

Improving light use efficiency models via the introduction of both the diffuse fraction and the radiation scalar

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摘要: The components and intensity of surface solar radiation may both affect vegetation light use efficiency (LUE) heavily, and thus are two crucial constraints for estimating gross primary production (GPP) in ecosystems. In this study, we introduce the diffuse photosynthetic photon flux density (PPFD) fraction (fdPPFD) and the radiation scalar to explain the diffuse fertilization effect (DFE) and the influence of radiation intensity on leaf LUE, respectively; and subsequently propose two new LUE models — the Big-Leaf Diffuse-Fraction Radiation-Scalar LUE (BDR-LUE) model based on the traditional big-leaf LUE models and the Two-Leaf Diffuse-Fraction Radiation-Scalar LUE (TDR-LUE) model based on the conventional two-leaf LUE models. Then, the two new models are calibrated and evaluated using 32 FLUXNET sites of six vegetation types where the diffuse PPFD data is available. The results demonstrate: (1) the improved models, especially the new BDR-LUE model, outperform conventional big-leaf LUE models and two-leaf LUE models clearly; (2) compared to the traditional Eddy Covariance-LUE (EC-LUE) model, the new BDR-LUE model decreases the root mean square error (RMSE) by at least 12.75%; (3) compared to the well-known Two-Leaf LUE (TL-LUE) model, the new TDR-LUE model decreases the RMSE by at least 9.81%; (4) The two new models can both accurately estimate annual and monthly changes of vegetation GPP; (5) the BDR-LUE model may be better than the TDR-LUE model in the type of cropland, but worse in the other vegetation types. Our study, therefore, indicates introducing both the fdPPFD and the radiation scalar in one LUE model is very necessary and the resulting new models are promising for the GPP estimation of terrestrial ecosystems.

关键词: Gross primary production, Light use efficiency model, Diffuse fertilization effect, Radiation scalar, Photosynthetic photon flux density