Detecting vegetation characteristics using remote sensing data and radiation transfer modeling

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ABSTRACT

Vegetation characteristics (e.g., leaf area index and chlorophyll content) are essential indicators of vegetation growing condition and physiological status. Compared to labour-intensive field surveys and lab experiments, remote sensing is a more advantageous tool for detecting these characteristics. Two approaches have been widely applied to estimating vegetation characteristics using remote sensing data: the empirical-based method and radiation transfer modelling (RTM). Generally, the empirical approach is sensor- or band-specific, while RTM is more robust and transferable. However, the applicability of RTM needs to be evaluated based on study purpose, since the parameters of RTM may not be suitable for all vegetation types, and therefore cannot be applied to estimating vegetation properties. This study firstly tried to test the performance of a widely applied leaf-level RTM, the PROSPECT model. We collected approximately 800 grass leaf samples of different species at various statuses (e.g., green, senescing, and decayed), and measured the corresponding leaf spectra and chemical components (e.g., chlorophyll content, water content). PROSPECT was then evaluated for simulating leaf spectra using collected leaf data. Out tests show that the PROSPECT model performed well in simulating the spectra of green leaves (i.e., chlorophyll content higher than 10 µg/cm²), with the RMSE of the spectral simulation around 0.5. However, it was generally challenging to simulate the spectra of senescing and decayed leaves (i.e., chlorophyll content lower than 10 µg/cm²) with an RMSE generally higher than 1. Therefore, a modification of the original PROSPECT model was necessary to improve its performance. We then tried to modify this model and integrate it into a canopy-level model, and simulate canopy reflectance. Eventually, we attempted to invert the integrated model to estimate vegetation characteristics at the canopy and landscape levels, using remote sensing data. Results show that after modification, the PROSPECT model works well for simulating the spectra of senescing and decayed leaves, with an RMSE of generally less than 1. After integrating the modified PROSPECT model into the canopy-level model, it is capable of simulating the spectra of heterogeneous canopies (i.e., mix of green, senescing, and decayed leaves), and therefore can be inverted to estimate vegetation properties at the canopy and landscape levels.