Comparison of the Photochemical Reflectance Index and Solar-induced Fluorescence for Estimating Gross Primary Productivity

- Qian Zhang, International Institute for Earth System Science, Nanjing University, China

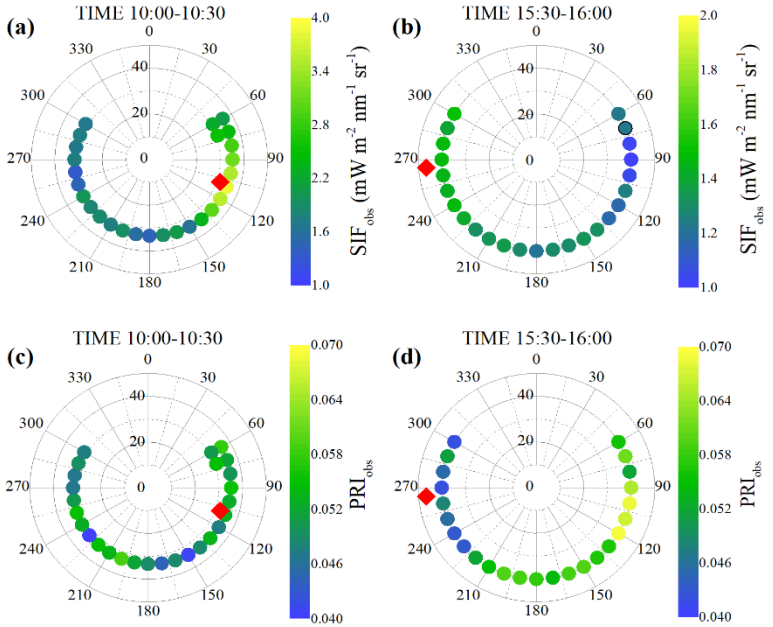
  Email: zhangqianzh@nju.edu.cn

- Jinghua Chen, Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences, China

  Email: chenjh.14b@igsnrr.ac.cn

Introduction

- Photochemical reflectance index (PRI) as a proxy for light use efficiency (LUE) has the potential to improve the estimates of vegetation gross primary productivity (GPP) using LUE model.
- Solar-induced fluorescence (SIF) has increasingly been shown to be a promising approach for directly estimating GPP.
- Anumber of factors including the view-geometry and environmental variables, which may disassociate PRI and SIF products from photosynthesis
- Multi-angle SIF and PRI observations were conducted in a maize field during the 2018 growing season

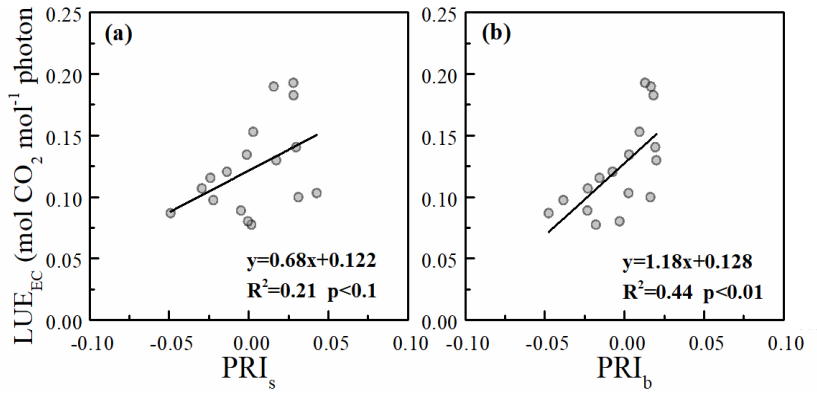


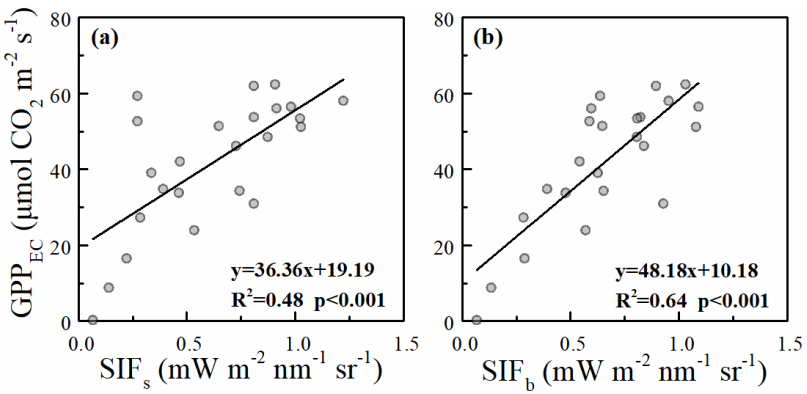
- SIF and PRI obtained at different view angles at different time on DOY 213 shown in a polar coordinate system (overhead view). The red diamond represents the average solar position within the 30 min.
- The observed SIF and PRI varied greatly with viewing azimuth angles and the angular pattern changed diurnally with the solar position

PRI-LUE

- s: single angle
- b: averaged from all angles

SIF-GPP





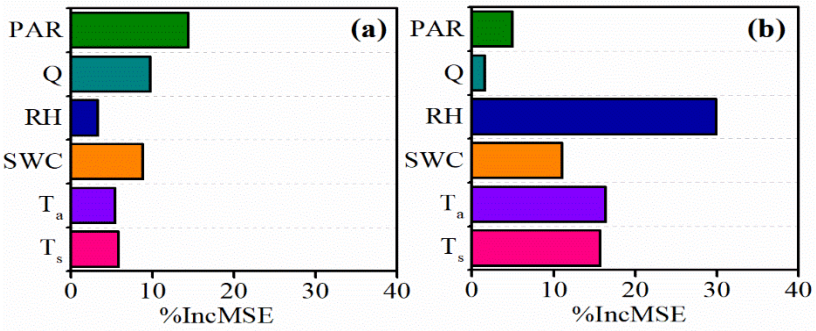
PRI-based and SIF-based models for GPP estimation

Explanatory terms for GPP regression model	$LUE_{PRI}^{*} \times APAR$: GPP_{EC}			SIF_{can}: GPP_{EC}		
	R^2	p	RMSE	R^2	p	RMSE
Daily mean[a]	0.44	<0.001	12.25	0.50	<0.001	11.75
30 min[b]	0.47	<0.001	15.28	0.45	<0.001	16.12
Day-by-Day[c]	0.71±0.22	0.00±0.01	4.59±3.08	0.38±0.23	0.08±0.19	8.90±5.51

Table Summary statistics for the PRI-based LUE model and the SIF-based linear model for GPP estimation at different time scales.

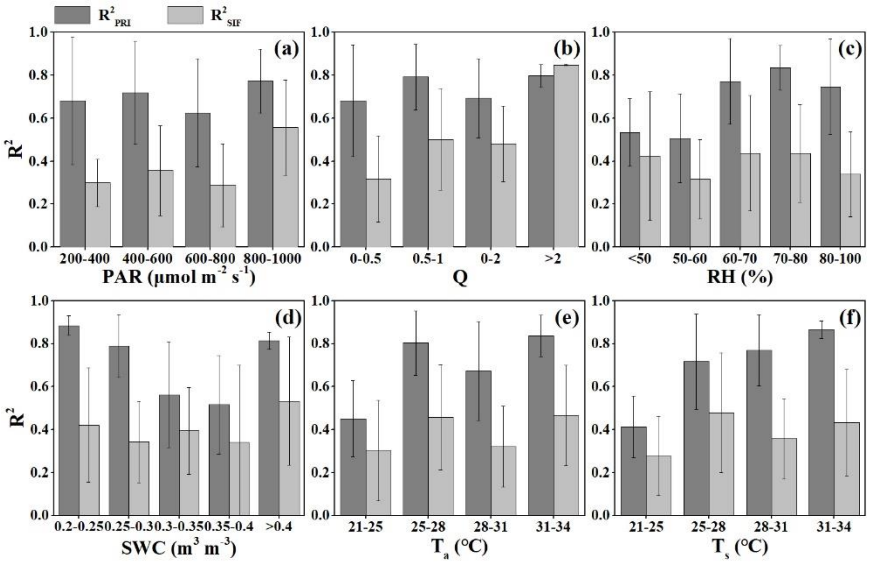
The seasonal GPP dynamics were better captured by the SIF-based linear model (R2=0.50) than the PRI-based LUE model (R2=0.45), while the PRI-based LUE model performed better in estimating the diurnal variations of GPP (R2=0.71).

Effects of environmental variables



Relative contributions of the predictor variables in the random forest model for explaining (a) R^2_{SIFb}, the correlation between SIF_b and GPP_{EC}, (b) R^2_{PRIb}, the correlation between $LUE_b \times APAR$ and GPP_{EC}

PAR and RH were of the most importance in the estimation of diurnal GPP variations using the SIF-based and the PRI-based models, respectively.



Distribution of R^2_{PRI} and R^2_{SIF} under the classified PAR, Q, RH, SWC, T_a, and T_s. Error bars represent standard deviations of R^2 under the classified ranges of the environmental variations.

The PRI-based LUE model performed better than the SIF-based model under most environmental conditions, while SIF should be a preference under clear days (Q>2).

Conclusion:

This study confirmed the importance of multi-angle observation of SIF and PRI in estimating GPP and LUE, and suggested that the environmental effects should be considered for accurately estimating GPP using SIF and PRI.