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Comment on bg-2021-214

Anonymous Referee #2

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-RC2, 2021

The authors show the impact of using radiative transfer schemes of increasing complexity on the SIF simulated by a land model. The different options include a big leaf versus a multilayer canopy, having sun and shaded leaves, considering the leaf angle distribution and a vertically varying Vcmax. The paper is very didactic with nice illustrative figures. It demonstrates in a very elegant way the consequences of using an average APAR when lots of the relationships are non-linear. The results are as expected, differences between models are quantified, and specific behaviors of the simpler models are explained in detail to the readers (e.g. Figure 10). The authors draw important conclusions, while using a simple formalism.

Main comments

The authors should clarify what they consider a land surface model. Indeed, they cite models such as CLM and ORCHIDEE that can run at global scales over centuries, such models simply cannot integrate the large number of operations performed by a model such as CliMA Land.

Do the authors precise somewhere how many layers they used (K)? Same for the leaf angle distribution?

Page 4, Figure 2: “The black dotted vertical lines indicate two leaves at low and high light conditions.”: Are they representative of shaded and sun leaves? Do sun and shaded leaves have different characteristics/parameter values? Or do they just differ by the level of light they receive? The authors should maybe show values/curves of APARsun, APARshaded and APAR for 1X/KX to clarify this point (e.g. Figure 6c in Bonan et al., 2021).

Page 4, lines 86-90: It is nice to show the correspondence with other land surface models.

Equations page 5: The authors should precise that not all models compute the APAR and fractions this way. I understand Bonan et al. (2011) describe in their section 2.3 "Radiative Transfer" different ways to address the 2X problem for CLM, with different results shown in their Figure 1.

Page 6, equation 8: What is p? Is the summation over i? Same questions for equation 9 on Page 7.

Page 7, lines 138-139: "The transpiration rate from the canopy is computed and used as a proxy for ecosystem evapotranspiration": I don't understand why the authors are doing that. Does this mean they don't have information on the evaporation of the bare soil and intercepted water? Or do they consider that these terms are negligible?

Page 7, line 142: "For "2KX", we plugged the Phi_F calculated for sunlit fraction": How is this Phi_F computed?

Page 7, line 156: "held air humidity constant at 0.47": Give unit.

Page 7, line 156: "a water vapor pressure of 1500 Pa at 25 °C": This is not clear, please give the considered equations, including for the computation of VPD.

Page 7, line 164: "prescribed leaf temperature and soil water potential to maximally reduce uncertainty": What does that mean? How do the authors do that?

Page 10, line 202-203: "The divergent flux responses to P_CO2 underlined the importance of adopting a more complex canopy concerning the dynamically changing radiation in a diurnal cycle and rapidly increasing P_CO2": How can we model a varying P_CO2 in a land surface model?

Minor comments

Page2, line 30: "and succeed the big-leaf model": weird formulation, is a word missing?

Page 3, Figure 1: angular distribution (b is missing)

Page 7, line 143: ”we re-simulate” -> we re-simulated

Page 7, line 153: “how they much” -> how much they

Page 16, line 243: “but decrease” -> but decreases

Page 19, line 319: “as did in” -> as done in