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Airborne laser scanning for forest health status assessment and radiative transfer modelling

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Structural parameters of forest stands/ecosystems are an important complementary source of information to spectral signatures obtained from airborne imaging spectroscopy when quantitative assessment of forest stands are in the focus, such as estimation of forest biomass, biochemical properties (e.g. chlorophyll /water content), etc. The parameterization of radiative transfer (RT) models used in latter case requires three-dimensional spatial distribution of green foliage and woody biomass. Airborne LiDAR data acquired over forest sites bears these kinds of 3D information.
The main objective of the study was to compare the results from several approaches to interpolation of digital elevation model (DEM) and digital surface model (DSM). We worked with airborne LiDAR data with different density (TopEye Mk II 1,064nm instrument, 1-5 points/m2) acquired over the Norway spruce forests situated in the Beskydy Mountains, the Czech Republic.
Three different interpolation algorithms with increasing complexity were tested: i/Nearest neighbour approach implemented in the BCAL software package (Idaho Univ.); ii/Averaging and linear interpolation techniques used in the OPALS software (Vienna Univ. of Technology); iii/Active contour technique implemented in the TreeVis software (Univ. of Freiburg).
We defined two spatial resolutions for the resulting coupled raster DEMs and DSMs outputs: 0.4 m and 1 m, calculated by each algorithm. The grids correspond to the same spatial resolutions of hyperspectral imagery data for which the DEMs were used in a/geometrical correction and b/building a complex tree models for radiative transfer modelling.
We applied two types of analyses when comparing between results from the different interpolations/raster resolution: 1/calculated DEM or DSM between themselves; 2/comparison with field data: DEM with measurements from referential GPS, DSM – field tree alometric measurements, where tree height was calculated as DSM-DEM.
The results of the analyses show that: 1/averaging techniques tend to underestimate the tree height and the generated surface does not follow the first LiDAR echoes both for 1 m and 0.4 m pixel size; 2/we did not find any significant difference between tree heights calculated by nearest neighbour algorithm and the active contour technique for 1 m pixel output but the difference increased with finer resolution (0.4 m); 3/the accuracy of the DEMs calculated by tested algorithms is similar.