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Comment on bg-2021-214

Anonymous Referee #1

Referee comment on "On the impact of canopy model complexity on simulated carbon, water, and solar-induced chlorophyll fluorescence fluxes" by Yujie Wang and Christian Frankenberg, Biogeosciences Discuss., https://doi.org/10.5194/bg-2021-214-RC1, 2021

In the manuscript "On the impact of canopy model complexity on simulated carbon, water, and solar-induced chlorophyll fluorescence fluxes", Wang and Frankenberg examined how different representations of canopy structure in models influence the estimates of carbon, water and SIF fluxes. They used a recent version of Land model in Climate Modelling Alliance to design 5 different representations of canopies – from simple to complex, and compared their estimated fluxes at one example site. I think this work is a valuable theoretical contribution to both model and remote sensing communities. It delivers a key message that the underlying assumptions of models and remote sensing on canopy structure are often not compatible with each other, and integrating them without proper consideration canopy structural can lead to biases. I am happy to support the paper, however, there is one major concern that I hope the authors could address first.

- I am not sure the definition of big leaf adopted by the authors is consistent with previous studies. From Sellers (Sellers et al., 1992) and De Pury and Farquhar ((De Pury and Farquhar, 1997), the big-leaf model is generally regarded as a single layer leaf without separation of sun/shaded fractions. My understanding is that once a canopy is separated into sunlit and shaded, it is regarded as a two-leaf or two-big-leaf structure.

- the author suggested that big-leaf model overestimated carbon and water fluxes, but that seems to contrast with previous studies (Sprintsin et al., 2012)(Luo et al., 2018) – sorry for self-citation - where these studies suggested that big-leaf underestimated GPP and ET. I think that's partly relevant to the different definitions of big-leaf used in the current study. One characteristic of big-leaf is that they often do not use leaf-level Vcmax. Instead they use canopy-level Vcmax (such as those introduced in Sellers and De Pury papers, or CLM4.5) – just imagine a really big-leaf with a Vcmax of up to 500 umol/m2/s (LAI X leaf-level Vcmax) and how it will never be light saturated! In this case, the Jenson's inequity is working in the opposite way that reduce GPP and ET through lower Ci/Ca and the problematic upscaling from gs to canopy conductance.

- I think the authors have done a great modelling experiment, and I agree with that multi-layer and sunlit/shaded separation is the way to go. But perhaps it is helpful to describe your different structure representations in the context of previous studies, or I concern that it may bring more confusions to the community – admittedly the perceptions of big-leaf have been already quite different between scholars.

Other minor comments:

- Considering the importance IJKX in this study and how other representations of canopy are based on it, maybe there is a need to show the equations on how to separate sunlit and shaded leaves in IJKX
- FQE was not defined, so it was not easy to grasp the key points from the heavy discussion in L240-260. Adding a few summary statements at the beginning of these paragraphs might help readers to follow.
- Figure 2b. Just curious about the environmental conditions for leaves described in this plot. Not very clear why Anet increases with Vcmax while gs becomes saturated.

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