Geophysical Research Abstracts,
Vol. 11, EGU2009-13465, 2009
EGU General Assembly 2009

Development, validation and inversion of a dorsiventral leaf radiative transfer model

J. Stuckens (1), W.W. Verstraeten (1), S. Delalieux (2), and P. Coppin (1)
(1) M3-BIORES, Katholieke Universiteit Leuven, (2) Flemish Institute of Technology (VITO)

A Dorsiventral Leaf Model (DLM) was constructed to simulate radiative transfer within leaves. DLM was conceived as a four layer plate model with a stochastic binomial distribution of different groups of layers that are either adjoint or separate by air spaces. This model structure allowed dorsiventral properties of leaves to be parameterized by an asymmetric distribution of pigments, water and dry matter in the parenchyma and mesophyll. In addition, different light diffusion rates of adaxially and abaxially incident light were introduced to better model important differences in near infrared abaxial and adaxial reflectance. Both adaxial and abaxial optical properties could be accurately simulated for a variety of monocot and dicot leaf types with an overall error in reflectance of less than 1%. The model's analytic nature facilitates integration with canopy radiative transfer models. In additon to a good approximation of optical properties, an accurate estimation of biophysical parameters was targeted. Sensitivity analyses were therefore set up to gain better insignts into the model's performance which allows optimization of the model inversion process. Results of the sensivity analysis indicate that parameter estimation from model inversion may be improved by (i) combining reflectance and transmittance measurements to minimize the impact of leaf structure (ii) adjusting procedures to account for errors and variability in the dry matter specifc absorption spectrum and (iii) schemes that minimize the impact of sampling errors. In addition, the use of white reflectance (reflectance with a whiteplate as a backing) was found to exhibit favorable qualities making it a suitable candidate to replace regular reflectance and transmittance measurements.
Different parameter estimation schemes were compared for two independant datasets. Results underpin the propositions of the sensivity analysis. By excluding the near-infrared wavelength range from the inversion process, high prediction accuracies for dry matter could be obtained by most schemes. The use of white reflectance provided results superior to other optical measurements, making it a valuable and fast alternative technique. Measurement variability caused by glossy leaf reflections could be successfully compensated by introducing a correction factor into the inversion scheme. The major improvements in predicted accuracies could therefore not be related to improvements in model structure but to techniques that compensate for inherent errors in measurements and model specifc absorption spectra. DLM is expected to have important potential in the study of leaf radiative transfer mechanisms and in the integration with canopy radiative transfer models.