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Modeling of small footprint airborne laser scanning returns using ray-tracing and L-systems

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Physical modeling in remote sensing

Airborne Laser Scanning (ALS) has been established as a valuable tool for the estimation of biophysical canopy variables, such as tree height and vegetation density. However, up to now most approaches are built upon empirical stand based methods for linking ALS data with the relevant canopy properties estimated by field work. These empirical methods mostly comprise regression models, where effects of site conditions and sensor configurations are contained in the models. Thus, these models are only valid for a specific study, which renders intercomparison of different approaches difficult. Physically based approaches exist e.g. for the estimation of tree height and tree location, however systematic underestimation depending upon sampling and vegetation type remains an issue. Using a radiative transfer model that builds on the foundation of the Open-Source ray tracer *povray* we are simulating return signals for various ALS system settings (e.g. scan angle, beam divergence) and different canopy types, where the reflectivity and density of canopy elements will be varied. The tree crowns are represented by fractal models (L-systems), which explicitly resolve the position and orientation of single leafs. Of special interest is the distribution and alignment of canopy elements inside the tree crowns and how they affect the ALS return signal and subsequent ALS data products such as tree height and vegetation density estimations (e.g. LAI). A sensitivity study is carried out in order to determine the effect of properties such as beam divergence, canopy reflectance and scan angle on the derived biophysical vegetation products. These forward simulations are a first step in the direction of physically based derivation of biophysical ALS data products and could improve the accuracy of the derived parameters by establishing correction terms.