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Remote Sensing Of Forest Structure Across Multiple Scales From Leaves To Canopies And Stands

The objective of the proposed research is to document the feasibility of deriving forest structural parameters - forest type composition, forest age, forest cover, tree density and crown shape - from multi-angle and hyperspectral data. The methodology is based on the novel idea of retrieving canopy spectral invariants - the recollision and escape probabilities - from optical remote sensing data. The recollision probability is a measure of the multi-level hierarchical structure in a vegetated pixel and can be obtained from hyperspectral data. The escape probability is sensitive to canopy geometrical properties such as aspect ratio (crown diameter to crown height) and can be derived from multi-angle spectral data. The escape and recollision probabilities have the potential to separate forest types based on crown shape and the number of hierarchical levels within the landscape. We propose to develop this methodology and test it with experimental data using existing ground and aircraft-based remote sensing data from various sites in the USA, Finland and Estonia. To achieve these objectives, we propose (a) to generate maps of the recollision and escape probabilities over selected sites in USA, Finland and Estonia; (b) to relate the maps to stand age, forest type, forest cover and tree density; and (c) to evaluate uncertainties and reliability of the spectral invariant approach to capture forest type composition change in the unique conditions of Northern Eurasia. The comparative uncertainty analysis of the results, and the statistical merits of remote sensing approach versus the forest inventory data will constitute the success metrics of the proposed proof-of-concept study.