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TanDEM-X radar challenges airborne laser scanning

when estimating tree height at stand-level in boreal forest

Ortho-photo

SUMMARY

TanDEM-X

Interferometric SAR data from the TanDEM-X mission were used to Estimate above-ground biomass (AGB) and Lorey's height (H₁) at two Swedish $\mathbf{\dot{\Sigma}}$ test sites with boreal forest. It was found, that both AGB and H_I could be estimated with about the same accuracy at standlevel from both TanDEM-X and airborne e laser scanning (ALS) data.

For example, the AGB was estimated with 14.6% RMSE from TanDEM-X and a 13.7% from ALS data. Moreover, the estimation of H_I was slightly better with TanDEM-X than with ALS data (4.1% vs. 4.4% RMSE).

Test site	Technique	Date	R^2_{adj}	RMSE (m)	RMSE (%)	Stands
Krycklan	InSAR	2011-06-17	0.90	1.1	7.6	29
Remningstorp	InSAR	2011-06-04	0.95	1.0	4.1	32
Krycklan	ALS	2010-10-13	0.92	1.0	6.5	29
Remningstorp	ALS	2010-08-29	0.94	1.05	4.4	32



Airborne laser p95

Kilometers Comparison between different data sources.



Results of height estimations vs. Lorey's height at stand-level.



Plot 167 from the Remningstorp test site. (a) projected in 2D. (b) 3D surface plot. (c) 3D point cloud. (d) from field.

Predicted Biomass [tons ha⁻¹] 30 250 Height [m] 20 150 ed Predict 50 R²_{adi}=0.95, RMSE=4.1% R²_{adi}=0.81, RMSE=14.6% 50 20 25 30 200 15 300 100 Field Estimated Biomass [tons ha⁻¹ Field Estimated Height [m] 100 30 100] 80 Predicted p99 [m] VR [0. 60 20 Predicted 20 40 10 S R_{adi}=0.71, RMSE=6.2% 2, di=0.98, RMSE=2.7% 0 100 15 20 25 80 30 35 ALS p99 [m] ALS VR [0..100]

METHOD

TanDEM-X is a German satellite mission with two formation-flying satellites (~250 m to 500 m separation). The bi-static radar interferometer operates at a wavelength of 3 cm and provides precise height measurements with a spatial resolution of 1-6 m.

A nation-wide ground model based on ALS data from Lantmäteriet was subtracted from the InSAR measured heights and the computed height model was used as explanatory variable in linear regression models, to estimate biomass and Lorey's height.

Moreover, the correlation against the ALS metrics height percentile 99 and vegetation ratio (VR, vegetation returns vs. ground returns) was evaluated.



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