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Sensitivity analysis of Radiative Transfer model towards leaf biophysical and biochemical parameter retrieval

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Coupling of leaf physiological models with leaf and canopy RT (Radiative Transfer) models allow evaluation and quantification of most influential variables using fluorescence signal emitted by the leaf and canopy. Using RTM output, one of the most successful method i.e. Sobol global sensitivity analysis was used to identify the most influential input variables through matrices such as first-order (S_i) and total-Order effect (S_{Ti}). The present study was conducted using the field-based and hyperspectral datasets in the agricultural site in Northern India. Ground bio-physical (Leaf water content, Leaf area Index) and bio-chemical (Chlorophyll) parameters were collected. RTM spectral outputs were generated for hyperspectral data within the spectral range of 350-2500 nm. To calculate the first order and total order sensitivity result of PROSPECT-4 (leaf) and PROSPECT+SAIL (canopy) RTMs were evaluated. Sobol results for PROSPECT-4 model reveal that the role of biochemical parameter chlorophyll content in the visible region and the influence of the other biophysical parameters such as Leaf structure and dry matter across the whole spectral range. Only Leaf water content reflectance was found around 1200 nm onwards. After coupling the leaf PROSPECT-4 model with SAIL (Scattering by Arbitrary Inclined Leaves) model, reference PROSAIL S_{Ti} results showed that the LAI variable shows 50% of the total variability, especially in the SWIR region. The present study is not only useful to know wavelength-dependent influential and non-influential RTM input variables but also for driving input variables of fluxes such as photosynthesis of the canopy and for the estimation of FPAR (Fraction of photosynthetically active radiation) values.