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Reconstruction of forest geometries from terrestrial laser scanning point clouds for canopy radiative transfer modelling

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The architecture of forest canopies is a key parameter for forest ecological issues helping to model the variability of wood biomass and foliage in space and time. In order to understand the nature of subpixel effects of optical space-borne sensors with coarse spatial resolution, hypothetical 3D canopy models are widely used for the simulation of radiative transfer in forests. Thereby, radiation is traced through the atmosphere and canopy geometries until it reaches the optical sensor. For a realistic simulation scene we decompose terrestrial laser scanning point cloud data of leaf-off larch forest plots in the Austrian Alps and reconstruct detailed model ready input data for radiative transfer simulations. The point clouds are pre-classified into primitive classes using Principle Component Analysis (PCA) using scale adapted radius neighbourhoods. Elongated point structures are extracted as tree trunks. The tree trunks are used as seeds for a Dijkstra-growing procedure, in order to obtain single tree segmentation in the interlinked canopies. For the optimized reconstruction of branching architectures as vector models, point cloud skeletonisation is used in combination with an iterative Dijkstra-growing and by applying distance constraints. This allows conducting a hierarchical reconstruction preferring the tree trunk and higher order branches and avoiding over-skeletonization effects. Based on the reconstructed branching architectures, larch needles are modelled based on the hierarchical level of branches and the geometrical openness of the canopy. For radiative transfer simulations, branch architectures are used as mesh geometries representing branches as cylindrical pipes. Needles are either used as meshes or as voxel-turbids. The presented workflow allows an automatic classification and single tree segmentation in interlinked canopies. The iterative Dijkstra-growing using distance constraints generated realistic reconstruction results. As the mesh representation of branches proved to be sufficient for the simulation approach, the modelling of huge amounts of needles is much more efficient in voxel-turbid representation.