Describing hierarchical canopy structure and within-canopy multiple scattering with spectral invariants for remote sensing purposes

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Keywords: canopy structure, radiative transfer, remote sensing, recollision probability, specral invariant

In the study of physical modelling of reflective properties of vegetation canopies, there has recently been interest in the concept of spectral invariants (Huang et al. 2007). The spectral invariant approach aims at separating radiative transfer inside canopy to terms that depend only on canopy structure, and to terms that depend only on wavelength. The wavelength dependent part being leaf optical properties (leaf reflectance and transmittance in different wavelengths). The spectral invariants are wavelength independent and describe canopy geometrical structure. Current studies show a good prospect of there being only a small set of parameters that well describe the effect of canopy structure on the multiple scattering of radiation inside the canopy. The most essential canopy spectral invariant is the recollision probability. The idea is a simple one: the recollision probability gives the chance that a photon, after being scattered from a phytoelement, again hits an element of the canopy. To be precise, the recollision probability should vary according to the orders of scattering, and according to the position inside the canopy. In practice, the simulation studies have shown that there is a robust single effective value. Thus, the recollision probability is a pure geometric concept and, together with leaf optical properties, it relates the canopy structure to the amount of absorbed multiply scattered radiation. The amount of absorbed direct (non-scattered) radiation is of course easily obtained from leaf optical properties and canopy direct transmission. To date, the recollision probability has been successfully used to describe shoot structure (Smolander and Stenberg 2005) and leaf internal structure (Lewis and Disney 2007) in canopies with homogeneous higher level structure, and crown structure when the within-crown structure is homogeneous (Huang et al. 2007, Mõttus et al. 2007). In the poster I will present results from applying the recollision probability for canopies with several levels of hierarchical structure (shoots, branches, tree crowns) and discuss the usefulness of the concept for relating models of canopy structure to models of canopy radiative transfer and reflectance.

References

Huang, D., Knyazikhin, Y., Dickinson, R.E., Rautiainen, M., Stenberg, P., Disney, M., Lewis, P., Cescatti, A., Tian, Y., Verhoef, W., Martonchik, J.V. and Myneni, R.B. 2007. Canopy spectral invariants for remote sensing and model applications. Remote Sensing of Environment 106(1): 106-122.

Lewis, P. and Disney, M. 2007. Spectral invariants and scattering across multiple scales from within-leaf to canopy. Remote Sensing of Environment 109(2): 196-206.

Mõttus M., Stenberg, P., and Rautiainen, M. 2007. Photon recollision probability in heterogeneous forest canopies: Compatibility with a hybrid GO model. Journal of Geophysical Research 112: D03104 doi:10.1029/2006JD007445.

Smolander S. and Stenberg P. 2005. Simple parameterizations of the radiation budget of uniform broadleaved and coniferous canopies. Remote Sensing of Environment 94(3): 355-363.