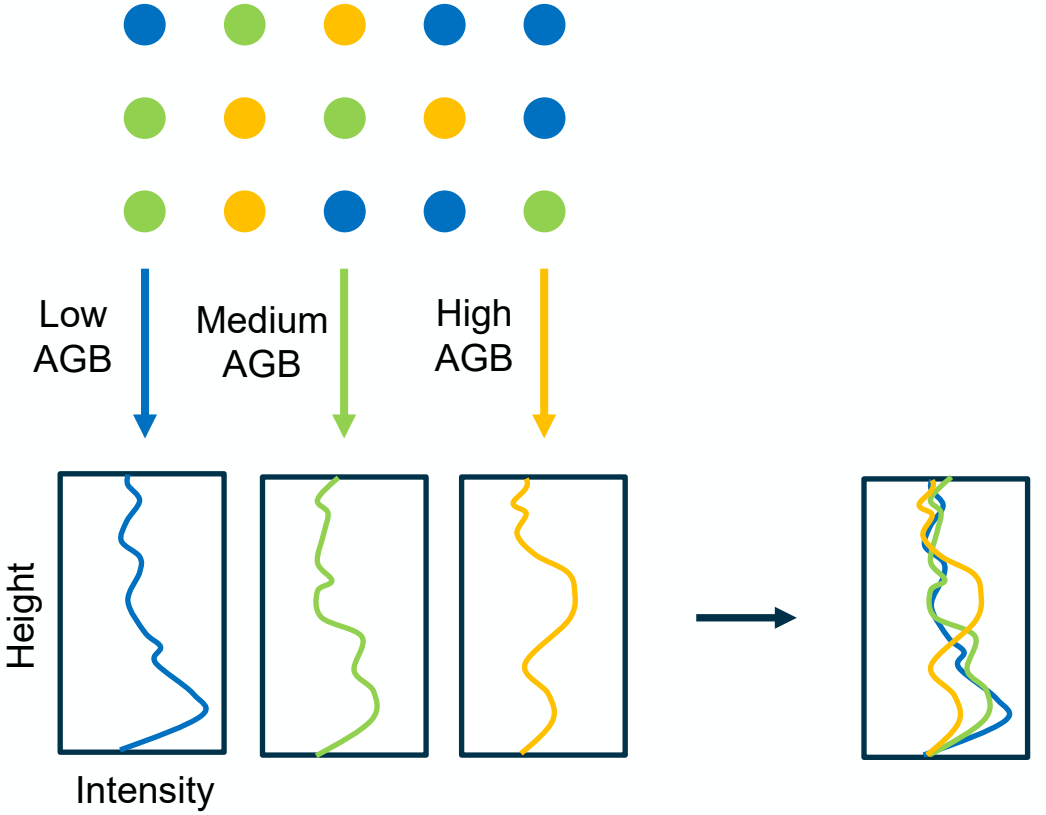


Area covered by radar acquisitions

Vertical reflectivity profiles analysis

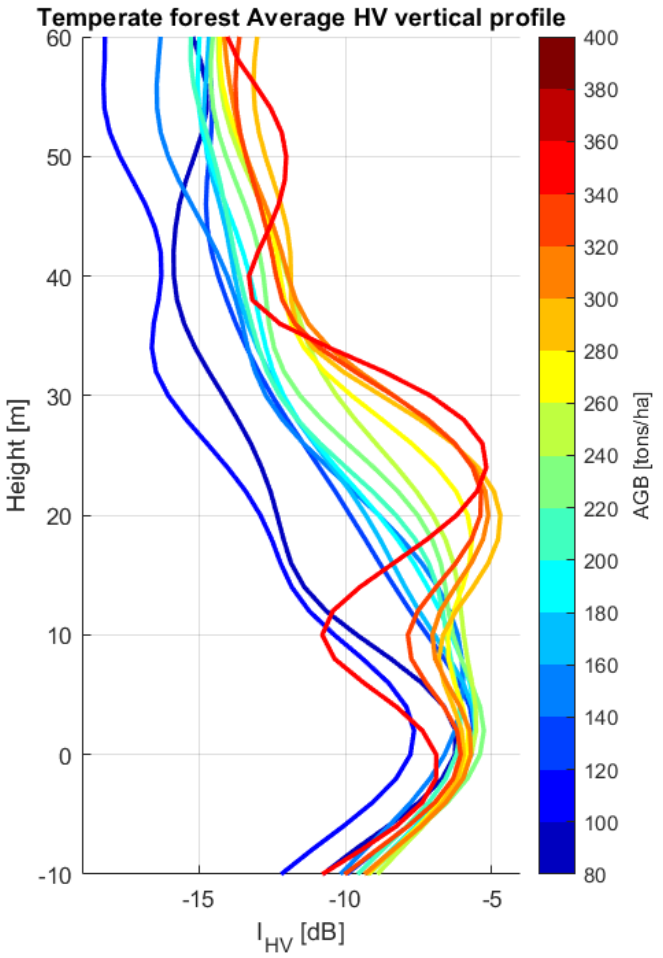
Method

- Extract data points, average over 0.5 ha cells.
- Sort data points according to AGB.
- Compute average vertical profile (i.e. height reflectivity function) for each AGB set.
- Color indicates AGB value for each profile.

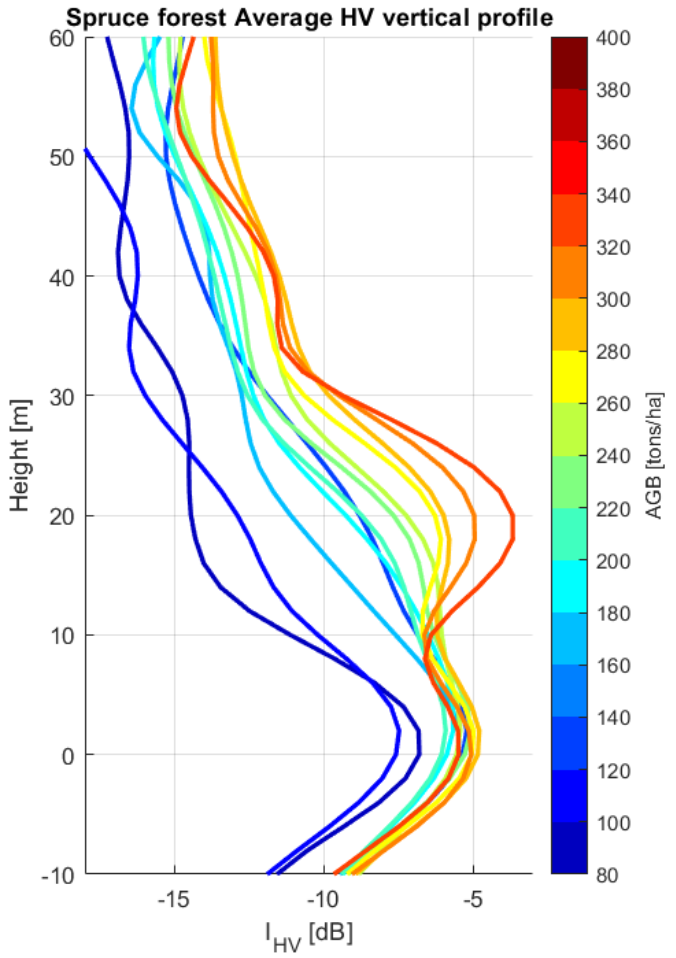


Vertical reflectivity profiles: P-band HV

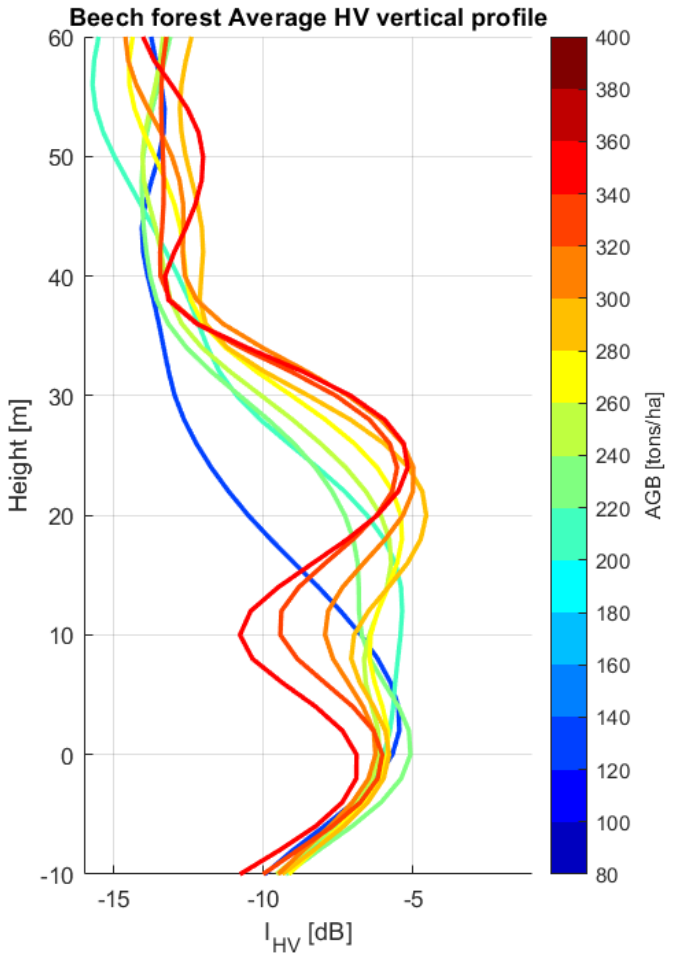
Temperate (combined)



Spruce

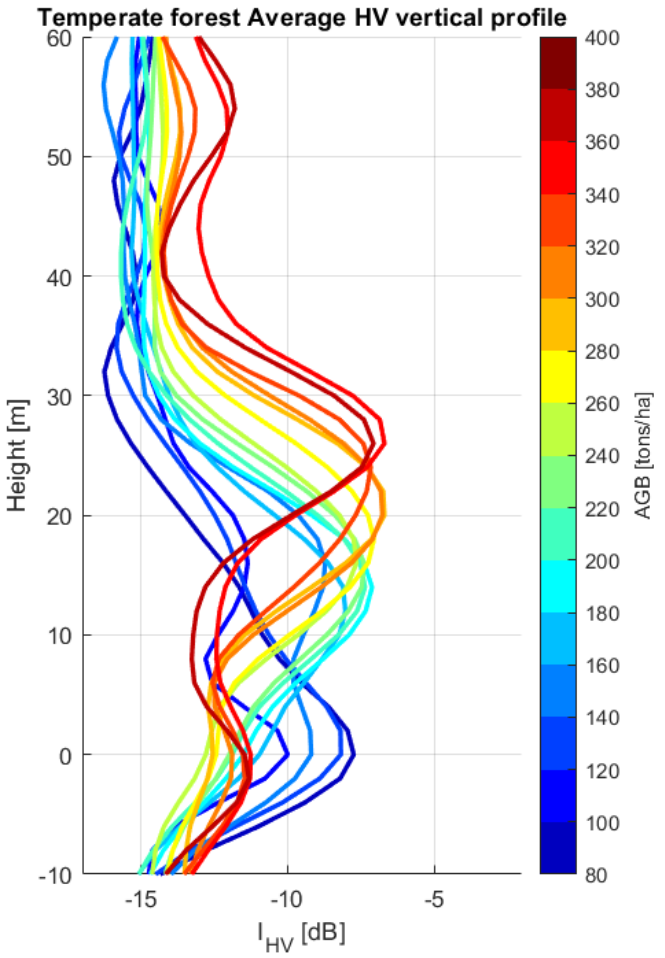


Beech

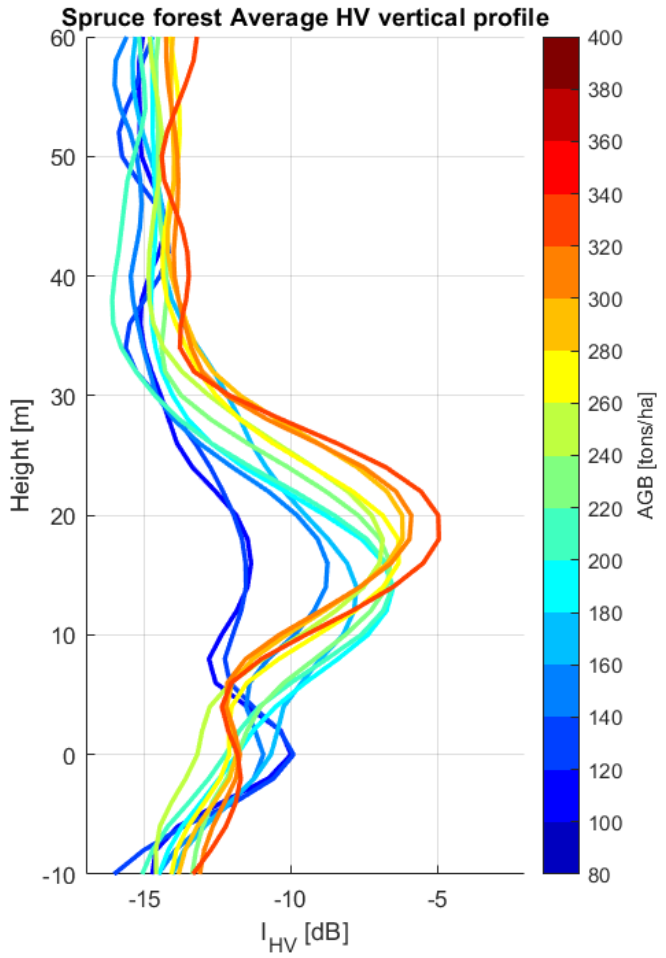


Vertical reflectivity profiles: L-band HV

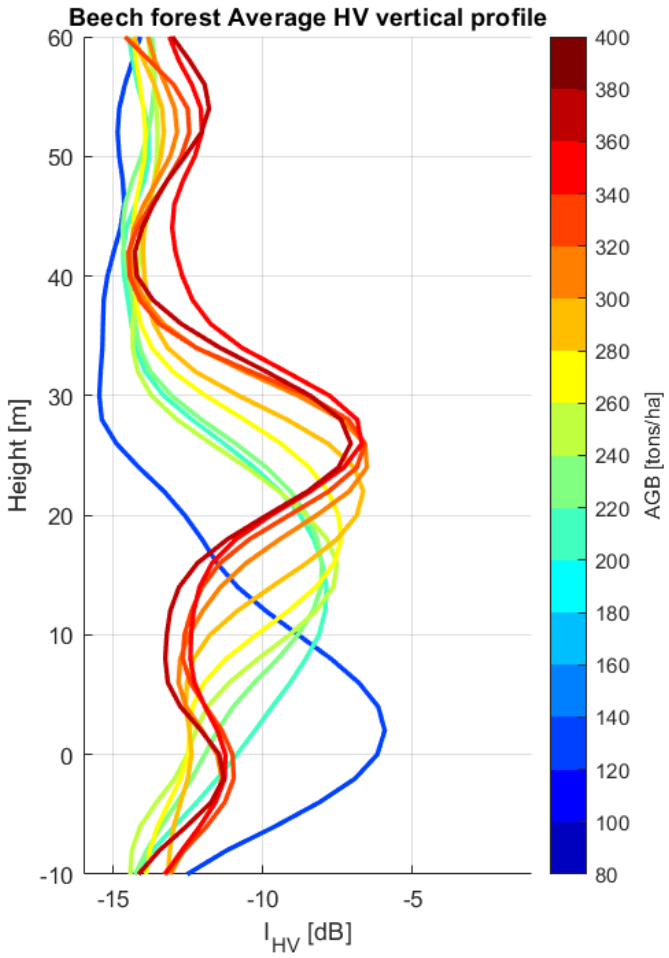
Temperate (combined)



Spruce

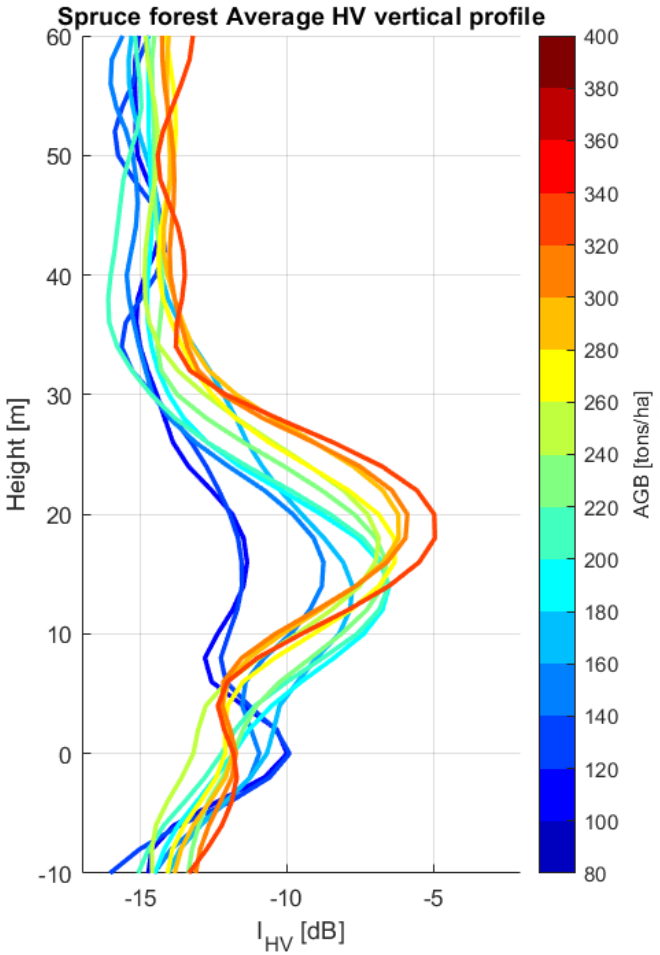


Beech

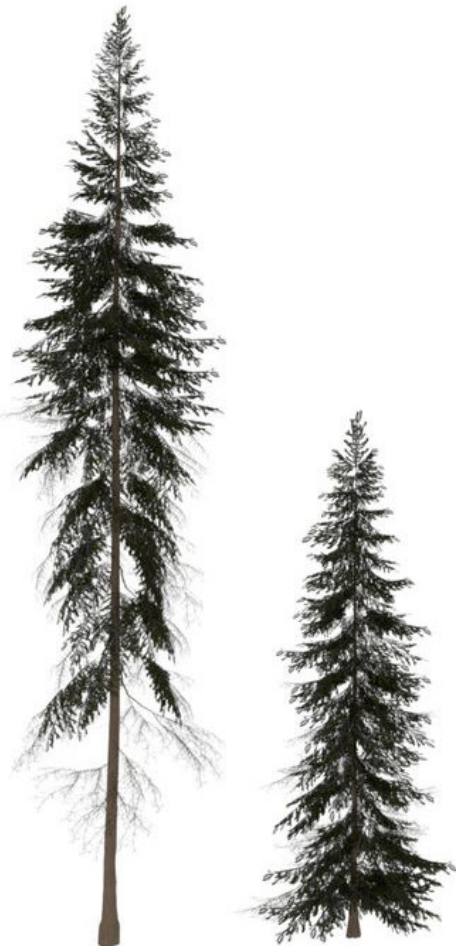


Spruce versus Beech

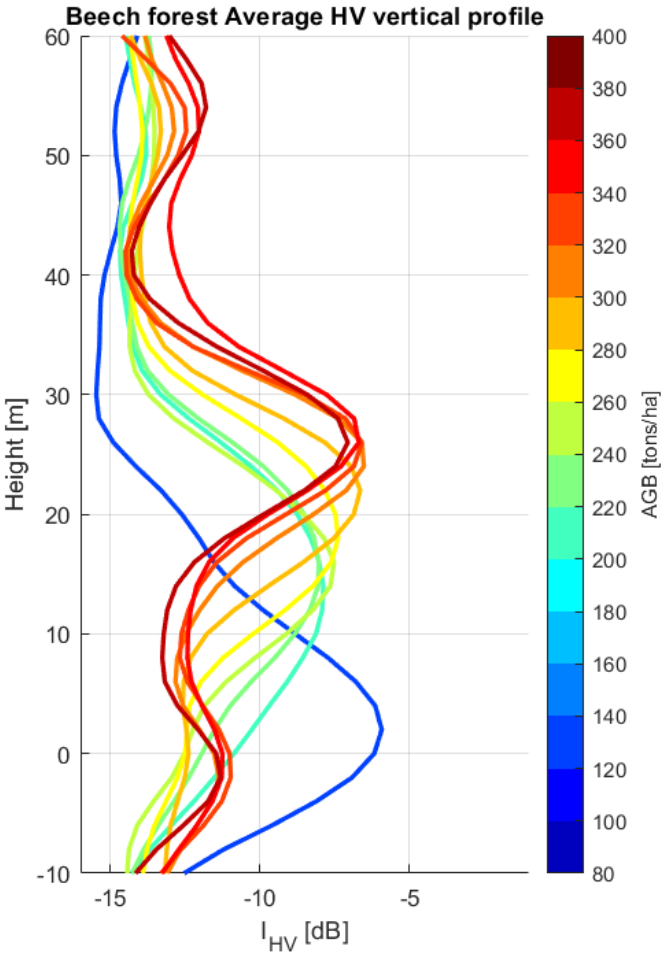
Spruce (L)



Spruce tree

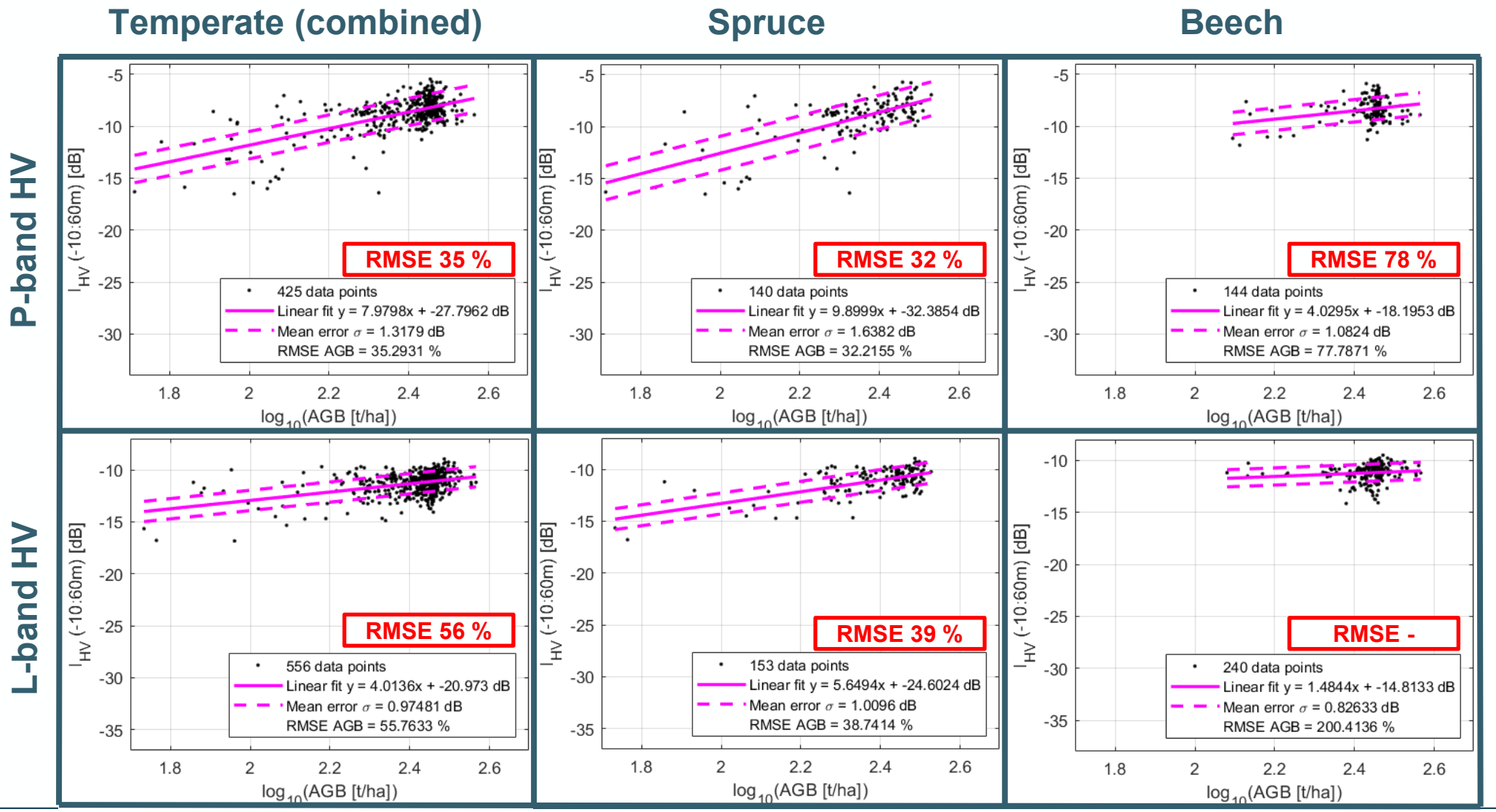


Beech (L)

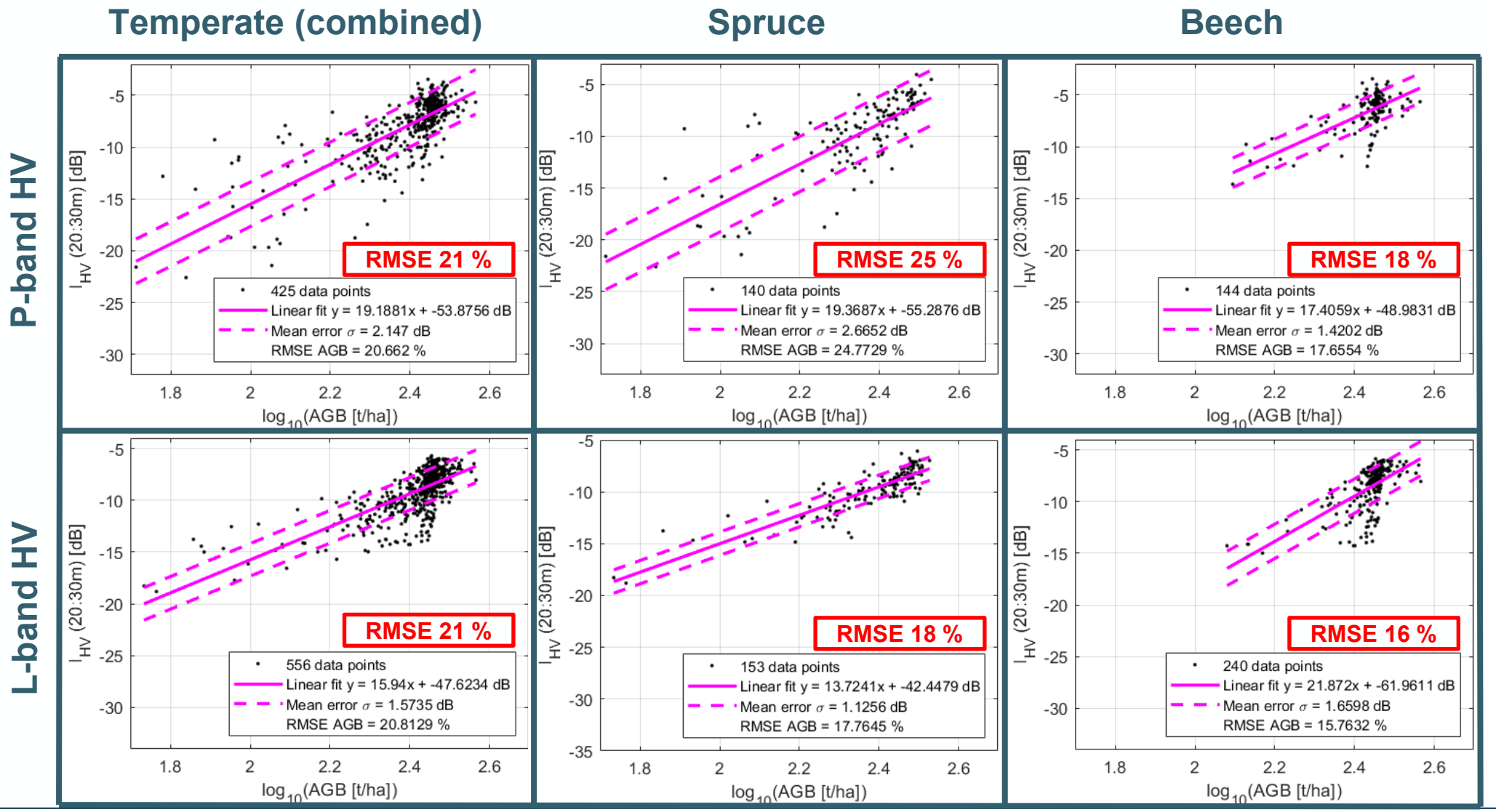


Beech tree

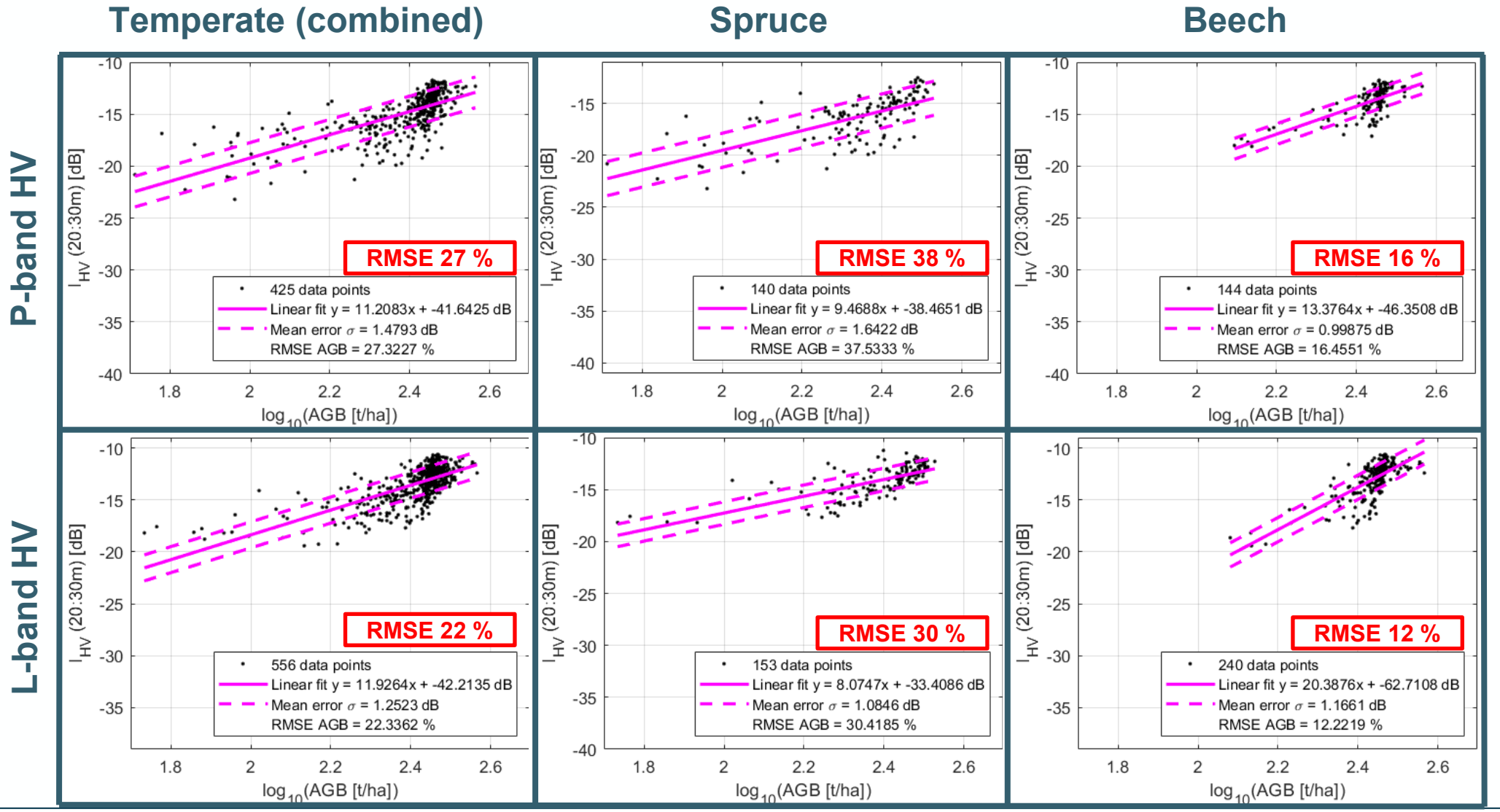
TomoSAR sensitivity to AGB (total intensity)



TomoSAR sensitivity to AGB (intensity, 20-30 m layer)



TomoSAR sensitivity to AGB (intensity fraction, 20-30 m)



Conclusions

Temperate forest

- TomoSAR intensity is sensitive to AGB.
- 21% RMSE for AGB estimates (both P and L-band).

Spruce forest

- Vertical reflectivity profile increases in intensity with AGB.
- Total intensity is sensitive to AGB.

Beech forest

- Vertical reflectivity profiles increases in height with AGB.
- Total intensity is not sensitive to AGB.

20-30 m layer intensity

- Good sensitivity to AGB for both spruce and beech.
- Estimation error on the order of lidar (ALS) AGB uncertainty.

20-30 m intensity fraction (layer/total)

- Improved sensitivity for beech forest AGB.
- Worse for spruce forest, since it discards information in total intensity.
- Estimation error on the order of lidar (ALS) AGB uncertainty.