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Estimating above-ground biomass in young forests with airborne laser scanning

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Abstract

Total above-ground biomass of spruce, pine and birch was estimated in three different field datasets collected in young forests in south-east Norway. The mean heights ranged from 1.77 to 9.66 m. These field data were regressed against metrics derived from canopy height distributions generated from airborne laser scanner (ALS) data with a point density of 0.9–1.2 m^{-2}. The field data consisted of 79 plots with size 200–232.9 m^2 and 20 stands with an average size of 3742 m^2. Total above-ground biomass ranged from 2.27 to 90.42 Mg ha^{-1}. The influences of (1) regression model form, (2) canopy threshold value and (3) tree species on the relationships between biomass and ALS-derived metrics were assessed. The analysed model forms were multiple linear models, models with logarithmic transformation of the response and explanatory variables, and models with square root transformation of the response. The different canopy

thresholds considered were fixed values of 0.5, 1.3 and 2.0 m defining the limit between laser canopy echoes and below-canopy echoes. The proportion of explained variability of the estimated models ranged from 60% to 83%. Tree species had a significant influence on the models. For given values of the ALS-derived metrics related to canopy height and canopy density, spruce tended to have higher above-ground biomass values than pine and deciduous species. There were no clear effects of model form and canopy threshold on the accuracy of predictions produced by cross validation of the various models, but there is a risk of heteroskedasticity with linear models. Cross validation revealed an accuracy of the root mean square error (RMSE) ranging from 3.85 to 13.9 Mg ha^{-1}, corresponding to 22.6% to 48.1% of mean field-measured biomass. It was concluded that airborne laser scanning has a potential for predicting biomass in young forest stands (> 0.5 ha) with an accuracy of 20–30% of mean ground value.

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