Shanqin Wang, J Geol Geophys 2017, 6:5 (Suppl)
DOI: 10.4172/2381-8719-C1-0012

Exploring radiative transfer model inversion of canopy properties of oilseed rape by numerical optimization based on simulation and field experiments

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Inversion of radiative transfer model may provide a generally applicable tool for assessment of crop status in precise agriculture. The potential of the PROSAIL inverted by means of hyper-parameter searching algorithms to find optimal values as estimation of target crop variables was investigated based on a simulation and a field experiments of oilseed rape (Brassica napus L.). First, one thousand of canopy reflectance spectra were simulated with PROSAIL using crop biophysical variables generated in reasonable range. By the inversion technique based on the Tree-structure Parzen Estimators (TPE), the simulated leaf area index (LAI), leaf dry mass (LMA) and leaf chlorophyll a+b (Cab) were used as measured variables to predict carotenoid content (Car), brown material (Cb) and equivalent water thickness (Cw) with high accuracy. Even using LAI as only measured variable with optimization of acceptable iterations, other properties could be estimated with reasonable accuracy. Then for practical application, the field experiment was conducted with one oilseed rape cultivar under eight nitrogen (N) rates (45-300 kg N ha-1) using a randomized complete block design with three replications for each treatment. Canopy reflectance, LAI, Cab and LMA were measured on four critical days after transplanting (DAT). The Cab was predicated with high accuracy (R2=0.72, nRMSE=0.12) for each sample by using LAI and LMA as known crop variables to invert PROSAIL based on TPE of maximum 3000 iterations. The higher estimation of Cab (R2=0.82, nRMSE=0.10) can be obtained with maximum 10000 iterations of optimization. Unfortunately, neither LMA nor Cab was successfully estimated by only using LAI as known variable, indicating the limits of the PROSAIL to deal with ill-posed problem if without enough parameter. Our results confirm the potential of RTM inversion by means of TPE for estimating vegetation variables at the canopy scale using hyperspectral measurements for crop precision management.

Biography

Shanqin Wang has completed his PhD from Wuhan University. Currently, he is the Lecturer of Huazhong Agricutural University. He has published more than 15 papers in reputed journals. His research focuses on the quantitative remote sensing of environment and agriculture, the geostatistics and the digital soil mapping.

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