



Improved Estimation of Gross Primary Productivity using Both Photochemical Reflectance Index and Sun-induced Fluorescence

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Observations of sun-induced fluorescence (SIF) and photochemical reflectance index (PRI) at the canopy level has the potential to improve the estimation of gross primary productivity (GPP) of terrestrial ecosystems. PRI is usually correlated with light use efficiency (LUE) of the vegetation. However, correlations of PRI with LUE varied dramatically throughout the growing season. In addition, it was found that the correlation of SIF with GPP was strong only on clear days. In this study, we are trying to develop a novel method of estimating canopy-level GPP by incorporating signals of multi-angle SIF, multi-angle PRI, radiation and eddy covariance (EC) measured GPP with the two-leaf scheme and a geometrical optical model. The specific steps of this method are as follows: (1) To use a two-leaf scheme to calculate the photosynthetic photon flux density of a representative sunlit leaf and a representative shaded leaf; (2) To separate EC-measured canopy GPP into sunlit and shaded portions using the rectangular hyperbola function of a leaf-level light response curve. Light use efficiencies (LUE) of sunlit and shaded portions of the canopy were calculated, accordingly; (3) To use multi-angle observed SIF to calculate SIF observed in the hotspot direction and SIF from sunlit and shaded portions of the canopy; (4) To use multi-angle observed PRI to calculate PRI from sunlit and shaded portions of the canopy; (5) To correlate canopy SIF calculated by two-leaf scheme with EC-measured GPP, hotspot SIF with EC-measured GPP, and multi-angle averaged SIF with EC-measured GPP, and to select the one with highest correlation coefficient (R^2) as a candidate for estimating GPP from SIF; (6) To correlate canopy PRI calculated by the two-leaf scheme with LUE calculated from EC-measured GPP and observed APAR; (7) To use SIF to estimate GPP if SIF data is available and R^2 between SIF and EC-measured GPP is higher than that between PRI and LUE. Otherwise, use PRI to estimate LUE and calculate canopy-level GPP using LUE model; and (8) To validate the modeled GPP with EC-measured GPP and evaluate the performance of this methodology. The field site is located in Houbai town, Jurong, Jiangsu province (31°9'N, 119°1'E). Continuous measurements of multi-angle PRI, multi-angle SIF, radiation and EC-measured GPP during DOY 217 to 304 were used in this study.