Biogeosciences Discussions

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Comment on bg-2021-354

Luis Guanter (Referee)

Referee comment on "Sun-induced fluorescence as a proxy for primary productivity across vegetation types and climates" by Mark Pickering et al., Biogeosciences Discuss., https://doi.org/10.5194/bg-2021-354-RC2, 2022

The study by Pickering et al. investigates the relationship between satellite-based SIF and GPP at the global scale. Spatially-downscaled GOME-2 SIF retrievals and FLUXCOM GPP data are compared with the overarching objective of better understanding the potential and limitations of SIF as a proxy for global GPP.

I do not find any major methodological weakness in the study, the manuscript is well written and presented, and the topic fits well with the scope of BGS, so I overall recommend the manuscript for publication.

I would appreciate if the authors could consider the points below in their revision of the manuscript.

Main comment – choice of the reference GPP dataset

The authors have selected FLUXCOM GPP data (8-day & 0.0833º "Remote Sensing" runs) as a benchmark for the evaluation of SIF ability to indicate GPP. I can understand this choice, as the FLUXCOM dataset is well established in the community and has been tested in several projects over the last years.

However, I also have strong concerns about whether the conclusions of the study would hold if a different remote sensing-based global dataset, or tower-based GPP data, were taken as a reference. For example, the values and variability of the SIF:GPP slopes

discussed in Section 3 would surely be different if global GPP estimates from e.g. the FLUXSAT https://daac.ornl.gov/VEGETATION/guides/FluxSat_GPP_FPAR.html or the VPM https://data.nal.usda.gov/dataset/global-moderate-resolution-dataset-gross-primary-production-vegetation-2000%E2%80%932016 products had been used as a reference, even if those two GPP products are also based on remote sensing data. Also, recent papers comparing TROPOMI SIF retrievals with tower-based GPP conclude that most of the vegetation types in North America can be grouped in 2-3 statistically-independent SIF:GPP linear models (see Li & Xiao https://doi.org/10.1016/j.rse.2021.112748 and Turner et al. https://doi.org/10.5194/bg-18-6579-2021), as opposed to the 12 independent groups proposed in this study.

It would be great if the authors could provide further evidence of the robustness of their findings by comparing to additional GPP data sets, these being global remote sensing-based, tower-based, or both. For example, the global FLUXSAT GPP data set is provided at 0.05º and a daily time set, so it should not be too difficult to include it in this analysis. Showing that e.g. Table 1 roughly holds for other reference GPP data set are used would be an important proof of consistency for the study.

Other comments

- Abstract: I would shorten the description of the implemented methodology and would add 2-3 lines summarizing the main results

- L64, 2nd equation (I miss equation numbers): please, state that this equation applies to instantaneous GPP and SIF, but a temporal sampling factor should be applied to account for the different temporal sampling in GPP and SIF (daily & all-sky for GPP, instantaneous & clear-sky for SIF). Related to this, one could wonder to what extent some of the features under analysis (SIF:GPP slopes, IAV, response to environmental factors) are not driven by this temporal sampling mismatch (see https://www.sciencedirect.com/science/article/pii/S0168192321001222).

- L76 "FLEX, scheduled for launch in 2023" – I think it will be at least 2025 https://www.esa.int/Applications/Observing_the_Earth/FutureEO/FLEX

- L258 "Downscaled FLUXCOM SIF" ☐ "Downscaled GOME-2 SIF"

- Sec. 4.4 and Fig. 6: I think the "No climate zone" case (only vegetation types, without segmentation by climate zone) should be added, as this would represent the usual "PFT-

based" scaling of other studies. It could include a test of how the SIF-based GPP differs if only the two clusters proposed by Turner et al. are used (see major comment above).

- Fig. 6, funny red line in the leftmost vertical label of the bottom left panel

- L453 (and elsewhere): "Strong correlation is noticeable in the SIFDS response to meteorological fluctuations, as can be seen clearly in equatorial rainforests". - I think the rainforest case should be handled with caution, as a large fraction of the observed trends could just be due to signal issues and retrieval artifacts

- Sec 4.5: the authors refer to this part of the analysis as an assessment of the response of SIF to "environmental stress". However, I am unsure that the tiny signal of stress (subtle changes in LUE or photosynthetic pigments) can be captured by a downscale SIF product with a monthly sampling. Also, the acquisition time of the SIF data (morning for GOME-2, it would be midday for TROPOMI) will also play a role of their ability to indicate stress. I would recommend the authors to discuss these issues in the text.