Biogeosciences Discuss.,
https://doi.org/10.5194/bg-2019-508-AC1, 2020

Biogeosciences Discussions
Open Access

Interactive comment on "Wide Discrepancies in the Magnitude and Direction of Modelled SIF in Response to Light Conditions" *by* Nicholas C. Parazoo et al.

Nicholas C. Parazoo et al.

nicholas.c.parazoo@jpl.nasa.gov

Received and published: 7 April 2020

Reviewer:

General: Parazoo et al. compare seven SIF-enabled TBMs against empirical SIF and GPP data from a subalpine evergreen coniferous forest. The models, which had SIF retro-fitted, share some common concepts but on the other hand differ widely in terms of other concepts, with corresponding impacts on simulated SIF. The authors describe the differences compared to the empirical data and discuss these in terms of the differences in model structure.

Printer-friendly version

Discussion paper

Interest in the adding SIF capabilities to TBMs is largely driven by the recent availability of global SIF satellite products which provides promising avenues for additional constraints on carbon cycling, especially for GPP. Given that this research field is still in its infancy, I think the scope of this study, even though limited to a single site and a few weeks of peak-vegetation period data, is justified. The manuscript is well written and I think the authors do a great job in navigating the reader through the complexity of the investigated TBMs without getting lost in the many aspects these models differ.

Author:

We thank the reviewer for the nice feedback and helpful comments, and for appreciating our decision to keep our scope of study limited. Our hope is to build off the baseline findings reported here.

Reviewer:

I have only really very few detailed comments (see below) and only one major comment, that is that I was wondering whether the model comparison would profit from adding simulations with the original SCOPE model. This model is some sort of golden standard for SIF modelling (in fact many of the investigated models have gleaned from SCOPE in one way or the other) and I could imagine that SCOPE simulations might provide a good benchmark for the investigated TBMs, which given their scope need to weigh complexity against realism. Even though SCOPE is much more complex in terms of the treatment of canopy radiative transfer and gas exchange, running it with pre-scribed meteo inputs and adjusting a few key parameters should be easy to do.

Author:

This was a great recommendation and worth the small amount of extra work. We now include results from SCOPE v1.73 with prescribed met input for the year of study (2017) and vegetation parameters (LAI, canopy height, leaf chlorophyll content, and Vcmax) calibrated to NR1 according to Raczka et al., 2019. Results from the stand-alone version of SCOPE are quite similarly qualitatively and quantitatively to the coupled version with BETHY (high bias in APAR and SIF), except with improved diurnal and synoptic variability compared to PhotoSpec. This provides a nice benchmark for TBM-SIFs in this study. We provide a description of SCOPE in the methods, references to SCOPE results throughout, and plots of SCOPE in all relevant figures (inc Figs 2-5 in the main text).

Reviewer:

Detailed comments:

l. 60: and theoretical models suggest a non-linear response at leaf-scale (Gu et al. 2019)

Author:

Corrected as follows:

"Spaceborne data indicate a linear relationship between SIF and GPP at large spatial (kilometer) and temporal (bi-weekly) scales (e.g., Sun et al., 2017) for several ecosystems, while theoretical models and ground-based measurements indicate a more non-linear relationship at leaf and canopy scales (Zhang et al., 2016; Gu et al., 2019; van der Tol et al., 2014; Magney et al., 2017, 2019a)"

Reviewer:

l. 84: a needle is anatomically a leaf

Author:

Changed ‘needle/leaf’ to ‘leaf’

Reviewer:

l. 102: not so much at leaf-scale really

Author:

Printer-friendly version

Discussion paper

Changed ‘leaf to canopy scale’ to ‘canopy scale’

Reviewer:

l. 103: the FLOX is missing in the list of tower-mounted spectrometer systems

Author:

We added FLOX and reference to Shan et al., 2019 and Julitta et al., 2017

Shan, N., Ju, W., Migliavacca, M., Martini, D., Guanter, L., Chen, J., Goulas, Y., Zhang, Y.: Modeling canopy conductance and transpiration from solarâĂŘinduced chlorophyll fluorescence. Agricultural and Forest Meteorology, 268, 189–201, 2019.

Julitta, T., Burkart, A., Colombo, R., Rossini, M., Schickling, A., Migliavacca, M., Cogliati, S., Wutzler, T., Rascher, U.: Accurate measurements of fluorescence in the O2A and O2B band using the FloX spectroscopy system - results and prospects. In: Proc. Potsdam GHG Flux Workshop: From Photosystems to Ecosystems, 24–26 October 2017, Potsdam, Germany. https://www.potsdam-flux-workshop.eu/, 2017

Reviewer:

Fig. 1: calling a 3-year average a climatology is a bit of a stretch in my view – maybe just refer to this as the 2015-2018 average?

Author:

Yes, thank you

Reviewer:

l. 165-174: how representative are these measurements for the larger footprint of the flux tower?

Author:

The answer is not very. We added the following stipulation at the end of the paragraph:

“We note that APAR measurements are only as representative as the distribution of PAR sensors beneath the canopy; while they are placed within the footprint of SIF (Sec 2.2.3) and fetch of eddy covariance (Sec 2.2.4) measurements, they cannot be a perfect representation of canopy APAR for each eddy covariance and SIF measurement.”

Reviewer:

l. 229: one sentence on the effects of complex terrain, for which NR1 is famous, on NEE and inferred GPP?

Author:

Good point. The location does not have a significant impact on daytime fluxes, but we added the following sentence for full disclosure.

“We note the tower location near the Continental Divide in the Rocky Mountains of Colorado does present slope flow challenges for eddy covariance during nighttime, but the relatively flat area of the tower reduces impact on daytime flux measurements (Burns et al., 2018).”

Burns, S. P., Swenson, S. C., Wieder, W. R., Lawrence, D. M., Bonan, G. B., Knowles, J. F., and Blanken, P. D.: A comparison of the diel cycle of modeled and measured latent heat flux during the warm season in a Colorado subalpine forest, Journal of Advances in Modeling Earth Systems, 10, 617–651, 2018.

Reviewer:

l. 260: wouldn’t that be the Ball-Berry-Woodrow (BBW) model? l. 261: and this simply the Leuning model?

Author:

Corrected in Sec 2.3.2 and in Table 1

Reviewer:

Table 1: what is the difference between big-leaf and single layer models? Where do two-leaf big-leaf models fall into?

Author:

Thank you for pointing out these differences. The models can be classified as follows.

BETHY = multiple layers (sunlit/shaded) ORCHIDEE/SIB3/4 = big leaf (sunlit only) CLM4.5/5 = two big leaf (sunlit/shaded) BEPS = two leaf (sunlit/shaded)

We clarify these differences in Table 1 and in Section 2.3.1 as shown below

"These differences, which are summarized in Table 1, include the representation of stomatal-conductance (all use Ball-Berry except CLM5.0, BEPS, and ORCHIDEE), canopy absorption of incoming radiation (all account for sunlit/shaded radiation except ORCHIDEE, SIB3, and SIB4), limiting factors for photosynthesis (Vcmax, LAI, radiation, stress) and SIF (kN, fluorescence photon re-absorption), scaling and radiative transfer methods for transferring leaf-level SIF simulations to top of canopy, and parameter optimization."

Reviewer:

l. 573: sunlit/shaded leaf area fractions

Author:

corrected, thank you

Reviewer:

l. 803-810: what are recommendations for model structure with respect to APAR?

Author:

We added the following recommendation at the end of Area 1, keeping in mind the stipulation that there is really no perfect in situ APAR measurement:

"We recommend further site-level investigation of observed and simulated canopy light absorption, emphasizing comparison of multi-layer and multi-leaf radiation schemes accounting for sunlit and shaded leaf area."

Reviewer:

l. 816: might refer to new approaches such as stomatal optimisation based on xylem hydraulics (Eller et al. 2020)

Author:

Agreed. We added the following recommendation at the end of Area 2:

"We also recommend more inclusion of stomatal optimization models (e.g., Eller et al., 2020) as optional parameterizations for TBMs, to better account for plant hydraulic functioning under water stress compared to the more widely used semi-empirical models."

l. 821: here I would think we also need more data from a wider variety of plant species under in situ conditions, especially all kinds of stress, ideally combining active and passive chlorophyll fluorescence measurements

Agreed. We added the following recommendation at the end of Area 3: "We also emphasize a need for more simultaneous measurements of active and passive chlorophyll fluorescence to determine the temporal dynamics of competing pathways (PQ, NPQ) from a wider variety of plant species under ambient conditions and different levels of stress."

Reviewer:

l. 833: for perspective - do the authors dare to say something about what they would expect from a similar model comparison for a well-watered high-LAI crop?

Author:

We added a 6th bullet point at the end:

“Finally, we note that our focus on a water limited subalpine evergreen needleleaf forest represents a challenging case study for models and observations. In many cases, there is strong covariance between LAI, SIF, APAR and GPP in cropping systems (Dechant et al., 2020), but because this study site experiences little change in canopy structure and APAR throughout the season (Magney et al, 2019b), our study sought to provide more explicit insight into the models sensitivity to photosynthesis and fluorescence. As such, it is possible that we would see more convergence of results, and a reduction in confounding effects (e.g., decreased NPQ), in a well-watered high-LAI cropping system. We therefore recommend similar model-observation assessments across a wider range of biota and climate.”

Interactive comment on Biogeosciences Discuss., https://doi.org/10.5194/bg-2019-508, 2020.

Printer-friendly version

Discussion paper