Geophysical Research Abstracts
Vol. 19, EGU2017-793-1, 2017
EGU General Assembly 2017

Establishment of the Relationship between the Photochemical Reflectance Index and Canopy Light Use Efficiency Using Multi-angle Hyperspectral Observations

Qian Zhang (1), Jing Chen (1,2), Yongguang Zhang (1), Feng Qiu (1), Weiliang Fan (3), and Weimin Ju (1)

(1) International Institute for Earth System Science, Nanjing University, China (zhangqianzh@gmail.com), (2) Department of Geography and Program in Planning, University of Toronto, Toronto, Canada (jing.chen@utoronto.ca), (3) School of Environmental and Resources Science, Zhejiang A & F University, Lin'an, China (fanweiliang@163.com)

The gross primary production (GPP) of terrestrial ecosystems constitutes the largest global land carbon flux and exhibits significant spatial and temporal variations. Due to its wide spatial coverage, remote sensing technology is shown to be useful for improving the estimation of GPP in combination with light use efficiency (LUE) models. Accurate estimation of LUE is essential for calculating GPP using remote sensing data and LUE models at regional and global scales. A promising method used for estimating LUE is the photochemical reflectance index (PRI = (R531 [U+FF0D] R570)/(R531 + R570), where R531 and R570 are reflectance at wavelengths 531 and 570 nm) through remote sensing. However, it has been documented that there are certain issues with PRI at the canopy scale, which need to be considered systematically.

For this purpose, an improved tower-based automatic canopy multi-angle hyperspectral observation system was established at the Qianyanzhou flux station in China since January of 2013. In each 15-minute observation cycle, PRI was observed at four view zenith angles fixed at solar zenith angle and (37º, 47º, 57º) or (42º, 52º, 62º) in the azimuth angle range from 45º to 325º (defined from geodetic north).

To improve the ability of directional PRI observation to track canopy LUE, the canopy is treated as two-big leaves, i.e. sunlit and shaded leaves. On the basis of a geometrical optical model, the observed canopy reflectance for each view angle is separated to four components, i.e. sunlit and shaded leaves and sunlit and shaded backgrounds. To determine the fractions of these four components at each view angle, three models based on different theories are tested for simulating the fraction of sunlit leaves. Finally, a ratio of canopy reflectance to leaf reflectance is used to represent the fraction of sunlit leaves, and the fraction of shaded leaves is calculated with the four-scale geometrical optical model. Thus, sunlit and shaded PRI are estimated using the least squares regression with multi-angle observations.

In both the half-hourly and daily time steps, the canopy-level two-leaf PRI (PRIt) can effectively enhance (>50% and >35%, respectively) the correlation between PRI and LUE derived from the tower flux measurements over the big-leaf PRI (PRIb) taken as the arithmetic average of the multi-angle measurements in a given time interval. PRIt is very effective in detecting the low-moderate drought stress on LUE at half-hourly time steps, while ineffective in detecting severe atmospheric water and heat stresses, which is probably due to alternative radiative energy sink, i.e. photorespiration. Overall, the two-leaf approach well overcomes some external effects (e.g. sun-target-view geometry) that interfere with PRI signals.