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Volumetric forest structure reconstruction from full-waveform airborne laser scanner data

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The scientific investigation of forest ecosystems requires precise information on the three-dimensional structure of the ecologic system. Full-waveform airborne laser scanner data are an ideal basis for the complete volumetric reconstruction of the forest structure in a voxel space. During the laser pulse propagation through the vegetation, each individual laser pulse echo is significantly affected by attenuation effects caused by partial reflections. As a result, the structure in the lower parts of the vegetation is underrepresented in the digitized pulse echo waveform.
We present novel methods, which enable the generation of volumetric forest stand representations of high geometric and radiometric quality. This requires a numerically stable reconstruction of the effective differential backscattering cross section utilizing appropriate deconvolution and regularization techniques. The essential element of the research is the description of the signal attenuation using applicable mathematical models as a basis for pulse history effect correction. For this purpose, correction methods compensating the signal attenuation based on these models were developed. The correction term is directly derived from the differential backscatter cross section. The basic idea is a gradual increase of the signal amplitudes depending on the individual history of each laser pulse.
The results contribute to an improved access to the information on vegetation structure contained in full-waveform laser scanner data. Furthermore, it allows to overcome limitations of existing approaches, which are mainly based on the extraction of discrete maxima.