EGU2020-21053
https://doi.org/10.5194/egusphere-egu2020-21053
EGU General Assembly 2020

Evaluating Light Use Efficiency Models and Parameter-upscaling Methods

Shanning Bao[1], Fabian Gans[1], Simon Besnard[1,2], Sujan Koirala[1], Alvaro Moreno[3], Sophia Walther[1], Ulrich Weber[1], Martin Jung[1], Miguel Mahecha[1], and Nuno Carvalhais[1]
[1]Department for Biogeochemical Integration, Max-Planck-Institute for Biogeochemistry, Jena, Germany (sbao@bgc-jena.mpg.de)
[2]Laboratory of Geo-Information Science and Remote Sensing, Wageningen University & Research, The Netherlands
[3]Image Processing Laboratory, University of Valencia, Valencia, Spain

Given its simplicity, the light use efficiency (LUE) concept is widely used for the estimation of gross primary productivity (GPP) at the ecosystem scale. In the last three decades, many types of LUE models have been developed to explain the dependencies of GPP to different environmental and meteorological conditions across spatial and temporal scales. Despite the simplicity, LUE models are robust against observations from daily to seasonal scales, though entailing challenges in parameter upscaling. The main differences across LUEs resides in the presence/absence of certain meteorological drivers and in the particular formulations of different response functions to diagnose instantaneous light use efficiency (ε*).

Here, we collected different algorithms for describing the meteorological constraints on ε* from literature and performed a factorial experiment by recombining the different response functions between the different models to assess model performance at site and network level. These models were forced and parameterized by remote sensing data, meteorological data and GPP for 177 eddy covariance flux sites from the FLUXNET2015 and LaThuile using a data assimilation approach. The results show that the two selected optimal LUE models had no significant differences in model performances at site-level at daily, weekly, and monthly scales. The Nash-Sutcliffe Model Efficiency Coefficient (NSE) of 50% sites were larger than 0.726 and 0.725 at daily, 0.788 and 0.783 at weekly, 0.836 and 0.834 at monthly and 0.544 and 0.510 at annual scales.

Based on the selected models, we further explored the different methods to upscale the optimized parameters: a) site means and medians per plant functional type and climate class, b) random forest regression, using bioclimatic variables and corresponding vegetation index, and c) selection according to the similarity between sites, determined via the NSE in mean seasonal cycle temperature, precipitation, radiation, and vegetation indexes within the same plant functional type. The model efficiencies in cross validation for both models show that using the median parameters per plant functional type had the best performance to upscale parameters from site-level to global-level at daily, weekly and monthly scales. Since the meteorological response functions and the corresponding parameters represent the sensitivity of plant photosynthesis to the meteorological conditions we further explore the relationship between the climate sensitivities and other environmental drivers as well as biophysical plant traits using global retrievals of Sun induced fluorescence. Our results emphasize that novel Earth Observations datasets and transfer learning approaches bridge the LUE formulation tradeoffs between complexity and tractability.