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A 3D model of the light interception in heterogeneous forest canopies

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We present an innovative methodology that is able to describe the direct interaction of a forest canopy with incoming radiation using terrestrial LiDAR data and a radiative transfer model. The proposed 'Voxel-based Light Interception Model' (VLIM) is designed to estimate the Percentage of Above Canopy Light (PACL) at any given point in the forest scene. A voxel-based representation of trees is derived from terrestrial LiDAR data as structural input. By combining LiDAR derived canopy structure with modeled radiation the light interception of canopies at near leaf level scale can be analysed. Virtual forest stands of three species (i.e. Fagus sylvatica L., Platanus, Populus nigra L.) were generated by means of stochastic L-systems as tree descriptors. Hemispherical laser measurements were simulated inside these virtual forests using ray-tracing technology.

Comparison of PACL estimates using VLIM with fully rendered light distributions throughout the canopy based on the L systems yielded a mean absolute error of 5.78%. The accuracy of the modeled light interception for the forest stands depends on the quality of the obtained LiDAR data. This illustrated the VLIM's functionality in light interception modeling for forest stands with varying structure in terms of leaf density, leaf distribution and leaf angle distribution.