

# Effects of Tree Species and Season on Boreal Forest Biomass Estimates from TanDEM-X

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# OUTLINE

- Study goal
- Test site and reference data
- Temporal stability
- Season and Species
- Conclusions

# STUDY GOAL

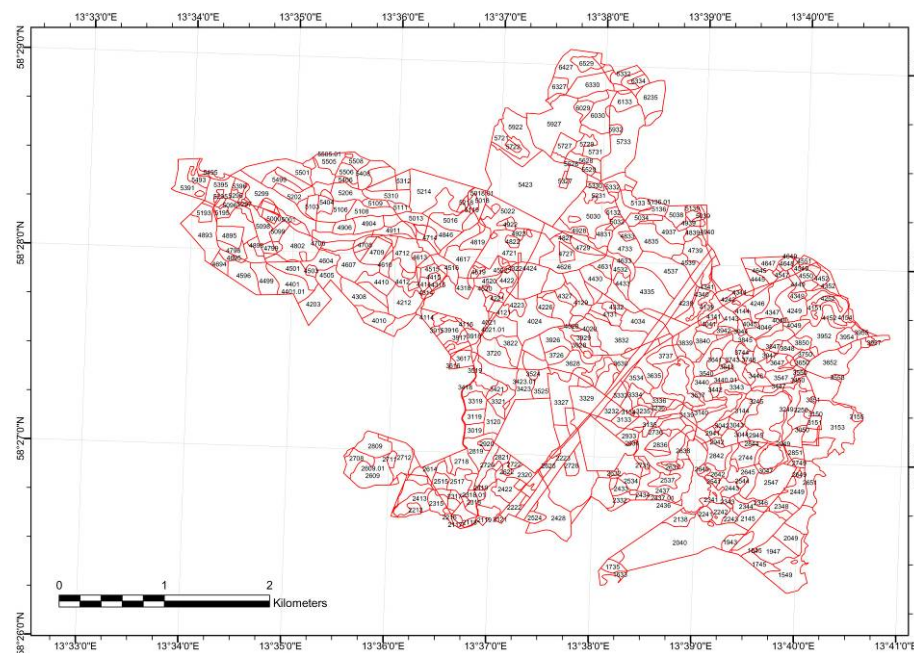
- **General:**
  - 3D forest parameter retrieval from interferometric TanDEM-X data (XTI\_VEGE0376)
- **This presentation:**
  - Biomass and height estimation
  - Error evaluation using in situ data

## Forest Test Site: Remningstorp Estate

**1200 hectares of production forest  
divided into > 500 stands**



Test site location



Stand-level biomass: 0 - 300 tons/ha  
Ground topography: 110 - 150 m asl

# Remningstorp: Tree Species



Norway spruce

Scots pine

Birch

# Remningstorp: Stratification

Young



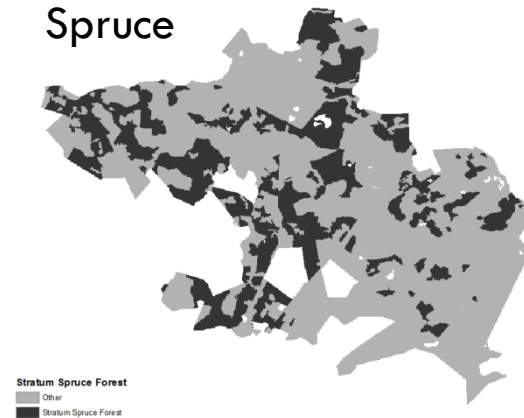
Pine



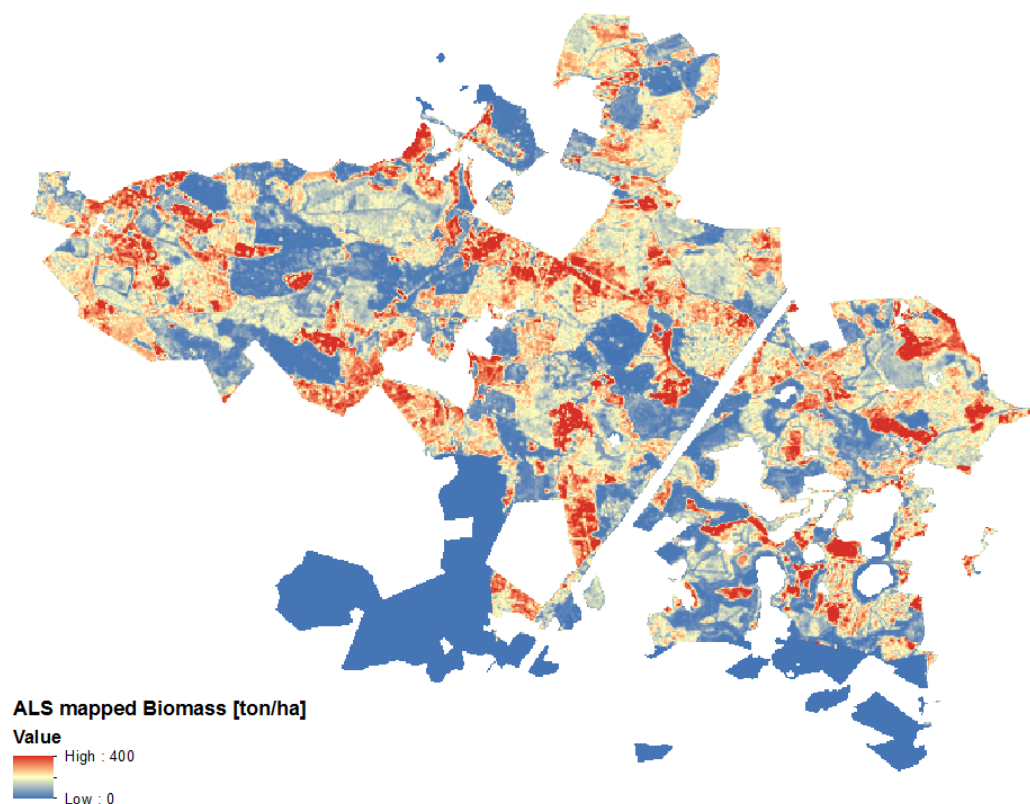
Mixed



Spruce

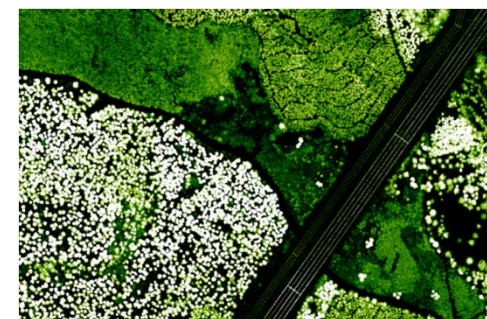


# Above-ground Biomass Map from Lidar



Grid: 10 m x 10 m grid  
Validation plots: 13% (RMSE)

Lidar data 0.5 m x 0.5 m grid

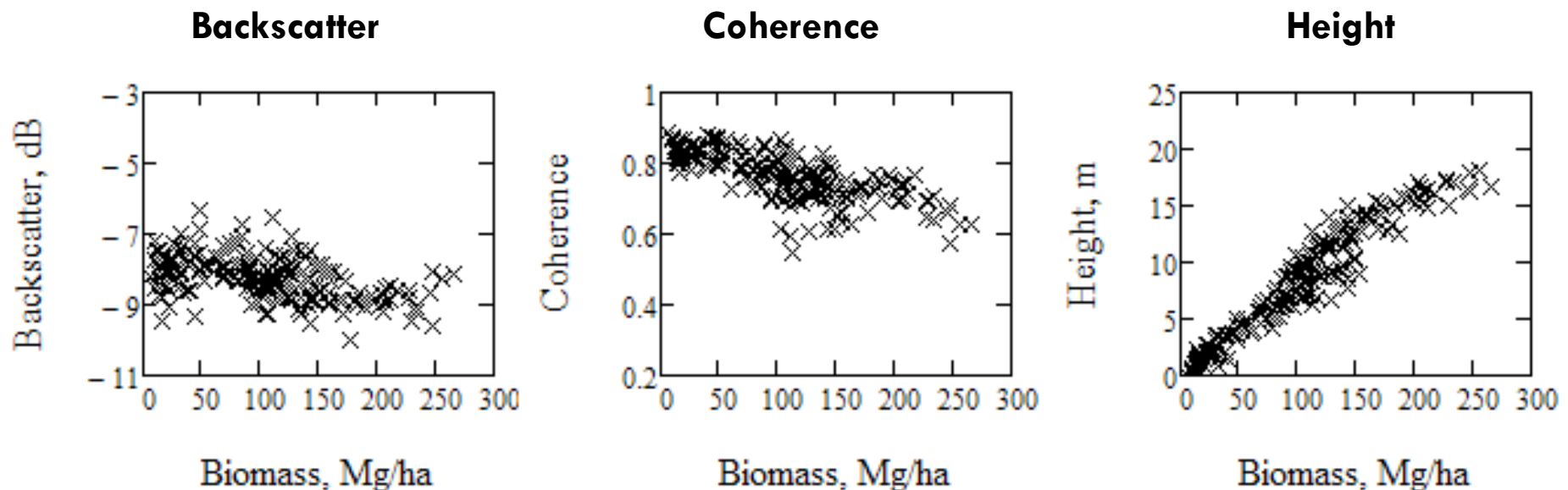


Parameters of retrieval model

	Estimate	Std. Error	t value	Pr (> t )
(Intercept)	1.9185	0.2001	9.59	0.00
<i>perc95</i>	0.0008	0.0001	11.02	0.00
<i>vegratio3</i>	0.0238	0.0022	10.79	0.00
<i>diffperc95_60</i>	-0.001	0.0001	-6.82	0.00
<i>IYoung</i>	-0.4923	0.2388	-2.06	0.0405
<i>IPine</i>	0.7439	0.3545	2.1	0.0371
<i>vegratio3</i> × <i>IYoung</i>	0.0067	0.0033	2.06	0.0410
<i>perc95</i> × <i>IPine</i>	-0.0003	0.0002	-2.02	0.0449

# TDM Sensitivity to Biomass

Date: 2012-02-01 (HOA = 80 m)

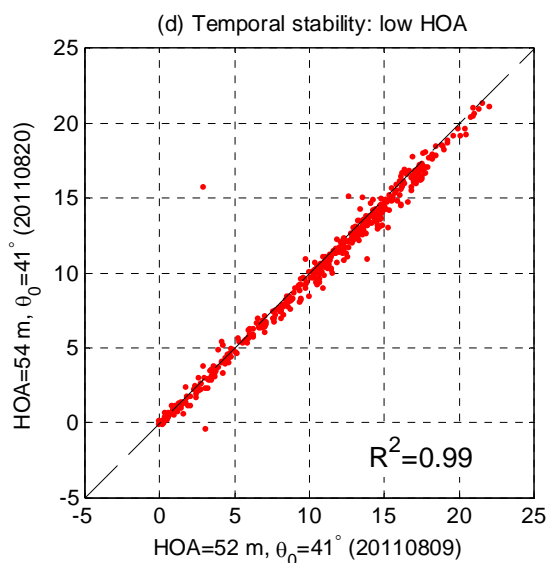


- Each data point corresponds to a forest stand (> 1 ha)
- In general, TDM height gives best sensitivity to biomass but non-linear height-to-biomass dependency

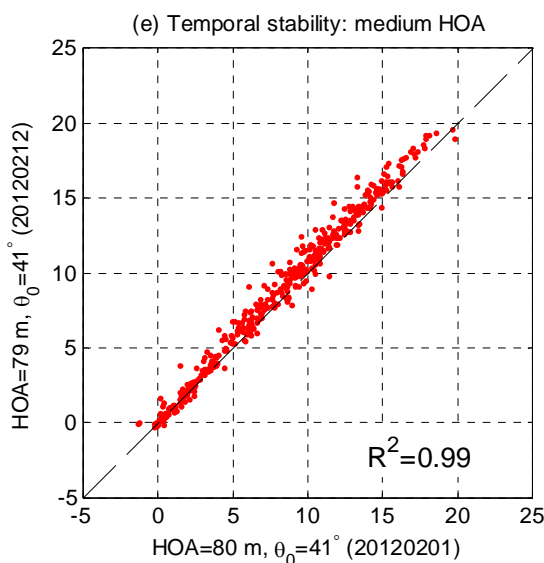


# TDM Height Temporal Stability

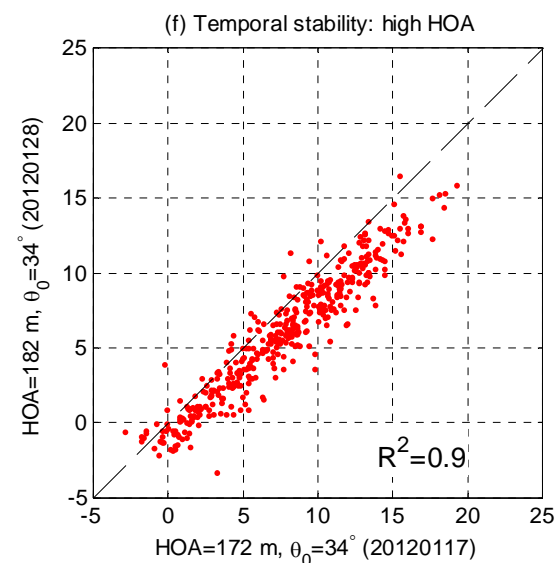
## 11-day separation (same season and HOA)



HOA  $\approx$  50 m



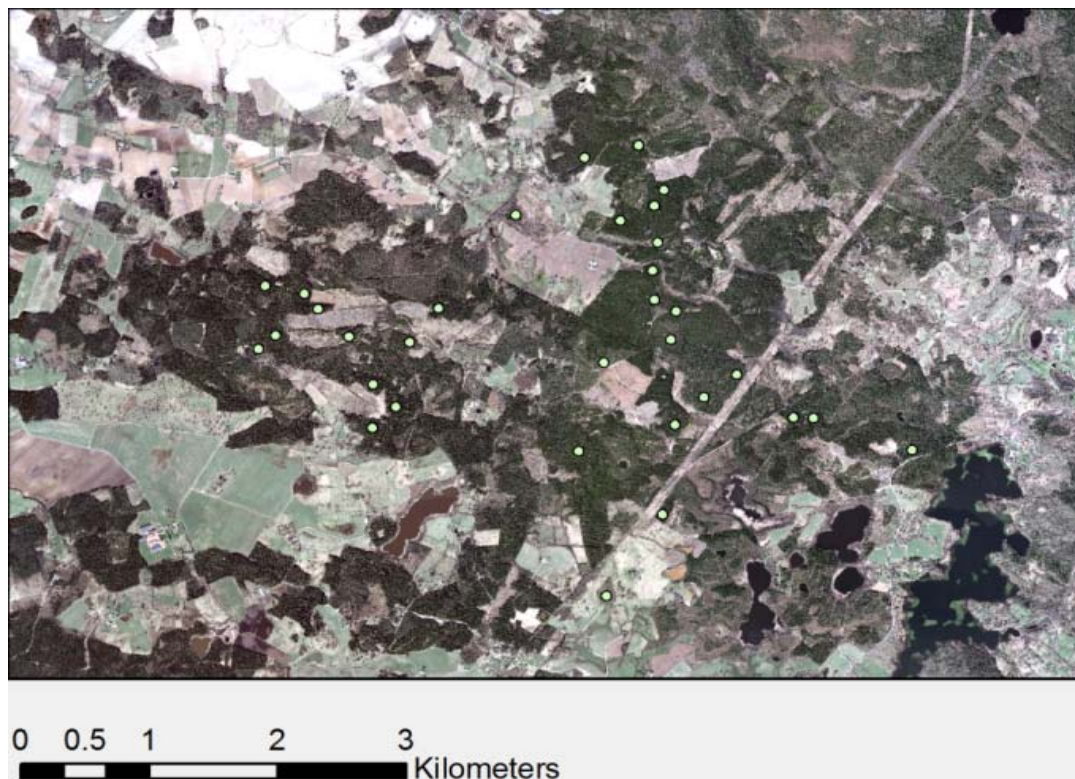
HOA  $\approx$  80 m



HOA  $\approx$  180 m

Consistent height retrievals but bias for high HOA case —?

# Individual Tree Plots



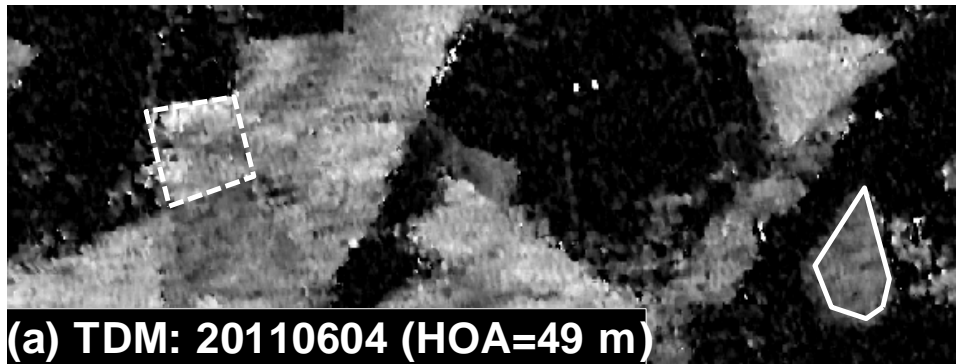
- 32 circular plot with 40-m radius
- Individual tree measurements (dbh > 5 cm)
- Biomass error < 5%

## Evaluation of TDM Linear Model Estimation

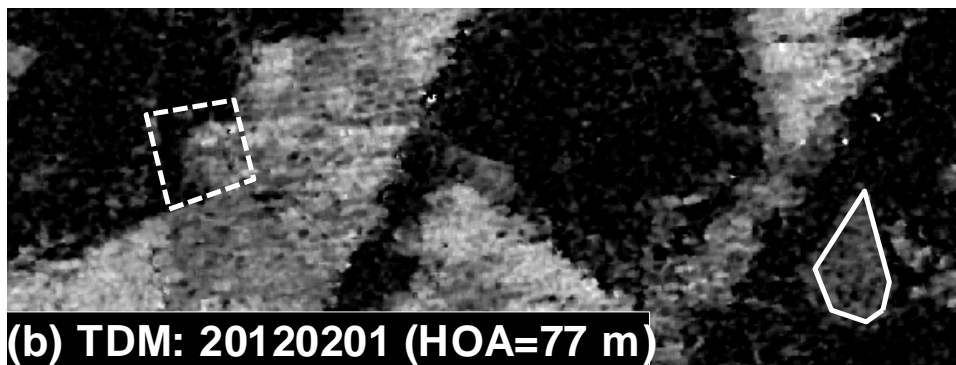
Model	RMSE	RMSE%	$R^2_{adj}$	q	Plots
Biomass Winter	28.8	18.6	0.733	1.05	32
Biomass Summer	35.7	23.1	0.563	1.07	32
HGV 20120201	1.70	7.19	0.843	1.07	32
HGV 20110604	1.22	5.14	0.919	1.07	32

- HGV = Basal-area-weighted height
- RMSE is based on cross-validation (leave-one-out) using the 32 plots with 40-m radius

# Seasonal Change



TDM Summer image  
19 deg

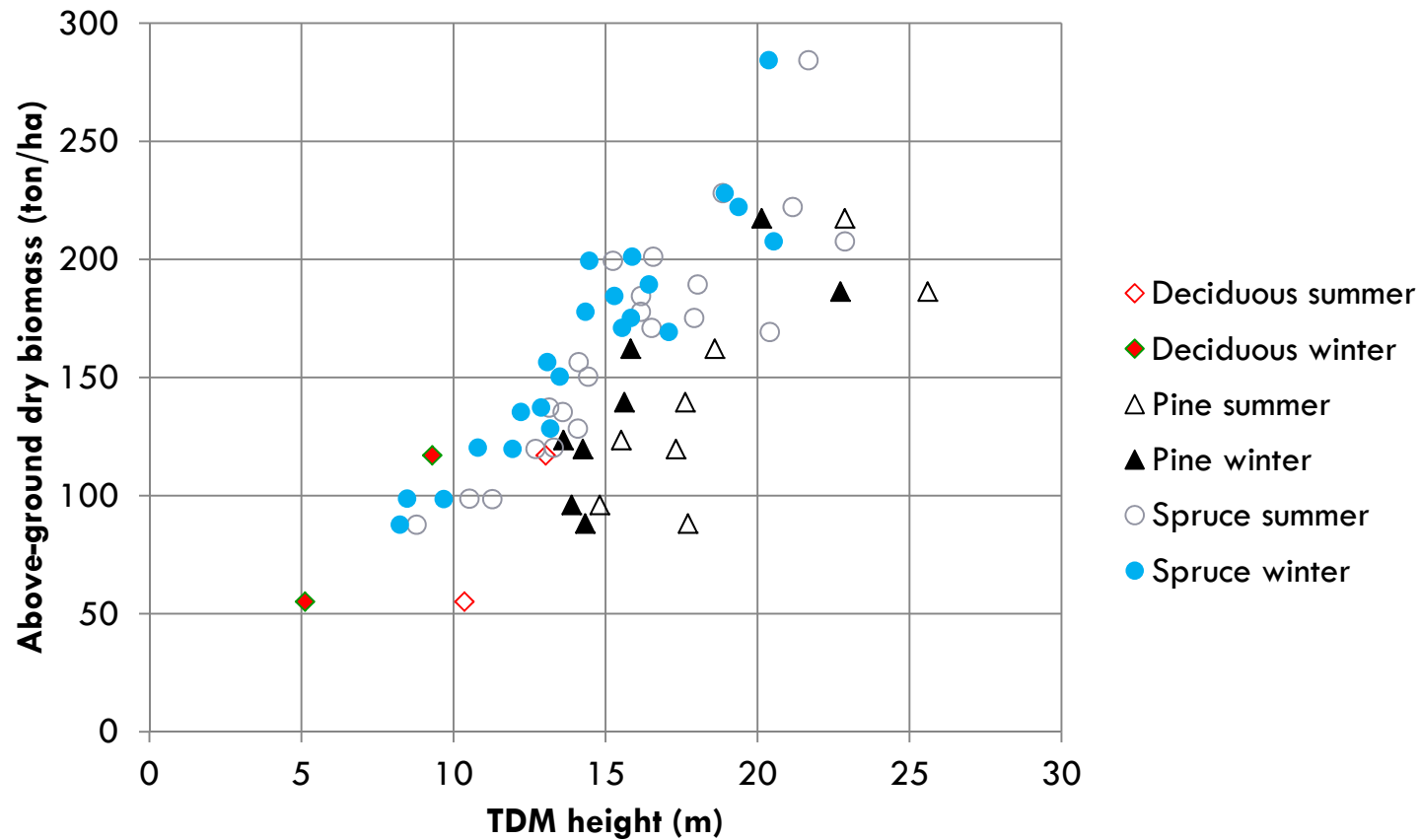


TDM Winter image  
-8 deg

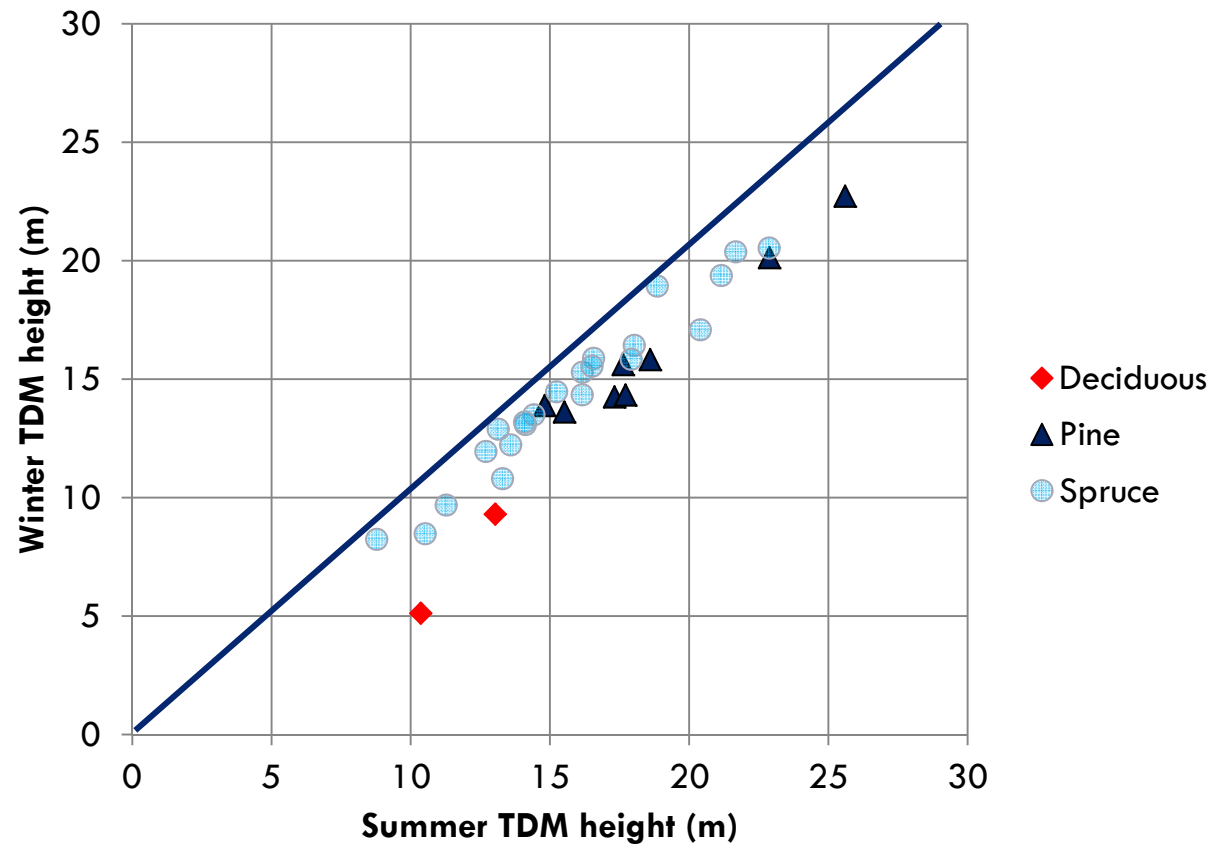


- Birch stand (marked) gives much lower height during winter
- Effect of leaf on/off? Moisture?

# Season and Species Effect



# Season and Species Effect



Effect is largest for deciduous (birch) but only two plots available

# CONCLUSIONS

- Lowest RMSE from cross-validation
  - Biomass estimate: "winter" 19%
  - Height estimate: "summer" 5%
- TDM height is generally higher for summer image, i.e. closer to dominant height
- Better biomass estimate in winter image may be explained by increased penetration