Biogeosciences Discussions

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Comment on bg-2021-95

Anonymous Referee #2

Referee comment on "Unveiling spatial and temporal heterogeneity of a tropical forest canopy using high-resolution NIRv, FCVI, and NIRvrad from UAS observations" by Trina Merrick et al., Biogeosciences Discuss., https://doi.org/10.5194/bg-2021-95-RC2, 2021

- **General Comments**
  - The authors present a very interesting and novel dataset of high-resolution vegetation indices (VI) in a tropical forest. They present correlations of the VIs to the gross primary productivity (GPP) of this forest and show how the VIs compare in capturing GPP for a given day. The authors also present a comparison of the VIs in their ability to capture structural heterogeneity of the forest. I found the study to be relevant and current given the emerging VIs used in this study. The spatial component of this study is very interesting as well. Here the authors show that NIRv and FCVI can capture more spatial heterogeneity in this forest in the reflection and absorption of radiation. My comments mostly focus on encouraging enhancement of the discussion that could provide more context for the analysis that was done and reducing the discussion of distracting concepts that were not tested. To tie the introduction and discussion to the analysis and results, the discussion and the introduction could better explain why NIRv_rad would be correlated to GPP with a clearer explanation of the GPP and NIRv (reflectance or radiance based) relationship and a reduced discussion of the role of the VIs in the SIF-GPP relationship. The paper could benefit from discussing the connections between canopy structure (height, size of tree clusters) and function (GPP) rather than the links between VIs and SIF. Below are some specific comments.

- **Specific comments**
  - The Light-Use Efficiency (LUE) model is the most widely used model to explain the relationship between GPP and vegetation indices such as NDVI as mentioned by the authors in line 42. I find the description of the LUE model to be inadequate in this paper considering it plays such a key role in understanding why vegetation indices correlate with GPP. Thinking of NIRv as an indicator of fPAR x f_esc could serve an analysis which includes observed SIF, but for the current analysis, it would be better to discuss NIRv_rad as an indicator for APAR. I would encourage the authors to present either: the equation for the LUE model with an explanation of the terms or a written description of the LUE logic and a description of its terms. Medlyn (1998) and Yuan et al. (2014) provide overviews of the LUE model and its terms. Presenting the LUE model can help readers understand exactly where vegetation indices fit in

estimating GPP when one does not have SIF observations and would help clarify vague sentences like "thus a joint relationship between a remote sensing vegetation quantity, PAR, and GPP." (lines 206 – 207)

- Since the study focuses solely on vegetation indices, can the authors expand more on why near-infrared reflectance or reflected near-infrared radiation and the vegetation indices that are built from it have shown good correlations with GPP?
- Making a clearer link between spatial canopy heterogeneity and GPP in the discussion can also help tie both the correlation and the power spectrum analysis together.
- I find the discussion of SIF here to be a bit too extensive given that SIF was not actually tested. The authors have covered an important point in mentioning the use of NIRv to capture the structural component of observed SIF and it is worth mentioning in a sentence or two, but I think an analysis which is not focused on a comparison between SIF and VIs does not need to explain how VIs are related to SIF as extensively as has been done. Instead, a focus on how near-infrared reflectance of vegetation, canopy structure, and light capture/absorption is related to GPP could help address the actual comparison being made. If the authors want to focus on how NIRv can be used in the GPP-SIF relationship, then the links between NIRv, SIF, and GPP need to be discussed further to allow a reader to understand what role NIRv plays in estimating GPP through the GPP-SIF relationship. Expanding the fPAR x f_esc equation to show the full GPP equation could help in this area. However, again, since the NIRv-GPP relationship was tested, the LUE model without SIF is a better conceptual glue for this analysis.
- Line 113: Can the authors expand on why NIRv needs to serve as a proxy for SIF if it can serve as a proxy for GPP and a radiance based NIRv can serve as a proxy for APAR? Using NIRv for addressing the structural component of the SIF-GPP relationship makes sense, but the utility of using NIRv as a proxy for SIF is not as clear.
- R in equation 3 and equation 4 is not explained until after equation 5. It can be clearer to explain what R represents after equation 3 and 4.
- It is unclear how this analysis supports the claim at line 236 since normalizing SIF with the UAS data was not done in this study.
- Claims made at the following lines need citations: line 32 – 33, lines 56 – 57, lines 75 – 76, lines 78 – 80, lines 91 – 94

- **Technical Corrections**
  - Line 49 – 50: consider changing "and questions linger about their ability to track green-up with RIs in tropical regions" to "and questions linger about the ability to track green-up with RIs in tropical regions" or "and questions linger about their ability to track green-up in tropical regions"
  - Line 84: consider changing "SIF signal or used to independently as" to "SIF signal or used independently as"

References

Medlyn, B. E.: Physiological basis of the light use efficiency model, Tree Physiology, 18, 167–176, https://doi.org/10.1093/treephys/18.3.167, 1998.

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