Reflectance of forests: from shoots to global models

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The science of passive optical remote sensing of vegetation canopies aims to convert the multi- and hyperspectral images taken by a satellite- or airborne sensor into useful information on the amount and types of plants covering the underlying surface, their structural properties and, ultimately, biochemical composition and functioning. New instruments and algorithms are being developed constantly. As the reflectance signal of forests exhibit a strong and spatially varying effect of threedimensional canopy structure, modern methods of remotely estimating leaf area index, canopy cover and absorbed photosynthetically active radiation have come to rely on complex algorithms based on the physical processes of radiative transfer. Such physically-based canopy reflectance models are especially promising for the boreal region. The traditional approaches based on vegetation indices fail in vegetation canopies which have well-expressed multilevel structure. Some recent models implicitly include wavelength independent structural parameters, so-called 'spectral invariants'. They represent the eigenvalues of the underlying radiative transfer equation and relate canopy optical properties to leaf optical properties. Thus, they provide a powerful and innovative theoretical basis for developing canopy reflectance models, enabling to separate the effects of canopy structure and canopy biochemical composition. Knowing the empirical relationships between the invariants and different characteristics of canopy structure would allow more realistic, yet simple representations of the canopies. We present the results of the recent SPRINTER project (funded by the MASI program of TEKES and Academy of Finland) aimed at developing improved methodology for quantitative remote sensing of vegetation based on the concept of spectrally invariant parameters, and validating and applying the developed methodology on test sites in Finland and through international vegetation remote sensing networks.