Seasonal modelling of leaf optical properties and retrieval of leaf chlorophyll content across the canopy using prospect

Tawanda W. Gara [a], Roshanak Darvishzadeh [a], Andrew K. Skidmore [a,b], Tiejun Wang [a]

a Faculty of Geo-Information Science and Earth Observation (ITC), University of Twente, P O Box 6, 7500 AA, Enschede, The Netherlands

[b] Department of Environmental Science, Macquarie University, NSW, 2106, Australia

Seasonal changes in leaf chlorophyll across the canopy vertical profile provides information on ecosystem structure and functioning. However, studies on the retrieval of leaf chlorophyll content (C_{ab}) using radiative transfer models such as PROSPECT across the canopy vertical profile throughout the growing season are lacking. In this regard, we sought to evaluate the performance of the PROSPECT in modelling leaf optical properties and retrieving C_{ab} across the canopy position throughout the growing season. We collected 588 leaf samples from the upper and lower canopies of deciduous stands over three seasons in Bavaria Forest National Park, Germany. PROSPECT input parameters were measured for all the samples, and their respective reflectance spectra were obtained using an ASD FieldSpec-3 Pro FR spectroradiometer coupled with an Integrating Sphere. To retrieve C_{ab}, we inverted the PROSPECT using a look-up-table (LUT) approach. Our results consistently revealed a strong agreement between the measured and PROSPECT simulated reflectance spectra for the lower canopy compared to the upper canopy especially in the NIR. This observation concurred with the pattern of C_{ab} retrieval accuracies across the canopy i.e. the C_{ab} retrieval accuracy for the lower canopy was consistently higher (NRMSE = 0.1-0.2) when compared to the upper canopy (NRMSE = 0.122 - 0.269) across all seasons. Results of this study demonstrate that although the PROSPECT model provides acceptable inversion of C_{ab}, subtle seasonal variations in leaf biochemistry and morphology across the canopy potentially affects the performance of the model.